RQF LEVEL 5

TRADEELECTRONIC SERVICE

MODULE CODE: ELSLI501

TEACHER’S GUIDE

Module name: REPAIRING ELECTRONIC LAB MEASURING INSTRUMENTS

TABLE OF CONTENT

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Acronyms

AC: Alternating Current

CRO : Cathode-ray oscilloscope

CRT: Cathode Ray Tube

DC: Direct Current

DSO : Digital Storage oscilloscope

EMF : Electromotive force

ESD: Electrostatic Discharge

GND: Ground

ICT: Information Communication Technology

LCD: Liquid Crystal Display

LCR: Inductance Capacitance Resistance

LED: Light Emitting Diode

OLED: Organic light emitting diode

PCB: Printed Circuit Board

PPE: Personal Protective Equipment

RF: Radio Frequency

VOM : volt-ohm-milliammeter

VT: Visual Testing

INTRODUCTION

In recent years, the rapid strides and remarkable advances in the field of electronics is partly due to modern electronic instruments. By using these instruments, we can gather much information regarding the performance of specific electronic circuit. Electronic instruments are also used for trouble shooting since they permit readings to be taken so that circuit faults can be located by ascertaining which component values do not coincide with the pre-established values indicated by the manufacturer. In fact, electronic instruments are playing a vital role in the fast-developing field of electronics. It is with this view that they have been treated in this module of “**REPAIRING ELECTRONIC LAB MEASURING INSTRUMENTS”**

The module describes the skills, knowledge and attitudes required to characterize, diagnose and repair electronic lab instruments. At the end of this module, participants will be able to check, diagnose and repair multimeter, ammeter, voltmeter, ohmmeter, LCR meter, oscilloscope, and spectrum analyzer.

Module Code and Title: ELSLI501 REPAIRING ELECTRONIC LAB MEASURING INSTRUMENTS

Learning Units:

1. Prepare the electronic lab measuring instruments repair work
2. Repair multimeter
3. Repair the oscilloscope
4. Repair the spectrum analyser
5. Repair LCR meter
6. Document the work done

LEARNING UNIT 1: PREPARE THE ELECTRONIC LAB MEASURING INSTRUMENTS REPAIR WORK

STRUCTURE OF LEARNING UNIT

Learning outcomes:

1.1 Proper analysis of electronic lab measuring instruments according to their technical specifications
1.2 Appropriate selection of the materials, tools and equipment according to their uses
1.3 Proper setup of the working environment according to the work to be done

Learning outcome 1.1: Proper analysis of electronic lab measuring instruments according to their technical specifications

Duration: 2hrs

Learning outcome 1 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Describe of Common electronics lab measuring instruments and their functions

2.Describe of Types of electronic lab instruments

3.Identify technical specification parameters of electronic lab measuring instrument

Resources

Equipment	**Tools**	**Materials**
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	**-** Internet access	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 1.1.1. Description of Common electronics lab measuring instruments and their fonctions

- **Multimeter**

A multimeter or a multitester, also know as a VOM (volt-ohm-milliammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. Analog multimeters use a microammeter with a moving pointer to display readings. Digital multimeters (DMM, DVOM) have a numeric display, and may also show a graphical bar representing the measured value. Digital multimeters are now far more common due to their lower cost, greater precision having obsoleted analog multimeters.

A typical multimeter can measure voltage, current, and resistance as discussed Below :

i) Ammeter :

As the name suggests, ammeter is a measuring instrument which measures the current flowing through any two points of an electric circuit. The unit of current is ampere and the measuring instrument is ammeter.

We can classify the ammeters into the following two types based on the type of current that it can measure.

- ✓ DC Ammeters
- ✓ AC Ammeters

DC Ammeter

As the name suggests, DC ammeter measures the DC current that flows through any two points of an electric circuit.

AC Ammeter

As the name suggests, AC ammeter measures the AC current that flows through any two points of an electric circuit.

ii. Ohmmeter :

Ohmmeter is used to measure the value of resistance between any two points of an electric circuit. It can also be used for finding the value of an unknown resistor.

iii. Voltmeter

As the name suggests, voltmeter is a measuring instrument which measures the voltage across any two points of an electric circuit. The units of voltage is volt and the measuring instrument is meter. Hence, the word “voltmeter” is obtained by combining the two words “volt” and “meter”.

We can classify the voltmeters into the following two types based on the type of voltage that it can measure.

- DC Voltmeters
- AC Voltmeters

DC Voltmeter

As the name suggests, DC voltmeter measures the DC voltage across any two points of an electric circuit.

AC Voltmeter

As the name suggests, AC voltmeter measures the AC voltage across any two points of an electric circuit.

- **LCR meter**

  An LCR meter is a type of electronic test equipment used to measure the inductance (L),

  Capacitance(C) and resistance (R) of an electronic component. In the simpler versions of this instrument the impedance was measured internally and converted for display to the corresponding capacitance or inductance value. Readings should be reasonably accurate if the capacitor or inductor device under test does not have a significant resistive component of impedance. More advanced designs measure true inductance or capacitance, as well as the equivalent series resistance of capacitors and the Q factor of inductive components.

- **Oscilloscope**

An oscilloscope, previously called an oscillograph and informally known as a scope or oscope, CRO (for cathode-ray oscilloscope), or DSO (for the more modern digital storage oscilloscope), is a type of electronic test instrument that graphically displays varying signal voltages, usually as a two-dimensional plot of one or more signals as a function of time.

Other signals (such as sound or vibration) can be converted to voltages and displayed. Oscilloscopes display the change of an electrical signal over time, with voltage and time as the Y- and X-axes, respectively, on a calibrated scale. The waveform can then be analyzed for properties such as amplitude, frequency, rise time, time interval, distortion, and others. Modern digital instruments may calculate and display these properties directly. Originally, calculation of these values required manually measuring the waveform against the scales built into the screen of the instrument. The oscilloscope can be adjusted so that repetitive signals can be observed as a continuous shape on the screen. A storage oscilloscope can capture a single event and display it continuously, so the user can observe events that would otherwise appear too briefly to see directly.

Indicative content 1.1.2 Description of Types of electronic lab instruments

1. **Analog instrument**

The analog instrument is the instrument which gives output that varies continuously as quantity to be measured as known as analog instrument. The analog instrument has :

- The accuracy of analog instrument is less.
- The analog instruments required more power.

- Sensitivity of analog instrument is more.
- The analog instruments are cheap.
- The analog instruments are extremely portable
- The resolution of analog instruments is less.

2. Digital instrument

The digital instrument is the instrument which gives output that varies in discrete steps and only has finite number of values is as digital instrument. The digital instrument has:

- The accuracy of digital instrument is more.
- The digital instruments required less power.
- Sensitivity of digital instrument is less.
- The digital instruments are expensive.
- The digital instruments are not easily portable.
- The resolution of digital instruments is more.

Ic

Indicative content 1.1.3 Technical specification parameters of electronic lab measuring instruments

1. Voltage

Voltage, electric potential difference, electric pressure or electric tension is the difference in electric potential between two points. The difference in electric potential between two points (i.e., voltage) in a static electric field is defined as the work needed per unit of charge to move a test charge between the two points. In the International System of Units, the derived unit for voltage is named volt. In SI units, work per unit charge is expressed as joules per coulomb, where 1 volt = 1 joule (of work) per 1 coulomb (of charge). The official SI definition for volt uses power and current, where 1 volt = 1 watt (of power) per 1 ampere (of current). This definition is equivalent to the more commonly used 'joules per coulomb'. Voltage or electric potential difference is denoted symbolically by ΔV, but more often simply as V, for instance in the context of Ohm's or Kirchhoff's circuit laws.

2. Current

An electric current is the rate of flow of electric charge past a point or region. An electric current is said to exist when there is a net flow of electric charge through a region. In electric circuits this charge is often carried by electrons moving through a wire. The SI unit of electric current is the ampere, which is the flow of electric charge across a surface at the rate of one coulomb per second.

The ampere (symbol : A) is an SI base unit Electric current is measured using a device called an ammeter. Electric currents cause Joule heating, which creates light in incandescent light bulbs. They also create magnetic fields, which are used in motors, generators, inductors, and transformers.

3. Temperature

Temperature is a physical property of matter that quantitatively expresses hot and cold. It is the manifestation of thermal energy, present in all matter, which is the source of the occurrence of heat, a flow of energy, when a body is in contact with another that is colder. The most common scales are the Celsius scale (formerly called centigrade), denoted °C, the Fahrenheit scale (denoted °F), and the Kelvin scale (denoted K), the latter of which is predominantly used for scientific purposes by conventions of the International System of Units (SI).

- **Resistance**

The electrical resistance of an object is a measure of its opposition to the flow of electric current. The inverse quantity is electrical conductance, and is the ease with which an electric current passes. Electrical resistance shares some conceptual parallels with the notion of mechanical friction. The SI unit of electrical resistance is the ohm (Ω), while electrical conductance is measured in Siemens (S).

- **Frequency**

Frequency is the number of occurrences of a repeating event per unit of time. It is also referred to as temporal frequency, which emphasizes the contrast to spatial frequency and angular frequency. Frequency is measured in units of hertz (Hz) which is equal to one occurrence of a repeating event per second. The period is the duration of time of one cycle in a repeating event, so the period is the reciprocal of the frequency.

- **Capacitance**

Capacitance is the ratio of the change in electric charge of a system, to the corresponding change in its electric potential. There are two closely related notions of capacitance : self capacitance and mutual capacitance. Any object that can be electrically charged exhibits self capacitance. A material with a large self-capacitance holds more electric charge at a given voltage than one with low capacitance. The notion of mutual capacitance is particularly important for understanding the operations of the capacitor, one of the three elementary linear electronic components (along with resistors and inductors).

The capacitance is a function only of the geometry of the design (e.g. area of the plates and the distance between them) and the permittivity of the dielectric material between the plates of the capacitor. For many dielectric materials, the permittivity and thus the capacitance, is independent of the potential difference between the conductors and the total charge on them.

- **Inductance**

  In electromagnetism and electronics, inductance is the tendency of an electrical conductor to oppose change in the electric current flowing through it. The flow of electric current through a conductor creates a magnetic field around the conductor, whose strength depends on the magnitude of the current. A change in current causes a change in the magnetic field. From Faraday's law of induction, any change in magnetic field through a circuit induces an electromotive force (EMF) (voltage) in the conductors ; this is known as electromagnetic induction. So the changing current induces a voltage in the conductor. This induced voltage is in direction which tends to oppose the change in current (as stated by Lenz's law), so it is called a back EMF. Due to this back EMF, a conductor's inductance opposes any increase or decrease in electric current through it.

- **Tolerance**

  Tolerance is the percentage of error in the resistor's resistance, or how much more or less you can expect a resistor's actual measured resistance to be from its stated resistance, some devices require your measurements to be more precise than others, and for this reason the tolerance is useful in identifying which resistor will give you a more accurate resistance reading. The smaller the tolerance percentage is, the higher the precision in your measurements.

Summary for the trainer related to the learning outcome

Common electronics lab measuring instruments:

- ✓ Multimeter
- ✓ Oscilloscope
- ✓ LCR meter

Types of electronic lab equipment

- ✓ Digital equipment
- ✓ Analog Equipment

Technical specification of electronic lab equipment

- ✓ Voltage
- ✓ Current
- ✓ Temperature
- ✓ Resistance
- ✓ Frequency
- ✓ Capacitance
- ✓ Inductance
- ✓ Tolerance

Theoretical learning Activity

- ✓ Ask trainees to brainstorm about electronic lab measuring equipment within groups
- ✓ Ask trainees to describe 3 common types of electronic lab measuring equipment within groups
- ✓ Ask trainees to describe technical specification of electronic lab measuring equipment within groups

Practical learning Activity

- ✓ Trainees in pair identify and use 3 common types of electronic lab measuring equipment

Check list

Check list	**Score**	
	Yes	**No**

Indicator: Functions of electronic lab measuring instruments are well stated (knowledge)		
1. Multimeter function is well stated		
2. Ohmmeter function is well stated		
3. Ammeter function is well stated		
4. Voltmeter function is well stated		
5. LCR meter function is well stated		
6. Oscilloscope function is well stated		
Indicator: Types of electronic lab instruments are well identified (knowledge)		
1. Analogue instruments (type) are described		
2. Digital instruments (type) are described		
Indicator: Technical specification parameters of electronic lab measuring instruments are well identified (skills & attitude)		
1. Voltage range is well identified		
2. Current range is well identified		
3. Resistance is well identified		
4. Frequency is well identified		
5. Capacitance is well identified		
6. Inductance is well identified		
7. Tolerance is well identified		
Observation		

Points to Remember (Take home message)

Digital multimeter combines many instrument that measure basic electrical quantities:

- Resistance
- current
- voltage

Learning outcome 1 formative assessment

Written assessment

1. Identify any four (4) electronic lab measuring instrument

2. The following instruments are not incorporate in digital multimeter except
    a) Ammeter
    b) Wattmeter
    c) Barometer
    d) Pressure meter

Answer:

1. Four common electronic lab instruments are: Multimeter, LCR meter, Spectrum analyzer, Oscilloscope.
2. Ammeter in which is incorporate in digital multimeter

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to demonstrate how these electronic laboratory measurement devices work (LCR meters, Digital Multimeter, Oscilloscope & Spectrum Analyzers). Assume you're in a position of the demonstrate the devices function as requested by your guest.

Answer:

Use check list provided in the practical activities for this assessment

Learning outcome 1.2 Select Materials, tools and equipment

Duration: 2hrs

Learning outcome 2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Differentiate tools, materials and equipment

2. Describe tools, materials equipment

3. Describe the use of materials, tools and equipment

Resources

Equipment	**Tools**	**Materials**

<table>
<tr><td>- Multimeter
- Oscilloscope
- Power supply
- Function generator
- Computer
- Projector</td><td>- Internet access</td><td>Electronic components
- Breadboard
- Wires
- Books - White board
- Marker pen</td></tr>
<tr><td colspan="3">Advance preparation:
Availability of Materials, tools and equipment
Proper preparation of working place
Availability of electricity</td></tr>
</table>

Indicative content 1.2.1: Difference between tools, materials and equipment

1. Equipment

The idea of equipment represents all sorts of machinery, functional devices or accessories which serve an individual, household or a community purpose. Usually, a set of tools that are designated for a specific task is known as equipment. This could be a small set of functional items in a finished product. For example, optical, electronic boxes, etc. Equipment of a house may be appliances while equipment may also include all sorts of devices needed for a specific task.

2. Materials

Electronic materials are the materials used in electrical industries, electronics and microelectronics, and the substances for the building up of integrated circuits, circuit boards, packaging materials, communication cables, optical fibers, displays, and various controlling and monitoring devices.

3. Tool

Any physical item that is used to achieve a goal but is not consumed during this process can be defined as a tool. Informally speaking, it can also be used to describe a specific procedure with a specific purpose as well. Tools can perform a variety of functions such as cutting and chopping, moving, shaping, fastening, guiding, enacting chemical changes, fastening, information and data manipulation, etc. There can be specific tools designated for specific purposes whereas most tools can serve a combination of uses.

Indicative content 1.2.2. Description of tools, materials equipment, and their uses

1. Repairing tools

- **Soldering irons**

A soldering iron is a hand tool used in soldering. It supplie heat to melt solder so that it can flow into the joint between two work pieces. A soldering iron is composed of a heated metal tip and an insulated handle. Heating is often achieved electrically, by passing an electric current (supplied through an electrical cord or battery cables) through a resistive heating element. Cordless irons can be heated by combustion of gas stored in a small tank, often using a catalytic heater rather than a flame. Simple irons less commonly used today than in the past were simply a large copper bit on a handle, heated in a flame. Soldering irons are most often used for installation, repairs, and limited production work in electronics assembly.

- **Screwdriver**

A screwdriver is a tool, manual or powered, used for screwing (installing) and unscrewing

(Removing) screws. A typical simple screwdriver has a handle and a shaft, ending in a tip the user puts into the screw head before turning the handle. The shaft is usually made of tough steel to resist bending or twisting. The tip may be hardened to resist wear, treated with a dark tip coating for improved visual contrast between tip and screw or ridged or treated for additional 'grip'. Handles are typically wood, metal, or plastic and usually hexagonal, square, or oval in crosssection to improve grip and prevent the tool from rolling when set down. Some manual screwdrivers have interchangeable tips that fit into a socket on the end of the shaft and are held in mechanically or magnetically. These often have a hollow handle that contains various types and sizes of tips, and a reversible ratchet action that allows multiple full turns without repositioning the tip or the user's hand.

- **Pliers**

Pliers are a hand tool used to hold objects firmly, possibly developed from tongs used to handle hot metal in Bronze Age Europe. They are also useful for bending and compressing a wide range of materials. Generally, pliers consist of a pair of metal first-class levers joined at a fulcrum positioned closer to one end of the levers, creating short jaws on one side of the fulcrum, and longer handles on the other side. This arrangement creates a mechanical advantage, allowing the force of the hand's grip to be amplified and focused on an object with precision. The jaws can also be used to manipulate objects too small or unwieldy to be manipulated with the fingers. Pincers are a similar tool with a different type of head used for cutting and pulling, rather than squeezing. Tools designed for safely handling hot objects are usually called tongs. Special tools for making crimp connections in electrical and electronic applications are often called "crimping pliers" each type of connection uses its own dedicated tool.

Cleaning tools

- **Brush**

A brush is a common tool with bristles, wire or other filaments. It generally consists of a handle or block to which filaments are affixed in either a parallel or perpendicular orientation, depending on the way the brush is to be gripped during use. The material of both the block and bristles or filaments is chosen to withstand hazards of its intended use, such as corrosive chemicals, heat or abrasion. It is used for cleaning, grooming hair, make up, painting, surface finishing and for many other purposes. It is one of the most basic and versatile tools in use today, and the average household may contain several dozen varieties.

- **Sponge**

The definition of a sponge is a an absorbent piece used for washing, or a pad of gauze used in medicine. An example of a sponge is what people use to clean the counters.

- **Soft clothing**

Soft clothing refers to any fabric such as cotton, fleece, silk, satin and so on. It describes fabrics that are soft to feel and soft on the skin. Clothing has evolved into an industry with countless varieties of fabrics that can be designed into a wide range of apparel such as shirts, pants, dresses, jackets and so on.

Indicative content 1.2.3. Description of materials and their use

Adhesive

Adhesive, any substance that is capable of holding materials together in a functional manner by surface attachment that resists separation. "Adhesive" as a general term includes cement, mucilage, glue, and paste, terms that are often used interchangeably for any organic material that forms an adhesive bond.

- **Soldering tin**

Solder is a fusible metal alloy used to create a permanent bond between metal work pieces.

solder must first be melted in order to adhere to and connect the pieces together after cooling, which requires that an alloy suitable for use as solder have a lower melting point than the pieces being joined. The solder should also be resistant to oxidative and corrosive effects that would degrade the joint over time. Solder used in making electrical connections also needs to have favorable electrical characteristics.

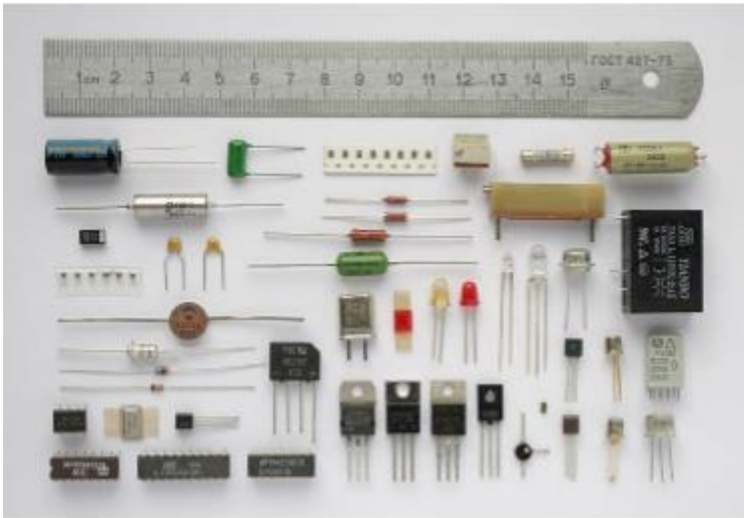
- **Cables and wires**

An electrical cable is an assembly of one or more wires running side by side or bundled, which is used to carry electric current. A cable assembly is the composition of one or more electrical cables and their corresponding connectors. A cable assembly is not necessarily suitable for connecting two devices but can be a partial product (e.g. to be soldered onto a printed circuit board with a connector mounted to the housing). Cable assemblies can also take the form of a cable tree or cable harness, used to connect many terminals together.

- **Electronic component**

An electronic component is any physical entity in an electronic system used to affect the electrons or their associated fields in a manner consistent with the intended function of the electronic system. Components are generally intended to be connected together, usually by being soldered to a printed circuit board (PCB), to create an electronic circuit with a particular function (for example an amplifier, radio receiver, or oscillator). Components may be packaged singly, or in more complex groups as integrated circuits. Some common electronic components are capacitors, inductors, resistors, diodes, transistors, etc.

Components are often categorized as active (e.g. transistors and thyristor) or passive (e.g. resistors, diodes, inductors and capacitors).



Indicative content 1.2.4. Description of Equipment and their use

Multimeter

A Multimeter is an electronic instrument, every electronic technician and engineers widely used piece of test equipment. Multimeter is mainly used to measure the three basic electrical characteristics of voltage, current and resistance. It can also be used to test continuity between two points in an electrical circuit. Multimeter has multi functionalities like, it acts like ammeter, voltmeter and ohmmeter. It is a handheld device with positive and negative indicator needle over a numeric LCD digital display.

Multimeters can be used for testing batteries, household wiring, electric motors and power supplies.

❖ **Applications**

The applications of ammeter mainly involve in various electrical and electronic projects for the purpose of components testing and also used in different measurement applications.

- Voltage Measurements
- High and low value DC measurement
- Peak to Peak and DC average measurement
- Current Measurements
- DC current measurement

- True RMS AC current
- Resistance Measurement
- Micro ohm meter
- Measuring resistance with constant voltage
- Measuring resistance with constant current

❖ **Types of Multimeters :**

There are different types of multimeter like Analog, Digital and Fluke multimeters.

Digital Multimeter :

We mostly used multimeter is digital multimeter (DMM). The DMM performs all functions from AC to DC other than analog. It has two probes positive and negative indicated with black and red color is shown in figure. The black probe connected to COM JACK and red probe connected by user requirement to measure ohm, volt or amperes. The jack marked VΩ and the COM jack on the right of the picture are used for measuring voltages, resistance and for testing a diode. The two jacks are utilized when LCD display that shows what is being measured (volts, ohms, amps, etc.). Overload protection that prevents damage to the meter and the circuit, and protects the

user.

The Digital Multimeter basically consists of a LCD display, a knob to select various ranges of the three electrical characteristics, an internal circuitry consisting of a signal conditioning circuitry, an analog to digital converter. The PCB consists of concentric rings which are connected or disconnected based on the position of the knob. Thus as the required parameter and the range

is selected, the section of the PCB is activated to perform the corresponding measurement. To measure the resistance, current flows from a constant current source through the unknown resistor and the voltage across the resistor is amplified and fed to an Analog to Digital Converter and the resultant output in form of resistance is displayed on the digital display. To measure an unknown AC voltage, the voltage is first attenuated to get the suitable range and then rectified to DC signal and the analog DC signal is fed to A/D converter to get the display, which indicates the RMS value of the AC signal. Similarly, to measure an AC or DC current, the unknown input is first converted to voltage signal and then fed to analog to digital converter to get the desired output (with rectification in case of AC signal).

Advantages of a Digital Multimeter are its output display which directly shows the measured

value, high accuracy, and ability to read both positive and negative values.

- **Analog Multimeter :**

The Analog Multimeter or VOM (Volt-Ohm-Milliammeter) is constructed using a moving coil meter and a pointer to indicate the reading on the scale. The moving coil meter consists of a coil wound around a drum placed between two permanent magnets. As current passes through the coil, magnetic field is induced in the coil which reacts with the magnetic field of the permanent magnets and the resultant force causes the pointer attached to the drum to deflect on the scale, indicating the current reading. It also consists of springs attached to the drum which provides an opposing force to the motion of the drum to control the deflection of the pointer.

For measurement of DC current, the D Arsonval movement described above can be directly used. However, the current to be measured should be lesser than the full scale deflection current of the meter. For higher currents the current divider rule is applied. Using different values of shunt resistors, the meter can also be used for multi range current measurement. For current measurement the instrument is to be connected in series with the unknown current source.

For measurement of DC voltage, a resistor is connected in series with the meter and the meter resistance is taken into account such that the current passing through the resistor is same as the current passing through the meter and the whole reading indicates the voltage reading. For voltage measurement, the instrument is to be connected in parallel with the unknown voltage source. For multirange measurement, different resistors of different values can be used, which are connected in series with the meter. For measurement of resistance, the unknown resistance is connected in series with the meter and across a battery, such that the current passing through the meter is directly proportional to the unknown resistance. For AC voltage or current measurement, the same principle is applied, except for the fact that the AC parameter to be measured is first rectified and filtered to get the DC parameter and the meter indicates the RMS value of the AC signal.

Advantages of an Analog Multimeter are that it is inexpensive, doesn't require a battery, can measure fluctuations in the readings. The two main factors affecting the measurement are the sensitivity and the accuracy. Sensitivity refers to the reciprocal of the full scale deflection current and is measured in ohms per volt.

Fluke Multimeter :

The fluke multimeters are protected against the transient voltage. It is a small portable device used to measure voltage, current and test diodes. The multi meter has multi selectors to select the desired function. The fluke MM automatically ranges to select most measurements. This means the magnitude of the signal does not have to be known or determined to take an accurate reading, it directly moved to the appropriate port for the desired measurement. The fuse is protected to prevent the damage, if connected to wrong port.

LCR meter

An LCR meter is a type of electronic test equipment used to measure the inductance (L), capacitance (C), and resistance (R) of an electronic component. In the simpler versions of this instrument the impedance was measured internally and converted for display to the corresponding capacitance or inductance value. Readings should be reasonably accurate if the capacitor or inductor device under test does not have a significant resistive component of impedance. More advanced designs measure true inductance or capacitance, as well as the equivalent series resistance of capacitors and the Q factor of inductive components.

Oscilloscope

An oscilloscope, previously called an oscillograph, and informally known as a scope or oscope, CRO (for cathode-ray oscilloscope), or DSO (for the more modern digital storage oscilloscope), is a type of electronic test instrument that graphically displays varying signal voltages, usually as a two-dimensional plot of one or more signals as a function of time. Other signals (such as sound or vibration) can be converted to voltages and displayed. Oscilloscopes display the change of an electrical signal over time, with voltage and time as the Y- and X-axes, respectively, on a calibrated scale. The waveform can then be analyzed for properties such as amplitude, frequency, rise time, time interval, distortion, and others. Modern digital instruments may calculate and display these properties directly. Originally, calculation of these values required manually measuring the waveform against the scales built into the screen of the instrument. The oscilloscope can be adjusted so that repetitive signals can be observed as a continuous shape on the screen. A storage oscilloscope can capture a single event and display it continuously, so the user can observe events that would otherwise appear too briefly to see directly.

Screwdriver machine

Most cordless drills these days are also designed to drive screws, that’s why they’re called a drill driver. If you’ve never used yours as a screwdriver or have tried but haven’t had much success, here’s a complete guide to using your drill to drive screws.

Which bit do I need for screws ?

The type of bit you need depends on the shape on the head of the screw. The most common is the star-shaped Phillips head. For this you will need a No. 2 Phillips head driver bit which is the correct size to suit most types of these screws. Other common driver bits you will come across are the internal hex drive for bugle head batten screws ; the square drive bit for decking screws and the nut setter hex bit which fits over roofing screws.

Which drill speed is best for driving screws ?

Low speed gives you the most control over driving screws, especially for the beginner and if you're using Phillips head bits screws which don't lock into the head of a screw as well as other types of bits. Once you get used to using your drill as a screwdriver, you can try cranking up the speed to get through the job quicker.

Select the right action setting

The action setting is the switch on the drill with pictures of a screw, a hammer and a drill bit. Turn it to the screw setting which means the drill is ready to drive screws. The other settings are for general drilling and for putting the drill into hammer mode when you're drilling into bricks or concrete.

What is the torque setting ?

The torque setting is the adjustable collar on the drill with a whole lot of numbers on it.

Torque is the turning power of the drill and the torque setting allows you to control how much force is applied to turn the screw. Putting the drill at the correct torque setting will mean you don't overdrives the screw. Test it out at the start of the job to get the right setting to suit the job you're doing. Generally soft materials need a low torque setting while for harder materials crank it up to a higher number.

My driver bit won’t stay in the head of the screw !

This usually happens with Phillips head screws as the head of the bit doesn’t lock into the screw as well as other bit types. If it does happen, stop immediately. The bit won’t lock back into the screw and all you’ll end up doing is stripping the head of the screw and creating an even bigger problem.

