Ethiopian TVET-System

BASIC ELECTRICAL/ELECTRONIC

EQUIPMENT SERVICING Level I

Based on May 2011 Occupational standards

October, 2019

Module Title: Troubleshooting AC/DC power supply with single-phase input

TTLM Code: EEL BEE1 TTLM 0919v1

This module includes the following Learning Guides

LG35: Prepare product and work station for troubleshooting

LG Code: EEL BEE1 07 M13 LO1-LG35

LG36: Diagnose Faulty Parts of Power Supply

LG Code: EEL BEE1 07M13 LO2-LG36

LG37: Maintain/Repair the Power Supply Unit

LG Code: EEL BEE1 M13 LO3-LG37

LG38: Rewind low-power transformer

LG Code: EEL BEE1 07 0811 LO4-LG38

LG39: Assemble Low-Power Transformer

LG Code: EEL BEE1 07 0811 LO5-LG39

LG40: Test and Inspect Repaired Products

LG Code: EEL BEE1 07 0811 LO6-LG40

Instruction Sheet	LG35: Prepare product and work station for troubleshooting

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: –

- Preparing troubleshooting workplace.
- Consulting responsible person for effective and proper work coordination.
- Preparing and checking required materials, tools and equipment.
- Preparing and obtaining parts and materials needed to complete the work.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to: -

- Prepare troubleshooting workplace.
- Consult responsible person for effective and proper work coordination
- Prepare and check required materials, tools and equipment.
- Prepare and obtain parts and materials needed to complete the work.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks". in each information sheets.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets and LAP Tests if any". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next Learning Guide.

Information Sheet 1	Preparing troubleshooting workplace

Introduction

A power supply is an electronic circuit or a device that converts the primary electric power in to ac or dc needed by different types of electronic circuit. A power supply may be implemented as a discrete, standalone device or as integral device that is hard wired to its load and designed to provide various ac and dc voltages. Therefore, all electronic equipment's require a source of DC power for normal operation.

The power supply circuit produces the DC voltage needed to operate electronic components. Of course, batteries can be and are used in portable equipment, but in larger systems, where considerable power is needed, batteries are an inconvenience and expensive. Electronic circuits normally require a different type and value of voltage than is available from standard 220V AC wall socket.

1.1. OH&S policies and procedures

- **Hazard and risk assessment**

Hazards exist in every workplace in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations. The Occupational Safety and Health Administration (OSHA) requires that employers protect their employees from workplace hazards that can cause injury.

Controlling a hazard at its source is the best way to protect employees. Depending on the hazard or workplace conditions, OSHA recommends the use of engineering or work practice controls to manage or eliminate hazards to the greatest extent possible. For example, building a barrier between the hazard and the employees is an engineering control; changing the way in which employees perform their work is a work practice control.

When engineering, work practice and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment (PPE) to their employees and ensure its use. Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs) hard hats, respirators and full body suits.

This guide will help both employers and employees do the following:

- ✓ Understand the types of PPE.

- ✓ Know the basics of conducting a "hazard assessment" of the workplace.
- ✓ Select appropriate PPE for a variety of circumstances.
- ✓ Understand what kind of training is needed in the proper use and care of PPE.

- **Occupational Health and Safety and You**

One of your most important responsibilities is to protect your Health and Safety as well as that of your co-workers. This will discuss some of your duties under the occupational Health and Safety legislation and help you to make your workplace safer and healthier.

- **You have responsibilities to:**
  - ✓ You must also comply with the legislation.
  - ✓ Protect your own Health and Safety and that of your co-workers;
  - ✓ Not initiate or participate in the harassment of another worker; and
  - ✓ Co-operate with your supervisor and anyone else with duties under the legislation.
- **Your Rights**
  - ✓ The right to know the hazards at work and how to control them;
  - ✓ The right to participate in Occupational Health and Safety; and
  - ✓ The right to refuse work which you believe to be unusually dangerous. You may not be punished for using these rights. An employer can be required to legally justify any action taken against a worker who is active in Health and Safety.
- **Your Right to Know and Participate**

If you are inexperienced, you must receive an orientation which includes;

- ✓ What to do in a fire or other emergency;
- ✓ First aid facilities;
- ✓ Prohibited or restricted areas;
- ✓ Workplace hazards; and
- ✓ Any other information you should know.
- ✓ You must also be supervised closely by a competent supervisor.
- ✓ Regularly inspect the workplace;

- ✓ Conduct accident investigations;
- ✓ Deal with the Health and Safety concerns of employees;
- ✓ Investigate refusals to work. and
- ✓ Continue refusal measures have been taken to satisfy you that the job is now safe to perform

- **The Requirement for PPE**

To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment.

In general, you should:

- ✓ Properly wear PPE,
- ✓ Attend training sessions on PPE,
- ✓ Care for, clean and maintain PPE, and
- ✓ Inform a supervisor of the need to repair or replace PPE.

Specific requirements for PPE are presented in many different OSHA standards.

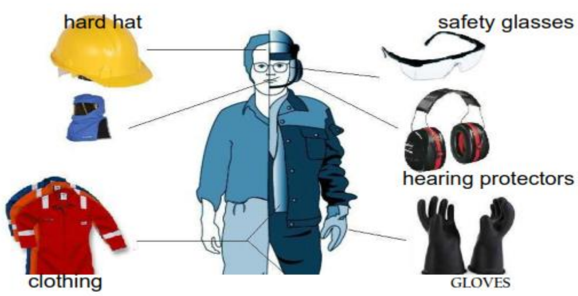

Figure1.1 PPE

- **The Hazard Assessment**

A first critical step in developing a comprehensive safety and health program is to identify physical and health hazards in the workplace. This process is known as a “hazard assessment.” Potential hazards may be physical or health-related and a comprehensive hazard assessment should identify hazards in both categories.

Examples of physical hazards include moving objects, fluctuating temperatures, high intensity lighting, rolling or pinching objects, electrical connections and sharp edges. Examples of health hazards include overexposure to harmful dusts, chemicals or radiation.

The hazard assessment should begin with a walkthrough survey of the facility to develop a list of potential hazards in the following basic hazard categories:

- ✓ Impact
- ✓ Penetration
- ✓ Compression (roll-over),
- ✓ Chemical,
- ✓ Heat/cold,
- ✓ Harmful dust,
- ✓ Light (optical) radiation, and
- ✓ Biologic.

In addition to noting the basic layout of the facility and reviewing any history of occupational illnesses or injuries, things to look for during the walkthrough survey include:

- ✓ Sources of electricity.
- ✓ Sources of motion such as machines or processes where movement may exist that could result in an impact between personnel and equipment.
- ✓ Sources of high temperatures that could result in burns, eye injuries or fire.
- ✓ Types of chemicals used in the workplace.
- ✓ Sources of harmful dusts.
- ✓ Sources of light radiation, such as welding, brazing, cutting, furnaces, heat treating, high intensity lights, etc.
- ✓ The potential for falling or dropping objects.
- ✓ Sharp objects that could poke, cut, stab or puncture.
- ✓ Biologic hazards such as blood or other potentially infected material.

When the walkthrough is complete, the employer should organize and analyze the data so that it may be efficiently used in determining the proper types of PPE required at the worksite. It is definitely a good idea to select PPE that will provide a level of protection greater than the minimum required to protect employees from hazards.

The workplace should be periodically reassessed for any changes in conditions, equipment or operating procedures that could affect occupational hazards. This periodic reassessment should also include a review of injury and illness records to spot any trends or areas of concern and taking appropriate corrective action. The suitability of existing PPE, including an evaluation of its condition and age, should be included in the reassessment.

Documentation of the hazard assessment is required through a written certification that includes the following information:

- ✓ Identification of the workplace evaluated;
- ✓ Name of the person conducting the assessment;
- ✓ Date of the assessment; and
- ✓ Identification of the document certifying completion of the hazard assessment.

- **Electrical Safety Hazards**

When electrical systems break down what are the primary hazards and what are the consequences to personnel?

- ✓ Electric shock-
- ✓ Exposure to Arc-Flash
- ✓ Exposure to Arc-Blast
- ✓ Exposure to excessive light and sound energies

Secondary hazards may include burns, the release of toxic gases, molten metal, airborne debris and shrapnel. Unexpected events can cause startled workers to lose their balance and fall from ladders or jerk their muscles possibly causing whiplash or other injuries.

Table1.1

CONDITION	EFFECTS
1-3mA of current	Mild sensation
10mA of current	Muscles contract, releasing grip may be difficult
30mA of current	Breathing difficult, possible loss of consciousness
30-75mA of current	Respiratory paralysis
100-200mA of current	Ventricular fibrillation
50-300mA of current	Shock (potentially fatal)
Over 1500mA of current	Tissue and organ burn
150° F	Cell destruction
200° F	Skin experiences "third degree" burns

1.2. Implementation of safety regulations

In the performance of your duties, you come across many potentially dangerous conditions and situations. You install, maintain, and repair electrical and electronic equipment in confined spaces where high voltages are present. Among the hazards of this work are injury caused by electric shock, electrical fires, and harmful gases. Also, you must include improper use of tools among these hazards. Common sense and carefully following established rules will produce an accident-free naval career.

Whenever you're working on any electronic equipment, your own safety has to come first. Every electronic technician must always take safety precautions before he or she starts work.

Electricity must be handled properly, or else it can injure or cause fatalities. Here are some basic steps that show you how to avoid accidents from occurring.

- **Electrical Shock**

Once you open up a set cover, you're actually exposing yourself to the threat of electric shock. Always keep in mind that safety has to come first. A serious shock may stop your heart and if large electric current flows through your body, you will receive serious burns.

There are three basic pathways electric current travels through the body;

1. **Touch Potential (hand/hand path)**

   - The current travels from one hand through the heart and out through the other hand. Because the heart and lungs are in the path of current, ventricular fibrillation, difficulty in breathing, unconsciousness, or death may occur.

2. **Step Potential (foot/foot path)**

   - The current travels from one foot through the legs, and out of the other foot. The heart is not in the direct path of current but the leg muscles may contract, causing the victim to collapse or be momentarily paralyzed.

3. **Touch/Step Potential (hand/foot path)**

   - The current travels from one hand, through the heart, down the leg, and out of the foot. The hear t and lungs are in the direct path of current so ventricular fibrillation.

Even though there may be no external signs from the electrical shock, internal tissue or organ damage may have occurred. Signs of internal damage may not surface immediately; and when it does, it may be too late. Any person experiencing any kind of electrical shock should seek immediate medical attention. Using the correct personal protective equipment (PPE) and following safe work practices will minimize risk of electrical shock hazards.

Figure 1.2 Illustrates the path of current through the body.

Here are some rules, which should help you to avoid electricity hazards.

- ✓ Always turn off the equipment and unplug it before you begin to work.
- ✓ If you have to run tests while the equipment is operating, turn the equipment on, make your test carefully, and then turn the equipment off again.
- ✓ Wear rubber bottom shoes or sneakers.
- ✓ Try to do the work with one hand, while keeping the other in your pocket. That keeps the possible current paths away from the heart.
- ✓ Don't attempt repair work when you are tired or rushed.
- ✓ Always assume that all the parts in the power supply are "HOT".

- ✓ Use only plastic screwdriver for shock protection during service operation.

- **Discharging Switch Mode Power Supply (SMPS) Capacitors.**

Most SMPS have a resistor to drain the charge in the main filter capacitor. But some resistors may fail and the capacitor can hold this charge even after you have turned off the equipment. This capacitor has a range of about 150uf to 330uf at 400 working voltage.

Before you start to work on a power supply, always turn off the power and discharge the capacitor. You can do this by placing a resistor across the two legs of the capacitor. The resistor value can be around 2.2 to 4.7 kilo ohms 10watt. It takes only a few seconds to fully discharge a capacitor. Double-check the capacitor with a voltmeter after every discharge.

NOTE / WARNING

Do not discharge capacitor with screwdriver because: -

- ✓ It may melt the tip of the screwdriver.
- ✓ It will damage the capacitor and its terminal.
- ✓ If we are too near to the point of discharge, the heavy spark generated may cause injury to our eyes.

- **Hot Ground Problem**

Modern equipment consists of two grounds, one of which is a “hot” ground while the other is a “cold” ground. Hot ground is in the primary side of a switch mode power supply while the cold ground is the equipment ground.

Be careful when taking voltage measurements around these grounds. For example, if you want to check the primary circuit of a power supply with power on, always ground your meter or scope to the hot ground, while check the secondary side using the cold ground.

If the “Hot” ground is not used and you use only the cold ground, the voltage measurement might not be correct and it may destroy your meter. One way to prevent this is to use an “isolation transformer”.

- **Isolation Transformer**

When servicing any electronic equipment, always use an isolation transformer to protect yourself from an electrical shock. During servicing, the isolation transformer is connected between the equipment and ac power line. An isolation transformer is a transformer that has a 1:1 turn ratio to provide the standard line voltage at the secondary outlet. This means that it does not change the voltage. The transformer still produces 240V AC at its outputs, but both sides of this AC lines are independent of ground. If you were to accidentally touch one of these outputs, you would be protected. The isolation transformer must be rated to handle the power of any equipment connected to it. Typical ratings are 250 to 500W.

- ✓ Note: A variable transformer is not an isolation transformer.

- **High Voltage**

Monitors and TV have sections that use very high DC voltages. The high voltage is needed to be applied t o t he CRT to at tract the electron be am to the phosphor. This high voltage could be as low as 12,000 volts in a monochrome Monitor or as high as 30,000 volts in large color monitor. Fly back Transformer is the part that is used to generate the high voltage. The high voltage circuit inside a Monitor or TV can give you a dangerous electric shock and causes you to jerk violently. You could cut yourself by accidentally knocking on sharp chassis edges. Be familiar with the high voltage circuits before you work on any high voltage equipment.

- **X-Radiation**

An X-ray is a form of radiation produced when a beam of electrons strikes some material at a relatively high speed. The only source of X-ray in a modern Monitor or TV is from the CRT. Prolong exposure to X-ray can be harmful. However, the CRT does not emit measurable X-ray if the high voltage is at the high voltage adjustment value only. When high voltage is excessive, then only X-ray is capable of penetrating the shell of the CRT, including the lead in glass material.

- **Wearing Goggles**

The CRT has a complete vacuum inside. It must be handled carefully and safely. Always wear goggles, to protect the eyes from flying glass, in the event of an implosion when removing and old tube from the set and installing a replacement.

Do not lift the CRT by the neck; instead hold the CRT with both hands on the heavy glass front of the tube. Also be sure to place the CRT facing downwards on a soft surface.

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Do not lift the CRT by the neck; instead hold the CRT with both hands on the heavy glass front of the tube. Also be sure to place the CRT facing downwards on a soft surface.

- **Electrostatically Sensitive Devices (ESD)**

Integrated circuits (IC) & some field-effect transistors are examples of ESD devices. These components can be easily damaged by static electricity. There are several techniques which can reduce the incidence of component damage, caused by static electricity.

- ✓ Immediately, before handling any ESD devices drain the electrostatic charge from your body by touching a known earth ground.
- ✓ Store ESD devices in conductive foam pad until installation in circuit.
- ✓ Wear a grounding strap, attached to your wrist.

Use only a grounded tip soldering iron to solder or de-solder ESD devices. (Some suggest using a battery powered soldering iron when working on ESD circuits).

- **Fire**

Before returning the equipment to the user, every reasonable precaution is taken to avoid fire hazards. Be sure to use only direct replacements and not one that defeats some safety measure. For example, the fuses in your equipment are carefully designed. Fuses must be replaced only with the same size, type and ratings. Should you install a fuse that is too large than the original rating, chances are that the equipment will be flammable?

- **Lifting**

Some equipment like TV, Hi-fi or Monitor can easily weight around 15 to 30 kilogram. Many problems arise when lifting this equipment from the floor. Wrong posture when lifting equipment may cause acute back pain. The right way to lift is keep your back straight and upright, and use your legs to supply the lifting power.

- **Ventilation**

Be sure that your work place has good ventilation. Prolong exposure or excessive inhalation of vapors from chemical spray and fumes from lead may cause damage to your nervous system or body.

1.3. Basic electrical safety rule concepts

Electrical Safety in the workplace can only be attained when trainees (workers) and companies diligently follow OSHA and industry accepted standards and regulations. It is our sincere hope and desire that this handbook has been helpful in informing the reader of the importance of Electrical Safety while providing methods and information on how to effectively and safely reduce electrical hazards.

- Unless there is a compelling safety issue such as life-support equipment, alarm systems, hazardous location ventilation, or lighting required for safety, OSHA requires that circuits be de-energized and the system be placed in an Electrically Safe Work Condition before any work is performed.
- When placing equipment in an Electrically Safe Work Condition always follow proper Lockout/tagout procedures.
- An Electrical Hazard Analysis must be performed on all circuits 50 volts and higher that may be worked on while energized.
- The Hazards must be identified and warning labels must be applied to all equipment that may be worked on while energized.
- Trainees must be trained on the equipment, hazards and safety precautions, and be certified as “qualified” to work on energized equipment. Training and certification must be documented.
- All work performed on energized equipment must be preceded by a job briefing and a signed Energized Electrical Work Permit.
- When working on or approaching energized circuits, proper protective clothing must be worn. The minimum flame retardant clothing, safety glasses, and protective gloves and equipment must meet OSHA and NFPA 70E guidelines. Protective insulating blankets and mats are also used to minimize exposure.
- Be certain there is adequate lighting for the tasks to be performed. Portable lighting must be fully insulated so that it will not accidentally cause short circuits when used near energized components.
- Use barricades or barriers to warn unqualified individuals from entering the area.
- Be prepared for the unexpected. Make sure emergency communications and trained medical personnel are available if something goes wrong.
- Use current-limiting overcurrent protective devices wherever possible to reduce the potential electrical hazards.

Self –Check-1	Written Test

Say True if the statement is correct and False if the statement is incorrect.

NO	Questions	Answer
1	A first critical step in developing a comprehensive safety and health program is known as a “hazard assessment.”	
2	Overexposure to chemicals or radiation is a physical hazard.	
3	Fluctuating temperatures and pinching objects are examples of health hazards	
4	Riding on equipment is prohibited except where designated for operator.	
5	Trouble shooting means finding the problem that occur in the equipment.	
6	In a step potential contact, current travels from one hand through the heart and out through the other hand.	
7	In a touch/step potential contact, current travels from one hand, through the heart, down the leg, and out of the foot.	
8	Participate in Occupational Health and Safety is the responsibility of the supervisor or the companies.	

Note:

Satisfactory rating above 5 out of 8 points **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score =________
Rating =________

Name__________________________ **Date** ____________________

Information Sheet-2	**Consulting Responsible Person.**

Definition and purpose of Consultation

Consultation: is an act of seeking and giving of advice, information, and/or opinion, usually involving a consideration.

The purpose of a consultation is to get an advice in solving a problem. You want to change something, achieve something, attain something, or become something, you need help. The current state of things isn't how you want it to be. Therefore, your instructor or supervisors knows what desired state.

1. **Instructors or Immediate supervisor**

Responsibilities include:

- Working with the shop management team to identify and priorities tasks
- Day to day guiding and supervising the training
- Prioritizing, giving and control daily tasks
- Maintenance, conservation and return of machinery and tools
- Staff training
- Regular inspections
- Ensuring all H & S policies are adhered to and working with the H&S Manager
- Organizing, linking with and top head and management.
- Making sure projects run smoothly and on target/budget.

Self-Check 2	Written Test

I. **Write your answer Briefly**

1. What is Consultation? 2pts

2. Write the purposes of Consultation. 2pts
3. List the Responsibilities of Instructors or Immediate Supervisors (At list 4). 4pts

Note:

Satisfactory rating above 6 out of 10 points **Unsatisfactory - below 6 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score =________ **Rating =________**

Name_________________________ **Date ____________________**

Information Sheet-3	Preparing & checking required materials tools & equipment

The following materials, tools and equipment's used for repairing SMPS Power supply should be check for their appropriateness and normal state for specific operation.

3.1. The required materials and their specifications for troubleshooting AC/DC power supply are as follows in the table below.

Table 3.1

S.N	Consumable Materials	Specifications	Remark
1	Copper Wires		
2	Stranded Wires		
3	Diodes		
4	Capacitor		
5	Resistor		
6	Solder		
7	Transistor		
8	Freezer spray		
9	IGBT Transistor		
10	Zener Diode		

3.2. The required tools and their specifications for troubleshooting AC/DC power supply are as follows in the table below.

Table 3.2

S.N	Tools	Specifications	Remark
1	Utility knife/stripper		
2	Wrenches (assorted)		
3	Allen wrench/key		
4	Screws (assorted)		
5	Pliers (assorted)		
6	Ball-peen hammer		
7			
8			

3.3. The required equipment's and their specifications for troubleshooting AC/DC power supply are as follows in the table below

Table 3.3

S.N	Equipment's	Specifications	Remark
1	Multi meter	Digital/ Analog	
2	Single phase power supply		
3	Conventional E-I Transformer	220V/50/60Hz	

4	Soldering iron		
5	ESD-free work bench with mirror	1m by 2m	
6	Vernier Caliper	Digital/Analog	
7	Micrometer	Digital	
8	Isolation Transformer	1:1/220V/50/60Hz	
9	Variable Transformer	0-220V/50/60Hz	
10	Capacitance Meter	Digital	
11	Blue ESR Meter	Digital	
12	Blue Ring tester	Digital	
13	Oscilloscope	Digital/ Analog	

3.4. Recommended test equipment for successful SMPS Repair

1. Isolation Transformer

Be aware that the dis advantage of switching power supply is that they can be very dangerous to work on it. This is because the HOT side of the AC line essentially goes to all power supply components on the primary side of transformer. If you accidentally touch anything in this primary power side circuit and ground at the same time, there would be a path for electricity to flow through your body and could receive a severe electrical shock.