Here’s a 4 Step guide to driving Phillips head screws :

1. Make sure the drill is at slow speed.

2. Check that the head of your bit is in good condition. A worn bit is less likely to stay in the head of the screw.

3. When driving, keep pressing on the drill to keep the head of the bit in the screw.

Don’t take the pressure off as you approach the material you’re screwing into, keep it on and let the torque setting stop the drill at the right spot.

4. Don’t try to keep driving a screw where a bit has already slipped. Pull it out and get a new one.

Soldering station

A soldering station is a multipurpose power soldering device designed for electronic components soldering. This type of equipment is mostly used in electronics and electrical engineering. Soldering station consists of one or more soldering tools connected to the main unit, which includes the controls (temperature adjustment), means of indication, and may be equipped with an electric transformer. Soldering stations may include some accessories – holders and stands, soldering tip cleaners, etc. Soldering stations are widely used in electronics repair workshops, electronic laboratories, in industry. Sometimes simple soldering stations are used for household applications and for hobbies.

The main soldering station elements which determine its compatibilities are soldering tools.

Different tools are used for different applications and soldering stations may be equipped with more than one of them at a time.

The main tools for soldering are :

- Contact soldering irons ;
- Desoldering tweezers or SMD hot tweezers ;
- Desoldering gun ;
- Hot air gun ;
- Infrared heater.

Soldering iron is the most common working tool of a soldering station. Some stations may use simultaneously several soldering irons to make the process quicker and more convenient, as there is no need to change the soldering tips or readjust the station or the soldering temperature. Some stations may use some specialized soldering irons, such as ultrasonic soldering irons or induction soldering irons.

Soldering iron as a part of soldering station has a number of advantages.

Increased operability

- The operator may set the temperature according to the solder alloy in use
- Stability of the preset temperature.
- Operation mode indication, including temperature display.

Better heating element quality

Main unit with power supply

Desoldering Tools

Desoldering is a very important stage in PCB repair. It is often needed to disassemble some components just to make sure they work or check their condition. That is why it is important to detach the elements without any possible damage to them.

- SMD hot tweezers

Heat up and may not only melt the solder alloy but grab the needed component as well. They may have different types of tips for different applications.

- Desoldering iron

Desoldering iron is usually made in a shape of a gun. It is capable of taking in the air (vacuum pickup) and solder alloy.

- Non-contact heating tools

Include hot air and infrared heaters. They are used for SMT disassembling.

- Hot Air Guns

They use a hot air stream for heating up the components. Hot air is focused on the certain area using special hot air nozzles. Usually soldering hot air guns are capable of providing temperatures from 100 to 480 °C.

- Infrared Heaters

The means that may be integrated in soldering stations are :

Soldering stations with infrared (IR) heaters are a separate type of soldering stations and differ a lot. Such stations provide high-precision soldering and the process is more like that in electronics industry. The temperature profile may be set based on the components being soldered. This minimizes the risk of components deformation or damage due to the temperature difference.

Air blower machine

Air blower machine is a simple and effective electrical device used in homes and industries to blow away dust from every nook and corner. For gadgets and electronics have delicate parts that cannot be cleaned with a cloth. This is when you need air blowers to remove dust with its continuous air pressure. This durable and efficient machine save a good amount of time and effort consumed in cleaning and dusting tasks.

- **Features of air blowers**

The electric air blower is easy to use the device with features such as

- May air blowers come with blowing and extraction features
- For different function, this hand-held machine has a variable speed control option
- Air blowers have a strong and comfortable grip for long hour usage with minimal fatigue.
- These are made from the strong material but lightweight
- They come in the cordless form as well
- Air blowers don't create much noise, thus can be used without disturbing neighbors and environment. How does air blower work ?

An impeller at the center of the air blower sucks air and creates a spiral flow of air thereby creating a dynamic pressure that forces the air to flow through a curved path and out of the blower. The different speed levels are set for various kinds of cleaning such as cleaning electronic components, leaves shed in the garden area, etc.

❖ **Types of air blowers**

Depending on the power capacity, design of blades, size, and application, air blowers come in different types as discussed below :

a**) Forward-curved**

Here the design of the blade is in a curved direction. This creates a higher velocity when rotating a low speed.

b) **Backward-curved** : Here the blades rotate at a much higher speed as compared to forward-curved blades. The flat blades move away from the direction of rotation. It is best for tasks that require high-static pressure.

c) **Airfoil :** It has airfoil-shaped blades that gradually curve down to narrow towards the outer end.

d) **Radial :** Used in small exhaust systems, the blades are not curved and generally used for cooling purposes.

Difference between blower and fan

FAN BLOWER	FAN BLOWER
Electrical device Mechanical device	Electrical device Mechanical device
Circulate the air all around/in every direction With impeller, the air is directed in one direction	Circulate the air all around/in every direction With impeller, the air is directed in one direction
A large amount of air circulated at a low pressure	A large amount of air circulated at a low pressure

Factors to consider before buying an air blower

- Opt for battery operated handheld air blowers for small tasks. They can be charged easily and quickly.
- Electric air blowers are best for long hour usage or cleaning of the larger area.
- Always select blowers that are light in weight that consumes lesser energy and can be used for a longer time without tiredness. Lightweight blowers are easy to handle, operate, maintain, and store
- Make use of the noise level is lower. It will not annoy you or others, especially during long time use.

Personal protective equipment (PPE)

PPE is the personal protective equipment that will protect the user against health or safety risks. They can include items such as safety helmets, gloves, eye protection, hazmat suits, high visibility clothing, safety footwear, safety tie together, ear plugs, ear defenders and respiratory protective equipment (RPE). In appropriate situations disposable PPE may be provided ; e.g. single-use coveralls. Employers have duties concerning the provision and use of personal protective equipment at work.

In the hierarchy of risk control, PPE is considered to rank lowest and represent the option of last resort. It is only appropriate where the hazard in question cannot be totally removed or controlled in such a way that harm is unlikely (for example by isolating the hazard or reducing the risk at source to an acceptable level).

There are a number of reasons for this approach :

- PPE protects only the person using it, whereas measures controlling the risk at source can protect everyone at the workplace ;

- Theoretical maximum levels of protection are seldom achieved using PPE, and the real level of protection is difficult to assess (due to factors such as poor fit, or failure to wear it when required). Effective protection can only be achieved by equipment which is correctly fitted, maintained and properly used at all times ;
- PPE may restrict the wearer by limiting mobility, visibility or by requiring additional weight to be carried.
- Use of PPE may alter employees' perception of the hazards they are dealing with.

Types of PPE

Various types of PPE are available for use in the workplace. The Health and Safety Executive provides guidance and general information about types of PPE used in industry, but it doesn't cover specialized and less-used items. Potential users should be involved in the selection of equipment they will be expected to wear and if possible more than one model should be made available to them.

The different types of PPE include :
Head protection (helmet)

- Respiratory protection (nose mask)
- Eye protection (googles)
- Hearing protection (earmuff)
- Hand and arm protection (groves)
- Foot and leg protection (boot or safety shoes)
- Body protection (overall or overcoat)

Head and scalp protection

There are five primary purposes of head protection, to protect :

- The head in falls ;
- Against falling objects, impact with fixed objects, or wielded weapons ;
- The head by offering thermal insulation ;
- Against entanglement and laceration to the head ;
- Against scalping/entanglement particularly on machinery where injuries are still numerous. Hair-nets and caps are also used for hygiene reasons

Eye protection

PPE for the eyes is intended to provide protection against impact, cuts, splashes, mists and sprays. The relevant standards are BS 7028 (Guide to Selection of Eye Protection for Industrial and Other Uses) and BS EN 166 (Specification for Eye Protectors).
All PPE must be regularly cleaned, but this is especially important in the case of eye protection as dirty lenses lead to poor vision and may contribute to accidents. Where lenses become scratched, pitted or cracked they should be replaced. Users who need to wear corrective lenses (glasses) should have this requirement accommodated in the

provision of the PPE to them e.g. as protective over glasses where appropriate, or in the form of prescription lenses if necessary. Where they may be required to wear eye protection on a regular and prolonged basis then any goggles, safety-glasses etc. should meet the user's prescription requirements.

Hearing protection

Assessments carried out under the 'Control of Noise at Work Regulations 2005' will determine whether personal ear protectors are required in the workplace or not, and the noise attenuation required. The relevant standard for the ear protectors is BS EN 352 Part 1. In providing hearing protection, employers should select protectors which are suitable for the working environment and should consider how comfortable and hygienic they are. Like other PPE, hearing protection will need to be compatible with other PPE (e.g. hard hats, dust masks and eye protection) worn by workers. Employers may also wish to provide a range of protectors to allow employees to choose ones which suit them.

Bearing mind that the theoretical attenuation is rarely achieved and it is therefore necessary to over-specify the protection. When selecting hearing protection, use the detailed noise assessment to determine the attenuation required at High, Medium and Low frequencies and match this against suitable products. Bear in mind that where ear plugs are used, training will be needed to ensure that they are used correctly. Where ear defenders are used it should be ensured that users do not use music headphones or buds simultaneously. For high noise environments, it may be appropriate to specify both plugs and defenders.

Hand and arm protection

Most work requires a degree of manual skill and consequently the hands are exposed to a wide range of hazards Risks include cuts, scratches, heat, cold, chemical contamination, vibration, burns, infection, skin irritation and dermatitis.

Before selecting hand and arm protection, the hierarchy of control measures must be followed. Gloves and gauntlets provide the main form of hand protection against a range of industrial hazards, but other forms of PPE such as mitts, wrist cuffs or armlets may also be used. In the case of manual handling where there may be a risk of piercing by abrasive, sharp or pointed objects, gloves should be provided where these hazards cannot otherwise be removed, isolated or reduced to an acceptable level. Such gloves are usually made from leather, chain mail, rubber, knitted Kevlar or stout canvas. However, gloves should not normally be worn where there is a risk of them being caught in machinery where chemical exposure is a hazard, and the risk extends to contact with the arms, gauntlets should be specified rather than gloves.

BS EN 14328 is the standard for gloves and armguards protecting against cuts by powered knives while BS EN 407 contains the specifications for gloves intended to protect against thermal risk such as heat and/or fire. BS EN 374 Part 1 covers gloves for protection against chemicals and microorganisms. BS EN 511 covers gloves for protection against the cold. BS EN 388 covers the specification of gloves against mechanical hazards.

Foot and leg protection

A wide range of safety footwear is available providing protection against many hazards to the feet or legs including crushing, slipping, piercing, temperatures, electricity, chemicals, cutting, and chopping. The relevant standard for safety footwear is BS EN ISO 20345. BS EN ISO 17249 :2004 is the standard for chainsaw footwear. Depending on the hazard various PPE options may be appropriate including safety boots and shoes with protective toe caps and penetration-resistant mid-sole ; gaiters ; leggings ; and spats.

Body protection

The Regulations' definition of PPE excludes ordinary working clothes and uniforms which have no specific protection for the wearer. However, body protection may be required for extended periods of work outdoors to protect against the weather, and to ensure high visibility during work where there is mixed vehicle and pedestrian traffic (see BS EN 471 + A1 'High-visibility Warning Clothing for Professional Use').

PPE for the body may also be required where workers are exposed to extremes of temperature (whether outdoors or indoors), as well as chemical or metal splash, spray from pressure leaks or spray guns, impact or penetration, contaminated dust, excessive wear, entanglement of own clothing or the risk of drowning.

When choosing body protection, the following factors should be considered :

- Thermal comfort, for example, due to sweating ;
- Cost and practicality of cleaning ;
- Emergency procedures, such as buoyancy or the need to be identified or spotted in
- Hazardous situations ;

Level of hygiene control required

- ✓ Level of personal contamination ;
- ✓ Personal preference ;
- ✓ Restriction of movement ;
- ✓ Storage ;
- ✓ Temperature and humidity fluctuation ;
- ✓ Whether the worker is involved in process that is wet or dry.

Respiratory protection

This covers equipment ranging from breathing apparatus and positive pressure powered respirators through to protective hoods, close fitting full face respirators, half mask respirators and disposable face masks. It is always essential to select the correct equipment both for the risk and the individual and to ensure there is adequate training in its use. It should be noted that the only form of respiratory protection which is suitable for work in a confined space is breathing apparatus, as other forms of respiratory protection do not provide a source of air or oxygen. Face fit testing requirements apply to all close fitting respirators. Where PPE is required it must :

- ✓ Be appropriate for the risks and for the working environment ;
- ✓ Take account of the user's health, ergonomic, physical and other factors adequately control the risk presented by the hazard without increasing overall risk experienced bythe worker ;
- ✓ Be supplied and replaced free of charge ;
- ✓ Comply with relevant legislation implementing the European Directives concerning the design and manufacture ; Where reasonably practicable provide a range of PPE to allow workers to choose the equipment that best suits their working environment and routines, but always ensure that the alternatives made available provide the level of protection required ;
- ✓ Provide training, instruction or information, including refresher training and demonstrations, as appropriate in the use and care of the PPE provided ;
- ✓ Ensure face fit testing is undertaken for close fitting respiratory protective equipment ;
- ✓ Establish a system of recording the issue of PPE and of monitoring, examination and repair for PPE and to allow for the reporting of missing or lost items.


Summary for the trainer related to the learning outcome

Repairing tools are Soldering irons, Screwdrivers and Pliers. Cleaning tools are Brushes, Sponge and Soft cloth Tpes of PPE : Overcoat (over all), Safety shoes, Eye glass, Nose mask, …


Theoretical learning Activity

- ✓ Ask trainees to brainstorm about difference between toll, material and equipment within groups)
- ✓ Ask trainees to Describe the use of materials, tools and equipment


Practical learning Activity

Trainee in pair Pick:

- Appropriate Repairing tools based on their functions
- Pick appropriate cleaning tools based on their functions

- Pick appropriate Repairing material based on their functions
- Pick appropriate cleaning material based on their functions
- Pick appropriate Repairing equipment based on their functions
- Pick appropriate cleaning equipment based on their functions

Check list	**Score**	
	Yes	**No**
Indicator: Difference between tools, materials and equipment are well described (Knowledge)		
1. Tools, material and equipment are well differentiated		
Indicator: Repairing tools are well used (skills & knowledge)		
1. Soldering		
2. Screwdrivers		
3. Pliers usage		
Indicator: Cleaning tools are well described (knowledge)		
1. Brushes		
2. Sponge		
3. Soft cloth		
Indicator: Repairing materials usage are well stated		
1. Soldering tin		
2. Screws		
3. Cables and wires		
4. Electronic components		
Indicator: electronic lab Equipment' functions are well stated		
1. Multimeter		
2. LC R Meter		
3. Oscilloscope		
4. Screwdriver machine		
5. Soldering station		
6. Air blowing machine		
7. PPE		
Indicator: tools, equipment and material are well selected based on their functions (skills)		
1. Repairing tools		
2. Cleaning tools		
3. Repairing material		
4. Cleaning material		
Observation		

Points to Remember

Difference between fan and blower	
FAN	blower
Electrical device Mechanical device	Electrical device Mechanical device
Circulate the air all around/in every direction with impeller, the air is directed in one direction	Circulate the air all around/in every direction with impeller, the air is directed in one direction
A large amount of air circulated at a low pressure	A large amount of air circulated at a low pressure

Learning outcome 2 formative assessment

Written assessment

1. Differentiate tool from equipment
2. Identify four (4) types of PPE
3. Choose the appropriate answer
   a) The following are repairing material except
      i) Soldering tin
      ii) Cables and wires
      iii) Soft cloth
      iv) Screws
   b) Repairing tools
      i) Soldering irons, Screwdrivers, Brushes
      ii) Sponge, Soft cloth, Pliers
      iii) Soldering irons, Screwdrivers and Pliers

Answer:

1. Any physical item that is used to achieve a goal but is not consumed during this process can be defined as a tool while equipment represents all sorts of machinery, functional devices or accessories which serve an individual, household or a community purpose
2. Four types of PPE are : Overcoat, Overall, Gloves and eye glass
3. a) Soft cloth

   b) Soldering irons, Screwdrivers and Pliers

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop Pick appropriate cleaning equipment based on their function. Assume you're in a position of the demonstrate cleaning equipment based on their function as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 1.3 set up the working environment

Duration: 2hrs

Learning outcome 3 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Describe Cleaning methods
2. Apply safety rules and guidelines
3. Arrange tools, equipment and material

Resources

Equipment	**Tools**	**Materials**
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 1.3.1. Description of Cleaning methods

Blowing

Any vapor or gas issuing from a vent under pressure. Or a method of producing hollowware by injecting air under pressure into a fluid mass, as of glass or plastic, and shaping the material within a decay. A "quiet" nozzle (i.e. one with low noise emission) should be selected.

The nozzle pressure must remain below 10 psi (69 or 70 kPa) and personal protection equipment (PPE) must be worn to protect the worker's body, especially the eyes, against particles and dust under pressure. Use effective guarding methods that prevent a chip or particle (of any size) from being blown into the eyes or unbroken skin of the operator or other workers nearby. You may also use barriers, baffles, or screens to protect other workers near the operator if there is a risk of exposure. In addition, air guns should also be used with some local exhaust ventilation or facilities to control the generation of airborne particulates. When compressed air cleaning is unavoidable, hazards can be reduced by making adjustments to the air gun such as :

- ✓ Chip guards or curtains that can deflect flying dust or debris,
- ✓ Extension tubes that provide the worker a safer working distance, or
- ✓ Air guns equipped with injection exhausts and particle collection bags

Brushing

A brush is a common tool with bristles, wire or other filaments. It generally consists of a handle or block to which filaments are affixed in either a parallel or perpendicular orientation, depending on the way the brush is to be gripped during use. The material of both the block and bristles or filaments is chosen to withstand hazards of its intended use, such as corrosive chemicals, heat or abrasion. It is used for cleaning, grooming hair, make up, painting, surface finishing and for many other purposes. It is one of the most basic and versatile tools in use today, and the average household may contain several dozen varieties.

Toweling

An absorbent cloth or paper for wiping and drying something wet, as one for the hands, face, or body after washing or bathing.

Indicative content 1.3.2. Safety rules and guidelines Individual safety precautions

Safety in the workplace begins with a proper safety plan that is put into place by management and observed by all employees. Safety precautions must be strictly adhered to because if they are not, some employees can put all other employees at risk. Work place accidents translate into days missed for work, reduced productivity, and lost profits. If an employee is seriously injured, they may turn to worker's compensation which ends up costing the business money in increased premiums. Also, morale among employees can suffer because they are concerned about their safety and ability to work in an environment where other employees have suffered an injury.

Employees should feel safe at work and protected from hazardous materials and dangerous machines. They should be provided with the proper safety equipment, be fully trained on the operational procedures of the equipment or machines that they will be working with, and tested from time to time on those procedures.

Operating safety precautions

All personnel must know and observe general safety precautions. Those who perform particular duties or operations must know and observe the safety precautions for those duties or operations. Those who don't understand safety precautions, and those who ignore them, are equally at risk of injury that may end in disablement or death. Therefore, all supervisory personnel must emphasize safety as part of their daily supervisory duties. This is especially important during the training of new personnel when they are forming good or bad habits. The following points are particularly important for supervisors : Be sure that personnel are practicing safety on equipment and that the equipment is in safe operating condition. Check safety devices to be sure they are working. If any safety device is not working, have it repaired immediately or post a prominent warning until it can be repaired. Versions with standard and nonstandard operating instructions and safety precautions for material under their technical control. These instructions are suitable for posting.

These are some operating precautions can be made in different activities to assure best safety operation precautions :

1) Never make any adjustments while the machine is operating.

2) Do not support the workplaces by hand. Use a holding device to prevent the work piece from being tom from the operator's hand.

3) Never clean away chips with your hand. Use a brush.

4) Keep all loose clothing away from turning tools.

5) Make sure that the cutting tools are running straight before starting the operation.

6) Never place tools or equipment on the drilling tables.

7) Keep all guards in place while operating.

8) Ease up on the feed as the drill breaks through the work to avoid damaged tools or workplaces.

9) Remove all chuck keys and wrenches before operating.

10) Always wear eye protection while operating any drilling machines.

Electrical safety precautions

It's vitally important to take safety precautions when working with electricity. Safety must not be compromised and some ground rules need to be followed first. The basic guidelines regarding the safe handling of electricity documented below will help you while working with electricity.

1. Avoid water at all times when working with electricity. Never touch or try repairing any electrical equipment or circuits with wet hands. It increases the conductivity of the electric current.

2. Never use equipment with frayed cords, damaged insulation or broken plugs.

3. If you are working on any receptacle at your home then always turn off the mains. It is also a good idea to put up a sign on the service panel so that nobody turns the main switch ON by accident.

4. Always use insulated tools while working.

5. Electrical hazards include exposed energized parts and unguarded electrical equipment which may become energized unexpectedly. Such equipment always carries warning signs like "Shock

Risk". Always be observant of such signs and follow the safety rules established by the electrical code followed by the country you are in.

6. Always use appropriate insulated rubber gloves and goggles while working on any branch circuit or any other electrical circuit.

7. Never try repairing energized equipment. Always check that it is de-energized first by using a tester. When an electric tester touches a live or hot wire, the bulb inside the tester lights up showing that an electrical current is flowing through the respective wire. Check all the wires, the outer metallic covering of the service panel and any other hanging wires with an electrical tester before proceeding with your work.

8. Never use an aluminum or steel ladder if you are working on any receptacle at height in your home. An electrical surge will ground you and the whole electric current will pass through your body. Use a bamboo, wooden or a fiberglass ladder instead.

Indicative content 1.3.3. Methods of arranging tools, equipment and material

Organization or arrangement of tools, materials and equipment is one of the keys to an effective workplace. It seems like such a simple thing, but the fact is that when we take the time to organize our workplace, we become more efficient. One reason for this increase in efficiency is the decrease in "search time" that results from an organized work area.

Whether it's a file, work order, tool, part, blueprint or even something as simple as a pen, we spend considerable time searching for these things, and this is time wasted.

Planning and organization makes efficient use of your time by keeping you focused from beginning to completion of a project.

Arrangement is an act of arranging ; state of being arranged, the manner or way in which things are arranged.

It is achieved by the following settings :

- Arrangement by uses : the tools, materials and equipment of the same function are put on the same level.
- Arrangement by size : the tools, materials and equipment of the same size, weight are put on the same level.
- Arrangement by types : the tools, materials and equipment of the same type are put on the same level.

Arrangement by type, uses and size or weight

Hand tools, a tool in numerically (digitally) controlled machines is composed of several parts, such as the cutting tool (which may be one piece or comprise a body plus index able inserts), a collet, and a tool holder with a machine taper. Putting the parts together accurately into an assembly is required to achieve error-free production. Logistics deals with demand planning, supplies and tool location. This includes, on one hand, the location in the warehouse and the purchasing of individual parts with the corresponding consumption report. It also allows for the planning and coordination of the movements of the assemblies within the shop floor.

Summary for the trainer related to the learning outcome content

Methods of arranging tools, equipment and material

- Arrangement by uses
- Arrangement by size
- Arrangement by types

Theoretical learning Activity

- ✓ Ask trainees to brainstorm about arrangement technique of material tools and material within groups
- ✓ Trainees discuu about safety precaution guidelines of material tools and material within groups)

Practical learning Activity

Trainee in pair arrange appropriately tools, material and equipment

Check list

Check list	**Score**	
	Yes	**No**
Indicator: Cleaning methods applications are well described (knowledge)		
1. Blowing, brushing and towelling are well differentiated		
Indicator: Safety rules and guidelines are well applied (skills)		
1. Individual safety precautions		
2. Operating safety precautions		
3. Electrical safety precautions		
Indicator: Tools, equipment and material are well arranged (skills)		
1. Arrangement by types		

2. Arrangement by uses		
3. Arrangement by size/ weight		
Observation		

Points to Remember (Take home message)

Cleaning technique are Blowing, brushing and towelling

Learning outcome 1 .3 formative assessment

Written assessment

1. Explain three cleaning techniques
2. The following are electronic lab equipment and their corresponding definitions. Column A consists of definitions of them and B their names. Match the column B equipment to its corresponding definition to the column A by writing the letter to the given space.

Answer	Column A	Column B
1…	1. An electronic measuring instrument that combines several measurement functions in one unit.	A. Ammeter
2…..	2. Electronic device that has the ability to generate various signal waveforms with adjustable parameters at its output.	B. Oscilloscope
	3. A type of electronic test equipment used to	C. Ohmmeter

3…	measure the properties of three passive electronic components	
4….	4. It is electronic equipment that measures the resistance.	D.Multimeter
5…	5. An instrument that converts electronic and electrical signals to a visual display.	E. Function generator
		F.LCR meter
		G. DC power supply

Answer:

Answer:

1. **Brushing**: Cleaning technique using brush
   Blowing: Cleaning technique using air blower
   Towelling: Cleaning technique using towell

2.

Answer	Column A	Column B
1…D.	1. An electronic measuring instrument that combines several measurement functions in one unit.	A. Ammeter
2…E..	2. Electronic device that has the ability to generate various signal waveforms with adjustable parameters at its output.	B. Oscilloscope
3…F.	3. A type of electronic test equipment used to measure the properties of three passive electronic components	C. Ohmmeter
4…C.	4. It is electronic equipment that measures the resistance.	D.Multimeter
5…B.	5. An instrument that converts electronic and electrical signals to a visual display.	E. Function generator
		F.LCR meter
		G. DC power supply

Practical assessment

Appropriately Arrange tools, material and equipment by respecting the standard after finishing the work.

Answer: Check list is provided in the practical activities

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LEARNING UNIT 2: REPAIR MULTIMETER

Duration: 7hrs

Learning outcome 1 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Explain multimeter operation
2. Describe multimeter functional parts
3. disassemble Multimeter
4. Check and test multimeter part

Resources

Equipment	Tools	Materials
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 2.1.1. Introduction to multimeter operation

The most basic things we measure are voltage and current. A multimeter is also great for some basic sanity checks and troubleshooting. Is your circuit not working ? Does the switch work ? Put a meter on it ! The multimeter is your first defense when troubleshooting a system. We will cover measuring voltage, current, resistance and continuity.

Indicative content 2.1.2. Description of multimeter functional parts

A multimeter is has three parts :

a) Display

b) Selection Knob

c) Port

A. Display

a display device for presentation of images, text, or video transmitted electronically,without producing a permanent record. The LCD is embedded on the PCB and is interfaced through pinouts on the PCB itself. A transparent plastic casing is over the LCD protecting it from the scratches. Also, shock absorption is provided by the rubber pads closely attached at the top and bottom of the LCD. The display usually has four digits and the ability to display a negative sign. A few multimeters have illuminated displays for better viewing in low light situations.

B. Selection knob

The selection knob allows the user to set the multimeter to read different values such as milliamps (mA) of current, voltage (V), resistance (Ω). Capacitance and identification of transistor pinout.

• Some multimeter employ the rotary switch to handle the switching ON and OFF options while some require a slider switch.

C. Ports

Two probes are plugged into two of the ports on the front of the unit. COM stands for common and is almost always connected to Ground or '-' of a circuit. The COM probe is conventionally black but there is no difference between the red probe and black probe other than color. 10A is the special port used when measuring large currents (greater than 200mA). mAVΩ is the port that the red probe is conventionally plugged in to. This port allows the measurement of current (up to 200mA), voltage (V), and resistance (Ω). The probes have a banana type connector on the end that plugs into the multimeter. Any probe with a banana plug will work with this meter. This allows for different types of probes to be used.

Indicative content 2.1.3. Multimeter disassembling process

- ✓ Find your accessible excellent mini screw driver, and start taking out screws.

- ✓ Next, remove the two screws hiding behind the battery plate.

- ✓ Lift the face of the multimeter slightly.

- ✓ Now notice the hooks on the bottom edge of the face. You will need to slide the face sideways with a little force to unlock these hooks.

- ✓ Once the face is unhooked, it should come out easily. Now you can see inside the multimeter!

Indicative content 2.1.4. Checking methods

Visual checking

Visual Inspection, or Visual Testing (VT), is the oldest and most basic method of inspection. It is the process of looking over a piece of equipment using the naked eye to look for flaws. It requires no equipment except the naked eye of a trained inspector. Visual inspection is simple and less technologically advanced compared to other methods. Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective. This is because there is no equipment that is required to perform it. For similar reasons it also one of the easiest inspection techniques to perform. It is also one of the most reliable techniques. A well-trained inspector can detect most signs of damage.

Measuring

Measurement is the process of using a device or tool to find the dimensions, time, pressure, amount, weight or mass of an object. We use measurements to help us solve problems in many real world situations. There are many types of test instruments used for troubleshooting. Some are specialized instruments, designed to measure various behaviors of specific equipment. There are other types of instruments, such as multimeters, that are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC voltages, resistance and current.

- Voltmeter : A voltmeter is used to test the differences in voltage between two points.
- Ohmmeter : An ohmmeter is used to measure the resistance between two points in a circuit.
- Ammeter : An ammeter is an instrument for measuring the current flowing in a circuit in amperes.
- Multimeter : A multimeter can test voltage, resistance and current. It is an ohmmeter, voltmeter and ammeter all in one.