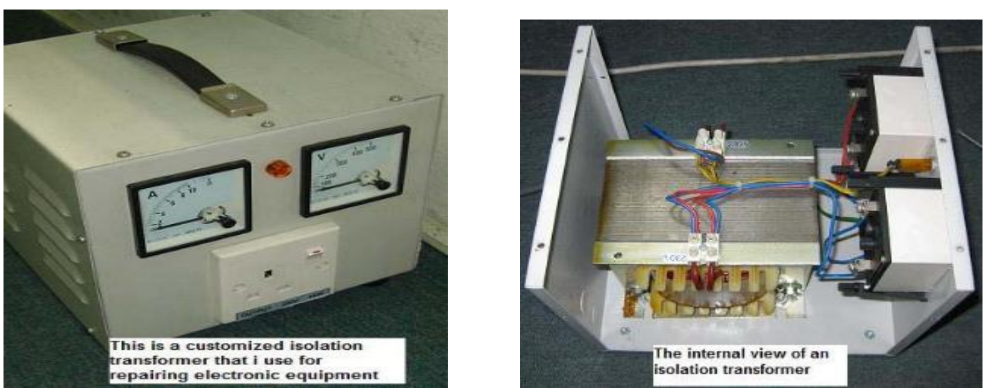


Figure3.1. Isolation Transformer

When servicing any electronic equipment which include the SMPS, always use an isolation transformer to protect yourself from an electrical shock. During servicing, isolation transformer is connected between the equipment and the ac power supply line. It has a 1:1 turn ratio to provide the standard line voltage at the secondary outlet.

2. Variable Transformer

The Variable Transformer (Variac) provides undistorted variation of AC voltage.

Figure3.2. Variable Transformer

NOTE: Variable Transformer is not Isolation Transformer.

3. Digital Capacitance Meter

It is necessary to determine a capacitor values and it is usually displays the capacitance in microfarad(uf), Nano Farad(nf) OR Pico Farad (pf).

Figure3.3. Digital Capacitance Meter

4. Blue ESR Meter

Almost all electrolytic capacitor failures are due to high ESR (Equivalent Series Resistance). The high internal resistance reduces the capacitor's rate of charge and discharge effectively, making it an "open" capacitor. High ESR is usually a result of dehydration of the electrolyte due to equipment heat, old age, corrosion, defective rubber seal and high ripple current.

High ESR in electrolytic capacitors causes various problems. In power section of any electronic equipment, they can cause no power problems or even power blink. In the color or video circuits of Monitor or Television, they cause intermittent or missing colors.

Figure3.4. Blue ESR Meter

5. Blue Ring tester

Using an ohmmeter (analogue or digital multimeter) or even an inductance meter to test a coil/winding will give you an inaccurate result. Why? Because both meters (ohmmeter and inductance meter) could misled you into believing that the coil/winding is good where in fact the coil/winding is shorted internally between windings! Your precious time will be wasted because you could not effectively locate the bad component (which is the coils). Now thanks to this simple yet a powerful tester to really test out the coils/windings that have shorted turns especially the **primary winding of switch mode power supply.**

This Blue ring tester is an inexpensive yet effective way to test any high Q inductive component. It is especially useful for doing a quick check on **SMPS Transformer, Flyback Transformers, Monitor B+ coil, Ballast**

Figure3.5. Blue Ring tester

6. Oscilloscope

Oscilloscopes offer a tremendous advantage over multimeters. An oscilloscope or "scope" can give you a "picture" of a changing electronic signal. Instead of reading signals in numbers or lighted indicators, an oscilloscope will show voltage versus time on a graphical display. Not only can you observe ac and dc voltages, but they are also very helpful for checking the "shape" of an electronic signal. If you know what kind of signal to expect, and the scope shows you a different signal, you know something is wrong. The scope can be used to check the operating characteristics of parts like transistors and capacitors. Oscilloscopes have being used for many years to troubleshoot power supply, amplifiers, and other analogue devices.

Figure3.6. Analogue and digital Oscilloscope

Self-Check 3	Written Test

I. Choose the best answer

1. ____________It is necessary to determine a capacitor values and it is usually displays the capacitance in microfarad(uf), Nano Farad(nf) OR Pico Farad (pf).

A. isolation transformer C. Digital Capacitance Meter

B. Variable transformer D. Blue Ring tester

2. During servicing, _____________is connected between the equipment and the ac power supply line.

A. isolation transformer C. Digital Capacitance Meter

B. Variable transformer D. Blue Ring tester

3. ____________Is used to test shorted coils/windings of the SMPS

A. isolation transformer C. Digital Capacitance Meter

B. Blue ESR Meter D. Blue Ring tester

II. Write your answer clearly

1. List at least 5 tools used for repairing SMPS.3pts

Note:

Satisfactory rating above 4 and above points **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score =________
Rating =________

Name_________________________ **Date** ____________________

Information Sheet-4	Preparing and obtaining parts and materials needed

Introduction.

Before starting troubleshooting the technician(you) should have to prepare and obtain the required materials, tools and equipment's needed for task as they are listed in the previous information sheet No3 and also, you should have to use the tools and test equipment's properly and safely.

4.1. Tools Needed

Tools are the basic requirement of a service technician, without tools, one cannot even open the cabinet and have access to the circuits. Some of the tools required for the tasks are described below.

- **Utility knife**

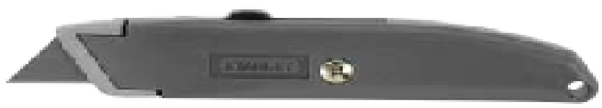


Figure 4.1 Utility knife

- **Wrenches**

A wrench's main function is to hold and turn nuts, bolts, caps, screws, plugs and various threaded parts. Applying excessive torque will strip or damage those threads, so quality wrenches are designed to keep leverage and intended load in safe balance.

Users should not put "cheaters" on wrenches to increase leverage. The proper size wrench should be used. Too large a reach will spread the jaws of an open-end wrench or damage the points of a box or socket wrench. When possible, a wrench should be pulled, not pushed.

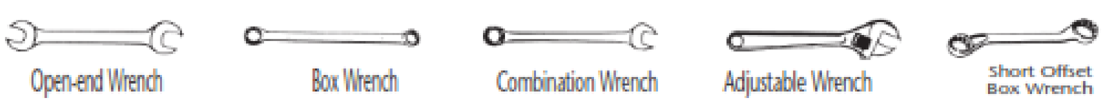


Figure 4.2. Different types of wrenches

- **Allen key**

Figure 4.3. Allen key

- **Screwdrivers**

Screws are made in different sizes, and they're designed to be turned by screwdrivers of the corresponding sizes. You will need a good set of screwdrivers with both Philips and flat slotted heads. Many people have the habit of trying to turn a screw with whichever screwdriver they have. Most screws can be turned easily if you use a screwdriver of the right size. A power screwdriver is also useful in electronic servicing because some equipment has numerous screws, that your hand will get tired unscrewing them.

Figure 4.4 Philips & Flat Screwdrivers

- **Long-Nose Pliers**

A long-nose plier is needed to remove components once they are de-soldered from the PCB board. They are very useful for reaching into tight spaces inside the equipment. For example, components located under the belly of the CRT are very difficult to remove without pliers.

Figure 4.5 Combination, Long-nose and adjustable pliers

- **Wire Cutters**

Wire cutters are useful for cutting wires, wire ties, and lead on large parts, such as resistors and capacitors.

Figure4.6. Wire-cutter

- **Wire Strippers**

Before you can make connections with a piece of wire, you must "strip" away the plastic insulation on a wire. Resist the temptation to strip insulation using wire cutters. Even if insulation should be removed successfully, wire cutters often leave a nick or pinch in the conductor, which later might fatigue and break.

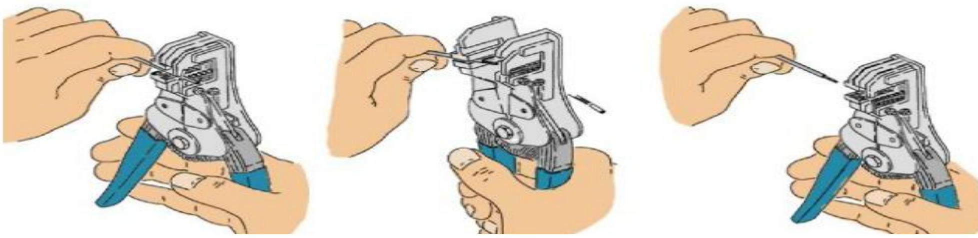


Figure 4.7. Wire Strippers

- **Spray Cleaner**

The wiper at a variable resistor might accumulate dust after operating for a certain amount of time. This can result in all types of erratic or intermittent circuit problem. A spray cleaner can be used to solve this kind of problem. However, if symptom persists, replace the variable resistor.

Figure 4.8 Spray Cleaner

- **Magnifying Lamp**

A magnifying lamp not only provides light, but also makes it easier to read component marking especially the surface mounted components (SMD) and small resistor color code. A magnifying lamp also can be used to check for cracks, broken solder joints or burnt components in a PCB board.

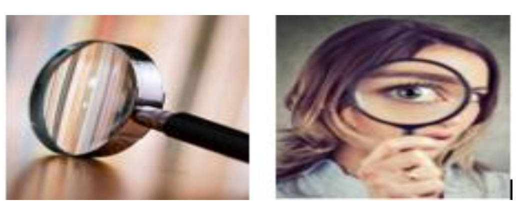


Figure 4.9 A magnifying lamp

- **Brush**

You may use a toothbrush to look for intermittent or bad connection in a PCB board. Simply run the toothbrush over the PCB board until you push the bad connection into working. Most of the time you can locate the fault using this way.

Figure 4.10. Tooth brush

- **Ball Peen Hammers**

Ball peen hammers are used with small shank, cold chisels for cutting and chipping work, rounding over rivet ends, forming unhardened metal work and similar jobs not involving nails. The striking face diameter should be approximately 3/8" larger than the diameter of the head of the object being struck. The hammer is designed with a regular striking face on one end and a rounded or half ball or peen on the other end taking the place of a claw.

Figure4.11 Ball Peen Hammer

4.2. Equipment's Needed

- **Soldering Irons**

Transistor and ICs can easily be destroyed by overheating. For this reason, you must choose carefully when you select a soldering iron for use with digital circuit like CMOS IC. Use a low-powered iron, with a rating of about 30 watts. Do not use a high-powered iron, because it can easily overheat an IC or other parts. If you overheat a trace on a circuit board, the heat can cause the trace to lift from the board. Soldering tips can be manufactured in a wide range of shapes and sizes. Before you select the best tip for the job, you must understand the ideal soldering conditions. Remember to turn off the equipment before you make any solder repairs.

Figure4.12. Soldering Irons

- **Soldering Iron Holders**

If you have a soldering iron with no switch, (some soldering irons have a switch, where each press will increase the power from 30w to 120w), it will remain hot all the time when it is plugged in. Sometimes the solder iron becomes too hot and it melts the plastic case of the soldering iron. The holder is often formed into a spiral, with lots of air space to radiate the heat from the iron and also to prevent the soldering tip from touching other parts which can sometimes cause fire.

Figure4.13 Soldering Iron Holder

- **De-soldering pump (solder sucker)**

A tool for removing solder when de-soldering a joint to correct a mistake or replace a component.

Figure4.14 Solder sucker

- **Vernier Caliper**

Figure4.15 Vernier Caliper

- **Micrometer**

Figure4.16 Micrometer

4.3. Consumable materials

- **Solder**

Solder is related by the proportion of lead to tin. For example, “60/40” solder is 60% tin and 40% lead. Most solders are manufactured with a hollow center which contains “flux”. As at needed for electronic troubleshooting.

Solder melts, the flux cleans the parts and prevents oxidation to ensure a good connection. Always use resin-core solder and under no circumstances should you use paste flux containing acids or solvents or use solder containing acid flux. Harsh solvents destroy delicate components leads and circuit traces.

Figure4.17. Solders

- **Solder remover wick (copper braid)**

✓ This is an alternative to the de-soldering pump shown below

.

Figure4.18. Solder remover wick (copper braid)

- **PCB rubber**

✓ This is an abrasive rubber for cleaning PCBs. It can also be used to clean stripboard where the copper tracks have become dull and tarnished.

Figure4.19. PCB rubber

- **Resistors**
- **Diodes**

✓ 1N4148 signal diode and 1N4001 rectifier diode, 5 of each.

Figure4.20. Rrectifiers diode,

- **Transistors**

✓ **General purpose,** low power, **NPN** transistors. These should have a maximum collector current (Ic max) of 100mA, and a minimum current gain (hFE min) of 200.

- For example: BC548B (BC108 equivalent).

✓ **General purpose**, medium power, NPN transistors. These should have a maximum collector current (Ic max) of 1A, and a minimum current gain (hFE min) of 30.

- For example: BC639 (BFY51 equivalent).

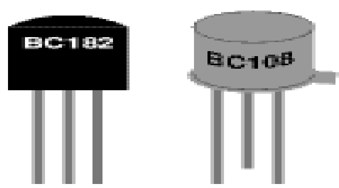


Figure4.21. General purpose NPN transistors

- **Capacitor**

✓ **Low values**: 0.01µF and 0.1µF metallized polyester, 10 of each.

✓ High values: 1µF 63V, 10µF 25V, and 100µF 25V electrolytic with radial leads, 10 of each; 220µF 25V and 470µF 25V electrolytic with axial leads, 3 of each.

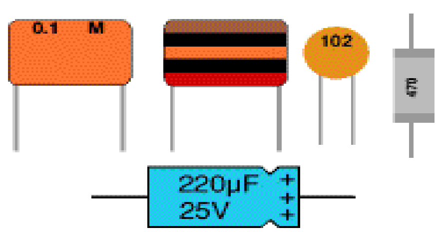


Figure 4.22. Capacitor

- **Transformer**
- **Copper-wire**

Figure4.23 Solid Copper-wire

- **Stranded Wires**

Figure4.24. Stranded Wires Copper-wire

4.4. Types of Power Supplies

A power supply is an electronic circuit or a device that converts the primary electric power in to ac or dc needed by different types of electronic circuit. A power supply may be implemented as a discrete, standalone device or as integral device that is hard wired to its load and designed to provide various ac and dc voltages. Therefore, all electronic equipment's require a source of DC power for normal operation.

The power supply circuit produces the DC voltage needed to operate electronic components. Of course, batteries can be and are used in portable equipment, but in larger systems, where considerable power is needed, batteries are an inconvenience and expensive. Electronic circuits normally require a different type and value of voltage than is available from standard 220V AC wall socket.

1. AC Power supply

An AC power supply typically takes the voltage from the mains supply and lowers it to the desired voltage. It is also known as unregulated power supply; this is because its output voltage varies depending on the load and on variation on the AC supply voltage. One of the major components in most ac power supply units is the power transformer. The power transformer performs one or more of the following function for a power supply.

- Steps up voltages
- Steps down voltages
- Electrically isolates the primary circuit from the secondary circuit
- Supplies separate voltages that are out-of-phase with each other
- Supplies a variable ac voltage.

- **Step-Down Transformer**

When the transformer primary coil turns are greater than the secondary coil turns, the voltage is stepped down and the current is stepped up in proportion to the turns ratio. In the ideal transformer the voltage multiplied by the current of the primary coil equals the voltage multiplied by the current of the secondary coil.

$$E_p \times I_p = E_s \times I_s$$

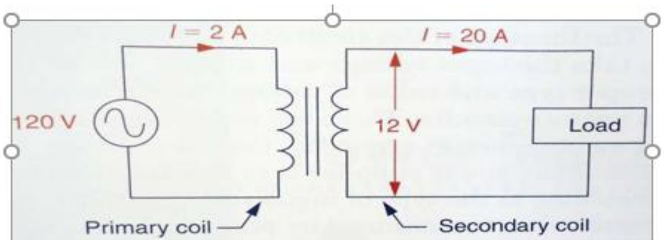


Figure4.25. Schematic diagram of a Step-Down Transformer

- **Step-Up Transformer**

When the transformer secondary coil turns are greater than the primary coil turns, the voltages is stepped up and the current is step down in proportion to the turns ratio (as shown in the next figure)

$$E_p \times I_p = E_s \times I_s$$

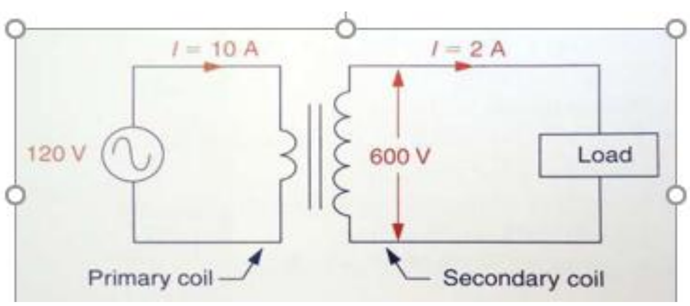


Figure4.26. Schematic diagram of Step-Up Transformer

- **Isolation**

A standard transformer electrically isolates the primary and secondary circuits which means it gives electrical separation between ac neutral or ground input and the power supply output common.

In transformer, the ac line voltage is connected to the primary coil to create a changing magnetic field that induces voltage in the secondary coil. The primary and secondary coils are not connected physically, but simply are magnetically linked. if a high voltage is applied to the primary coil of a step-down transformer, the low secondary voltage is completely isolated from the high primary voltage. If a person touched either wire of the secondary coil he/she would not be shocked by the high primary voltage (as shown in the figure bellow)

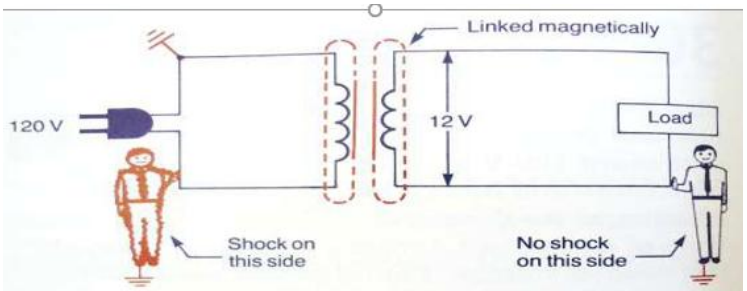


Figure4.27. Schematic diagram of an Isolation Transformer

- **Center-tapped Transformer**

It is built to provide separate secondary voltages that are out-of-phase with each other (the next fig.). The secondary winding is made with a center-tap connection that provides a common point for two equal output voltages. These two voltages are said to be 1800 out-of-phase with each other.

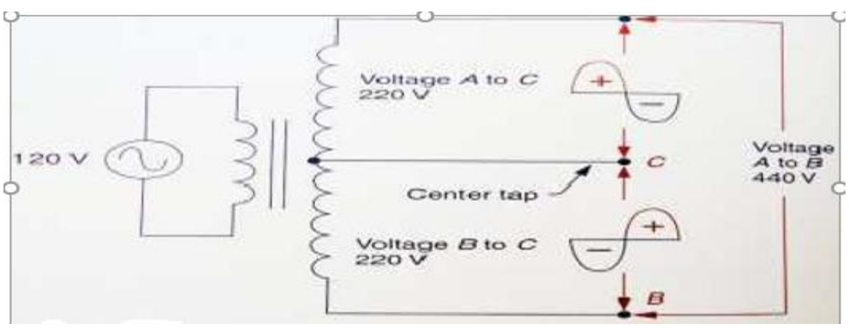


Figure4.28. Schematic diagram of a Center-tapped Transformer

- **Auto-transformer (variable ac power supply)**

The theory of operation for autotransformer is the same as for any other transformer except that there is no isolation between the primary and secondary coils. The entire winding is considered to be the primary coil, and part of the primary and secondary coil. If one end of the secondary winding is movable, the autotransformer can be used to provide a variable ac secondary coil voltage, so that its primary and secondary coils are physically connected together.

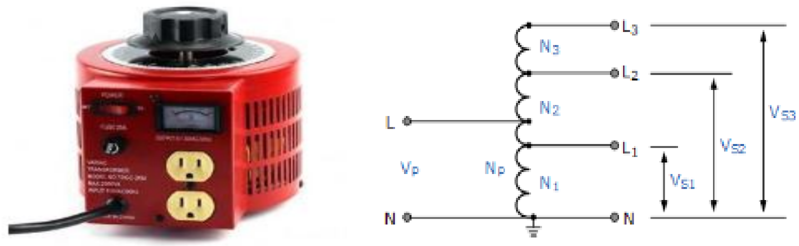


Figure4.29. Variable AC power supply and Schematic diagram of an autotransformer Transformer

2. **DC Power Supply**

The function of the DC power supply is to provide the necessary DC voltage and current, with low levels of AC ripple and with a good stability and regulation. A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source.

All Electronic circuits require a source of well-regulated dc, at voltages of typically between 5 V and 30 V. Thus a power supply system can be defined as an electronic circuit which converts the ac input of 50/60Hz power line to a dc output voltage.

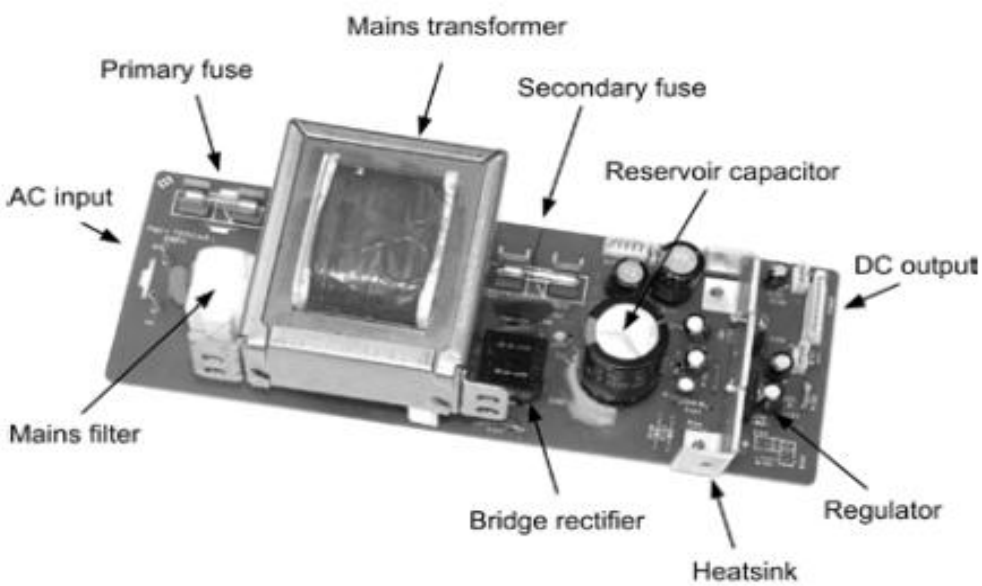


Figure4.30. A simple and Dual Polarity DC power supply

Generally, DC Power supplies for electronic devices can be divided in to Conventional (linear) and switching mode power supplies.