General Meter Rules

1. Before you perform a test, you should know what the meter should read if the circuit is operating normally.

2. You should make your prediction based on a circuit diagram. If the reading is anything other than your predicted value, you know that this part of the circuit is being affected by the electrical fault.

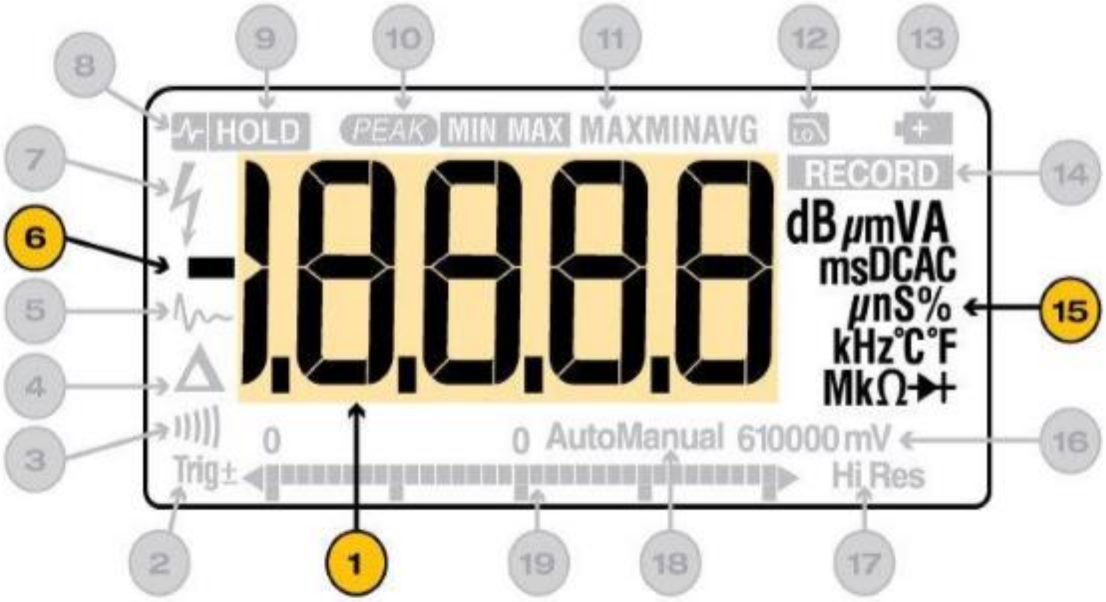
3. You should always test the meter before using it to troubleshoot.

For a voltmeter, test the meter on a known voltage source before using. Your meter should read the correct voltage.

For an ohmmeter, touch the meter leads together. The display should read 0 ohms, or very close to 0. With the leads apart it should read OL (infinity).

Indicative content 2.1.5. Checking multimeter parts

- ✓ Display



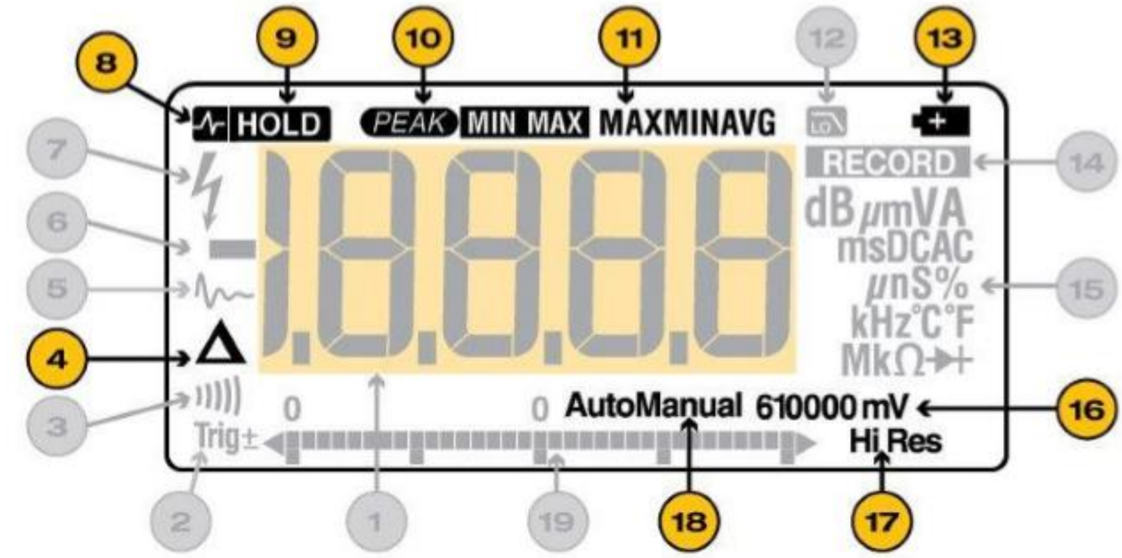
1	18.8.8.8	Digits
6	—	Negative reading indicator
15	**Measurement units**	
	V mV	Volts Millivolts
	A mA µA	Amps Milliamps microamps
	DCAC	direct current, alternating current
	µF	Capacitance measured in microfarads; 1 µF = 1 microfarad, or 10-6F
	µF nF	Capacitance measured in microfarads; 1 µF = 1 microfarad, or 10-6F Capacitance measured in nanofarads; 1 nF = 1 nanofarad, or 10-9F
	nS	Nanosiemens
	Hz kHz	Frequency, measured in hertz Frequency, measured in kilohertz (1 kHz = 103Hz, or 1000 Hz)
	°C°F	Temperature, in degrees Celsius and degrees Fahrenheit

Ω kΩ MΩ	Resistance, measured in ohms Resistance, measured in kilo-ohms (1 kΩ = 103Ω, or 1000 Ω) Resistance, measured in megohms (1 MΩ = 106Ω, or 1000000 Ω)
⯈⎮	Diode test
ms	Pulse width, measured in milliseconds (ms)
%	Duty cycle

Secondary Indicators

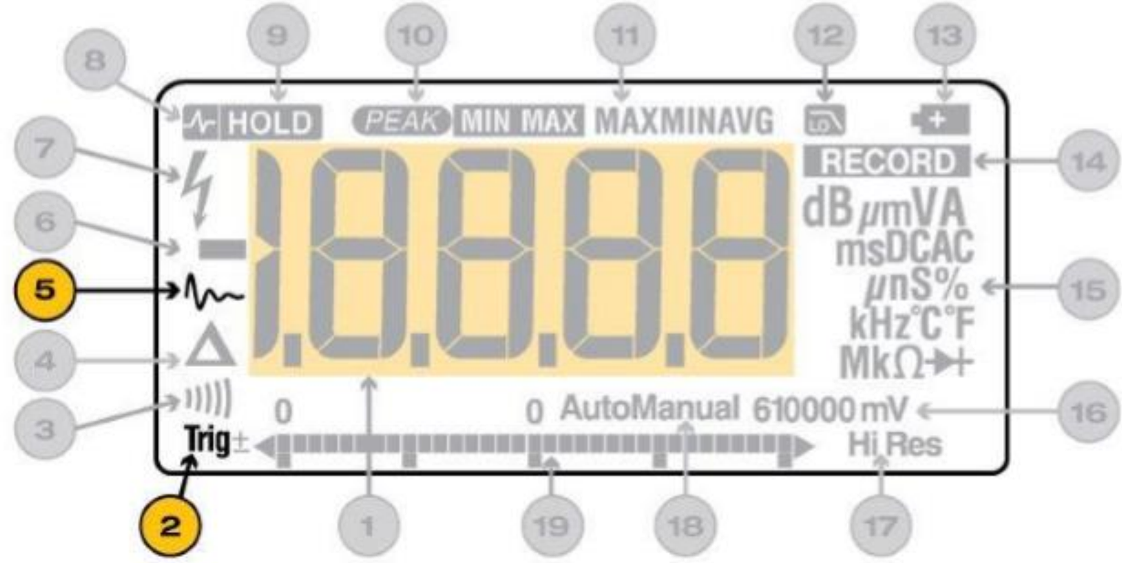
3	·))))	Continuity beeper
7	ϟ	High-voltage input (if 30 V or greater, ac or dc)
12	LO	Low pass filter mode
14	RECORD	Recording mode
19		Analog bar graph

Convenience Indicators



4	Δ	Relative (REL) mode
8		Auto Hold active
9	HOLD	Display hold
10	PEAK	Peak Min Max mode
11	MIN MAX MAXMINAVG	Min Max recording
13		Low battery indicator
16	610000 mV	Selected range
17	Hi Res	High-resolution mode
18	AutoManual	Auto or Manual range

*Specialized Indicators_*



2	Trig	Polarity
5		Smoothing

Controls

A multimeter has controls to allow you to select the quality to be measured, such asresistance, current or voltage. Typically, the main control will be a dial which you twist to select what you are testing. Buttons or switches re also possible either as primary or as secondary control. For selecting the range of values you are looking at for example (although many multimeters find the range automatically). Inside the multimeter there are different circuits for various measurements ; the controls allow you to select which circuit is in use.

Battery

Touch the red multimeter probe to the positive terminal of the 9-volt battery. Touch the black multimeter probe to the negative terminal of the 9-volt battery. The voltage of the battery will appear on the multimeter screen. If the measured voltage is not at least eight volts, replace the battery.

DC/AC Voltage Test : Battery

1. Plug the black jack into the COM port on multimeter and the red jack into the Voltage port (often indicated as VΩmA).
2. Set meter dial to DC voltage (indicated by a V)
3. Place the red probe to the "+" and the black probe to the "-" pole on the battery.

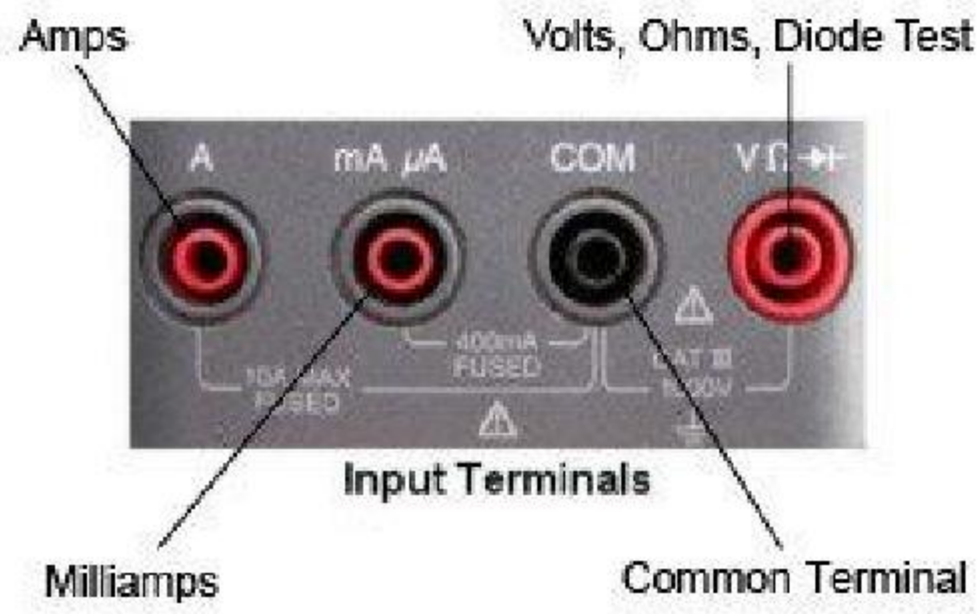
Your meter should display the DC voltage. You can follow the same steps to measure AC voltage, resistance and continuity. Just make sure the dial is correctly placed to measure the appropriate unit (e.g. VAC, VDC, Ω, Diode, etc.).

Ports

Basic meters will usually have three ports to measure the following :

1. COM
2. Volts/Ohms
3. Amps

Some DMMs have only one port for Amps, while some have milliamp ports and Amp (shown below). The milliamps port is used for measuring currents less than 300 mA (typical) for a more exact reading.



Selector

The rotary selector, shown here above is used to select the type of measurement you wish to perform.

- The "V" with the wavy line above it is for measuring AC voltage.
- The "V" with the dotted and solid lines above it is for measuring DC voltage.
- The "mV" with the dotted and solid lines above it is for measuring DC milli-volts.
- The "Ω" position is for measuring resistance.
- The next position has a "diode" symbol. This position allows us to test diodes.
- The "mA/A" position is for measuring milliamp's and Amps.
- The last position, "μA" is for measuring micro-amps.

⚠ Summary for the trainer related to the learning outcome

External part of digital multimeter

Theoretical learning Activity

- ✓ Ask trainees to brainstorm about main part of digital multimeter within groups

Practical learning Activity

- ✓ Trainee in pair check multimeter parts functionalities

Check list

Check list	**Score**	
	Yes	**No**
Indicator: Multimeter operation is well described		
1. Multimeter usage are well stated		
Indicator: Multimeter functional parts are well demonstrated		
1. Power supply part		
2. Control and active part		
3. Display part		
Indicator: Multimeter disassembling process is followed		
1. User manual is well used		
Indicator: Checking methods are well described		
1. Visual checking		
2. Measuring		
Indicator: Multimeter parts functionalities are well checked		
1. Display		
2. Control part		
3. Battery		
4. Ports		
5. Buttons		
6. Selector		
Observation		

Points to Remember

- Voltmeter : A voltmeter is used to test the differences in voltage between two points.
- Ohmmeter : An ohmmeter is used to measure the resistance between two points in a circuit.
- Ammeter : An ammeter is an instrument for measuring the current flowing in a circuit in amperes.
- Multimeter : A multimeter can test voltage, resistance and current. It is an ohmmeter, voltmeter and ammeter all in one.

Learning outcome 2 .1 formative assessment

Written assessment

1. List main parts of digital multimeter
2. State two (2) Checking methods

Answer:

1. Main part of multimeter: Display, Control part, Battery, Ports, Buttons, Selector
2. Two Checking methods are Visual checking and Measuring

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to check multimeter parts functionalities. Assume you're in a position of the checking multimeter parts functionalities as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 2.2: Identify multimeter fault

Duration: 3hrs

Learning outcome 2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify general faults that occur in multimeter

2. Describe fault identification techniques of multimeter

Resources

Equipment	Tools	Materials
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	-Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 2.2.1. Identification of general faults that occur in multimeter

Battery failure

The first step is to check the battery. Try to power on your digital multimeter. If the multimeter doesn't turn on or the display is dim you may have a weak or dead battery. Simply replace the battery and you should be good to go. No practical method exists to quantify all conditions of a battery in a short, comprehensive test. State-of-health (SoH) cannot be measured per se, it can only be estimated to various degrees of accuracy based on available symptoms. If the symptoms are vague or not present, a reliable measurement is not possible.

When testing a battery, three SoH indicators must be evaluated:

1. Capacity, the ability to store energy

2. Internal resistance, the capability to deliver current, and

3. Self-discharge, reflecting mechanical integrity and stress-related conditions

Batteries come in many conditions and a charge can easily mask a symptom allowing a weak battery to perform well. Likewise, a strong battery with low charge shares similarities with a pack that exhibits capacity loss. Battery characteristics are also swayed by a recent charge, discharge or long storage. These mood swings must be clearly identified when testing batteries. Batteries come in many conditions and a charge can easily mask a symptom allowing a weak battery to perform well. Likewise, a strong battery with low charge shares similarities with a pack that exhibits capacity loss. Battery characteristics are also swayed by a recent charge, discharge or long storage. These mood swings must be clearly identified when testing batteries.

The figure below demonstrates the usable battery capacity in volume that can be filled with a liquid, permanent capacity loss in the form of "rock content" that reduces the volume, and internal resistance in tap size symbolizing current flow.

The leading health indicator of a battery is capacity, a measurement that represents energy storage. A new battery should deliver 100 percent of the rated capacity. This means a 5Ah pack should deliver five amperes for 1 hour. If the battery quits after 30 minutes, then the capacity is only 50 percent. Capacity also supports warranty obligations with a replacement due when falling below 80 percent. Most importantly, capacity defines end of battery life. Lead acid starts at about 85 percent and increases in capacity through use before the long and gradual decrease begins. Lithium-ion starts at peak and begins its decline immediately, albeit very slowly. Nickel-based batteries need priming to reach full capacity when new or after a long storage.

Buttons freeze

You try to press the RANGE or HOLD button on your Multimeter, but one or both of them do not do anything. The buttons are jammed If the buttons are not working, the buttons may be jammed and you will need to reinstall or replace them.

Screen crash

You turn on your Multimeter and use it to measure a value in a circuit. The multimeter seems to be working, but the display is not showing the entire value. Segments, or whole characters, of the output are missing from the seven segment LCD display. The LCD is damaged if a segment of the multimeter measurements are not displaying, the LCD (display) on your Multimeter may be partially or fully damaged. You will need to replace the LCD.

Probes cut-out

The leads are broken If the multimeter is not measuring and there are no error messages, the multimeter leads may be broken and you will need to get a new pair. Make sure to only use leads with the multimeter that are accepted for use with it according to the Multimeter Service Manual.

Electronic circuit failure

Electronic circuit have a wide range of failure modes. These can be classified in various ways such as by time or cause. Failure can be caused by excess temperature, excess current or voltage, ionizing radiation, mechanical shock, stress or impact and many other causes.

Open-circuit trace faults

Open-circuit voltage (abbreviated as OCV or VOC) is the difference of electrical potential between two terminals of a device when disconnected from any circuit. There is no external load connected. No external electric current flows between the terminals.

Alternatively, the open-circuit voltage may be thought of as the voltage that must be applied to a solar cell or a battery to stop the current. Current will only flow in a circuit. That is, around a continuous path (or multiple paths) from and back to the source of EMF. Any interruption in the circuit, such as an open switch, a break in the wiring, or a component such as a resistor that has changed its resistance to an extremely high value will cause current to cease. The EMF will still be present, but voltages and currents around the circuit will have changed or ceased all together. The open switch or the fault has caused what is commonly called an open circuit.

Remember that wherever an open circuit exists, although voltage may be present there will be no current flow through the open circuit section of the circuit.

Short-circuit trace faults

A short circuit (sometimes abbreviated to short or s/c) is an electrical circuit that allows a current to travel along an unintended path with no or very low electrical impedance. This results in an excessive current flowing through the circuit. The opposite of a short circuit is an "open circuit", which is an infinite resistance between two nodes. It is common to misuse "short circuit" to describe any electrical malfunction, regardless of the actual problem.

Defective electronic components

Electronic components have a wide range of failure modes. These can be classified in various ways, such as by time or cause. Failures can be caused by excess temperature, excess current or voltage, ionizing radiation, mechanical shock, stress or impact, and many other causes. In semiconductor devices, problems in the device package may cause failures due to contamination, mechanical stress of the device, or open or short circuits.

Ic

Indicative content 2.2.2. Fault identification techniques

Testing

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. You can use a standard multimeter or if you are looking for a quick and easy way to test components.

Measuring

Measurement is the process of using a device or tool to find the dimensions, time, pressure, amount, weight or mass of an object. We use measurements to help us solve problems in many real world situations. There are many types of test instruments used for troubleshooting. Some are specialized instruments, designed to measure various behaviors of specific equipment. There are other types of instruments, such as multimeters, that are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC voltages, resistance and current.

Visualization

Visualization, or Visual Testing (VT), is the oldest and most basic method of inspection. It is the process of looking over a piece of equipment using the naked eye to look for flaws. It requires no equipment except the naked eye of a trained inspector. Visual inspection is simple and less technologically advanced compared to other methods. Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective.

Visual Inspection, used in maintenance to facilities in easy way of faults identification without losing time in measurement, mean inspection of equipment and structures using either or all of raw human senses such as vision, hearing, touch and smell and/or any non specialized inspection equipment provide quickly response the technicians. Where the faults locate and possible solutions.

Summary for the trainer related to the learning outcome

General faults that occur in multimeter :

- Battery failure
- Buttons freeze
- Screen crash
- Probes cut-out
- Electronic circuit failure
- Open-circuit trace faults
- Short-circuit trace faults
- Defective electronic components

Theoretical learning Activity

Ask trainees to brainstorm about difference different fault occur in multimeter within groups

Practical learning Activity

- ✓ Trainee in pair apply Fault identification techniques Pick appropriate cleaning material based on their functions

Check list

Check list	**Score**	
	Yes	**No**
Indicator: multimeter general faults are well identified		
1. Battery failure		
2. Buttons freeze		
3. Screen crash		
4. Probes cut-out		
5. Probes cut-out		
6. Open-circuit faults		
7. Short-circuit faults		
8. Defective electronic components		
Indicator: Fault identification techniques are well applied		
1. Testing		
2. Measuring		
3. Visualization		
Observation		

Points to Remember

Fault identification techniques

- Testing
- Measuring
- Visualization

Learning outcome 2 .2 formative assessment

Written assessment

1. Identify general faults that occur in multimeter

2. The following are fault identification techniques except
   a) Testing
   b) Measuring
   c) Visualization
   d) Soldering

Answer:

1. faults that occur in multimeter:
   - Battery failure
   - Buttons freeze
   - Screen crash
   - Probes cut-out
   - Electronic circuit failure: Open-circuit trace faults Short-circuit trace faults Defective electronic components
2. Soldering

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply Fault identification techniques. Assume you're in a position of the applying Fault identification techniques as requested by your guest.

Answer: Check list is provided in the practical activities

LEARNING OUTCOME 2. 3: FIX MULTIMETER FAULTS

Duration: 3hrs

Learning outcome 3 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify Faults fixing techniques

2. Assemble and disassemble multimeter

Resources		
Equipment	**Tools**	**Materials**
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 2.3.1. Faults fixing techniques

Desoldering and Soldering different component

- ✓ **Solder**

Turning to the actual techniques of soldering, firstly it's best to secure the work somehow so that it doesn't move during soldering and affect your accuracy. In the case of a printed circuit board, various holding frames are fairly popular especially with densely populated boards: the idea is to insert all the parts on one side ("stuffing the board"), hold them in place with a special foam pad to prevent them falling out, turn the board over and then snip off the wires with cutters before making the joints. The frame saves an awful lot of turning the board over and over, especially with large boards. Other parts could be held firm in a modeler's small vice, for example. Solder joints may need to possess some degree of mechanical strength in some cases, especially with wires soldered to, say, potentiometer or switch tags, and this means that the wire should be looped through the tag and secured before solder is applied. The down side is that it is more difficult to de-solder the joint (see later) and remove the wire afterwards, if required. Otherwise, in the case of an ordinary circuit board, components' wires are bent to fit through the board, inserted flush against the board's surface, splayed outwards a little so that the part grips the board, and then soldered.

Desoldering Methods

A soldered joint which is improperly made will be electrically "noisy", unreliable and is likely to get worse in time. It may even not have made any electrical connection at all, or could work initially and then cause the equipment to fail at a later date ! It can be hard to judge the quality of a solder joint purely by appearances, because you cannot say how the joint actually formed on the inside, but by following the guidelines there is no reason why you should not obtain perfect results.

A joint which is poorly formed is often called a "dry joint". Usually it results from dirt or grease preventing the solder from melting onto the parts properly, and is often noticeable because of the tendency of the solder not to "spread" but to form beads or globules instead, perhaps partially. Alternatively, if it seems to take an inordinately long time for the solder to spread, this is another sign of possible dirt and that the joint may potentially be a dry one.

A typical printed circuit board, or PCB, contains a large number of electronic components.

These components are held on the board by solder flux that creates a strong bond between the pins of a component and their corresponding pads on the board. However, the main purpose of this solder is to provide electrical connectivity. Soldering and desoldering is performed to install a component on a PCB or to remove it from the board.

Soldering is a process used for joining metal parts to form a mechanical or electrical bond. It typically uses a low melting point metal alloy (solder) which is melted and applied to the metal parts to be joined and this bonds to the metal parts and forms a connection when the solder freezes. It is different to welding in that the parts being joined are not melted and are usually not the same material as the solder.

Soldering is a common practice for assembling electrical components and wiring.

Soldering may be used to join wires or attached components to a printed circuit board (PCB). Wires, component leads and tracks on circuit boards are mostly made of copper. The copper is usually covered with a thin layer of tin to prevent oxidization and to promote better bonding to other parts with solder. When soldering bare copper wires they are often “tinned” by applying molten solder before making a joint.

Replacement of defective components

A method of replacing a defective electronic component having a plurality of electrical leads bonded to electrical contacts on a support by cutting leads adjacent the bond site, rebounding the stubs to the contacts, replacing the defective component and bonding the leads of the replacement component to the electrical contacts. Preferably, the leads are cut simultaneously with the rebounding of the stubs. The leads may be bonded to the top of the stub or to the side of the stub. A bonding tool is provided for simultaneously cutting a lead and rebounding the resultant stub.

Removing the short circuit

Short Circuits : In electrical devices, short circuits are usually caused by a breakdown in a wire's insulation or when another conductor is introduced and causes the electricity to flow in an unintended way. To fix this problem, you will need to replace the wire.
Locate the wires in your device that are causing the short. Remove the wire by using a soldering gun to melt the solder holding the wire to the contact point and pulling the wire free.
Make a new wire to replace the damaged one. To do this you can go to your local hardware store and purchase wire that have already been cut and prepared. These wires will come in specific lengths, so if you want a length that's different from these you can make your own.
Unwind a length of insulated copper wire from a spool and cut the wire so its the length you need. Use utility knife to remove some of the insulation from both ends of the wire. Expose enough wire so that you can easily attach it to the contact points.
Put some solder on the contact points and put the wire's exposed ends on them.
Use your soldering iron to attach the new wire to the contact points.

Removing the open circuit :
Remember that wherever an open circuit exists, although voltage may be present there will be no current flow through the open circuit section of the circuit. Also, as Power (P) is V x I and the current (I) = 0, no power will be dissipated.

2.3.2. Multimeter assembling process

After fixing the faults in multimeter, you put all parts in its slot and put-on the cover and insert the screws in the holes. Then use screw driver to fix well all screws in these holes according to the user manual.

Summary for the trainer related to the learning outcome

Faults fixing techniques:

- Desoldering and soldering different components
- Replacement of defective components.
- Removing the shortcircuit
- Removing the open circuit


Theoretical learning Activity

Ask trainees to brainstorm about fault fixing techniques in multimeter


Practical learning Activity

✓ Trainee in pair apply Fault fault fixing techniques in multimeter and multimeter assembling process

Check list

Check list	**Score**	
	Yes	**No**
Indicator: multimeter Faults fixing techniques are well applied		
1. Desoldering and Soldering different components		
2. Replacement of defective components		
3. Removing the short circuit		
4. Removing the open circuit		
Indicator: Multimeter assembling process is applied		
1. User manual is well followed		
Observation		


Points to Remember

Removing short circuitisveryimportant before testing your device

Learning outcome 2 .3 formative assessment

Written assessment

1. Identify Faults fixing techniques of multimeter

   Answer

   1. Desoldering and soldering different components
   2. Replacement of defective components.
   3. Removing the short circuit
   4. Removing the open circuit

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to fix digital multimeter. Assume you're in a position of the fixing the digital multimeter as requested by your guest.

Answer: Check list is provided in the practical activities

LEARNING OUTCOME 2.4: TEST MULTIMETER

Duration: 1hrs

Learning outcome 4 objectives :

By the end of the learning outcome, the trainees will be able to:

1.Apply Testing techniques techniques

Resources

Equipment	**Tools**	**Materials**
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 2.4.1. Testing techniques

Continuity testing

In electronics, a continuity test is the checking of an electric circuit to see if current flows (that it is in fact a complete circuit). A continuity test is performed by placing a small voltage (wired in series with an LED or noise-producing component such as a piezoelectric speaker) across the chosen path. If electron flow is inhibited by broken conductors, damaged components, or excessive resistance, the circuit is "open". Devices that can be used to perform continuity tests include multimeters which measure current and specialized continuity testers which are cheaper, more basic devices, generally with a simple light bulb that lights up when current flows. An important application is the continuity test of a bundle of wires so as to find the two ends belonging to a particular one of these wires ; there will be a negligible resistance between the "right" ends, and only between the "right" ends.

Voltage measurement

Instruments for measuring voltages include the voltmeter, the potentiometer, and

the oscilloscope. Analog voltmeters, such as moving-coil instruments, work by measuring the current through a fixed resistor, which, according to Ohm's Law, is proportional to the voltage across the resistor. The potentiometer works by balancing the unknown voltage against a known voltage in a bridge circuit. The cathode-ray oscilloscope works by amplifying the voltage and using it to deflect an electron beam from a straight path, so that the deflection of the beam is proportional to the voltage. To measure voltage is to determine the “differential” voltage between two separate points in an electrical circuit. For example, to measure the voltage across a single resistor, you measure the voltage at both ends of the resistor. The difference between the voltages is the voltage across the resistor. Usually, differential voltage measurements are useful in determining the voltage that exists across individual elements of a circuit, or if the signal sources are noisy.

Current measurement

Current can be measured using an ammeter. Electric current can be directly measured with a galvanometer, but this method involves breaking the electrical circuit, which is sometimes inconvenient. Current can also be measured without breaking the circuit by detecting the magnetic field associated with the current. There are two main ways to measure current one is based on electromagnetics and is associated with the early moving coil meter, and the other is based on the main theory of electricity, Ohm’s law.

Electronic components testing

Repairing an electronic device begins with testing these electronic components through multimeter. Multimeters can measure resistance, current, voltage capacitance and identification of transistor pinout such as NPN and PNP. They can test devices powered by either AC or DC voltages and work in or out of circuit.

Functionality testing

Functional Testing is defined as a type of testing which verifies that each function of the device/circuit operates in conformance with the requirement specification. It is performed by feeding input to the circuit/device and test/measure the output.

Resistance tests how much current is lost as electricity flows through a component or circuit. It’s measured in ohms, and it is slightly more complicated to test than continuity.

Whereas continuity works on a range of zero to one (or OL), resistance can come in different strengths so you need to know how much resistance a given part should have.

Summary for the trainer related to the learning outcome content

Testing techniques:

- Continuity testing
- Voltage measurement
- Current measurement
- Electronic components testing
- Functionality testing

Theoretical learning Activity

Ask trainees to discuss about testing technique of multimeter

Practical learning Activity

Trainee in pair apply multimeter Testing techniques

Check list

Check list	**Score**	
	Yes	**No**
Indicator: Testing techniques are well stated		
1. Continuity testing		
2. Voltage measurement		
3. Current measurement		
4. Electronic components testing		
Indicator: Testing techniques are applied		

1. Continuity testing		
2. Voltage measurement		
3. Current measurement		
4. Electronic components testing		
Observation		

Learning outcome 2.4 formative assessment

Written assessment

1.List any two testing techniques applied after digital multimeter repair.

2. Answer true or False:

a) Checking available voltage at the two terminals of component is called continuity testing

b) The following components are found inside the multimeter: Diode, Resistor and transistor.

Answer:

1. Testing techniques are:

- Continuity
- Voltage measurement
- Current measurement
- Electronic components

2. a) False

   b) True

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to Apply testing techniques of digital multimeter. Assume you're in such position as requested by your guest.

Answer: Check list is provided in the practical activities

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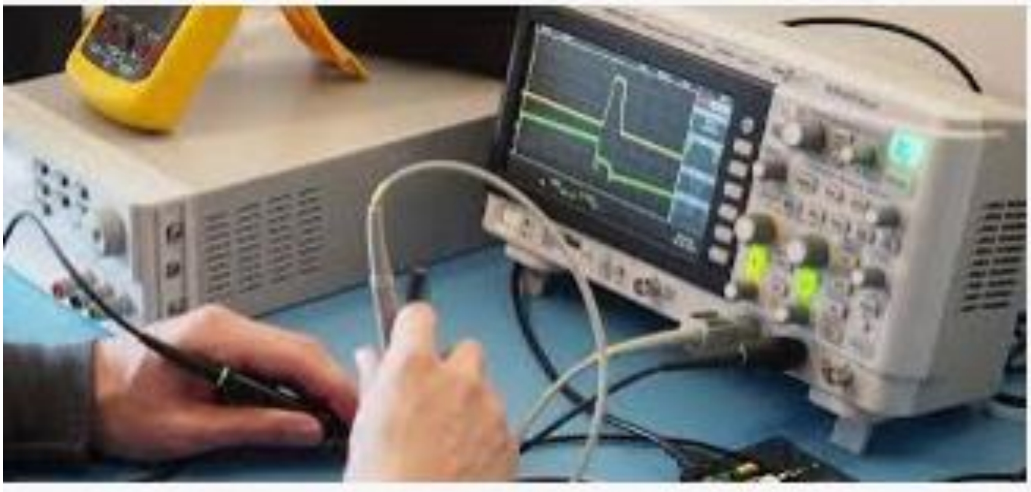
LEARNING UNIT 3: REPAIR THE OSCILLOSCOPE



STRUCTURE OF LEARNING UNIT

Learning outcomes:

3.1 Check Oscilloscope parts
3.2 Identify faults
3.3 Fix faulty parts
3.4 Test Oscilloscope

Learning outcome 3.1 Check Multimeter functional parts

Duration: 20hrs

Learning outcome 1 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Explain correctly oscilloscope operation

2. Describe oscilloscope functional part

3. Disassembling oscilloscope

4. Check perfectly oscilloscope parts

Resources

Equipment	Tools	Materials
- Multimeter - Oscillscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

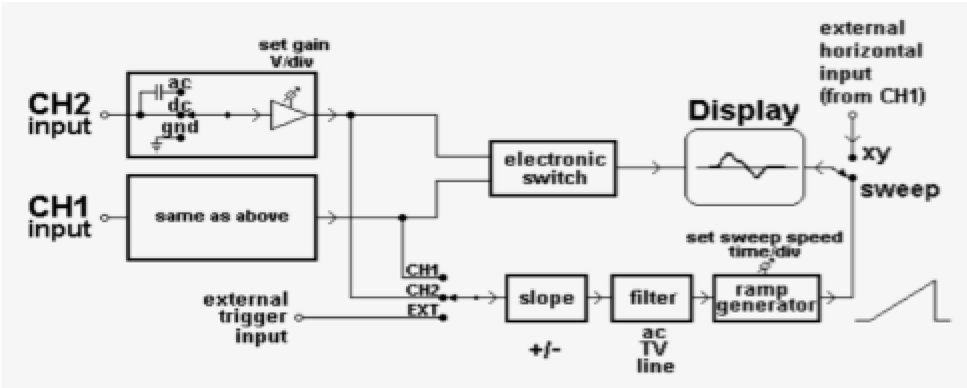
Availability of Materials, tools and equipment

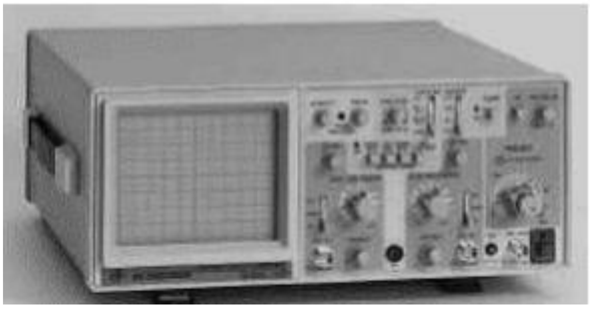
Proper preparation of working place

Availability of electricity

Indicative content 3.1.1 Introduction to oscilloscope operation

The single most important diagnostic tool used by experimental physicists is the oscilloscope. Certainly all scientists and engineers should be familiar with this common instrument. An oscilloscope (scope for short) can be used to "see" an electrical signal by displaying a duplication of a voltage signal as a function of time. The display is generated by a sweeping electron beam striking a fluorescent screen, the same principle behind common television displays. The purpose of this lab exercise is to introduce the fundamentals of oscilloscope operation and its practical use. The oscilloscope is used to obtain "voltage versus time" pictures of electrical signals. The display consists of a tube with an electron gun, x and y-deflection plates, and a phosphor screen which glows in response to an internal electron beam. In normal operation the beam is swept continuously from left to right at a uniform speed. (The beam is shut off during its rapid return to the left side.) A triggered ramp generator generates this sweep motion by applying a "sawtooth" voltage to the x-deflection plates. The sweep rate and method of triggering can be varied using controls on the front panel. An external voltage connected to one of the oscilloscope inputs can be internally amplified and applied to the y-deflection plates. The combination of the x and y-motions then causes the beam to trace out a plot of the input voltage as a function of time.

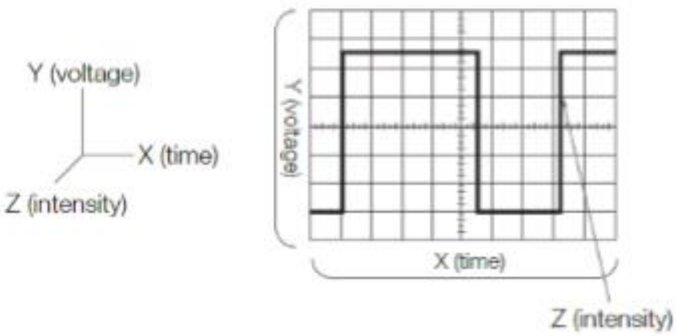




3.1.2. Description of oscilloscope functional parts

Display

The oscilloscope is basically a graph-displaying device it draws a graph of an electrical signal. In most applications, the graph shows how signals change over time: the vertical(Y) axis represents voltage and the horizontal (X) axis represents time. The intensity or brightness of the display is sometimes called the Z axis. The Z axis can be represented by color grading of the display.



Control part

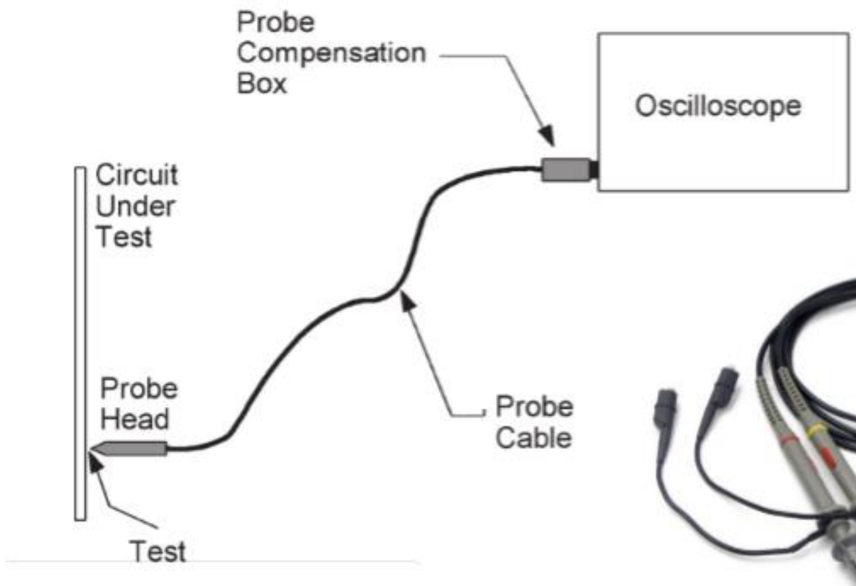
The Systems and Controls of an Oscilloscope a basic oscilloscope consists of four different systems the vertical system, horizontal system, trigger system, and display system. Understanding each of these systems will enable you to effectively apply the oscilloscope to tackle your specific measurement challenges.

Buttons

The menu system consists of a front-panel menu button that, when pressed, displays a menu for the desired function. If the Math button has been pressed while one or more of the analog input channels is active, the Math menu appears across the bottom of the display. The available menu selections are Dual Waveform Math, FFT, Advanced Math, Label and Auto-Scale. Each of these selections has an associated soft key directly below it.

Probes

An oscilloscope probe is a device that makes a physical and electrical connection between a test point or signal source and an oscilloscope. Depending on your measurement needs, this connection can be made with something as simple as a length of wire or with something as sophisticated as an active differential probe. Essentially, a probe is some sort of device or network that connects the signal source to the input of the oscilloscope.



3.1.3. Oscilloscope disassembling process

This is process of breaking down a device into separate parts. Make sure the Oscilloscope is turned off, then start the standard way of removing cases used to be to undo the screws on the case. The screwdrivers as per the type of screw are required to do that task after detaching the internal board from the oscilloscope. It includes removing the power cable from electricity switchboard, before removing all the connectors from the motherboard, make sure you memorize the connectors for assembling the oscilloscope if required, as that may require connecting the connectors at its place. Remove the screws from the back of the motherboards and you will be able to detach it from the cabinet.

3.1.4. Checking methods

Visual checking

Visual Inspection, or Visual Testing (VT), is the oldest and most basic method of inspection. It is the process of looking over a piece of equipment using the naked eye to look for flaws. It requires no equipment except the naked eye of a trained inspector. Visual inspection is simple and less technologically advanced compared to other methods. Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective. This is because there is no equipment that is required to perform it. For similar reasons it also one of the easiest inspection techniques to perform. It is also one of the most reliable techniques. A well-trained inspector can detect most signs of damage.

Measuring Measurement is the process of using a device or tool to find the dimensions, time, pressure, amount, weight or mass of an object. We use measurements to help us solve problems in many real world situations. There are many types of test instruments used for troubleshooting. Some are specialized instruments, designed to measure various behaviors of specific equipment. There are other types of instruments, such as multimeters, that are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC voltages, resistance and current.

- Voltmeter : A voltmeter is used to test the differences in voltage between two points.
- Ohmmeter : An ohmmeter is used to measure the resistance between two points in a circuit.
- Ammeter : An ammeter is an instrument for measuring the current flowing in a circuit in amperes.
- Multimeter : A multimeter can test voltage, resistance and current. It is an ohmmeter, voltmeter and ammeter all in one.

2.1.5. Checking Oscilloscope parts

Display

To begin, plug the cord into the wall socket, adjust the front support for easy viewing, and turn on the scope by depressing the red power button at the lower right of the front panel. Configure the knob and switch settings Most of these settings will be discussed at length. After the scope warms up, with these initial settings, a horizontal line (or possibly two) should appear on the screen. If not, try the positioning knobs explained below. Use the intensity knob to adjust the brightness of the so-called trace, but no more intense than necessary as this has a detrimental effect on the phosphor of the display. Use the focus knob to adjust the sharpness of the trace. Positioning of the trace is accomplished with the knobs labeled with vertical or horizontal arrows. In the upper right hand corner, moves the trace horizontally. The position knobs in the middle of the front panel move their respective traces vertically.

Control part

When using an oscilloscope, you adjust settings in these areas to accommodate an incoming

Signal :

- ✓ Vertical : This is the attenuation or amplification of the signal. Use the volts/div control to adjust the amplitude of the signal to the desired measurement range.
- ✓ Horizontal : This is the time base. Use the sec/div control to set the amount of time per division represented horizontally across the screen.
- ✓ Trigger : This is the triggering of the oscilloscope. Use the trigger level to stabilize a repeating signal, or to trigger on a single event.

Vertical System and Controls

Vertical controls are used to position and scale the waveform vertically, set the input coupling, and adjust other signal conditioning. Common vertical controls include :

- ✓ Position
- ✓ Coupling : DC, AC, and GND
- ✓ Bandwidth : Limit and Enhancement
- ✓ Termination : 1M ohm and 50 ohms
- ✓ Offset
- ✓ Invert : On/Off
- ✓ Scale : Fixed Steps and Variable

Horizontal System and Controls

An oscilloscope's horizontal system is most closely associated with its acquisition of an input signal. Sample rate and record length are among the considerations here. Horizontal controls are used to position and scale the waveform horizontally. Common horizontal controls include :

- ✓ Acquisition
- ✓ Sample Rate
- ✓ Position and Seconds per Division
- ✓ Time Base
- ✓ Zoom/Pan
- ✓ Search
- ✓ XY Mode
- ✓ Trigger Position
- ✓ Scale

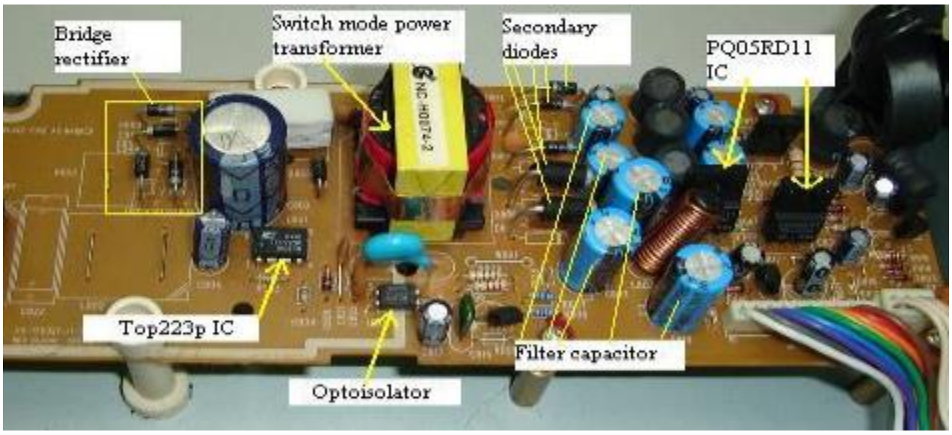
- ✓ Trace Separation
- ✓ Record Length
- ✓ Resolution

Trigger System and Controls

An oscilloscope's trigger function synchronizes the horizontal sweep at the correct point of the signal. This is essential for clear signal characterization. Trigger controls allow you to stabilize repetitive waveforms and capture single-shot waveforms. The trigger makes repetitive waveforms appear static on the oscilloscope display by repeatedly displaying the same portion of the input signal.

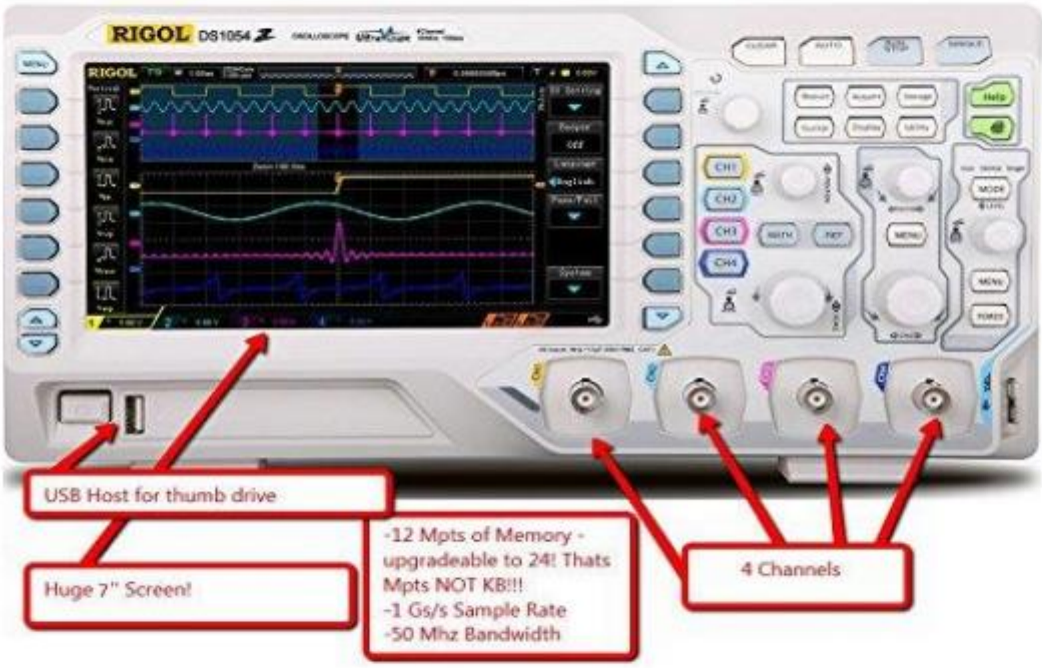
Power supply

Once the measurement system is properly set up, the task of performing power measurements can begin. The common power measurements can be divided into three categories : input analysis, switching device analysis and output analysis.



Ports

When you plug the active probe cable connector into the analog channel input port, the oscilloscope detects the active probe type and characteristics. Depending on the manufacturer, it may permit the user to refine measurement and display. Active probes differ from passive probes in other respects. Their dynamic range is lower, typically three to eight volts. They can be damaged by probing above rated voltage and also by electrostatic discharge. To limit electromagnetic interference, the ground return lead may be screened.



Buttons

- ✓ Plug in: The power cord attaches to the 3 pin socket on the back of the oscilloscope.
- ✓ Turn on: The power button is found on the front of the oscilloscope at the far lower left.

Press the power button and wait around 10 seconds for the device to start up

Connect inputs

The two input terminals to the oscilloscope are of BNC type. You may need to use a BNC-banana adaptor to connect the usual wires you use to construct circuits in your experiments, in which case a positive and negative banana wire are combined by the adaptor into one BNC lead. The BNC leads fit into the input terminals with a push and twist. The GDS-1022 is a dual channel oscilloscope and so will take two simultaneous inputs.

Default Setup

To return the scope to its default setup you must first press the "Save/Recall" Menu button and then select "Default Setup" from the displayed menu using the first Function button. The scope remembers its previous settings so the default setup option can be useful.

Horizontal Menu Button Settings

The Horizontal Menu button is found immediately above the TIME/DIV knob.

Menu button

Upon pressing the Horizontal Menu button (circled, right) the horizontal menu options appear next to the Function buttons, headed by "Hor. MENU".

Display button Settings

The Display button is found among the Menu buttons.

- ✓ Display button

Upon pressing the display button the Display menu appears next to the Function buttons. From the Display menu you can select:

- ✓ Vector or dot drawing
- ✓ Accumulate
- ✓ Refresh
- ✓ Contrast
- ✓ Grid options

Probes

Probes have different (sometimes switchable) attenuation ratios that change how the signals are fed into your oscilloscope. For example, a 10:1 probe connected to a 1-V signal will pass 100 mV to the scope's input.

Summary for the trainer related to the learning outcome

Oscilloscope functional parts

- Display
- Control part
- Power supply
- Ports
- Buttons
- Probes

Theoretical learning Activity

- ✓ Ask trainees to brainstorm about main part of digital Oscilloscope within groups

Practical learning Activity

Trainee in pair:

- **Check oscilloscope parts functionalities**
- **Apply oscilloscope disassembling process**

Check list

Check list	**Score**	
	Yes	**No**
Indicator: oscilloscope operation is well described		
1. Oscilloscope usage		
Indicator: oscilloscope functional parts are well described		
1. Display		
2. Control part		
3. Power supply		
4. Ports		
5. Buttons		
6. Probes		
Indicator: Probes oscilloscope parts functionalities are well Checked		
1. Display		
2. Control part		
3. Ports		
4. Power supply		
5. Buttons		
6. Probes		
Indicator: Oscilloscope disassembling process is well applied		
1. Visual checking		
2. Measuring		
Indicator: Multimeter parts functionalities are well checked		
1. User manual is well followed		
Observation		

Points to Remember

Oscilloscope is used to measure amplitude, frequency and period of testing circuit

Learning outcome 3.2 formative assessment

Written assessment

1. List main parts of digital oscilloscope
2. State two (2) Checking methods

Answer:

1. Main part of multimeter: Display, Control part, Power supply, Ports, Buttons, Probes
2. Two Checking methods are Visual checking and Measuring

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply oscilloscope disassembling process. Assume you're in a position of the apply oscilloscope disassembling process as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 3.2: Identify oscilloscope faults

Duration: 5hrs
Learning outcome 2 objectives : By the end of the learning outcome, the trainees will be able to: 1. Identify general faults that occur in oscilloscope 2. Describe fault identification techniques of oscilloscope
Resources

Equipment	Tools	Materials
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 3.2.1. Identification of general faults that occur in oscilloscope

Power supply system failure

A bad power supply can be the root of many oscilloscope problems. Caused by a faulty power supply that would normally be overlooked. How to diagnose a faulty supply by testing its voltage outputs, as well as how to replace the defective unit. There are some obvious signs that should lead you to suspect a faulty power supply.

These signs **include :**

A system that is completely dead (nothing happens when the system is turned on)

Smoke

Circuit breakers popping when the device is turned on.

Buttons freeze

You try to press the button on your oscilloscope, but no one of them do not do anything. The

Buttons are jammed If the buttons are not working, the buttons may be jammed and you will need to replace them.

Screen crash

Screen can be crashed due to external pressure stress or expiration of installed software used, you have differentiated these difference issues before doing any diagnostic on screen. If screen crash caused by external pressure stress you have to replace with the new one which is compatible with the previous one.

Probes cut-out

A probe works in conjunction with an oscilloscope as part of the measurement system. Precision measurements start at the probe tip. The right probes matched to the oscilloscope and the device under test (DUT) not only allow the signal to be brought to the oscilloscope cleanly, they also amplify and preserve the signal for the greatest signal integrity and measurement accuracy.

Electronic circuit failure

Electronic circuit have a wide range of failure modes. These can be classified in various ways such as by time or cause. Failure can be caused by excess temperature, excess current or voltage, ionizing radiation, mechanical shock, stress or impact and many other causes.

Open-circuit trace faults

Open-circuit voltage (abbreviated as OCV or VOC) is the difference of electrical potential between two terminals of a device when disconnected from any circuit. There is no external load connected. No external electric current flows between the terminals.

Alternatively, the open-circuit voltage may be thought of as the voltage that must be applied to a solar cell or a battery to stop the current. Current will only flow in a circuit. That is, around a continuous path (or multiple paths) from and back to the source of EMF. Any interruption in the circuit, such as an open switch, a break in the wiring, or a component such as a resistor that has changed its resistance to an extremely high value will cause current to cease. The EMF will still be present, but voltages and currents around the circuit will have changed or ceased all together. The open switch or the fault has caused what is commonly called an open circuit.

Remember that wherever an open circuit exists, although voltage may be present there will be no current flow through the open circuit section of the circuit.

Short-circuit trace faults

A short circuit (sometimes abbreviated to short or s/c) is an electrical circuit that allows

a current to travel along an unintended path with no or very low electrical impedance. This results in an excessive current flowing through the circuit. The opposite of a short circuit is an "open circuit", which is an infinite resistance between two nodes. It is common to misuse "short circuit" to describe any electrical malfunction, regardless of the actual problem.

Defective electronic components

Electronic components have a wide range of failure modes. These can be classified in various ways, such as by time or cause. Failures can be caused by excess temperature, excess current or voltage, ionizing radiation, mechanical shock, stress or impact, and many other causes. In semiconductor devices, problems in the device package may cause failures due to contamination, mechanical stress of the device, or open or short circuits.

3.2.2. Fault identification techniques

Testing

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. You can use a standard multimeter or if you are looking for a quick and easy way to test components.

Measuring

Measurement is the process of using a device or tool to find the dimensions, time, pressure, amount, weight or mass of an object. We use measurements to help us solve problems in many real world situations. There are many types of test instruments used for troubleshooting. Some are specialized instruments, designed to measure various behaviors of specific equipment. There are other types of instruments, such as multimeters, that are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC voltages, resistance and current.

Visualization

Visualization, or Visual Testing (VT), is the oldest and most basic method of inspection. It is the process of looking over a piece of equipment using the naked eye to look for flaws. It requires no equipment except the naked eye of a trained inspector. Visual inspection is simple and less technologically advanced compared to other methods. Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective.

⚠ Summary for the trainer related to the learning outcome

General faults that occur in oscilloscope

- Power supply system failure
- Buttons freeze
- Screen crash
- Probes cut-out
- Electronic circuit failure


Theoretical learning Activity

✓ Ask trainees to brainstorm about difference fault occur in oscilloscope within groups


Practical learning Activity

✓ Trainees in pair apply fault identification techniques

Check list

Check list	**Score**	
	Yes	**No**
Indicator: oscilloscope general faults are well identified		
1. Power supply system failur		
2. Buttons freeze		
3. Screen crash		
4. Probes cut-out		
5. Open-circuit trace faults		
6. Short-circuit trace faults		
7. Grounding faults		
8. Defective electronic components		
Indicator: oscilloscope Fault identification techniques are well applied		
1. Testing		
2. Measuring		
3. Visualization		
Observation		

Learning outcome 3.2 formative assessment

Written assessment

1. Identify general faults that occur in Oscilloscope
2. The following are fault identification techniques except
   a) Testing
   b) Measuring
   c) Visualization
   d) Soldering

Answer:

Faults that occur in multimeter:

- Buttons freeze
- Screen crash
- Probes cut-out
- Electronic circuit failure: Open-circuit trace faults Short-circuit trace faults Defective electronic components

2. Soldering

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply Fault identification techniques. Assume you're in a position of the applying oscilloscope disassembling process as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 3.3: Fix the oscilloscope faulty parts

Duration: 3hrs

Learning outcome 3 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify Faults fixing techniques of Oscilloscope
2. Assemble and disassemble Oscilloscope

Resources

Equipment	**Tools**	**Materials**
✓ Multimeter ✓ Oscilloscope ✓ Power supply ✓ Function generator ✓ Computer ✓ Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 3.3.1. Faults fixing techniques

Desoldering and Soldering different component

- ✓ **Solder**

Turning to the actual techniques of soldering, firstly it's best to secure the work somehow so that it doesn't move during soldering and affect your accuracy. In the case of a printed circuit board, various holding frames are fairly popular especially with densely populated boards: the idea is to insert all the parts on one side ("stuffing the board"), hold them in place with a special foam pad to prevent them falling out, turn the board over and then snip off the wires with cutters before making the joints. The frame saves an awful lot of turning the board over and over, especially with large boards. Other parts could be held firm in a modeler's small vice, for example. Solder joints may need to possess some degree of mechanical strength in some cases, especially with wires soldered to, say, potentiometer or switch tags, and this means that the wire should be looped through the tag and secured before solder is applied. The down side is that it is more difficult to de-solder the joint (see later) and remove the wire afterwards, if required. Otherwise, in the case of an ordinary circuit board, components' wires are bent to fit through the board, inserted flush against the board's surface, splayed outwards a little so that the part grips the board, and then soldered.