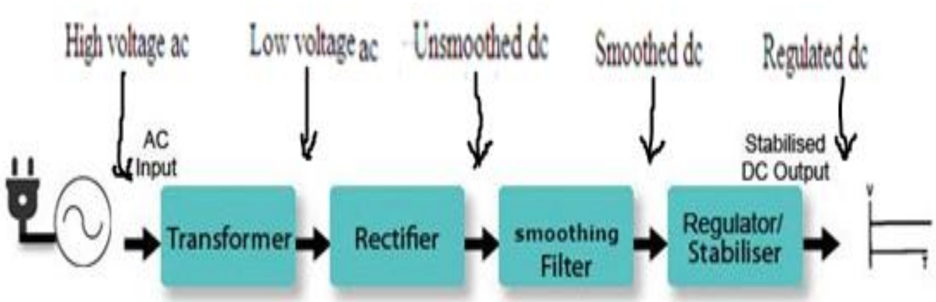


Figure4.31. Block diagram of regulated dc power supply

The conventional power supply is usually a relatively simple design, but it becomes increasingly bulky and heavy for high current equipment due to the need for large transformers and heat slinked electronic regulation circuitry. Switched mode power supply of the same rating as a linear power supply will be smaller, is usually more efficient, but will be more complex.

4.5. Main Parts and function of DC power supply

The power supply unit used to convert alternating current to direct current consists of four main parts.

1. Transformer
2. Rectifier
3. Filter and
4. Voltage regulator

1. Transformer

Since the final voltage desired is generally not 220V so a transformer is usually include stepping the ac line voltage up or down depending on the exact needs of the electronic circuits. Generally electronic circuits require low voltage supply; therefore, mostly the purpose of the transformer is to step down the line voltage. For example, a step down transformer with turn's ratio 10:1 would reduce the 220v ac input in to 22v dc output. The output current capabilities of this transformer will be1:10 which will be ideal. Since most electronic circuits require low voltage supply with high current capability. Thus, the output, or secondary, voltage of a step-down unit is lower than the input, or primary, voltage. The other purpose of a transformer is isolate the output from the input circuit this reduces the risk of electrical shock.

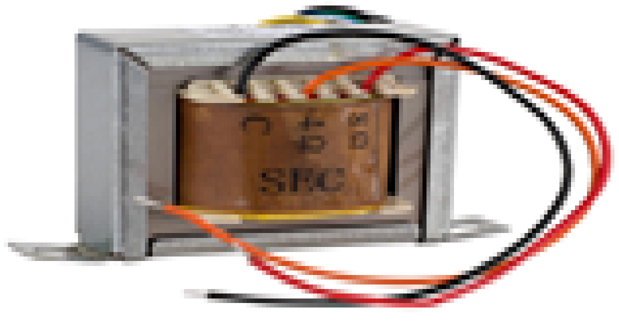


Figure4.32. Actual Step down transformer

2. Rectifiers

It is used to convert alternating current (ac) to direct current (pulsating dc), which is unidirectional current that supplied to the filter circuit as an input. Basically there are two types of rectifiers, such as half wave, full wave (center tap and bridge).

All rectifier diodes are made from silicon and therefore have a forward voltage drop of 0.7V. The table shows maximum current and maximum reverse voltage for some popular rectifier diodes. The 1N4001 is suitable for lowest voltage circuits with a current of less than 1A.

Table5.1

Diode	Maximum Current	Maximum Reverse Voltage
1N4001	1A	50V
1N4002	1A	100V
1N4007	1A	1000V
1N5401	3A	100V
1N5408	3A	1000V

I. Half wave Rectifier

The simplest form of rectifier circuit makes use of a single diode to “chop off” half of the ac input cycle. It operates on only either positive or negative half-cycles of the supply. Mains voltage (220 to 240 V) is applied to the primary of a step-down transformer (T_1).

The secondary of T_1 steps down the 240 V r.m.s. to 12 V r.m.s. (the turns ratio of T_1 will thus be 240/12 or 20:1). Diode D_1 will only allow the current to flow in the direction shown (i.e. from cathode to anode) so that, D_1 will be forward biased during each positive half-cycle (relative to common) and will effectively behave like a closed switch.

When the circuit current tries to flow in the opposite direction, the voltage bias across the diode will be reversed, causing the diode to act like an open switch

The switching action of D_1 results in a pulsating output voltage which is developed across the load resistor (R_L). The circuit is called half wave rectifier, because only half of the input wave is converted to output wave.

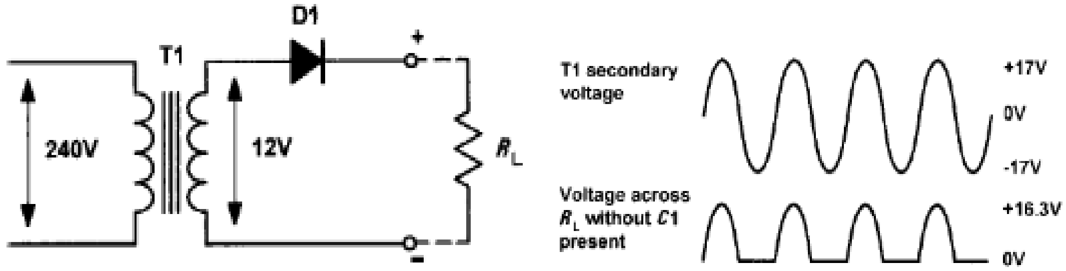


Figure4.33 Half wave Rectifier and its waveform.

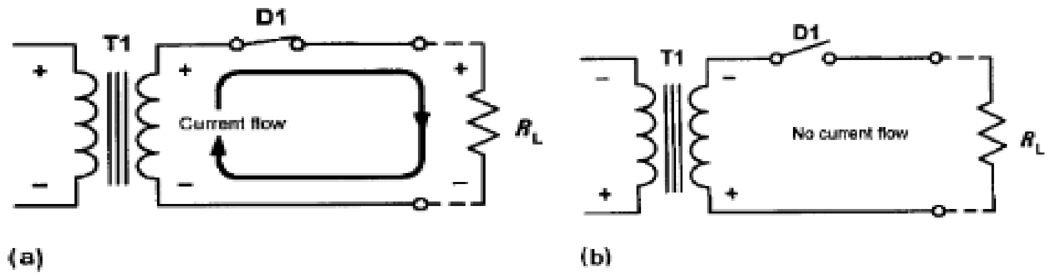


Figure4.34. (a) Half-wave rectifier circuit with D1and (b) half-wave rectifier with D1 not conducting

During a positive half cycle of input voltage, the diode conducts and the current flows through RL and the circuit developed VO$= I_L * R_L$. During the negative half cycle of the input voltage the diode is reverse biased and it is cut off. Thus, $I_L = 0$, & $V_o = 0$, since there is no flow of current there is no output voltage. Since V_o is in pulsating dc it is an average of the maximum and minimum values of the pulse.

$$V_{av} = \frac{V_{in(p)}}{\pi}, \quad V_{av} = 0.318 V_{in}(p) = 32\%$$

The advantage of half wave rectifier is it requires only one diode and its disadvantage is low output voltage; the output is poor or hard to smooth out, because the waveform is so irregular, high ripple factor (poor filtering action). Ripple factor is a measure of purity or ability of filtering action of the circuit.

II. Full wave Rectifier

The half wave rectifier output is difficult to filter to a smooth dc level because an output voltage and current are only half of each input cycle to the load. Unfortunately, the half-wave rectifier circuit is relatively inefficient as conduction takes place only on alternate half-cycles. A better rectifier arrangement would make use of both positive and negative half-cycles. This full-wave rectifier circuits offer a considerable improvement over their half wave counterparts. They are not only more efficient but are significantly less demanding in terms of the smoothing components. Full wave rectifier provides double output of a half wave rectifier and better filtering action. Ripple factor for full wave rectifier is reduced to 0.48 because $V_{av} = 2V_p/\pi$. This implies Vav= 64%Vp, but for half wave Vav= Vp/π, this implies 32% Vp. There are two types of full wave rectifiers, these are center tap and bridge rectifier.

a. Full-wave, Center-Tap Rectifier

It requires two diodes and a center tapped transformer. The center tap, a wire coming out of the exact middle of the secondary winding, is connected to common ground. This produces out-of-phase waves at the ends of the winding. These two waves can be individually half-wave rectified, cutting off the negative half of the cycle. Because the waves are 180 degrees (half a cycle) out of phase, the output of the circuit has positive pulses for both halves of the cycle as shown in figure (4B) below.

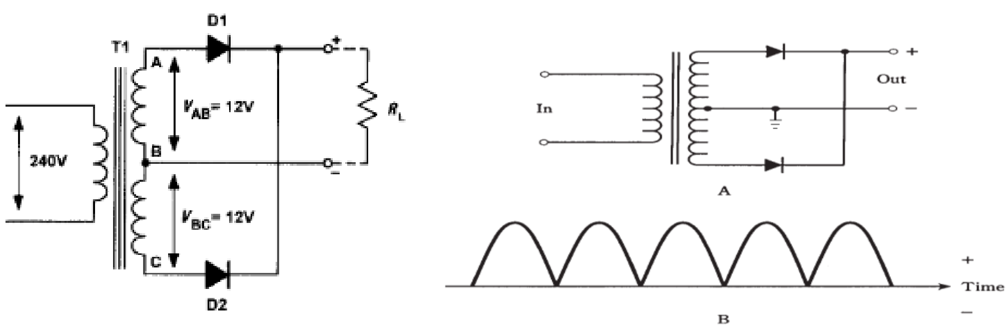


Figure4.36. *Schematic diagram of a full-wave, Center-tap rectifier and its out put*

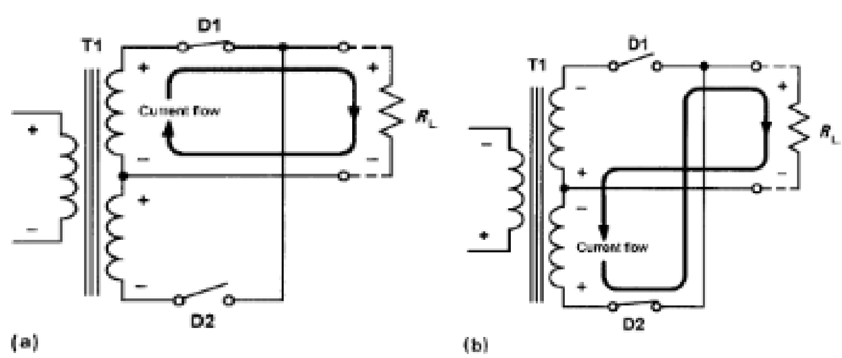


Figure4.37. Schematic diagram of a full-wave, Center-tap rectifier with (a)D1conducting and D2 non-conducting (b) D2 conducting and D1 non-conducting

b. Full-wave Bridge Rectifier

Another way to get full-wave rectification is the bridge rectifier, the output waveform is just like that of the full-wave, centre-tap circuit. The bridge circuit does not need a centre-tapped transformer secondary. This is its main practical advantage. Electrically, the bridge circuit uses the entire secondary on both halves of the wave cycle; the centre-tap circuit uses one side of the secondary for one half of the cycle, and the other side for the other half of the cycle. For this reason, the bridge circuit makes more efficient use of the transformer.