Desoldering Methods

A soldered joint which is improperly made will be electrically "noisy", unreliable and is likely to get worse in time. It may even not have made any electrical connection at all, or could work initially and then cause the equipment to fail at a later date! It can be hard to judge the quality of a solder joint purely by appearances, because you cannot say how the joint actually formed on the inside, but by following the guidelines there is no reason why you should not obtain perfect results.

A joint which is poorly formed is often called a "dry joint". Usually it results from dirt or grease preventing the solder from melting onto the parts properly, and is often noticeable because of the tendency of the solder not to "spread" but to form beads or globules instead, perhaps partially. Alternatively, if it seems to take an inordinately long time for the solder to spread, this is another sign of possible dirt and that the joint may potentially be a dry one.

A typical printed circuit board, or PCB, contains a large number of electronic components.

These components are held on the board by solder flux that creates a strong bond between the pins of a component and their corresponding pads on the board. However, the main purpose of this solder is to provide electrical connectivity. Soldering and desoldering is performed to install a component on a PCB or to remove it from the board.

Soldering is a process used for joining metal parts to form a mechanical or electrical bond. It typically uses a low melting point metal alloy (solder) which is melted and applied to the metal parts to be joined and this bonds to the metal parts and forms a connection when the solder freezes. It is different to welding in that the parts being joined are not melted and are usually not the same material as the solder.

Soldering is a common practice for assembling electrical components and wiring.

Soldering may be used to join wires or attached components to a printed circuit board (PCB). Wires, component leads and tracks on circuit boards are mostly made of copper. The copper is usually covered with a thin layer of tin to prevent oxidization and to promote better bonding to other parts with solder. When soldering bare copper wires they are often “tinned” by applying molten solder before making a joint.

Replacement of defective components

A method of replacing a defective electronic component having a plurality of electrical leads bonded to electrical contacts on a support by cutting leads adjacent the bond site, rebounding the stubs to the contacts, replacing the defective component and bonding the leads of the replacement component to the electrical contacts. Preferably, the leads are cut simultaneously with the rebounding of the stubs. The leads may be bonded to the top of the stub or to the side of the stub. A bonding tool is provided for simultaneously cutting a lead and rebounding the resultant stub.

Removing the short circuit

Short circuits: In electrical devices, short circuits are usually caused by a breakdown in a wire's insulation or when another conductor is introduced and causes the electricity to flow in an unintended way. To fix this problem, you will need to replace the wire.

Locate the wires in your device that are causing the short. Remove the wire by using a soldering gun to melt the solder holding the wire to the contact point and pulling the wire free.

Make a new wire to replace the damaged one. To do this you can go to your local hardware store and purchase wire that have already been cut and prepared. These wires will come in specific lengths, so if you want a length that's different from these you can make your own.

Unwind a length of insulated copper wire from a spool and cut the wire so its the length you need. Use a utility knife to remove some of the insulation from both ends of the wire. Expose enough wire so that you can easily attach it to the contact points.

Put some solder on the contact points and put the wire's exposed ends on them. Use your soldering iron to attach the new wire to the contact points.

Removing the open circuit

Remember that wherever an open circuit exists, although voltage may be present there will be no current flow through the open circuit section of the circuit. Also, as Power (P) is V x I and the current (I) = 0, no power will be dissipated.

Ic

3.3.2. Oscilloscope assembling process

The assembling of the oscilloscope is exactly the opposite of disassembling operation. Before starting assembling the oscilloscope, make sure you have the screws and a screwdriver for those screws header.

Steps to be followed are :

1. The first step for assembling the oscilloscope starts with mounting the motherboards in socket of the case. You don't need to apply any force. The special ZIF (zero insertion force) to prevent any damage to the boards inserted in the case.
2. Now select the appropriate cable and connect one end of the cable to its socket and another end at its appropriate connector on the motherboards for linking them together.

3. Put-on the cover and start screwing the screws in its appropriate holes by using correspond screwdrivers.

Summary for the trainer related to the learning outcome

Faults fixing techniques:
- Desoldering and soldering different components - Replacement of defective components. - Removing the shortcircuit - Removing the open circuit

Theoretical learning Activity

- ✓ Ask trainees to brainstorm about difference fault fixing techiniques applied in oscilloscope within groups

Practical learning Activity

Trainee in pair fix the oscilloscope

Check list

Check list	Score

	Yes	No
Indicator: Testing techniques are well stated		
1. Desoldering and Soldering different components		
2. Replacement of defective components		
3. Removing the short circuit		
4. Removing the open circuit		
Indicator: oscilloscope Faults fixing techniques are well applied		
1. Desoldering and Soldering different components		
2. Replacement of defective components		
3. Removing the short circuit		
4. Removing the open circuit		
5. Desoldering and Soldering different components		
Observation		

Learning outcome 3.3 formative assessment

Written assessment

1. Identify Faults fixing techniques of Oscilloscope
2. Complete the sentence with the words in brackets

Soldering is a process used for ……………. metal parts to form a mechanical or electrical bond. Replacing the defective component is done by the process of……….. (joining, desoldering)

Answer:

1. Fixing faults techniques:

5. Desoldering and soldering different components
6. Replacement of defective components.
7. Removing the short circuit
8. Removing the open circuit

2. Soldering is a process used for **joining** metal parts to form a mechanical or electrical bond. Replacing the defective component is done by the process of desoldering.

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply multimeter assembling process. Assume you're in a position of the appling multimeter assembling process as requested by your guest.

Learning outcome 3.4: Test oscilloscope

Duration: 1hrs

Learning outcome 4 objectives :

By the end of the learning outcome, the trainees will be able to:

1.Apply Testing techniques techniques of oscilloscope

Resources

Equipment	Tools	Materials
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 3.4.1. Testing techniques

Continuity testing

In electronics, a continuity test is the checking of an electric circuit to see if current flows (that it is in fact a complete circuit). A continuity test is performed by placing a small voltage (wired in series with an LED or noise-producing component such as a piezoelectric speaker) across the chosen path. If electron flow is inhibited by broken conductors, damaged components, or excessive resistance, the circuit is "open". Devices that can be used to perform continuity tests include multimeters which measure current and specialized continuity testers which are cheaper, more basic devices, generally with a simple light bulb that lights up when current flows. An important application is the continuity test of a bundle of wires so as to find the two ends belonging to a particular one of these wires ; there will be a negligible resistance between the "right" ends, and only between the "right" ends.

Voltage measurement

Instruments for measuring voltages include the voltmeter, the potentiometer, and the oscilloscope. Analog voltmeters, such as moving-coil instruments, work by measuring the current through a fixed resistor, which, according to Ohm's Law, is proportional to the voltage across the resistor. The potentiometer works by balancing the unknown voltage against a known voltage in a bridge circuit. The cathode-ray oscilloscope works by amplifying the voltage and using it to deflect an electron beam from a straight path, so that the deflection of the beam is proportional to the voltage. To measure voltage is to determine the “differential” voltage between two separate points in an electrical circuit. For example, to measure the voltage across a single resistor, you measure the voltage at both ends of the resistor. The difference between the voltages is the voltage across the resistor. Usually, differential voltage measurements are useful in determining the voltage that exists across individual elements of a circuit, or if the signal sources are noisy.

Current measurement

Current can be measured using an ammeter. Electric current can be directly measured with galvanometer, but this method involves breaking the electrical circuit, which is sometimes inconvenient. Current can also be measured without breaking the circuit by detecting the magnetic field associated with the current. There are two main ways to measure current one is based on electromagnetics and is associated with the early moving coil meter, and the other is based on the main theory of electricity, Ohm’s law.

Electronic components testing

Repairing an electronic device begins with testing these electronic components through a multimeter. Multimeters can measure resistance, current, voltage capacitance and identification of transistor pinout such as NPN and PNP. They can test devices powered by either AC or DC voltages and work in or out of circuit.

Functionality testing

Functional Testing is defined as a type of testing which verifies that each function of the device/circuit operates in conformance with the requirement specification. It is performed by feeding input to the circuit/device and test/measure the output.

Resistance tests how much current is lost as electricity flows through a component or circuit. It's measured in ohms, and it is slightly more complicated to test than continuity.

Whereas continuity works on a range of zero to one (or OL), resistance can come in different strengths so you need to know how much resistance a given part should have.

Summary for the trainer related to the learning outcome content

Testing techniques :

- Continuity testing
- Voltage measurement
- Current measurement
- Electronic components testing
- Functionality testing

Theoretical learning Activity

Ask trainees to discuss about fault testing technique of oscilloscope

Practical learning Activity

Trainee in pair apply oscilloscope testing techniques

Check list

Check list	Score

	Yes	No
Indicator: oscilloscope Testing techniques are described		
1. Continuity testing		
2. Voltage measurement		
3. Current measurement		
4. Electronic components testing		
Indicator: oscilloscope Testing techniques are applied		
1. Continuity testing		
2. Voltage measurement		
3. Current measurement		
4. Electronic components testing		
5. Functionality testing		
Observation		

Learning outcome 3.4 formative assessment

Written assessment

1.List any two testing techniques applied after oscilloscope repair.

2. Answer true or False:

a) Checking available voltage at the two terminals of component is called continuity testing

b) The following components are found inside the oscilloscope: Diode, Capacitor and transistor.

Answer:

1. Testing techniques are:

- Continuity
- Voltage measurement
- Current measurement
- Electronic components

2. a) False

   b) True

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to Apply testing techniques of oscilloscope. Assume you're in such position as requested by your guest.

Answer: Check list is provided in the practical activities

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1. IET LABS, I. (2006). LCR meter information guide. West Roxbury: WikipediA/www.ietlabs.com .
2. PAIN, R. (1996). Practical electronic fault finding and troubleshooting. Oxford : Reed Educational and publishing Ltd.
3. Tektronix. (30 october 2009). oscilloscope fundamentals. www.tektronix.com.

LEARNING UNIT 4: REPAIR THE SPECTRUM ANALYSER

STRUCTURE OF LEARNING UNIT

Learning outcomes:

1.1 Check Spectrum Analyser functional parts
1.2 Identify spectrum analyser faults
1.3 Fix spectrum analyser faulty parts
1.3 Test spectrum analyser

Learning outcome 4.1 Check Spectrum Analyser functional parts

Duration: 10hrs

Learning out come 1objectives :

By the end of the learning outcome, the trainees will be able to:

1.Explain the working principle of spectrum analyser

2.Disassemble the spectrum analyser

3.Check the function of spectrum analyser parts

Resources

Equipment	**Tools**	**Materials**
- Multimeter - spectrum analyser - Computer - PPE	- Screw driver kit - Plier kit - Allen keys - Internet access	- Electronic components - Breadboard - Books - White board - Marker pen - Duster - Class notes

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 4.1.1: Introduction to spectrum analyser operation

A spectrum analyser is a device that displays signal amplitude (strength) as it varies by signal frequency. The frequency appears on the horizontal axis, and the amplitude is displayed on the vertical axis. To the casual observer, a spectrum analyser looks like an oscilloscope, and in fact, some devices can function either as oscilloscopes or spectrum analysers. The electronics industry uses spectrum analysers to examine the frequency spectrum of radio frequency (RF) and audio signals. These devices display the individual elements of these signals, as well as the performance of the circuits producing them. Through the use of spectrum analysers, organizations can determine what modifications may be needed to reduce interference and thus improve the performance of Wi-Fi systems and wireless routers.

a. How spectrum analysers work

Most spectrum analysers offer users the opportunity to set a start, stop and center frequency. The center frequency is halfway between the stop and start frequencies and is also the axis for the frequency used to determine the span the range between the start and stop frequencies.

With an RF spectrum analyser, the analyser measures the radio "noise floor" and measures how close two signals can be while still being resolved into two separate peaks. Today, as spectrum analysis software and digital or spectrum analyser app offerings have become more common, more analysers are able to do analog-to-digital conversion and sample a significant input signal and frequency range. A modern spectrum analyser may be able to show displayed average noise level, calculating the average noise level detected by the device. These detectors are typically capable of sample detection, peak detection or average detection.

b) Uses for spectrum analysers

A spectrum analyser can be used to determine whether or not a wireless transmitter is working according to federally defined standards for purity of emissions. Output signals at frequencies other than the intended communications frequency appear as vertical lines (pips) on the display. A spectrum analyser can also be used to determine, by direct observation, the bandwidth of a digital or analog signal.

c. Types of spectrum analysers

- **Swept or superheterodyne**

A swept-tuned, or superheterodyne, spectrum analyser down-converts part of the input signal to the center frequency of a band-pass filter by running a voltage-controlled oscillator across a range of frequencies. This allows for the full frequency range of the device to be analyzed. In this case, the resolution bandwidth is closely related to the minimum bandwidth detectable by the device and is controlled by the band-pass filter. The smaller the bandwidth, the greater the spectral resolution.

- **Fast Fourier transformer**

FFT Some digital spectrum analysers use Fourier transforms a way of decomposing a signal into its individual frequencies. These analysers need a sampling frequency at least twice the bandwidth because frequency resolution is the inverse of the time over which the wave is measured and Fourier transformed

- **Real-time**

Real-time analysers collect real-time bandwidth and sample the incoming RF spectrum in a limited span of time, converting the information using the fast Fourier transform (FFT) algorithm. Because it's real-time data collection, there is no "blind time," and there are no gaps in the calculated RF spectrum.

- **Audio**

Spectrum analysers can also be used in the audio spectrum, displaying volume levels of frequency bands audible to humans. This method is aimed at analyzing the harmonics of an audio signal. Once known as wave analysers, these types of spectrum analysers are widely used by sound engineers and can run on almost any computer equipped with a sound card.

d. Advantages and disadvantages

Swept-tuned spectrum analysers face tradeoffs between how rapidly the display can update a full frequency span and the resolution. Sometimes, if engineers are working with a very weak signal, a preamplifier is needed before analysis can begin. On the other hand, FFT analysers can strain the capabilities of analog-to-digital converters and require significant processing power, limiting the possible frequency range that can be analyzed. Real-time FFT analysers can offer good resolution while reducing potential gaps in sampling.

The input of the spectrum analyser cannot tolerate large signals; before you connect a signal to the input, be sure you know that the signal will not exceed the maximum allowable input rating of the spectrum analyser.

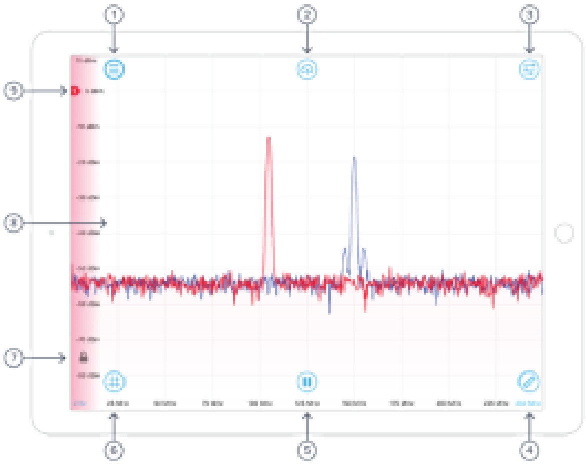
Indicative content 4.1.2: Spectrum analyser disassembling

This is process of breaking down a device into separate parts.
Steps:

1. Make sure the spectrum analyser is turned off, then start the standard way of removing cases used to be to undo the screws in the case.
2. The screwdrivers as per the type of screw are required to do that task after detaching the internal board from the spectrum analyser. It includes removing the power cable from electricity switchboard, before removing all the connectors from the motherboard, make sure you memorize the connectors for assembling the spectrum analyser if required, as that may require connecting the connectors at its place.
3. Remove the screws from the back of the motherboards and you will be able to detach it from the cabinet.

Indicative content 4.1.3: Description of spectrum analyser functional parts

a. User Interface



1 Main menu

2. Save data

3. Controls

4. measurements

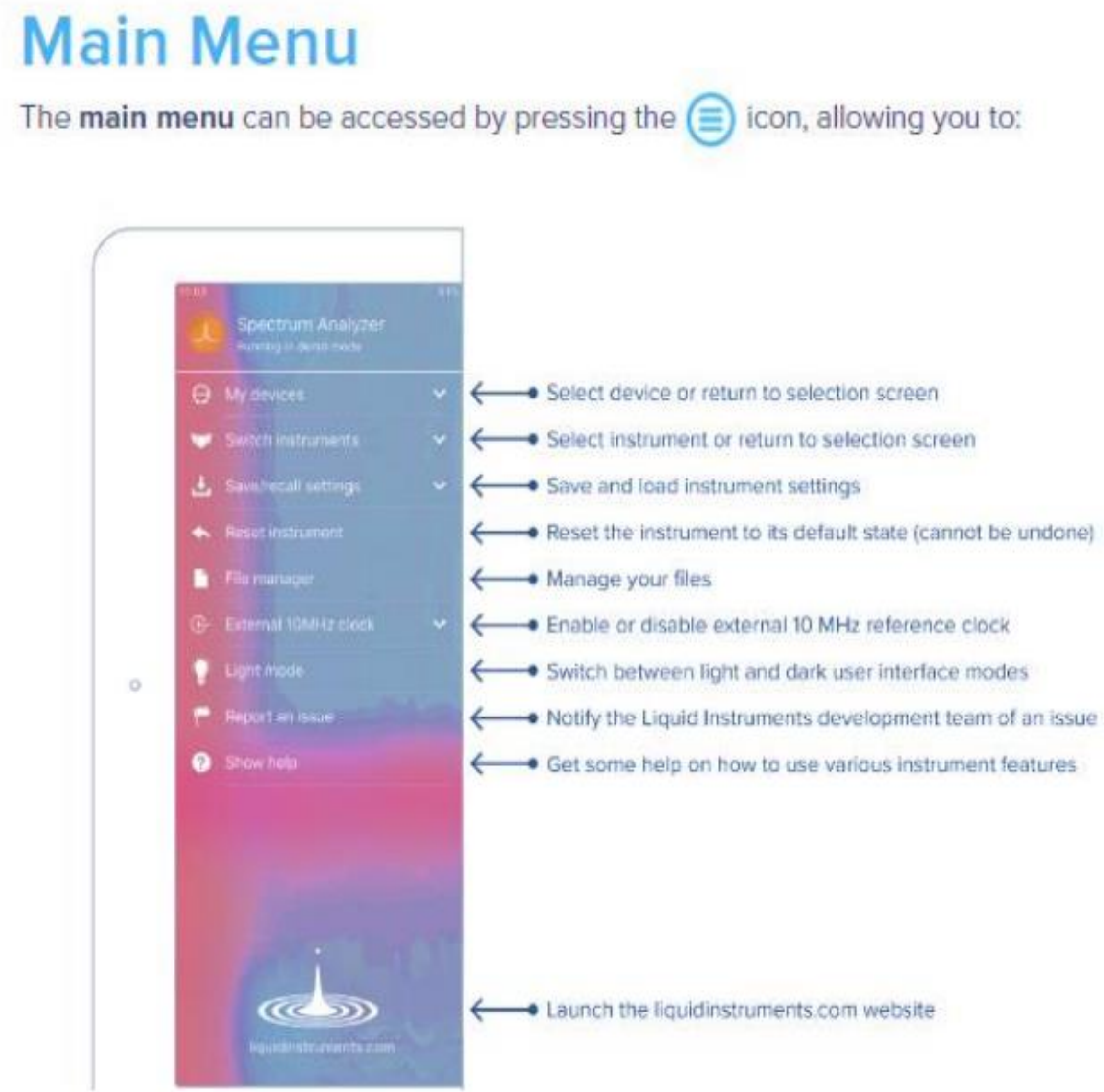
5. Play/Pause

6. Cursors

7.Vertical scaleslock

8. Signal display area

9. Reference position indicator



b. Controls

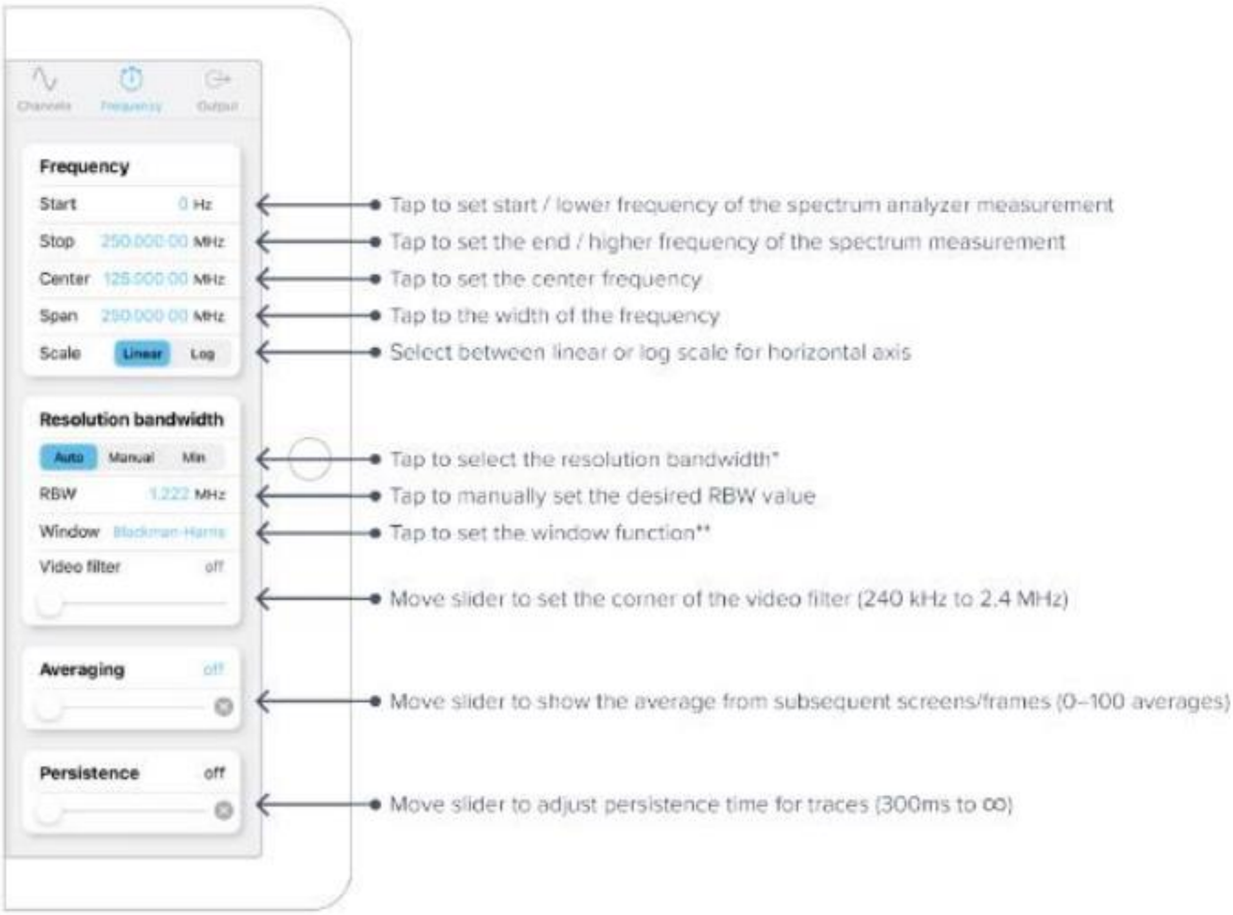
The controls options can be accessed by pressing the icon, allowing you to reveal or hide the control drawer, giving access to all instrument settings. Also available by swiping in from/out to the right-hand side of the screen. Controls drawer gives you access to Channels, Frequency, and Output settings.

Channels

The channels pane allows you to change the input settings for each ADC channel and adjust the input scales, coupling, and enable/disable the math channel.

Frequency

The frequency pane allows you to change parameters related to the frequency domain (horizontal axis), including frequency span, resolution bandwidth and video bandwidth.



Note that [Start, stop] and [Center, Span] in the frequency panel are equivalent representations of the measured frequency range.

Auto: determines the best resolution to sync

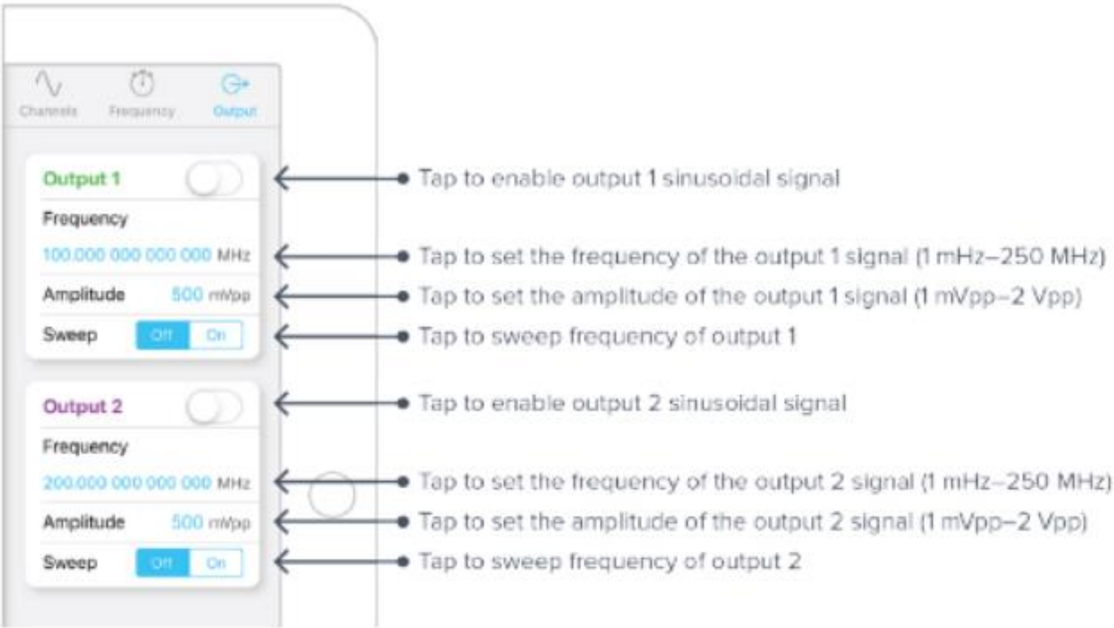
Manual: manually set the resolution bandwidth of the spectrum analyser

Min: uses the smallest RBW available.

Available options: Blackman-Harris, Flat top, Hanning, and None.

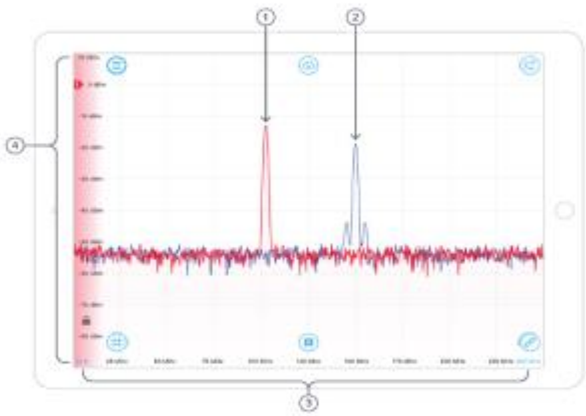
c. Output

The output pane allows you to configure the integrated sine wave generator for the spectrum analyser.



d. Display

This area is intended to display the spectrum of input and math channels, where the horizontal axis is the measured frequency range and the vertical axis is the power or PSD in linear or log scales.

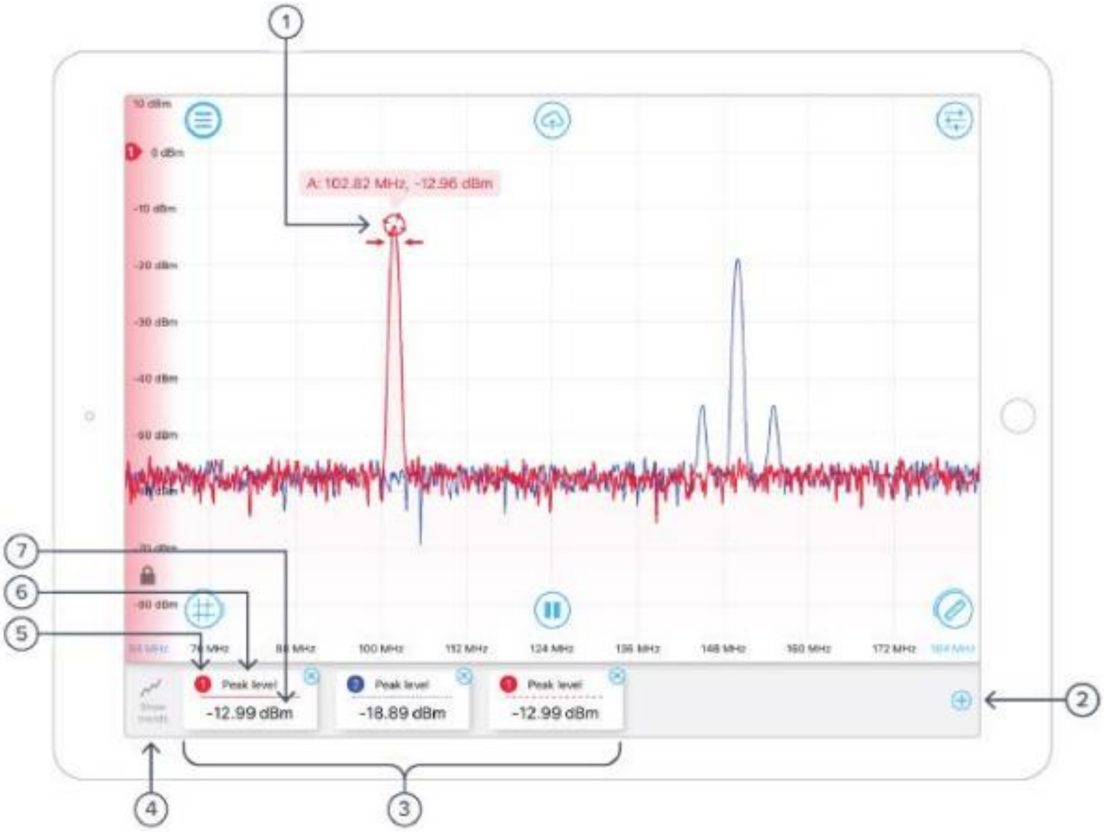


ID	Description
1	Spectrum for input Channel 1
2	Spectrum for input Channel 2.
3	Frequency axis: shows the frequency scale for both channels
4	Power axis: shows the power scale for the active channel

The scales of both axes can be adjusted by pinch the touch screen. The shaded color near the vertical axis indicates the active channel. Red represents channel 1, blue represents channel 2, and yellow represents the math channel. The vertical scales of the two channels can be locked with the lock button

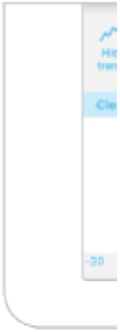
e. Measurements

The measurements can be accessed by pressing the icon, allowing you to add/remove measurements to probe spectra's peak level, peak frequency, power, etc. The measurement function operates on a per channel or per markers basis.



ID	Description
1	Measurement marker, tap to reveal additional options
2	Tap to add measurements
3	List of current measurement cards, tap to reveal additional options
4	Tap to show measurements trends.
5	Source channel
6	Measurement type
7	Measurement reading

Note that measurement markers can be added by dragging the measurement icon to snap on the input signal. In addition, a plot of measurements vs. time can be accessed by tapping the show trends button.

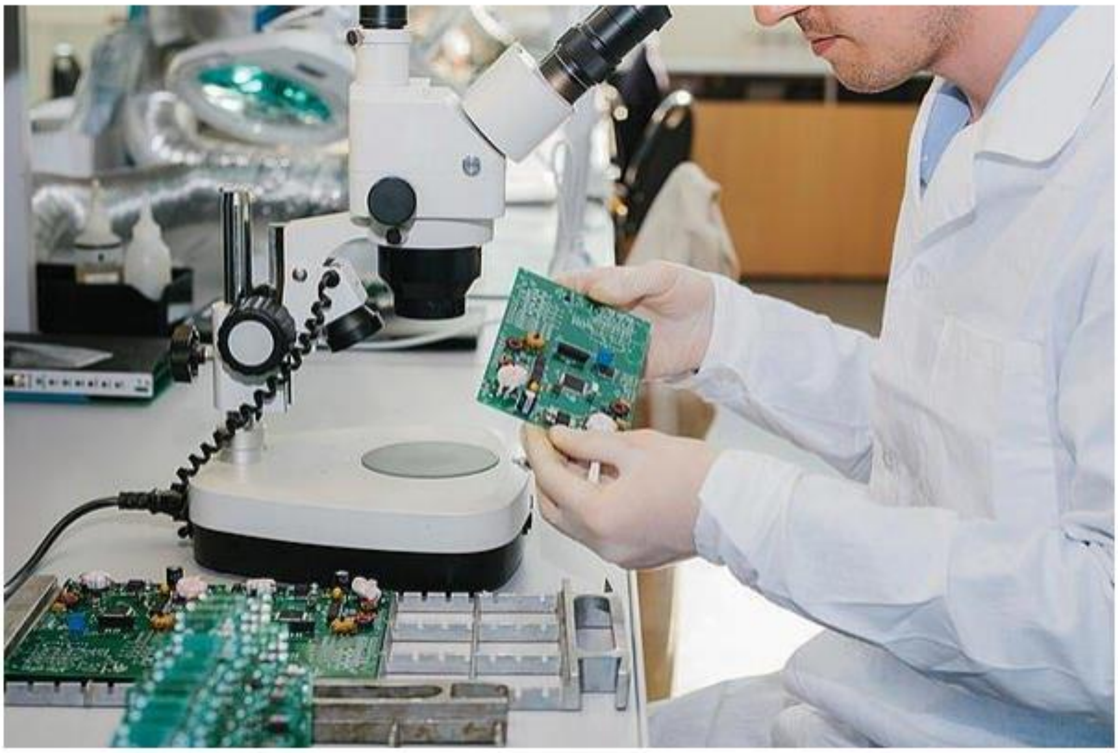


ID	Description
1	Trend line style for Tile
2	Trend line style for Tile
3	Trend line for Tile
4	Trend line for Tile 2

Indicative content 4.1.4: Checking methods

- ✓ **Visual checking**

Visual Inspection, or Visual Testing (VT), is the oldest and most basic method of inspection. It is the process of looking over a piece of equipment using the naked eye to look for flaws. It requires no equipment except the naked eye of a trained inspector. Visual inspection is simple and less technologically advanced compared to other methods. Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective. This is because there is no equipment that is required to perform it. For similar reasons it also one of the easiest inspection techniques to perform. It is also one of the most reliable techniques. A well-trained inspector can detect most signs of damage.



- **Measuring Measurement**

is the process of using a device or tool to find the dimensions, time, pressure, amount, weight or mass of an object. We use measurements to help us solve problems in many real world situations. There are many types of test instruments used for troubleshooting. Some are specialized instruments, designed to measure various behaviors of specific equipment. There are other types of instruments, such as multimeters, that are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC voltages, resistance and current.

- **Voltmeter:** A voltmeter is used to test the differences in voltage between two points.
- **Ohmmeter:** An ohmmeter is used to measure the resistance between two points in a circuit.
- **Ammeter:** An ammeter is an instrument for measuring the current flowing in a circuit in amperes.
- **Multimeter**: A multimeter can test voltage, resistance and current. It is an ohmmeter, voltmeter and ammeter all in one.

General Meter Rules

Before you perform a test, you should know what the meter should read if the circuit is operating normally. You should make your prediction based on a circuit diagram. If the reading is anything other than your predicted value, you know that this part of the circuit is being affected by the electrical fault.

You should always test the meter before using it to troubleshoot.

- For a voltmeter, test the meter on a known voltage source before using. Your meter should read the correct voltage.
- For an ohmmeter, touch the meter leads together. The display should read 0 ohms, or very close to 0. With the leads apart it should read OL (infinity)

Indicative content 4.1.4: Checking spectrum analyser functional parts

a) Display

The display when looking at how to use a spectrum analyser, one of the main elements of the test equipment is the display. The display has a graticule which typically has ten major horizontals and ten major vertical divisions.

The horizontal axis of the analyser is linearly calibrated in frequency with the higher frequency being at the right-hand side of the display. The vertical axis is calibrated in amplitude. This scale is normally logarithmic, although it is often possible to have other scales including linear ones for specialized measurements.

A logarithmic scale is normally used because it enables signals over a very wide range to be seen on the spectrum analyser - signals of interest may vary by 70dB, 80dB or more. Typically, a value of 10 dB per division is used. This scale is normally calibrated in dBm (i.e. decibels relative 1 milliwatt) and therefore it is possible to see absolute power levels as well as comparing the difference in level between two signals.

b) Control part

In addition to the display of the spectrum, modern analysers using digital technology often have soft keys to provide various functions around the edge of the display.

- In addition to the display of the spectrum, modern analysers using digital technology often have soft keys to provide various functions around the edge of the display.

- **Setting the frequency** to set the frequency of a spectrum analyser, there are two selections that can be made. These selections are independent of each other and on different controls or entered via a keypad separately:
    - **Centre frequency**: The Centre frequency selection sets the frequency of the Centre of the scale to the chosen value. It is normally where the signal to be monitored would be located. In this way the main signal is in the Centre of the display and the frequencies either side can be monitored.
    - **Span:** The span selection is the extent of the frequency coverage that is to be viewed or monitored when using the spectrum analyser. The span may be given as a bandwidth per division on the graticule, or the total span that is seen on the calibrated part of the screen, i.e. within the maximum extents of the calibrations on the graticule. Another option that is often available is to set the start and stop frequencies of the scan. This is another way of expressing the span as the difference between the start and stop frequencies is equal to the span. Reducing the span will allow better resolution of the signal, allowing close in components of the signal to be seen.
    - **Top and bottom frequencies**: As an alternative to setting the span and the center frequency, many analysers offer the capability to enter the start and stop or top and bottom frequencies for the sweep.

- **Gain and attenuation adjustments** there are other controls to use on a spectrum analyser. Most of these fall into one of two categories. The first is associated with the gain or attenuation of sections within the spectrum analyser.

If sections of the test equipment are overloaded, then spurious signals may be generated within the instrument. This can be prevented by including extra attenuation using the input attenuator. However, if too much attenuation is inserted, additional gain is required in the later stages (IF gain) and the background noise level is increased and this can sometimes mask lower level signals. Thus a careful choice of the relevant gain levels within the spectrum analyser is needed to obtain the optimum performance.

Modern test equipment often has a single gain control, normally called the reference level control, that combines the input attenuation and IF gain controls. It automatically adjusts both to obtain the optimum setting. In this way both overload at one end the scale and noise floor at the other end are optimized.

Normally the overall gain is adjusted so that the peak of the signal of interest is placed towards the top of the display - typically a gap of 10dB from the top is a sufficient margin. In this way the spurious and other signals over in amplitude can also be seen very easily.

If the reference level is reduced too far, the signals will reduce in value and get progressively closer to the residual noise level. For reasonable measurements there should be a 20dB difference between the signal and the noise.

- **Scan rate** the spectrum analyser operates by scanning the required frequency span from the low to the high end of the required range. The speed at which it does this is important. Obviously the faster it scans the range the faster the measurement can be made. However, the rate of scan of the test instrument is limited by two other elements. These are the filter that is used in the IF, and the video filter that may also be used to average the reading. These filters must have time to respond otherwise signals will be missed and the measurements rendered useless.

  It is still essential to keep the scan rate as high as is reasonably feasible to ensure that measurements are made as quickly as possible. Normally the scan rate, span and the filter bandwidths are linked within the test equipment to ensure the optimum combination is chosen. Scan rate is a key setting especially when large numbers of measurements need to be made, for example in RF design where ICs or RF circuits need to be characterized, or in electronics manufacturer where test times must be kept to a minimum.
- **Filter bandwidths** the other controls concern the filter bandwidths within the instrument. There are generally two types:
  - **IF filter**: The IF filter basic provides the resolution of the spectrum analyser in terms of the frequency. Choosing a narrow filter bandwidth will enable signals to be seen that are close together. However, by the very fact that they are narrow band these filters do not respond to changes as quickly as wider band ones. Accordingly, a slower scan rate must be chosen when using them.

    When having to use narrow bandwidths and slow scan rates, the time that a measurement can be made by reducing the span that needs to be scanned. Even though a slow scan rate must be used, the range over which the scan must be made can be reduced, thereby reducing the scan time for the analyser.
  - **Video filter**: The video filter function was used with many analogue spectrum analysers and is not commonly seen on those using digital signal processing. It provides a form of averaging to be applied to the signal. This has the effect of reducing the variations caused by noise and this can help average the signal and thereby reveal signals that may not otherwise be seen. Using video filtering also limits the speed at which the spectrum analyser can scan. Modern FFT and real time spectrum analysers will have a special averaging function.

    On modern spectrum analysers the filter bandwidth is normally automatically linked with the span, and scan rate, so that the optimum setting is chosen for any given situation. The narrower the filter, the finer the detail that is seen, and the lower the noise floor level. (NB noise is proportional to bandwidth, so the lower the bandwidth the lower the noise). As mentioned above a good rule of thumb is to ensure that there is a 20dB difference between the noise and the signal level for reasonable measurements.

    The filter bandwidth may also be referred to as the resolution in view of the fact that finer detail can be seen with narrower filter bandwidth levels.

- **Markers**: One very useful facility that is incorporated on virtually new spectrum analysers is that of the use of markers. These detect the level of particular portions of the waveform and can be used for measuring the levels of different signals, and comparing figures like the levels of harmonics or spurious signals with respect to the carrier.
  Typically, these markers can be set to select the peak, second peak and so forth, or to measure the level at a given point - a wheel or knob is generally used to set the frequency for this.
  These markers are usually controlled by the soft function keys that are normally present as soft keys on the touch screen, or as buttons around the screen.

✓ **Power supply**

Once the measurement system is properly set up, the task of performing power measurements can begin. The common power measurements can be divided into three categories: input analysis, switching device analysis and output analysis.

✓ **Input Analysis**

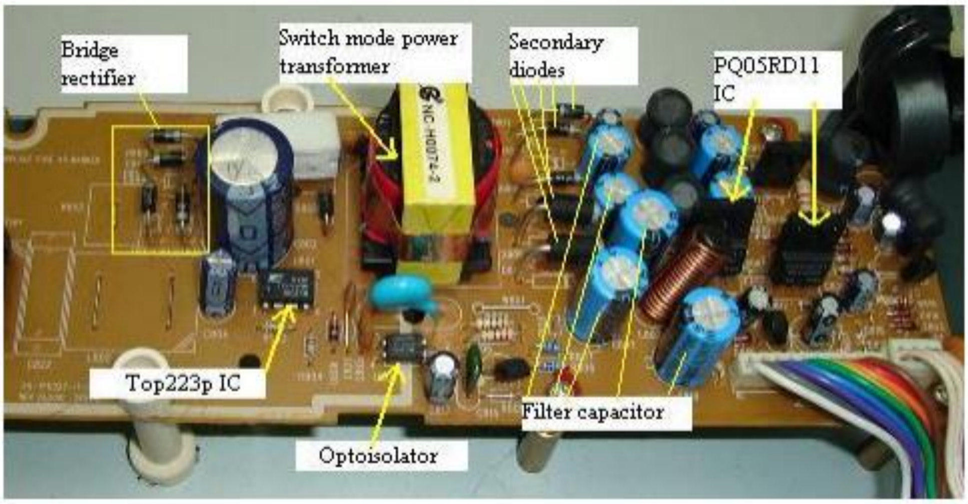
Real-world electrical power lines never supply ideal sine waves, and there is always some distortion and impurity on the line. A switching power supply presents a non-linear load to the source. Because of this, the voltage and current waveforms are not identical. Current is drawn Page 121 of 164 for some portion of the input cycle, causing the generation of harmonics on the input current waveform.

✓ **Harmonics**

Switching power supplies tend to generate predominantly odd-order harmonics, which can find their way back into the power grid. The effect is cumulative, and as more and more switching supplies are connected to the grid (for example, as an office adds more desktop computers), the total percentage of harmonic distortion returned to the grid can rise. Since this distortion causes heat buildup in the cabling and transformers of the power grid, it’s necessary to minimize harmonics.

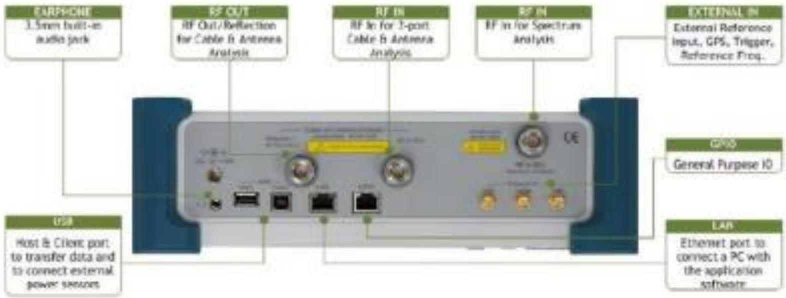
✓ **Power Quality**

Power quality does not depend on the electricity producer alone. It also depends on the power supply and the end user’s load. The power quality characteristics at the power supply define the “health” of the power supply and determine the effects of distortions caused by non-linear loads.



- ✓ **Port**

For applications requiring fewer input ports, the 4-Port Decimator saves you money upfront, and is easily upgraded in the future to an 8-Port Decimator should you require additional input ports. Simply pay the difference for a software upgrade without installing additional hardware. Both units provide a built-in Cross-Pol Isolation measurement function and Carrier Monitoring capability. It is operated as a traditional spectrum analyser, with a browser-based user interface that is intuitive, familiar, and usable right away with no training. The 4-Port or 8-Port Decimator is ideally suited for installation in an RF system, Teleport, broadcast facility, Cable Network or Wireless Cell Tower where multiple feeds need to be monitored, either locally or by using our Remote Management Protocol.



- ✓ **Buttons**

Spectrum Analyser Tab:

Clicking this tab brings out the Spectrum Analyser instrument in front. The white box will allow the user to run/stop the Spectrum Analyser while other instrument tab is open.

Signal Plot:

Displays the signal in frequency domain. X-axis measures the frequency of the signal and Y-axis displays the amplitude in dBFS.

Channel Controls:

Clicking the orange or violet button allows the user to enable/disable the channels. Clicking the button on the right of the channel will bring out the channel settings.

Sweep:

Clicking the Sweep button will bring out the sweep settings that will allow the user to modify the signal plot window’s display.

Markers:

Clicking the marker button will bring out the marker controls.

Run/Stop and Single Run:

Clicking the Run button will allow the spectrum analyser to continuously capture data. Clicking the Single button will allow the spectrum analyser the capture the data once.

Instrument Settings:

Clicking the instrument settings button will show the instrument settings panel.

Last opened panel:

Clicking this button will bring out the last opened panel.

- ✓ **Probes**

RF probes that are engineered for in-circuit test measurement that can be used with signal/spectrum analysers, signal source analysers and network analysers.

Spectrum Analysers are generally used to measure radio frequency (RF) signals. The signals are generally conveyed to the RF input of the analyser with an antenna, magnetic probe, or utilizing a cable link with a matched impedance. This decreases impedance mismatching which usually lessens reflected power and gives the most accurate measurement. This is not generally an adequate connection technique especially in circuits that are always prone to loading when connected to low impedance inputs, more particularly on Spectrum Analysers.

Summary for the trainer related to the learning outcome content

- ✓ A spectrum analyser is a device that displays signal amplitude (strength) as it varies by signal frequency
- ✓ Types of spectrum analysers

• Swept or superheterodyne • Fast Fourier transformer • Real-time • Audio

Theoretical learning Acivity

- ✓ Ask trainees to discuss about spectrum analyser operation within groups
- ✓ Ask trainees to discuss about spectrum analyzer functional parts within groups

Practical learning Activity

Trainee in pair:

- Apply spectrum analyser checking methods
- Check spectrum analyser parts functionalities

Check list

Check list	**Score**	
	Yes	**No**
Indicator: spectrum analyser operation is well described		
1. Spectrum analyser usage is well identified		
Indicator: Spectrum analyser disassembling process is well applied		
1.user manual is well followed		
Indicator: spectrum analyzer functional parts are well described		
1. Display		
2. Control part		
3. Power supply		
4. Ports		
5. Buttons		
6. Probes		
Indicator: spectrum analyser Checking methods are well applied		
1. Display		
2. Control part		
3. Ports		
4. Power supply		
5. Buttons		
6. Probes		
Indicator: spectrum analyser Checking methods are well applied		

1. Visual checking		
2. Measuring		
Indicator: spectrum analyser parts functionalities are well checked		
1. Display		
2. Control part		
3.		
Observation		

Learning outcome 4.1 formative assessment

Written assessment

1. List main parts of spectrum analyse
2. Explain working principle of spectrum analyse

Answer:

1. Main part of multimeter: Display, Control part, Power supply, Ports, Buttons, Probes
2. A spectrum analyzer is a device that displays signal amplitude (strength) as it varies by signal frequency. The frequency appears on the horizontal axis, and the amplitude is displayed on the vertical axis. To the casual observer, a spectrum analyzer looks like an oscilloscope, and in fact, some devices can function either as oscilloscopes or spectrum analysers.

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply spectrum analyzer disassembling process. Assume you're in a position of the apply spectrum analyzer disassembling process as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 4.2 Identify spectrum analyser faults

Duration: 8hrs

Learning out come 2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify general faults that occur in spectrum analyser:

2.Describe fault techniques identification in spectrum analyser

Resources

Equipment	**Tools**	**Materials**
- Multimeter - spectrum analyser - Computer - PPE - Electricity tester	- Screw driver kit - Plier kit - Allen keys - Internet access	- Electronic components - Breadboard - Books - White board - Marker pen - Duster - Class notes

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 4.2.1: Identification of general faults that occur in oscilloscope

a) Power supply system failure

A bad power supply can be the root of many oscilloscope problems. Caused by a faulty power supply that would normally be overlooked. How to diagnose a faulty supply by testing its voltage outputs, as well as how to replace the defective unit.

There are also some obvious signs that should lead you to suspect a faulty power supply. These signs include:

- A system that is completely dead (nothing happens when the system is turned on) ♣ Smoke
- Circuit breakers popping when the device is turned on.

b) Buttons freeze

You try to press the button on your oscilloscope, but no one of them do not do anything. The buttons are jammed If the buttons are not working, the buttons may be jammed and you will need to replace them.

c) Screen crash

Screen can be crashed due to external pressure stress or expiration of installed software used, you have differentiated these difference issues before doing any diagnostic on screen. If screen crash caused by external pressure stress you have to replace with the new one which is compatible with the previous one.

d) Probe

A probe works in conjunction with an oscilloscope as part of the measurement system. Precision measurements start at the probe tip. The right probes matched to the oscilloscope and the device under test (DUT) not only allow the signal to be brought to the oscilloscope cleanly, they also amplify and preserve the signal for the greatest signal integrity and measurement accuracy.

e) electronic circuit failure

- **Open-circuit trace faults**

Open-circuit voltage (abbreviated as OCV or VOC) is the difference of electrical potential between two terminals of a device when disconnected from any circuit. There is no external load connected. No external electric current flows between the terminals. Alternatively, the open-circuit voltage may be thought of as the voltage that must be applied to a solar cell or a battery to stop the current. Current will only flow in a circuit. That is, around a continuous path (or multiple paths) from and back to the source of EMF. Any interruption in the circuit, such as an open switch, a break in the wiring, or a component such as a resistor that has changed its resistance to an extremely high value will cause current to cease. The EMF will still be present, but voltages and currents around the circuit will have changed or ceased altogether. The open switch or the fault has caused what is commonly called an open circuit.

Remember that wherever an open circuit exists, although voltage may be present there will be no current flow through the open circuit section of the circuit.

- **Short-circuit trace faults**

A **short circuit** (sometimes abbreviated to **short** or **s/c**) is an electrical circuit that allows a current to travel along an unintended path with no or very low electrical impedance. This results in an excessive current flowing through the circuit. The opposite of a short circuit is an "open circuit", which is an infinite resistance between two nodes. It is common to misuse "short circuit" to describe any electrical malfunction, regardless of the actual problem.

- **Ground faults**

Ground faults is a type of fault that caused by missing of ground wire in the circuit this can cause unpredicted movement of electrical charge that can spread in all circuit and result the over current in the circuit. It is said to be dangerous faults because it can cause electrocution where you touch on any conduction parts of devices due to motion of unpredicted changes. It causes power disturbance in the current which tend the devices to be damaged and overheat

- **Defective electronic components**

Electronic components have a wide range of failure modes. These can be classified in various ways, such as by time or cause. Failures can be caused by excess temperature, excess current or voltage, ionizing radiation, mechanical shock, stress or impact, and many other causes.

In semiconductor devices, problems in the device package may cause failures due to contamination, mechanical stress of the device, or open or short circuits

Indicative content 4.2.2: Fault identification techniques

a) Testing

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. You can use a standard multimeter or if you are looking for a quick and easy way to test components.

b) Measuring

Measurement is the process of using a device or tool to find the dimensions, time, pressure, amount, weight or mass of an object. We use measurements to help us solve problems in many real-world situations. There are many types of test instruments used for troubleshooting. Some are specialized instruments, designed to measure various behaviors of specific equipment. There are other types of instruments, such as multimeters, that are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC voltages, resistance and current.

c) Visualization

Visualization, or Visual Testing (VT), is the oldest and most basic method of inspection. It is the process of looking over a piece of equipment using the naked eye to look for flaws. It requires no equipment except the naked eye of a trained inspector. Visual inspection is simple and less technologically advanced compared to other methods.

Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective

Summary for the trainer related to the learning outcome content

General faults that occur in spectrum analyse:

- Power supply system failure
- Buttons freeze
- Screen crash
- Probes cut-out
- Electronic circuit failure (Open-circuit, trace faults, Short-circuit trace faults Grounding faults, and Defective electronic components)

Theoretical learning Acivity

- ✓ Ask trainees to describe general faults that occur in spectrum analyser within groups
- ✓ Ask trainees to discuss Fault identification techniques within groups

Practical learning Activity

Trainee in Apply faults identification methods

Check list

Check list	Score	
	Yes	No

Indicator: spectrum analyser general faults are well identified		
1. Power supply system failure		
2. Buttons freeze		
3. Screen crash		
4. Probes cut-out		
5. Open-circuit trace faults		
6. Short-circuit trace faults		
7. Grounding faults		
8. Defective electronic components		
Indicator: Fault identification techniques are well applied		
1. Testing		
2. Measuring		
3. Visualization		
Observation		

Learning outcome 4.2 formative assessment

Written assessment

1. Identify general faults that occur in general faults that occur in spectrum analyzer
2. The following are fault identification techniques except
   e) Testing
   f) Measuring
   g) Visualization
   h) Desoldering

Answer:

1. General faults that occur in spectrum analyzer

   - Buttons freeze
   - Screen crash
   - Probes cut-out
   - Electronic circuit failure: Open-circuit trace faults Short-circuit trace faulty e defective electronic components

2. Soldering

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply Fault identification techniques of spectrum analyser. Assume you're in a position of the applying faults identification method as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 4.3 Fix spectrum analyser faulty parts

Duration: 7hrs		
Learning out come 2 objectives : By the end of the learning outcome, the trainees will be able to: 1. Apply fault fixing techniques to repair spectrum analyser 2.Assemble the spectrum analyser		
Resources		
Equipment	**Tools**	**Materials**
- Multimeter - spectrum analyser - Computer - PPE - Electricity tester	- Screw driver kit - Plier kit - Allen keys - Internet access	- Electronic components - Breadboard - Books - White board - Marker pen - Duster - Class notes
Advance preparation: Availability of Materials, tools and equipment		

Proper preparation of working place Availability of electricity

Indicative content 4.3.1: Faults fixing techniques

a) Solder

Turning to the actual techniques of soldering, firstly it's best to secure the work somehow so that it doesn't move during soldering and affect your accuracy. In the case of a printed circuit board, various holding frames are fairly popular especially with densely populated boards: the idea is to insert all the parts on one side ("stuffing the board"), hold them in place with a special foam pad to prevent them falling out, turn the board over and then snip off the wires with cutters before making the joints. The frame saves an awful lot of turning the board over and over, especially with large boards. Other parts could be held firm in a modeler’s small vice, for example.

Solder joints may need to possess some degree of mechanical strength in some cases, especially with wires soldered to, say, potentiometer or switch tags, and this means that the wire should be looped through the tag and secured before solder is applied. The down side is that it is more difficult to de-solder the joint (see later) and remove the wire afterwards, if required. Otherwise, in the case of an ordinary circuit board, components' wires are bent to fit through the board, inserted flush against the board's surface, splayed outwards a little so that the part grips the board, and then soldered.

Desoldering Methods

A soldered joint which is improperly made will be electrically "noisy", unreliable and is likely to get worse in time. It may even not have made any electrical connection at all, or could work initially and then cause the equipment to fail at a later date! It can be hard to judge the quality of a solder joint purely by appearances, because you cannot say how the joint actually formed on the inside, but by following the guidelines there is no reason why you should not obtain perfect results.

A joint which is poorly formed is often called a "dry joint". Usually it results from dirt or grease preventing the solder from melting onto the parts properly, and is often noticeable because of the tendency of the solder not to "spread" but to form beads or globules instead, perhaps partially. Alternatively, if it seems to take an inordinately long time for the solder to spread, this is another sign of possible dirt and that the joint may potentially be a dry one.

- **Replacement of defective components**

A method of replacing a defective electronic component having a plurality of electrical leads bonded to electrical contacts on a support by cutting leads adjacent the bond site, rebounding the stubs to the contacts, replacing the defective component and bonding the leads of the replacement component to the electrical contacts. Preferably, the leads are cut simultaneously with the rebounding of the stubs. The leads may be bonded to the top of the stub or to the side of the stub. A bonding tool is provided for simultaneously cutting a lead and rebounding the resultant stub.

- **Removing the short circuit**

Short Circuits: In electrical devices, short circuits are usually caused by a breakdown in a wire's insulation or when another conductor is introduced and causes the electricity to flow in an unintended way. To fix this problem, you will need to replace the wire.