The main disadvantage of the bridge circuit is that it needs four diodes rather than two. This doesn't always amount to much in terms of cost, but it can be important when a power supply must deliver a high current. Then, the extra diodes two for each half of the cycle, rather than one dissipate more overall heat energy. When current is used up as heat, it can't go to the load. Therefore, centre-tap circuits are preferable in high-current applications.

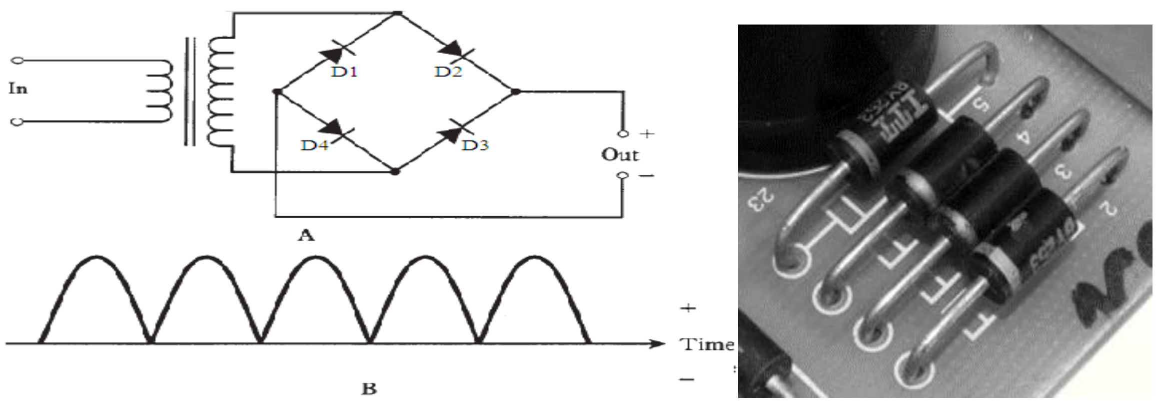


Figure4.38. *Schematic diagram of a full-wave bridge rectifier and its out put*

Figure4.39. *Various types of Bridge Rectifiers*

3. Filter or smoothing circuits

Electronic equipment doesn't like the pulsating dc that comes straight from a rectifier. The ripple in the waveform must be smoothed out, so that pure, battery-like dc is supplied. Thus, the filter in a dc power supply is used to remove the ripple from the pulsating current. So that the output of the power supply is a pure dc, that is, the filter is used to convert the pulsating dc output coming from the rectifier in to a constant or smooth dc voltage. The simplest filter is one or more large-value capacitors, connected in parallel with the rectifier output.

Filter capacitors work by "trying" to keep the dc voltage at its peak level. This is easier to do with the output of a full-wave rectifier as compared with a half-wave circuit. The remaining waveform bumps are the ripple. With a half-wave rectifier, this ripple has the same frequency as the ac, or 60 Hz. With a full-wave supply, the ripple is 120 Hz. The capacitor gets recharged twice as often with a full-wave rectifier, as compared with a half-wave rectifier. This is why the ripple is less severe, for a given capacitance, with full-wave circuits.

The capacitor, C1 has been added to ensure that the output voltage remains at, or near, the peak voltage even when the diode is not conducting. When the primary voltage is first applied to T1, the first positive half-cycle output from the secondary will charge *C*1 to the peak value seen across *R*L*.* Hence *C*1 charges to the peak of the positive half-cycle. Because *C*1 and *R*L are in parallel, the voltage across *R*L will be the same as that across *C*1. The time required for *C*1 to charge to the maximum (peak) level is determined by the charging circuit time constant (the series resistance multiplied by the capacitance value) RC.

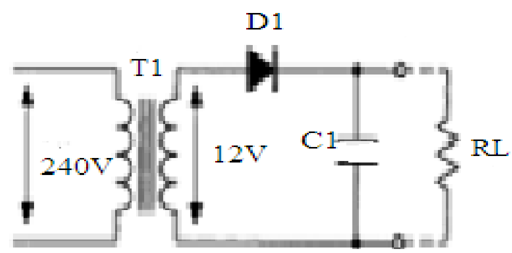


Figure4.40. *A half wave rectifier circuit with filter capacitor*

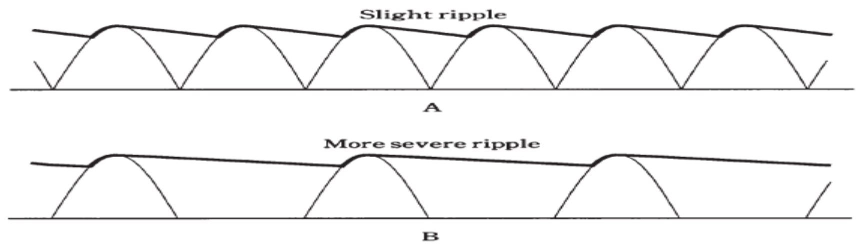


Figure4.41. Filtered output for: (A) full-wave rectification and (B) half-wave rectification

4. Voltage Regulators

All source of power supply has internal resistance due to this resistance there will be an IR drop within the power source and the terminal voltage (output voltage across the load) will decrease as the load is applied. The higher the load the higher the IR drop therefore the term regulation is used as an indication of a power source to maintain a constant output voltage.

For critical electronics applications a linear regulator may be used to set the voltage to a precise value, stabilized against flections in input voltage and load. The regulator also greatly reduces the ripple and noise in the output DC current. Linear regulators often provide current limiting, protecting the power supply and attached circuit from over current. If a reverse biased Zener diode is connected across the output of a power supply, the diode will limit the output voltage of the supply as long as it has a high enough power rating.

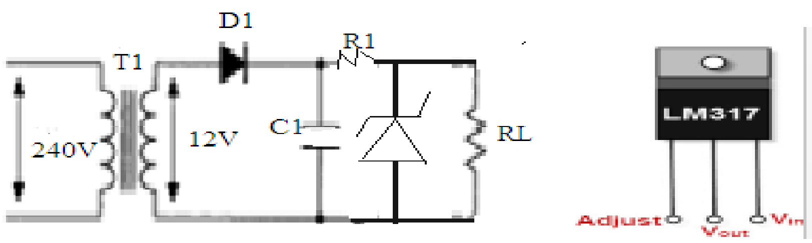


Figure4.42. Voltage regulator

As increase in the ac input voltage would cause an increase in the dc output from the filter which would cause an increase in the current that flow through the series resister R1, the zener diode and the load. The reverse biased zener diode will however, maintain a constant voltage across its anode and cathode. That means despite the input voltage and current variations with additional voltage being dropped across the series resistor as a result the zener diode regulator will maintain a constant output voltage regardless of the variation in the ac input voltage and load current. Totally the zener diode achieves this by increasing and decreasing current Iz in response to load resistance changes, however the zener voltage Vz and the output voltage (Vo or $V_{RL)}$ always remains constant.

Zener diodes are made to have well-defined, constant avalanche voltages. Suppose a certain Zener diode has an avalanche (rush) voltage, also called the Zener voltage*,* of 50 V. If a reverse bias is applied to the P-N junction, the diode acts as an open circuit below 50 V. When the voltage reaches 50 V, the diode starts to conduct. The more the reverse bias tries to increase, the more current flows through the P-N junction.

This effectively prevents the reverse voltage from exceeding 50 V. The current through a Zener diode, as a function of the voltage, is shown in Fig. below. The Zener voltage is indicated by the abrupt rise in reverse current as the reverse bias increases. A typical Zener-diode voltage-limiting circuit is shown in Fig. below. There are other ways to get voltage regulation besides the use of Zener diodes, but Zener diodes often provide the simplest and least expensive alternative. Zener diodes are available with a wide variety of voltage and power-handling ratings. Power supplies for solid-state equipment commonly employ Zener diode regulators.