Locate the wires in your device that are causing the short. Remove the wire by using a soldering gun to melt the solder holding the wire to the contact point and pulling the wire free. Make a new wire to replace the damaged one. To do this you can go to your local hardware store and purchase wire that have already been cut and prepared. These wires will come in specific lengths, so if you want a length that's different from these you can make your own. Unwind a length of insulated copper wire from a spool and cut the wire so it's the length you need. Use a utility knife to remove some of the insulation from both ends of the wire. Expose enough wire so that you can easily attach it to the contact points. Put some solder on the contact points and put the wire's exposed ends on them. Use your soldering iron to attach the new wire to the contact points.

- **Removing the open circuit**

Remember that wherever an open circuit exists, although voltage may be present there will be no current flow through the open circuit section of the circuit. Also, as Power (P) is V x I and the current (I) = 0, no power will be dissipated. Looking further at the simple circuit used in Resistors & Circuits Module. Let´s put some actual voltages and currents in and see what happens under 'Open Circuit' conditions. To select a number of open circuit conditions that might occur in different parts of the circuit. Notice how the voltages and currents around the circuit change depending on where the break in the circuit (the open circuit) occurs. Checking the voltages around a circuit with a voltmeter, and noticing where they differ from what would be expected in a correctly working circuit, is one of the main techniques used for tracing a fault in any circuit.

Making sense of this method depends on understanding a few basic facts about the circuit:

- The current IS supplied to the circuit by the battery (E) is divided into two currents I1 flowing through R1 and I2 flowing through R2 and R3.

- Because R2 and R3 are connected in series, the same current (I2) flows through both resistors.
- Both branches of the circuit (R1 and R2/R3 have the same resistance in this circuit (150Ω, commonly shown in circuit diagrams as 150R).
- Therefore, half of the 40mA supply current (20mA) flows through each 150Ω branch of the circuit, causing the shown voltages to be developed across each resistor.

It would be unusual in practice to be given all of the current and voltage information on every circuit diagram. The voltages and currents would need to be worked out where needed by applying the methods described in our section on Current and Voltage in Series and Parallel Resistor Networks.

Fault finding techniques vary with the complexity of the circuit involved but all rely to some degree on the basic methods shown here, and very often on the application of Ohms Law.

Indicative content 4.3.2: Spectrum analyser assembling process

The assembling of the spectrum analyser is exactly the opposite of disassembling operation.

Steps to be followed:

1. Before starting assembling the spectrum analyser, make sure you have the screws and a screwdriver for those screws' header.
2. first step for assembling the spectrum analyser starts with mounting the motherboards in socket of the case. You don't need to apply any force.
3. The special ZIF (zero insertion force) to prevent any damage to the boards inserted in the case.
4. Now select the appropriate cable and connect one end of the cable to its socket and another end at its appropriate connector on the motherboards for linking them together.
5. Put on the cover and start fastening the screws in its appropriate holes by using correspond screwdrivers.

Summary for the trainer related to the learning outcome

Faults fixing techniques

- Desoldering and soldering different components
- Replacement of defective components
- Removing the short circuit
- Removing the open circuit Functionality testing

Theoretical learning Activity

Ask trainees to discuss about fault fixing technique in Spectrum analyser

Practical learning Activity

Trainees Apply:

- Fault fixing techniques
- Spectrum analyser assembling process

Check list

Check list	**Score**	
	Yes	**No**
Indicator: Faults fixing techniques are well applied		
1. Desoldering and Soldering different components		
2. Replacement of defective components		
3. Removing the short circuit		
4. Removing the open circuit		
Indicator: Spectrum analyzer assembling process is well applied		
1. User manual is well followed		
Observation		

Learning outcome 4.3 formative assessment

Written assessment

1. Identify Faults fixing techniques of spectrum analyzer
2. Answer true or False
   The circuit presents open circuit as fault, its resultant resistance is tending to zero

   Answer:

1. Faults fixing techniques of spectrum analyzer
   - Desoldering and soldering different components
   - Replacement of defective components.
   - Removing the short circuit
   - Removing the open circuit
2. False

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply spectrum analyzer assembling process. Assume you're in a position of the applying spectrum analyzer assembling process as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 4.4: Test spectrum analyser

<table>
<tr><td colspan="3">Duration: 5hrs</td></tr>
<tr><td colspan="3">Learning out come 4 objectives :
By the end of the learning outcome, the trainees will be able to:
1. Apply testing techniques after repair spectrum analyser</td></tr>
<tr><td colspan="3">Resources</td></tr>
<tr><td>Equipment</td><td>Tools</td><td>Materials</td></tr>
</table>

• Multimeter • spectrum analyser • Computer • PPE • Electricity tester	• Screw driver kit • Plier kit • Allen keys • Internet access	• Electronic components • Breadboard • Books • White board • Marker pen • Duster • Class notes
Advance preparation: Availability of Materials, tools and equipment Proper preparation of working place Availability of electricity		

Indicative content 4.4.1: Testing techniques

Continuity testing

In electronics, a continuity test is the checking of an electric circuit to see if current flows (that it is in fact a complete circuit). A continuity test is performed by placing a small voltage (wired in series with an LED or noise-producing component such as a piezoelectric speaker) across the chosen path. If electron flow is inhibited by broken conductors, damaged components, or excessive resistance, the circuit is "open". Devices that can be used to perform continuity tests include multimeters which measure current and specialized continuity testers which are cheaper, more basic devices, generally with a simple light bulb that lights up when current flows. An important application is the continuity test of a bundle of wires so as to find the two ends belonging to a particular one of these wires; there will be a negligible resistance between the "right" ends, and only between the "right" ends.

Test continuity with a Digital Multimeter, follow the following steps

1. Adjust the dial to the meter continuity (the little speaker) function.
2. Plug the test leads into the suitable terminal.
3. Touch the component under test using the leads

The DMM beeps under good continuity that allows the flow of current. If no continuity exists, the DMM does not beep.

- ✓ **Voltage measurement**

Instruments for measuring voltages include the voltmeter, the potentiometer, and the oscilloscope. Analog voltmeters, such as moving-coil instruments, work by measuring the current through a fixed resistor, which, according to Ohm's Law, is proportional to the voltage across the resistor. The potentiometer works by balancing the unknown voltage against a known voltage in a bridge circuit. The cathode-ray oscilloscope works by amplifying the voltage and using it to deflect an electron beam from a straight path, so that the deflection of the beam is proportional to the voltage. To measure voltage is to determine the "differential" voltage between two separate points in an electrical circuit. For example, to measure the voltage across a single resistor, you measure the voltage at both ends of the resistor. The difference between the voltages is the voltage across the resistor. Usually, differential voltage measurements are useful in determining the voltage that exists across individual elements of a circuit, or if the signal sources are noisy.

Follow the following steps for Measuring Voltage:

To start, let's measure voltage on a AA battery: Plug the black probe into COM and the red probe into mAVΩ. Set the multimeter to "V" in the DC (direct current) range. Almost all portable electronics use direct current), not alternating current. Connect the black probe to the battery's ground or '-' and the red probe to power or '+'. Here is a step-by-step guide on how to use a multimeter to test for voltage:

- First, figure out whether the application being testing utilizes AC or DC voltage. Afterward, adjust the meter dial to the suitable function to DC Voltage or AC voltage.

- Adjust the range to the number little higher than the predictive value. If the value being measured is unknown, then set the range to the maximum available number.

- Plug in the test leads into the common (black) and voltage (red) terminals.
- Apply the leads to the test circuit.
- Position and reposition the test till a dependable reading appears on the meter LCD.
- While measuring AC voltage, variations may happen in the reading. As the test continues the measurement will steady.

- ✓ **Current measurement**

Current can be measured using an ammeter. Electric current can be directly measured with a galvanometer, but this method involves breaking the electrical circuit, which is sometimes inconvenient. Current can also be measured without breaking the circuit by detecting the magnetic field associated with the current. There are two main ways to measure current one is based on electromagnetics and is associated with the early moving coil meter, and the other is based on the main theory of electricity, Ohm's law.

- ✓ **Electronic components testing**

Once you have the component out of the appliance, you're ready to use the multi-meter. These devices test a lot of things, and the most common are continuity, voltage, and resistance:

- ➢ **Continuity tests measure if electricity can flow through the part**.

Plug the two probes into the multimeter and set the dial to 'continuity.' If you place the red and black probes on either side of the part (some parts have diodes and are one-directional so you need to arrange the probes accordingly), and you get a read of approximately zero, electricity can flow through the part. If it can't, your multimeter will go towards one or displays OL for open loop. The question is whether electricity is supposed to flow through or not.

- ➢ **Resistance tests how much current is lost as electricity flows through a component or circuit.**

It's measured in ohms, and it is slightly more complicated to test than continuity. Whereas continuity works on a range of zero to one (or OL), resistance can come in different strengths so you need to know how much resistance a given part should have. Then you'd manually set the range on your multimeter around that amount so the multimeter can provide a readout of if the resistance is lower or higher than that amount. You can fine tune the range by making it lower if the multimeter reads close to zero or by making it higher if it read one or OL (overload). Once you have a range in the device, place the probes on either side of the device to find the ohms of resistance. The component should be isolated from any power source otherwise you can ruin your meter. We prefer the use of an analog meter to accomplish this.

- ➢ **The third common test is for voltage, or the force of the electric pressure.**

You'll need to know whether the appliance is DC (direct current) or AC (alternating current). Checking voltage can be very dangerous, be sure to get the proper training before attempting. Just like with resistance testing, you'll need to manually set the expected range and make sure both the multimeter can handle the maximum expected voltage. Some components can be electrically ok, but a voltage check can ensure it is mechanically ok.

- ✓ **Functionality testing**

Functional testing is a quality assurance (QA) process and a type of black-box testing that bases its test cases on the specifications of the software component under test. Functions are tested by feeding them input and examining the output, and internal program structure is rarely considered (unlike white-box testing). Functional testing is conducted to evaluate the compliance of a system or component with specified functional requirements. Functional testing usually describes what the system does. **White-box testing** (also known as **clear box testing, glass box testing, transparent box testing, and structural testing**) is a method of software testing that tests internal structures or workings of an application, as opposed to its functionality (i.e. black-box testing). In white-box testing an internal perspective of the system, as well as programming skills, are used to design test cases. The tester chooses inputs to exercise paths through the code and determine the expected outputs. This is analogous to testing nodes in a circuit, e.g. in-circuit testing (ICT). White-box testing can be applied at the unit, integration and system levels of the software testing process.

In-circuit test (ICT) is an example of white box testing where an electrical probe tests a populated printed circuit board (PCB), checking for shorts, opens, resistance, capacitance, and other basic quantities which will show whether the assembly was correctly fabricated

Summary for the trainer related to the learning outcome

Testing techniques :

- Continuity testing
- Voltage measurement
- Current measurement
- Electronic components testing
- Functionality testing

Theoretical learning Activity

Ask trainees to discuss about fault testing technique of Spectrum analyser

Practical learning Activity

Trainee in pair apply Spectrum analyser testing techniques

Check list

Check list	Score	
	Yes	No
Indicator: Testing techniques are well applied		
1. Continuity testing		
2. Voltage measurement		
3. Current measurement		
4. Electronic components testing		
5. Functionality testing		
Observation		

Learning outcome 4.4 formative assessment

Written assessment

1. Identify fault testing techniques of spectrum analyzer
2. Answer true or False
   The circuit presents short circuit as fault, its resultant current is tending to infinity

Answer:

1. Fault testing techniques of spectrum analyzer
   - Continuity testing
   - Voltage measurement
   - Current measurement
   - Electronic components testing
   - Functionality testing
2. True

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply spectrum analyzer assembling process. Assume you're in a position of the applying spectrum analyzer assembling process as requested by your guest.

Answer: Check list is provided in the practical activities

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LEARNING UNIT 5: REPAIR LCR METER

STRUCTURE OF LEARNING UNIT

Learning outcomes:

5.1 Check LCR meter functional parts
5.2 Identify LCR meter faults
5.3 Fix LCR meter faulty parts
5.4 Test LCR meter

Learning outcome 5.1 Check LCR meter functional parts

Duration: 5hrs

Learning out come 5.1 objectives :

By the end of the learning outcome, the trainees will be able to:

1.Explain the working principle of LCR meter

2.Disassemble the LCR meter

3.Check LCR meter parts

Resources

Equipment	**Tools**	**Materials**
- Multimeter - LCR meter - Projector - Computer - PPE	- Screw driver kit - Plier kit - Allen keys - Internet access	- Breadboard - Books - White board - Marker pen - Duster - Class notes

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 5.1.1: Introduction to LCR meter operation

LCR meters or LCR bridges are items of test equipment or test instrumentation used to measure the inductance, capacitance, and resistance of components. LCR meters tend to be specialist items of test equipment, often used for inspection to ensure that the components arriving are correct. They can also be used in a development laboratory where it is necessary to test and measure the true performance of particular components.

The LCR meter or LCR Bridge takes its name from the fact that the inductance, capacitance and resistance are denoted by the letters L, C, and R respectively. Some versions of the LCR meter use a bridge circuit format as the basis of its circuit giving the name that is often used.

A variety of meters are available. Simpler versions of LCR meters provide indications of the impedance only converting the values to inductance or capacitance.

More sophisticated designs of LCR bridge are able to measure the true inductance or capacitance, and also the equivalent series resistance and tanδ of capacitors and the Q factor of inductive components. This makes them valuable for assessing the overall performance or quality of the component.

Indicative content 5.1.2: Description of LCR meter functional parts

1. Hold/Run button: It is used to start and stop measuring. Log data button: When selected, the measurements of parameters selected in the “Data options” field are logged in the table shown in area 6.

2. Data options panel: It is used to select the desired parameter for which the measurement will be displayed on the Main window panel shown on area 4.

3. Measurement option panel: It is used to select a measuring frequency, range mode and range value. The user can select between the Parallel and Series measuring modes as well as between the Tolerance, Relative or Normal modes (modes described in the features section)

4. Main display: On this panel the measurements of parameter selected in "Data option" field are shown. Where the Primary parameter is shown with a larger font and the secondary parameter with smaller one. This is a very common practice since by reading values from the display the user can automatically see the most important results.

5. Secondary display: On the secondary display the main settings are shown: current selected parameters, measuring frequency and range mode. Also the Min, Max and Average value or Primary parameters are shown.

6. Logging table: Is used to log and export measured data. Logging is started by selecting the "Log data" button.

7. Option buttons field: I used to manipulate with the table. The "Clear Min/Max" button will reset the Min and Max value on the Secondary display.

Indicative content 5.1.3: LCR meter disassembling process

This is process of breaking down a device into separate parts.

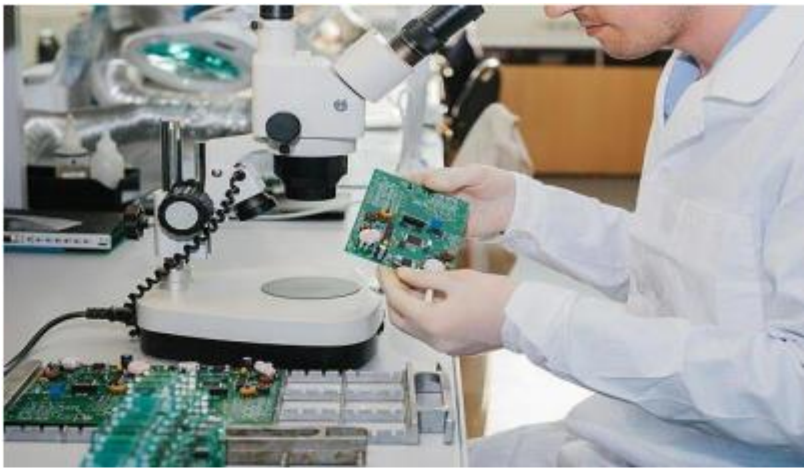
Steps to be followed:

1. Make sure the LCR meter is turned off, then start the standard way of removing cases used to be to undo the screws in the case.
2. The screwdrivers as per the type of screw are required to do that task after detaching the internal board from the LCR meter. It includes removing the power cable from electricity switchboard, before removing all the connectors from the motherboard, make sure you memorize the connectors for assembling the LCR meter if required, as that may require connecting the connectors at its place.
3. Remove the screws from the back of the motherboards and you will be able to detach it from the cabinet.

Indicative content 5.1.4: Checking methods

1. **Visual checking**

Visual Inspection, or Visual Testing (VT), is the oldest and most basic method of inspection. It is the process of looking over a piece of equipment using the naked eye to look for flaws. It requires no equipment except the naked eye of a trained inspector. Visual inspection is simple and less technologically advanced compared to other methods. Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective. This is because there is no equipment that is required to perform it. For similar reasons it also one of the easiest inspection techniques to perform. It is also one of the most reliable techniques. A well-trained inspector can detect most signs of damage



2. **Measuring**

Measurement is the process of using a device or tool to find the dimensions, time, pressure, amount, weight or mass of an object. We use measurements to help us solve problems in many real-world situations. There are many types of test instruments used for troubleshooting. Some are specialized instruments, designed to measure various behaviors of specific equipment.

There are other types of instruments, such as multimeters, that are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC voltages, resistance and current.

- **Voltmeter**: A voltmeter is used to test the differences in voltage between two points.

- **Ohmmeter**: An ohmmeter is used to measure the resistance between two points in a circuit.
- **Ammeter**: An ammeter is an instrument for measuring the current flowing in a circuit in amperes.
- **Multimeter**: A multimeter can test voltage, resistance and current. It is an ohmmeter, voltmeter and ammeter all in one.

General Meter Rules

Before you perform a test, you should know what the meter should read if the circuit is operating normally. You should make your prediction based on a circuit diagram. If the reading is anything other than your predicted value, you know that this part of the circuit is being affected by the electrical fault. You should always test the meter before using it to troubleshoot. For a voltmeter, test the meter on a known voltage source before using. Your meter should read the correct voltage. For an ohmmeter, touch the meter leads together. The display should read 0 ohms, or very close to 0. With the leads apart it should read OL (infinity)

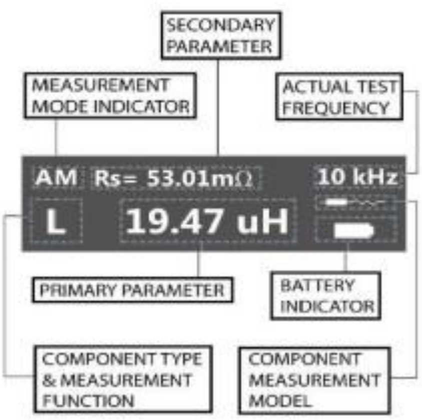
In the simpler versions of this instrument the impedance was measured internally and converted for display to the corresponding capacitance or inductance value. Readings should be reasonably accurate if the capacitor or inductor device under test does not have a significant resistive component of impedance.

Ic

Indicative content 5.1.5: Checking LCR meter parts

a) Display

The LCR-meter OLED display is divided into sections.



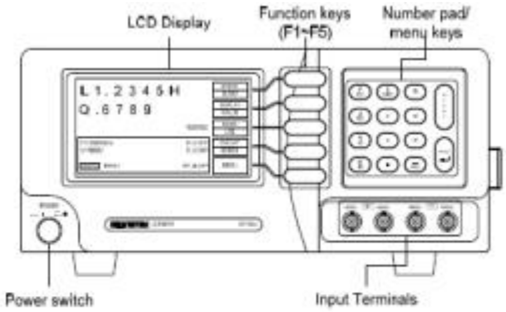
- **Primary parameter**: the primary parameter is located in the middle of screen and uses the largest font in the example the main impedance value is 144.3 pf
- **Secondary Parameter**: The Secondary Parameter is located on the top of the screen. This is where the ESR values can be found and other minor impedance readings.
- **Measurement Mode**: Shown in fig.1 as 'AM', this indicates that the device will automatically determine the type of component being evaluated. The device will automatically select the proper measurement mode.
- **Component Type and Measurement Function**: The LCR-Reader will display what test mode it is operating under. When measuring a Capacitance, the device will show C, R for Resistance, and L for Inductance
- **Test Frequency**: The device is evaluating components with the frequency shown; 100Hz, 1kHz, 10kHz
- **Battery Icon**: This shows the battery's remaining power.

Display indicators

In the following table, the different icons and indicators are explained

indicator	**Description**
A	‘Automatic’ measurement mode
L	‘Inductance’ measurement mode
C	Capacitance’ measurement mode
R	‘Resistance’ measurement mode
100Hz	100 Hz test frequency
1kHz	1 kHz test frequency
10kHz	10 kHz test frequency
AC	Automatic circuit mode selection

b) Control parts

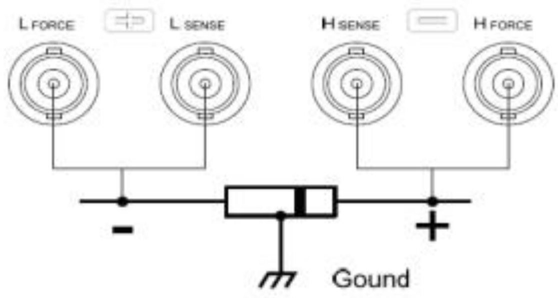


7. Bias	7 BIAS	The bias key selects an internal or external bias. The bias will be displayed on the bottom of the LCD display as INT.B (internal bias) or EXT.B (external bias).
8.On/Off	8 ON/OFF	The On/Off key turns the internal or external bias on or off.
4. PPM	4 PPM	Measures Dissipation and Quality factor as PPM.
1. C.V	1 C.V	Turns constant voltage mode on or off.
0. R.H	0 R.H	Used to turn Range Hold On or Off.
-. FREQ	— FREQ	Used to enter test frequencies.

c) Battery

The battery icon on the bottom-right of the display gives an indication of the remaining charge. This icon will be filled in when the battery is full and will "empty" as the battery depletes. Some LCR meter such as LCR-Reader is powered by a Li-Ion battery and is rechargeable via a micro-USB. To charge the battery, simply plug the device into a power source like a computer or USB-wall adapter. The adapter should have an output voltage of 5V+/- 5% with an output current of 100 mA or greater.

It takes about 2 hours for a full charge, and will last up to 80 hours of continuous use.



Terminals	Force and Sense terminals	
	LFORCE	Current return
	LSENSE	Low potential
	HSENSE	High potential
	HFORCE	Current output

Force and Sense terminals

Description	HFORCE	Carries the signal current source. Connected to the + side of the device under test.
	HSENSE	Together with Lsense, monitors the Potential. Connected to the + side of the device under test.
	LSENSE	Together with Hsense, monitors the Potential. Connected to the – side of the device under test.
	LFORCE	Accepts the signal current return. Connected to the – side of the device under test.
	GND	If the test component has a large metal area NOT connected to either of the terminals, connect to the GND input to minimize noise level.

d) Ports

1. Discharge the test component before connecting the fixture set.
2. Connect the test lead into the front terminals. Line the lead fixture up to the front terminals and slide in. Turn the BNC handle counter clockwise to unlock the fixture. Turn the handles clockwise to lock the fixture.
3. Connect the fixture to the test component. If the component has polarity, connect the H side to the positive lead and the L side to the negative lead. Make sure the distance between the lead base and fixture clip is short enough.
4. If the test component has an outer case unconnected to either of the leads, connect to the ground terminal for noise level reduction.

There are other parts like buttons, selectors and probes.

Summary for the trainer related to the learning outcome

LCR meter functional parts

- Display
- Control part
- Battery
- Ports
- Buttons
- Probes

Theoretical learning Activity

Ask trainees to brainstorm about main part of LCR meter within groups

Practical learning Activity

Trainee in pair:

- Check LCR meter parts functionalities
- Apply LCR meter disassembling process

Check list

Check list	**Score**	
	Yes	**No**
Indicator: LCR meter operation is well described		
1. LCR meter usages is well identified		
Indicator: LCR meter functional parts are well identified		
1. Display		

2. Control part		
3. Power supply		
4. Ports		
5. Buttons		
6. Probes		
7. Selector		
Indicator: LCR meter disassembling process is well applied		
1. user manual is well followed		
Indicator: Checking methods		
1. Visual checking		
2. Measuring		
Indicator: LCR meter parts functionalities are well checked		
1. Control part		
2. Ports		
3. Display		
4. Power supply		
5. Buttons		
6. Probes		
7. Selector		
Observation		

Points to Remember

LCR meter is used to measure three basic electrical quantities : Resistance, inductance and capacitance

Learning outcome 5.1 formative assessment

Written assessment

1. List main parts of LCR meter parts
2. LCR meter is electronic lab measuring instrument that has ability to measure 3 passive components:
    a) Resistance, Capacitance and Conductance
    b) Inductance, Reactance and conductance
    c) Resistance, Inductance and conductance

d) Capacitance, Resistance and inductance

Answer:

1. Main part of LCR meter: Display, Control part, Power supply, Ports, Buttons, Probes, Battery.
2. Capacitance, Resistance and inductance

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to Disassemble LCR meter. Assume you're in a position of the apply LCR meter disassembling process as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 5.2 Identify LCR meter faults

Duration: 4hrs

Learning out come 5.2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify general faults that occur in LCR meter:

2.Explain fault techniques in LCR meter

Resources

Equipment	**Tools**	**Materials**
- Multimeter - LCR meter - Projector - Computer - PPE	- Screw driver kit - Plier kit - Allen keys - Internet access	- Breadboard - Books - White board - Marker pen - Duster - Class notes

Advance preparation:

Availability of Materials, tools and equipment Proper preparation of working place Availability of electricity

Indicative content 5.2.1: Identification of general faults that occur in LCR meter

a) Battery failure

The first step is to check the battery. Try to power on your LCR meter. If the LCR meter doesn't turn on or the display is dim you may have a weak or dead battery. Simply replace the battery and you should be good to go. No practical method exists to quantify all conditions of a battery in a short, comprehensive test. State-of-health (SoH) cannot be measured per se, it can only be estimated to various degrees of accuracy based on available symptoms. If the symptoms are vague or not present, a reliable measurement is not possible. When testing a battery, three SoH indicators must be evaluated:

1. Capacity, the ability to store energy
2. Internal resistance, the capability to deliver current, and
3. Self-discharge, reflecting mechanical integrity and stress-related conditions

Batteries come in many conditions and a charge can easily mask a symptom allowing a weak battery to perform well. Likewise, a strong battery with low charge shares similarities with a pack that exhibits capacity loss. Battery characteristics are also swayed by a recent charge, discharge or long storage. These mood swings must be clearly identified when testing batteries. Batteries come in many conditions and a charge can easily mask a symptom allowing a weak battery to perform well. Likewise, a strong battery with low charge shares similarities with a pack that exhibits capacity loss. Battery characteristics are also swayed by a recent charge, discharge or long storage. These mood swings must be clearly identified when testing batteries.

b) Buttons freeze

You try to press the RANGE or HOLD button on your LCR meter, but one or both of them do not do anything. The buttons are jammed If the buttons are not working, the buttons may be jammed and you will need to replace them.

c) Screen crash

You turn on your LCR meter and use it to measure a value in a circuit. The LCR meter seems to be working, but the display is not showing the entire value. Segments, or whole characters, of the output are missing from the display. The screen is damaged If the measurements are not displaying on the LCD (display) on your LCR meter may be partially or fully damaged. You will need to replace the display.

d)Probes cut-out

The leads are broken If the LCR meter is not measuring and there are no error messages, the LCR meter leads may be broken and you will need to get a new pair. Make sure to only use leads with the LCR meter that are accepted for use with it according to the LCR meter Service Manual.

e) electronic circuit failure

- **Open-circuit trace faults**

Open-circuit voltage (abbreviated as **OCV** or $\mathbf{V_{OC}}$) is the difference of electrical potential between two terminals of a device when disconnected from any circuit. There is no external load connected. No external electric current flows between the terminals. Alternatively, the open-circuit voltage may be thought of as the voltage that must be applied to a solar cell or a battery to stop the current. Current will only flow in a circuit. That is, around a continuous path (or multiple paths) from and back to the source of EMF. Any interruption in the circuit, such as an open switch, a break in the wiring, or a component such as a resistor that has changed its resistance to an extremely high value will cause current to cease. The EMF will still be present, but voltages and currents around the circuit will have changed or ceased altogether. The open switch or the fault has caused what is commonly called an open circuit.

Remember that wherever an open circuit exists, although voltage may be present there will be no current flow through the open circuit section of the circuit.

- **Short-circuit trace faults**

A short circuit (sometimes abbreviated to short or s/c) is an electrical circuit that allows a current to travel along an unintended path with no or very low electrical impedance. This results in an excessive current flowing through the circuit. The opposite of a short circuit is an "open circuit", which is an infinite resistance between two nodes. It is common to misuse "short circuit" to describe any electrical malfunction, regardless of the actual problem.

- **Defective electronic components**

Electronic components have a wide range of failure modes. These can be classified in various ways, such as by time or cause. Failures can be caused by excess temperature, excess current or voltage, ionizing radiation, mechanical shock, stress or impact, and many other causes. In semiconductor devices, problems in the device package may cause failures due to contamination, mechanical stress of the device, or open or short circuits.

Indicative content 5.2.2: Fault identification techniques

Testing

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. You can use a standard multimeter or if you are looking for a quick and easy way to test components.

- **Measuring**

Measurement is the process of using a device or tool to find the dimensions, time, pressure, amount, weight or mass of an object. We use measurements to help us solve problems in many real world situations. There are many types of test instruments used for troubleshooting. Some are specialized instruments, designed to measure various behaviors of specific equipment. There are other types of instruments, such as multimeters, that are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC voltages, resistance and current.

- **Visualization**

Visualization, or Visual Testing (VT), is the oldest and most basic method of inspection. It is the process of looking over a piece of equipment using the naked eye to look for flaws. It requires no equipment except the naked eye of a trained inspector. Visual inspection is simple and less technologically advanced compared to other methods. Despite this, it still has several advantages over more high-tech methods. Compared to other methods, it is far more cost effective.

Summary for the trainer related to the learning outcome

General faults that occur in LCR meter :

- Battery failure
- Buttons
- freeze
- Screen crash
- Probes cut-out
- Electronic circuit failure:


Theoretical learning Activity

Ask trainees to brainstorm about difference fault occur in LCR meter within groups


Practical learning Activity

✓ Trainees in pair apply fault identification techniques

Check list

Check list	**Score**	
	Yes	**No**
Indicator: LCR general faults are well identified		
1. Battery failure		
2. Buttons freeze		
3. Screen crash		
4. Probes cut-out		
5. Open-circuit trace faults		
6. Short-circuit trace faults		
7. Grounding faults		
8. Defective electronic components		
Indicator: Fault identification techniques are well applied		
1. Testing		
2. Measuring		
3. Visualization		
Observation		


Points to Remember (Take home message)

Fault identification techniques:

- Testing
- Measuring
- Visualization

Learning outcome 5.2 formative assessment

Written assessment

1. Identify general faults that occur in general faults that occur in LCR meter
2. The following are fault identification techniques except
   a) Testing
   b) Measuring
   c) Visualization
   d) Desoldering

Answer:

1. General faults that occur in LCR meter

   - Buttons freeze
   - Screen crash
   - Probes cut-out
   - Electronic circuit failure: Open-circuit trace faults Short-circuit trace faults Defective electronic components
2. Soldering

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply Fault identification techniques of LCR meter. Assume you're in a position of the applying faults identification method as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 5.3 Fix LCR meter faulty parts

Duration: 3hrs

Learning out come 5.2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify fault techniques in LCR meter:

2. Assemble LCR meter

Resources

Equipment	**Tools**	**Materials**
- Multimeter - LCR meter - Projector - Computer - PPE	- Screw driver kit - Plier kit - Allen keys - Internet access	- Breadboard - Books - White board - Marker pen - Duster - Class notes

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 5.3.1: Faults fixing techniques

1. Solder

Turning to the actual techniques of soldering, firstly it's best to secure the work somehow so that it doesn't move during soldering and affect your accuracy. In the case of a printed circuit board, various holding frames are fairly popular especially with densely populated boards: the idea is to insert all the parts on one side ("stuffing the board"), hold them in place with a special foam pad to prevent them falling out, turn the board over and then snip off the wires with cutters before making the joints. The frame saves an awful lot of turning the board over and over, especially with large boards. Other parts could be held firm in a modeler's small vice, for example.

Solder joints may need to possess some degree of mechanical strength in some cases, especially with wires soldered to, say, potentiometer or switch tags, and this means that the wire should be looped through the tag and secured before solder is applied. The down side is that it is more difficult to de-solder the joint (see later) and remove the wire afterwards, if required. Otherwise, in the case of an ordinary circuit board, components' wires are bent to fit through the board, inserted flush against the board's surface, splayed outwards a little so that the part grips the board, and then soldered.

2. Desoldering Methods

A soldered joint which is improperly made will be electrically "noisy", unreliable and is likely to get worse in time. It may even not have made any electrical connection at all, or could work initially and then cause the equipment to fail at a later date! It can be hard to judge the quality of a solder joint purely by appearances, because you cannot say how the joint actually formed on the inside, but by following the guidelines there is no reason why you should not obtain perfect results.

A joint which is poorly formed is often called a "dry joint". Usually it results from dirt or grease preventing the solder from melting onto the parts properly, and is often noticeable because of the tendency of the solder not to "spread" but to form beads or globules instead, perhaps partially. Alternatively, if it seems to take an inordinately long time for the solder to spread, this is another sign of possible dirt and that the joint may potentially be a dry one.

3. Replacement of defective components

A method of replacing a defective electronic component having a plurality of electrical leads bonded to electrical contacts on a support by cutting leads adjacent the bond site, rebounding the stubs to the contacts, replacing the defective component and bonding the leads of the replacement component to the electrical contacts. Preferably, the leads are cut simultaneously with the rebounding of the stubs. The leads may be bonded to the top of the stub or to the side of the stub. A bonding tool is provided for simultaneously cutting a lead and rebounding the resultant stub.

4. Removing the short circuit

Short Circuits. In electrical devices, short circuits are usually caused by a breakdown in a wire's insulation or when another conductor is introduced and causes the electricity to flow in an unintended way. To fix this problem, you will need to replace the wire. Locate the wires in your device that are causing the short. Remove the wire by using a soldering gun to melt the solder holding the wire to the contact point and pulling the wire free. Make a new wire to replace the damaged one. To do this you can go to your local hardware store and purchase wire that have already been cut and prepared.

These wires will come in specific lengths, so if you want a length that's different from these you can make your own. Unwind a length of insulated copper wire from a spool and cut the wire so it’s the length you need. Use a utility knife to remove some of the insulation from both ends of the wire. Expose enough wire so that you can easily attach it to the contact points. Put some solder on the contact points and put the wire's exposed ends on them. Use your soldering iron to attach the new wire to the contact points.

5. Removing the open circuit

Remember that wherever an open circuit exists, although voltage may be present there will be no current flow through the open circuit section of the circuit. Also, as Power (P) is V x I and the current (I) = 0, no power will be dissipated. Looking further at the simple circuit used in Resistors & Circuits Module. Let´s put some actual voltages and currents in and see what happens under ‘Open Circuit’ conditions. To select a number of open circuit conditions that might occur in different parts of the circuit. Notice how the voltages and currents around the circuit change depending on where the break in the circuit (the open circuit) occurs. Checking the voltages around a circuit with a voltmeter, and noticing where they differ from what would be expected in a correctly working circuit, is one of the main techniques used for tracing a fault in any circuit. Making sense of this method depends on understanding a few basic facts about the circuit:

1. The current IS supplied to the circuit by the battery (E) is divided into two currents I1 flowing through R1 and I2 flowing through R2 and R3.
2. Because R2 and R3 are connected in series, the same current (I2) flows through both resistors.

3. Both branches of the circuit (R1 and R2/R3 have the same resistance in this circuit (150Ω, commonly shown in circuit diagrams as 150R).
4. Therefore, half of the 40mA supply current (20mA) flows through each 150Ω branch of the circuit, causing the shown voltages to be developed across each resistor.

It would be unusual in practice to be given all of the current and voltage information on every circuit diagram. The voltages and currents would need to be worked out where needed by applying the methods described in our section on Current and Voltage in Series and Parallel Resistor Networks.

Fault finding techniques vary with the complexity of the circuit involved but all rely to some degree on the basic methods shown here, and very often on the application of Ohms Law.

Ic

Indicative content 5.3.2: LCR meter assembling process

The assembling of the LCR meter is exactly the opposite of disassembling operation. Steps to be followed:

1. Before starting assembling the LCR meter, make sure you have the screws and a screwdriver for those screws header.
2. first step for assembling the LCR meter starts with mounting the motherboards in socket of the case.
3. You don't need to apply any force. The special ZIF (zero insertion force) to prevent any damage to the boards inserted in the case.
4. Select the appropriate cable and connect one end of the cable to its socket and another end at its appropriate connector on the motherboards for linking them together.
5. Put on the cover and start fastening the screws in its appropriate holes by using correspond screwdrivers.

⚠ Summary for the trainer related to the learning outcome

Faults fixing techniques:

- Desoldering and soldering different components
- Replacement of defective components.
- Removing the shortcircuit
- Removing the open circuit

Theoretical learning Activity

Ask trainees to brainstorm about fault fixing techniques in LCR meter

Practical learning Activity

✓ Trainee in pair apply Fault fault fixing techniques in LCR meter and LCR meter assembling process

Check list

Check list	**Score**	
	Yes	**No**
Indicator: Faults fixing techniques are well applied		
1. Desoldering and Soldering different components		
2. Replacement of defective components		
3. Removing the short circuit		
4. Removing the open circuit		
Indicator: LCR meter assembling process is well applied		
1. User manual is well followed		
Observation		

Points to Remember (Take home message)

LCR meters are measuring instruments that measure a physical property known as impedance. Impedance, which is expressed using the quantifier Z, indicates resistance to the flow of an AC current

Learning outcome 5.3 formative assessment

Written assessment

1. Identify Faults fixing techniques of LCR meter
2. Answer true or False:
   The circuit presents open circuit as fault, its resultant resistance is tending to zero

Answer:

1. Faults fixing techniques of LCR meter
   - Desoldering and soldering different components
   - Replacement of defective components.
   - Removing the short circuit
   - Removing the open circuit
2. False

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply LCR meter assembling process. Assume you're in a position of the applying LCR meter assembling process as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome 5.4: Test LCR meter

Duration: 3hrs

Learning out come 5.4 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify fault techniques in LCR meter:

2. Assemble LCR meter

Resources

Equipment	Tools	Materials
- Multimeter - LCR meter - Projector - Computer - PPE	- Screw driver kit - Plier kit - Allen keys - Internet access	- Breadboard - Books - White board - Marker pen - Duster - Class notes

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 5.4.1: testing techniques

1. Continuity testing

In electronics, **a continuity** test is the checking of an electric circuit to see if current flows (that it is in fact a complete circuit). A continuity test is performed by placing a small voltage (wired in series with an LED or noise-producing component such as a piezoelectric speaker) across the chosen path. If electron flow is inhibited by broken conductors, damaged components, or excessive resistance, the circuit is "open".

Devices that can be used to perform continuity tests include multimeters which measure current and specialized continuity testers which are cheaper, more basic devices, generally with a simple light bulb that lights up when current flows. An important application is the continuity test of a bundle of wires so as to find the two ends belonging to a particular one of these wires; there will be a negligible resistance between the "right" ends, and only between the "right" ends.

Test continuity with a Digital Multimeter, follow the following steps:

- ✓ Adjust the dial to the meter continuity (the little speaker) function.
- ✓ Plug the test leads into the suitable terminal.
- ✓ Touch the component under test using the leads The DMM beeps under good continuity that allows the flow of current. If no continuity exists, the DMM does not beep.

2.Voltage measurement

Instruments for measuring voltages include the voltmeter, the potentiometer, and the oscilloscope. Analog voltmeters, such as moving-coil instruments, work by measuring the current through a fixed resistor, which, according to Ohm's Law, is proportional to the voltage across the resistor. The potentiometer works by balancing the unknown voltage against a known voltage in a bridge circuit. The cathode-ray oscilloscope works by amplifying the voltage and using it to deflect an electron beam from a straight path, so that the deflection of the beam is proportional to the voltage.

To measure voltage is to determine the “differential” voltage between two separate points in an electrical circuit. For example, to measure the voltage across a single resistor, you measure the voltage at both ends of the resistor. The difference between the voltages is the voltage across the resistor. Usually, differential voltage measurements are useful in determining the voltage that exists across individual elements of a circuit, or if the signal sources are noisy.

Follow the following steps for Measuring Voltage: To start, let’s measure voltage on a AA battery: Plug the black probe into COM and the red probe into mAVΩ. Set the multimeter to “V” in the DC (direct current) range. Almost all portable electronics use direct current), not alternating current. Connect the black probe to the battery’s ground or ‘-’ and the red probe to power or ‘+’.

Here is a step-by-step guide on how to use a multimeter to test for voltage:

- First, figure out whether the application being testing utilizes AC or DC voltage. Afterward, adjust the meter dial to the suitable function to DC Voltage or AC voltage.
- Adjust the range to the number little higher than the predictive value. If the value being measured is unknown, then set the range to the maximum available number.
- Plug in the test leads into the common (black) and voltage (red) terminals.
- Apply the leads to the test circuit.
- Position and reposition the test till a dependable reading appears on the meter LCD.
- While measuring AC voltage, variations may happen in the reading. As the test continues the measurement will steady.

3. Current measurement

Current can be measured using an ammeter. Electric current can be directly measured with a galvanometer, but this method involves breaking the electrical circuit, which is sometimes inconvenient. Current can also be measured without breaking the circuit by detecting the magnetic field associated with the current. There are two main ways to measure current one is based on electromagnetics and is associated with the early moving coil meter, and the other is based on the main theory of electricity, Ohm's law.

4. Electronic components testing

Once you have the component out of the appliance, you're ready to use the multi-meter. These devices test a lot of things, and the most common are continuity, voltage, and resistance:

• **Continuity tests measure if electricity can flow through the part**. Plug the two probes into the multimeter and set the dial to 'continuity.' If you place the red and black probes on either side of the part (some parts have diodes and are one-directional so you need to arrange the probes accordingly), and you get a read of approximately zero, electricity can flow through the part. If it can't, your multimeter will go towards one or displays OL for open loop. The question is whether electricity is supposed to flow through or not.

• **Resistance tests how much current is lost as electricity flows through a component or circuit**. It's measured in ohms, and it is slightly more complicated to test than continuity. Whereas continuity works on a range of zero to one (or OL), resistance can come in different strengths so you need to know how much resistance a given part should have. Then you'd manually set the range on your multimeter around that amount so the multimeter can provide a readout of if the resistance is lower or higher than that amount. You can fine tune the range by making it lower if the multimeter reads close to zero or by making it higher if it read one or OL (overload). Once you have a range in the device, place the probes on either side of the device to find the ohms of resistance. The component should be isolated from Page 159 of 164 any power source otherwise you can ruin your meter. We prefer the use of an analog meter to accomplish this.

• **The third common test is for voltage, or the force of the electric pressure**. You'll need to know whether the appliance is DC (direct current) or AC (alternating current). Checking voltage can be very dangerous, be sure to get the proper training before attempting. Just like with resistance testing, you'll need to manually set the expected range and make sure both the multimeter can handle the maximum expected voltage. Some components can be electrically ok, but a voltage check can ensure it is mechanically ok.

6. Functionality testing

Functional testing in general verifies that each function of the device operates in conformance with the requirement specification. Ensuring that electrical and electronic products comply with the regulation requirements or with the specific requirements defined by the client.

Functional testing is also a quality assurance (QA) process and a type of black-box testing that bases its test cases on the specifications of the software component under test. Functions are tested by feeding them input and examining the output, and internal program structure is rarely considered (unlike white-box testing). Functional testing is conducted to evaluate the compliance of a system or component with specified functional requirements. Functional testing usually describes what the system does. White-box testing (also known as clear box testing, glass box testing, transparent box testing, and structural testing) is a method of software testing that tests internal structures or workings of an application, as opposed to its functionality (i.e. black-box testing).

In white-box testing an internal perspective of the system, as well as programming skills, are used to design test cases. The tester chooses inputs to exercise paths through the code and determine the expected outputs. This is analogous to testing nodes in a circuit, e.g. in-circuit testing (ICT). White-box testing can be applied at the unit, integration and system levels of the software testing process. In-circuit test (ICT) is an example of white box testing where an electrical probe tests a populated printed circuit board (PCB), checking for shorts, opens, resistance, capacitance, and other basic quantities which will show whether the assembly was correctly fabricated

Summary for the trainer related to the learning outcome

Testing techniques :

- Continuity testing

- Voltage measurement
- Current measurement
- Electronic components testing
- Functionality testing

Theoretical learning Activity

Ask trainees to discuss about fault testing technique of LCR meter

Practical learning Activity

Trainee in pair apply LCR meter testing techniques

Check list

Check list	**Score**	
	Yes	**No**
Indicator: Testing techniques are well applied		
1. Continuity testing		
2. Voltage measurement		
3. Current measurement		
4. Electronic components testing		
5. Functionality testing		
Observation		

Learning outcome 5.4 formative assessment

Written assessment

1. Identify fault testing techniques of LCR meter
2. Answer true or False

   The circuit presents Open circuit as fault; its resultant current is tending to infinity

Answer:

1. Fault testing techniques of spectrum analyzer

- Continuity testing
- Voltage measurement
- Current measurement
- Electronic components testing
- Functionality testing

2. False

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply testing technique. Assume you're in a position of the applying testing techniques as requested by your guest.

Answer: Check list is provided in the practical activities

REFERENCES:

1. IET LABS, I. (2006). LCR meter information guide. West Roxbury: WikipediA/www.ietlabs.com.
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LEARNING UNIT 6: DOCUMENT THE WORK DONE

STRUCTURE OF LEARNING UNIT

Learning outcomes:

6.1 Review the previous work
6.2 Record the work process
6.3 Write technical recommendation

Learning outcome 6.1 Review the previous work document

Duration: 20hrs

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe work document elements

2. Analyse the previous work document

Resources

Equipment	**Tools**	**Materials**
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access **- Pliers** **- Screw drivers** **-Twizzer** **-Allen keys**	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 6.1.1 Description of work document elements

A. Repairing date

This is the date provided on the report about work carry out. This date will be used to identify how a device experience fault either according to long-life or fault caused by operator have lack of skills on the device.

B. Addresses of technician

Location where the technician company carry out their daily activity. When you have a device experienced with fault you can visit the technician in that location and ask help to fix the problem of your devices. This address of technician includes : house number, road address, telephone number, company name, email address etc.

C. Status of the device

After receiving the device, you have to check every part of that device to identify the part experienced problem. Then write the behaviors of that device for further maintenance.

D. Name of the repaired parts

After repairing the device show its part had problem in order to increase the measurement on recommendation councils and how they can take care on that part of that device.

E. Work carried out

Show how you fix the problem, show also the techniques used to identify the problem and fix it. Provide also tools, equipment and materials used to fix that problem of a device.

F. Recommendation

Give advice according to work carry out and fault identified, for future faults prevention. Simple deal with the rules and regulation you can take in order to avoid many faults for our devices.

6.1.2. Analysis of the previous work document

1. Previous faults

Before starting repairing activities, first review the previous report to identify the faults of that devices. The repair according to the previous report if there is no relation with the previous faults. And help the technicians to identify faults easier.

2. Previous used Techniques

Review the previous techniques used to fix the problem. If it can be possible to reuse you can go ahead. Else apply another technique to fix the present faults.

3. Previous status of the devices

Review the status of the device before it experienced with a problem, and determine how a device being affected or crushed.

4. Previous recommendation

Review the previous recommendation to identify if the advice they had given were respected else they have to replace some part for better performance.

Summary for the trainer related to the learning outcome

Work document elements:

- Repairing date
- Addresses of technician
- Status of DC Power supply parts
- Name of the repaired parts
- Work carried out Recommendation

Theoretical learning Activity

Ask trainees to brainstorm about work document after repair within groups

Points to Remember (Take home message)

Previous work document:

- ➢ Previous faults
- ➢ Previous used Techniques
- ➢ Previous status of the DC Power supply
- ➢ Previous recommendation

Learning outcome 6.1 formative assessment

Written assessment

1. List any four (4) elements of work document
2. The following are main point to consider while analyzing previous work except:
   a) Previous faults
   b) Previous used Techniques
   c) Previous recommendation
   d) Addresses of technician

Answer:

1. Elements of work document:
   - Repairing date
   - Addresses of technician
   - Status of DC Power supply parts
   - Name of the repaired parts
   - Work carried out
   - Recommendation
2. Addresses of technician

Learning outcome 6.2: Record the work process

Duration: 2hrs

Learning outcome 2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Describe the work carried out

Resources

Equipment	Tools	Materials
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	Electronic components - Breadboard - Wires - Books - White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 6.2.1. Description of the work carried out

- Faulty parts: show the part of the device have a problem
- type of fault: identify the type of fault either hardware or software
- tools, materials and Equipment used: identify all requirement to fix fault well.
- Steps and Techniques used to fix the fault: show clearly the ways for fixing the faults on device.

- Status of the device after work: compare the status of device before repair and the status of device after repair to know if the problem is fixed well.

Summary for the trainer related to the learning outcome

Work carried out after repair:

- Faulty parts
- Type of fault tools, materials and Equipment used
- steps and Techniques used to fix the fault
- Status of the DC Power supply after work


Theoretical learning Activity

Ask trainees to brainstorm about work carried out after repair within groups


Practical learning Activity

Trainee Record the work done process

Check list

Check list	**Score**	
	Yes	**No**
Indicator: Work Document elements are well described		
1. Repairing date		
2. Addresses of technician		
3. Status of DC Power supply		
4. Name of the repaired part		
5. Steps work carried out		
6. Recommendation		
Indicator: The work carried out is well described		
1. Fixed fault		
2. tools, materials and Equipment used		
3. steps and techniques used to fix the fault		
Observation		

Learning outcome 6.2 formative assessment

Written assessment

1. There are the points to be taken into consideration when describing the work that has been done, list them.

Answer:

- Faulty parts
- Type of fault
- tools, materials and Equipment used
- steps and Techniques used to fix the fault
- Status of the device after work

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to apply testing technique. Assume you're in a position of the applying testing techniques as requested by your guest.

Answer: Check list is provided in the practical activities

Learning outcome6.3: Write technical recommendation

Duration: 3hrs

Learning outcome 3 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Describe element of technical recommendation

Resources

Equipment	**Tools**	**Materials**
- Multimeter - Oscilloscope - Power supply - Function generator - Computer - Projector	- Internet access - Pliers - Screw drivers -Twizzer -Allen keys	-Electronic components - Breadboard - Wires - Books -White board - Marker pen

Advance preparation:

Availability of Materials, tools and equipment

Proper preparation of working place

Availability of electricity

Indicative content 6.3.1. Description of element of technical recommendation

1. **Propose preventive strategies :**

Suggesting the way to prevent future faults. Preventive maintenance aims at keeping the equipment in good operating conditions and reliable in order to avoid any breakdown.

Consists in inspecting, controlling and preserving the equipment by cleaning, adjusting and also replacing pieces when estimated necessary.

The different tasks of preventive maintenance should be achieved daily, weekly, monthly or annually. Preventive maintenance could be divided into two levels : periodic maintenance and predictive maintenance.

- **Periodic maintenance**

Both personnel using the equipment daily and the person in charge of maintenance are involved in condition-monitoring tasks in a routine way. Possible method for periodic preventive maintenance - Documents such as follow-up forms have to be elaborated beforehand - The person in charge of maintenance completes periodically the follow-up forms - Any instrument should also be provided with its own maintenance book, where specific actions can be described precisely.

- **Predictive maintenance**

The person in charge of maintenance is also involved in life-extending tasks, which have to be Scheduled regularly, even if less frequent than routine, in order to prevent faults from occurring in the long-term. The aim in this case is to identify imminent troubles and bring Solutions to prevent equipment from failing, mainly by inspecting and then correcting, Adjusting and/or replacing parts.

2. **Suggest solutions to faced challenges :**

Find the way to get solution to against future faults. In a well-managed maintenance system, all inspections done during preventive or corrective.

Maintenance should be listed, recorded and archived every year in order to provide long term monitoring. Corrective maintenance is systematically done after a mechanical or electrical failure. It aims at quickly restoring the equipment and making it reliable again. This action consists in analyzing the problem and solving it, generally by replacing pieces when possible.

3. **Propose the periodic checkup :**

Elaborate how you can prevent faults by doing frequently maintenance to avoid faults. Both personnel using the equipment daily and the person in charge of periodic checkup are involved in condition-monitoring tasks in a repetitive way.

Possible method for periodic checkup

- Documents such as follow-up forms have to be elaborated beforehand

- The person in charge of maintenance completes periodically the follow-up forms

- Any instrument should also be provided with its own maintenance book, where specific actions can be described precisely.

⚠ Summary for the trainer related to the learning outcome

element of technical recommendation:

- Propose preventive strategies
- Suggest solutions to faced challenges
- Propose the periodic check up

Theoretical learning Activity

Ask trainees to brainstorm about work carried out after repair within groups

Practical learning Activity

Trainee Write a technical recommendation on repaired LCR meter

Check list

Check list	**Score**	
	Yes	**No**
Indicator: element of technical recommendation are well described		
1. Propose preventive strategies		
2. Suggest solutions to faced challenges		

3. Propose the periodic check up		
Observation		

Points to Remember (Take home message)

Description of the work carried out: ➢ Faulty parts ➢ Type of fault ➢ Tools, materials and Equipment used ➢ Steps and Techniques used to fix the fault ➢ Status of the DC Power supply after work

Learning outcome 6.3 formative assessment

Written assessment

1. List elements of technical recommendation
2. What are advantages of providing technical recommendation to the customer?

Answer:

1. Elements of technical recommendation: Propose preventive strategies, suggest solutions to faced challenges, propose the periodic checkup.
2. Advantages of technical recommendation
    - Provide Relevant Material.
    - Engage Customers.
    - Transform Shoppers to Clients.
    - Increase Average Order Value.
    - Boost Number of Items per Order.
    - Control Retailing and Inventory Rules.
    - Lower Work and Overhead

Practical assessment

At the inspection of M&J School located in Northern Province, RTB inspector appeared and asked one trainee in the training workshop to write a technical recommendation on repaired digital multimeter. Assume you're in a position of the writing a technical recommendation on repaired digital multimeter as requested by your guest.

Answer: Check list is provided in the practical activities

Integrated situation

CRC POLYTECHNIC is an integrated college located in NGORORERO District. It offers trainings in Electronics, telecommunications, computer and electricity related trades. The institution needs to hire an electronic lab technician who is in charge of maintaining their electronic measuring instruments. Their lab is equipped with multimeter, voltmeter, ammeter, ohmmeter, LCR meter, oscilloscope and spectrum analyzer. Among the criteria to be hired, a candidate should prove, in addition to his/her certificate, that s/he is competent to repair any given faulty (electronic lab) instruments within 5hours. As qualified electronic lab technician, being committed to this position, one of the tests to be employed will be to repair the given electronic lab instruments, whose faults diversify. Some don't switch on; others have faulty buttons while others don't display anything on screen. These last were working correctly before but suddenly they got faulty. Tasks to be performed are:

- Specify the defective electronic lab instruments among the available ones;
- Identify the fault(s) for the selected ones;
- Rectify the fault(s) of them;
- Document the work done

Note: All required materials, tools and equipment are available.

- **Tools:** Tool box, Screw drivers kit, Pliers, Wire stripper, cutter, Tweezers, Tester ,Cleaning tools, Soldering iron,Desoldering pump,Cabinet organizer , Extension cables, Power source (ACDC)
- **Equipment:** Multimeter, Oscilloscope, Function generator, Soldering station, PPE, LCR meter
- **Materials:** Electronic components, Soldering wire, Screws, Wires, Insulator tape, Adhesives, Cleaning materials

Assesment Criterion 1: Quality of Process

Check list	**Score**	
	Yes	**No**
Indicator: Required Tools, equipment and materials are well selected		
Tools		
1. Tool box		
2. Screw drivers kit		
3. Pliers		
4. Wire stripper		
5. Cutter		
6. Tweezers		
7. Tester		
8. Cleaning tools		
9. Soldering iron		
10. Desoldering pump		
11. Cabinet organizer		
11. Extension cables		
12. Power source (AC-DC)		
Materials		
13. Electronic components		
14. Soldering wire		
15. Screws		

16. Wires		
17. Insulator tape		
18. Adhesives		
19. Cleaning materials		
Equipment		
20. Multimeter		
21. Oscilloscope		
22. Function generator		
23. Soldering station		
24. PPE		
25. LCR meter		
Indicator: Functionality of Lab instruments is well checked		
1. Instruments status is identified		
2. Defective instruments are identified		
3. Trial uses of measuring instrument are performed		
Indicator: Faults are well identified		
1. Functional parts are checked		
2. Fault identification techniques are applied		
3. Faulty part is identified		
Indicator: faulty parts are well fixed		
1. Faulty fixing techniques are applied		
2. Functional parts are checked		
Observation		

Assesment Criterion 2: Quality of product

Check list	**Score**	
	Yes	**No**
Indicator: Instruments are well repaired		
1. The instruments are turning on		
2. Instruments faults are fixed		
3. The measurement range is normal		
4. The instruments parameters are set to normal		
Observation		

Assesment Criterion 3: Relevance

Check list	**Score**	
	Yes	**No**
Indicator: : Efficient use of materials		

1. No material is wasted		
Indicator: tools are well used		
1. No tool is damaged		
Indicator: instruments are repaired		
1. Time is expected		
2. Faults are fixed		
Observation		

Assesment Criterion 4: Safety

Check list	**Score**	
	Yes	**No**
Indicator: PPE are well used		
1. Gloves		
2. Overall		
3. Safety shoes		
4. Antistatic wrist strap		
Observation		

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