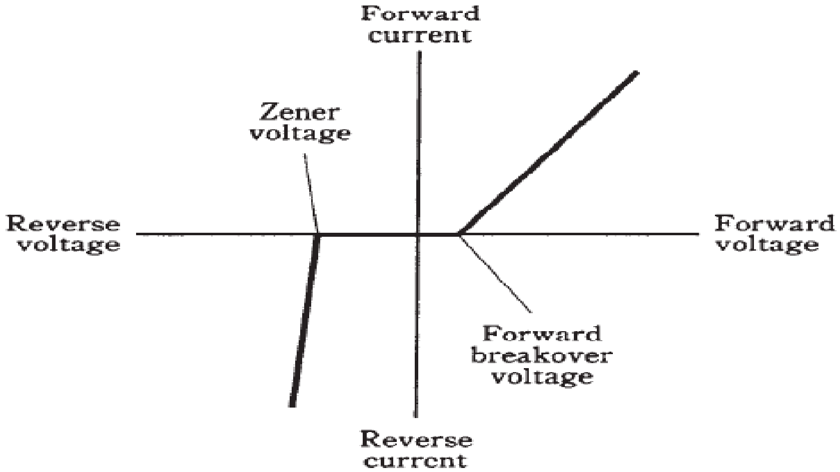


Figure4.43. Current through a Zener diode, as a function of the bias voltage

4.6. Types of dc power supply

1. Un-Regulated dc power supply

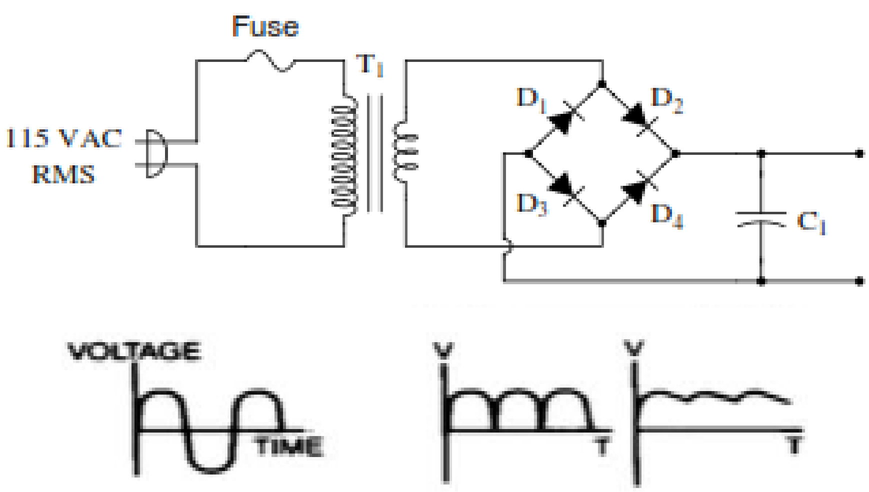


Figure4.44. Schematic diagram and output of unregulated dc power supply

2. Regulated linear dc power supply

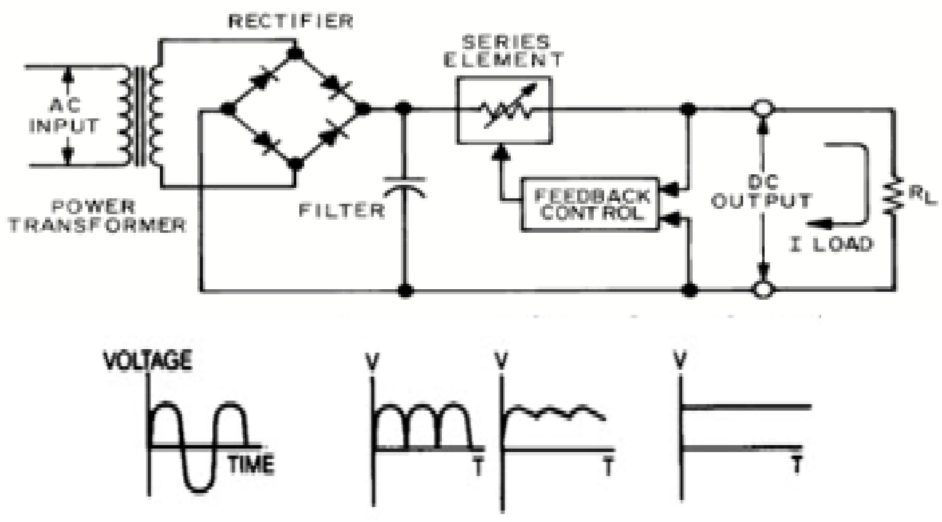


Figure4.45. Schematic diagram of a regulated linear dc power supply

3. Switch Mode Power Supply

It is a power supply that provides the power supply function through low loss components such as capacitors, inductors and transformers and the use of switches that are in one of two states, on or off. The advantage is that the switch dissipates very little power in either of these two states and power conversion can be accomplished with minimal power loss, which equates to high frequency.

SMPS have been used for many years in industrial applications where good efficiency, light weight and small size were of prime concern. Today SMPS often called (often called "chopper" "switchers") are used extensively in AC powered electronic devices such as computers, monitors, television receivers and VCRs.

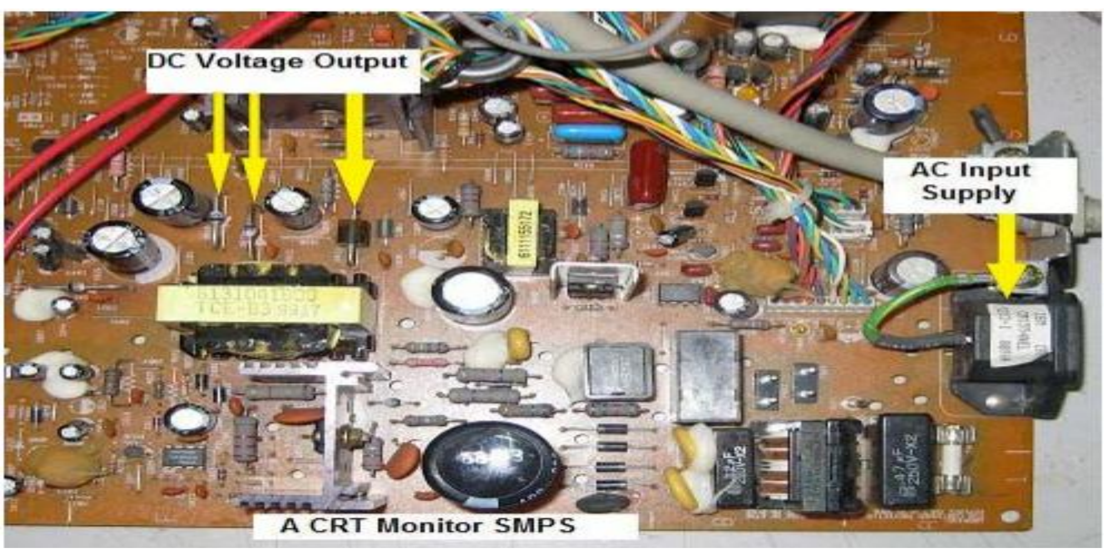


Figure4.46. ACRT Monitor SMPS Board

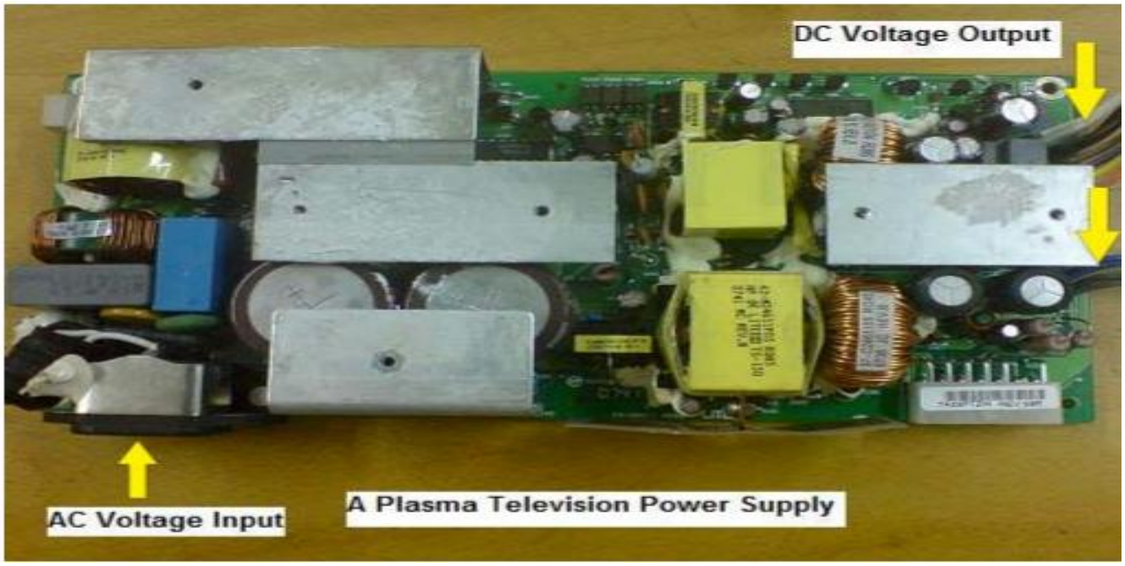


Figure4.47. A Plasma Television Monitor SMPS Board

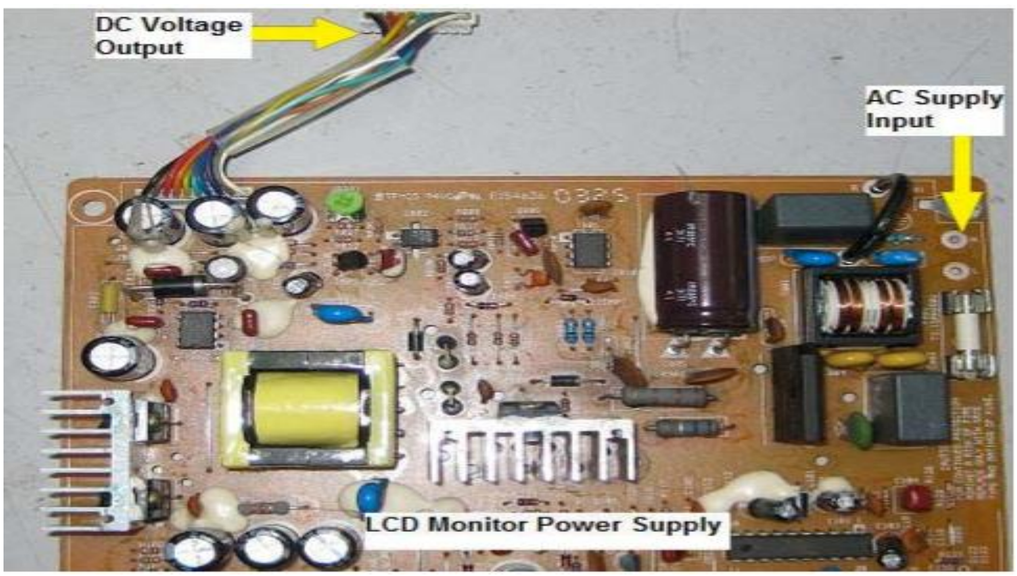


Figure4.48. LCD Monitor SMPS Board

Figure4.49. A dot matrix Power Supply Board

In SMPS, the AC mains input is directly rectified and then filtered to obtain a DC voltage. The resulting DC voltage is then switched on and off at a high frequency by electronic switching circuitry, thus producing an ac current that will pass through a high frequency transformer or inductor. Switching occurs at a very high frequency there by enabling the use of transformers and filter capacitors that are much smaller, lighter, and less expensive than those found in linear power supplies operating at mains frequency. After the inductor or transformer secondary, the high frequency AC is rectified and filtered to produce DC output voltage.

SMPS are always regulated to keep the output voltage constant; the power supply employs a feedback controller that monitors current drawn by the load. The switching duty cycle increases as power output requirements increase.

SMPS often include safety features such as current limiting circuit to protect the device and the user from harm. In the event that an abnormal high current power draw is detected, the SMPS can assume this is a direct short and will shut itself down before damage is done.

SMPS have an absolute limit on their minimum current output. They are only able to output above a certain power level and cannot function below that point. SMPS with protection circuits may briefly turn on but then shut down when no load has been detected.

Some SMPS use filters or additional switching stages in the incoming rectifier circuit to improve the wave form of the current taken from the AC line. This adds to the circuit complexity.

A SMPS offers three main advantages over a conventional linear power supply.

- High efficiency & less heat generation

- Better regulation
- Smaller size and weight. Of these, greater efficiency is the biggest advantage.

- **Applications of SMPS**

Since it has a reduced cost, size and weight, it is mostly applied in Monitors, TVs, Mobile chargers, PCs, Laptop and camcorder power packs, Printers, fax machines, VCRs, Portable CD players, DVD players ,micro electronics based devisesin automotive,computing,communications,customer electronics and industrial applications.

4.7. Identifying electronic components in different types of SMPS

This will help you to be familiar with the sections and components used in SMPS and provides an information in preparing troubleshooting and repairing SMPS.

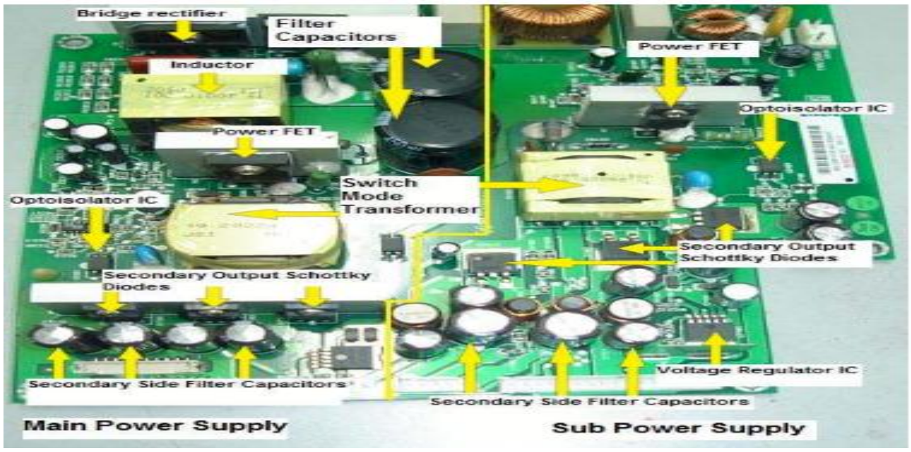


Figure4.50 typical LCD Monitor SMPS

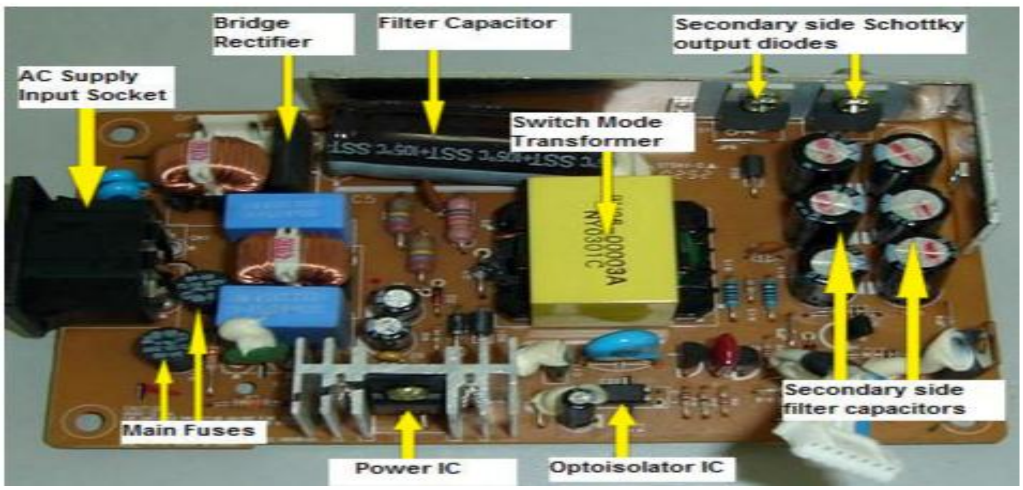


Figure4.51. A typical Samsung LCD Monitor SMPS Board

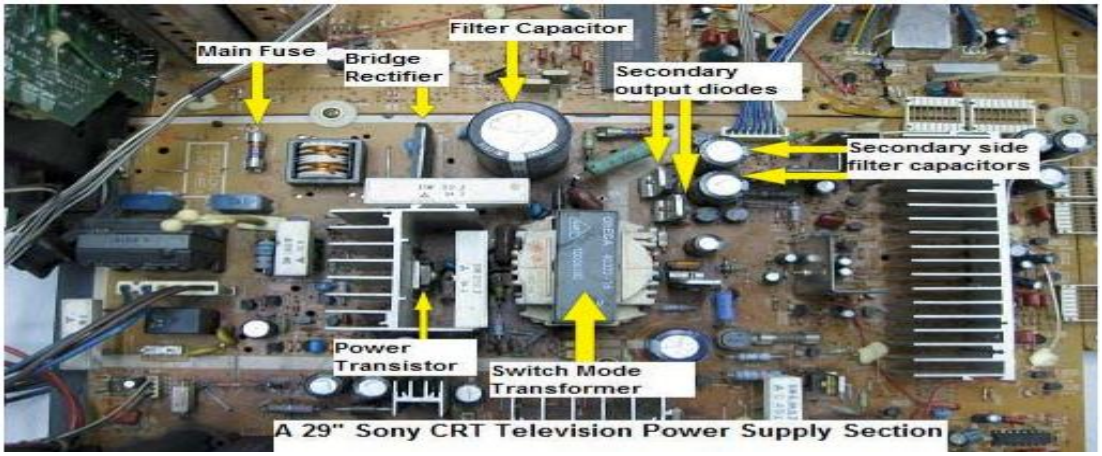


Figure4.52. A 29 Inch Sony CRT Television SMPS (Primary Side)

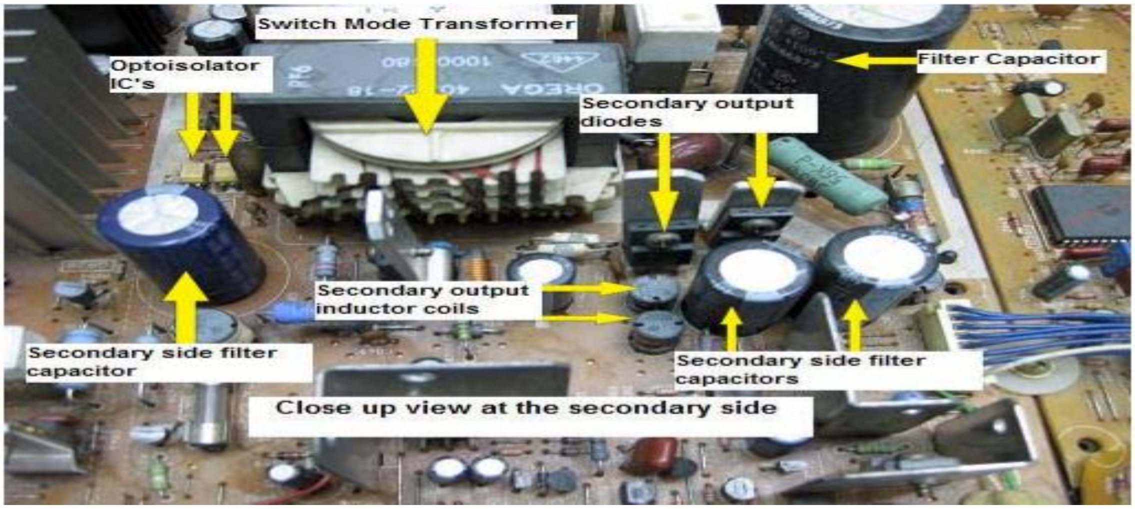


Figure4.53. A 29 Inch Sony CRT Television SMPS (Secondary Side)

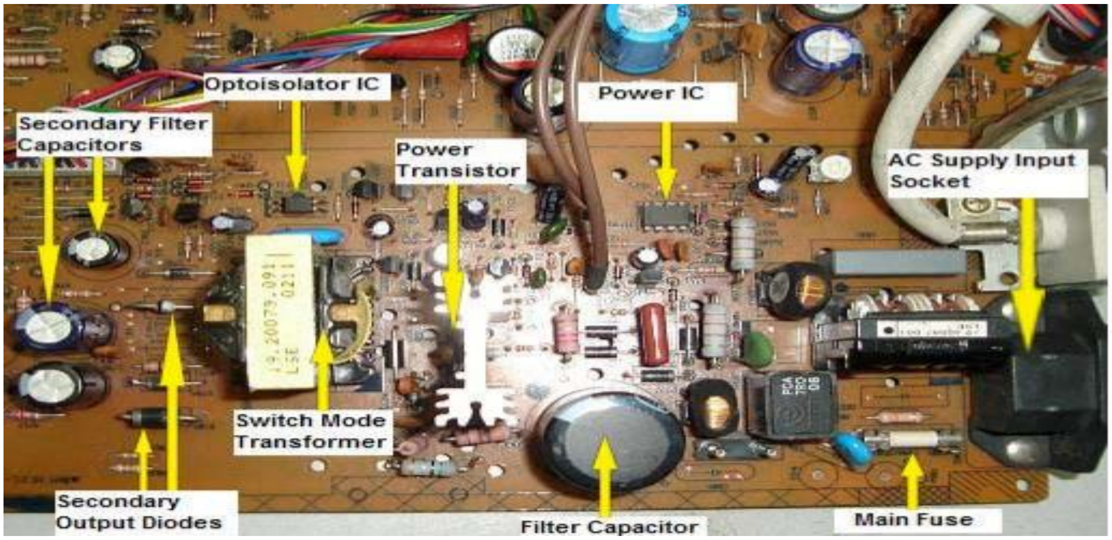


Figure4.54. A Typical CRT Monitor SMPS Board

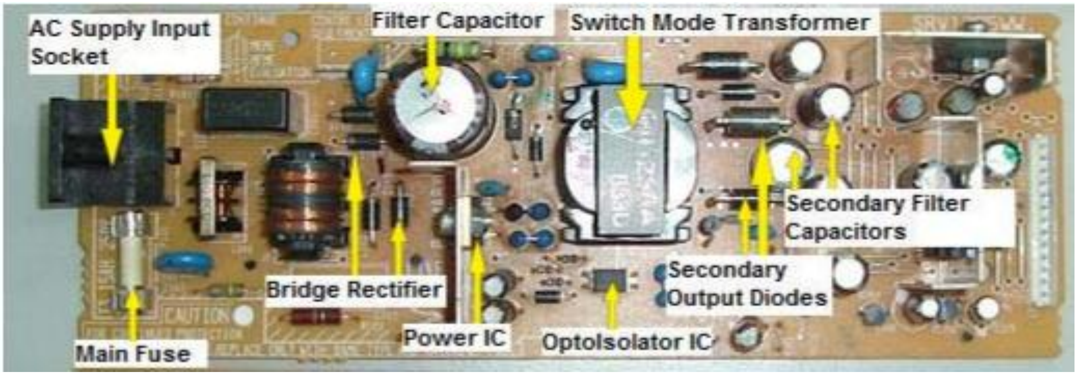


Figure4.55. A Typical Satellite Receiver SMPS Board

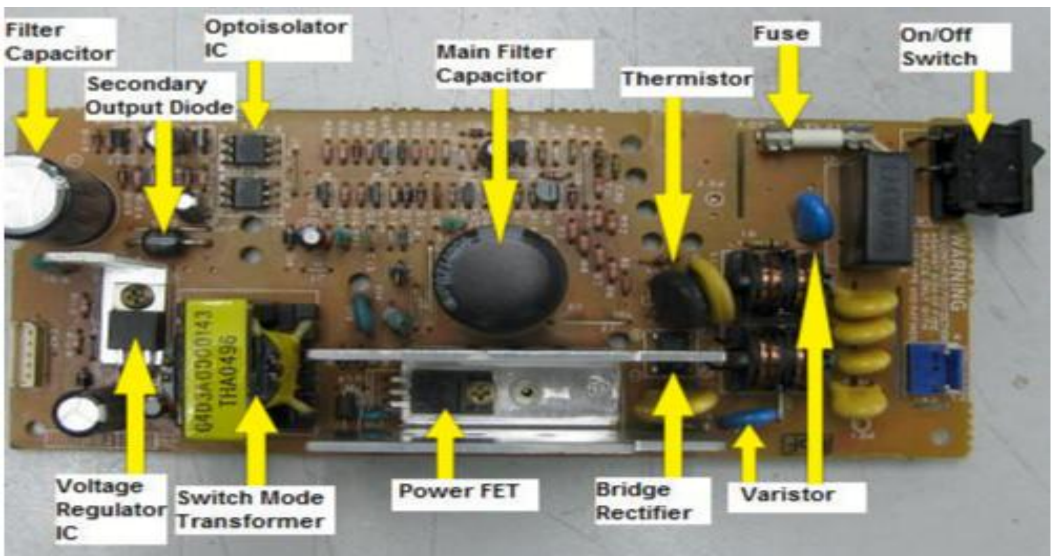


Figure4.56. A Typical Dot matrix Power Supply Board

4.8. Working principles and Block Diagram of a Typical SMPS.

Basically all of the power supply functions are almost the same which is to produce an output voltage for various secondary circuits.

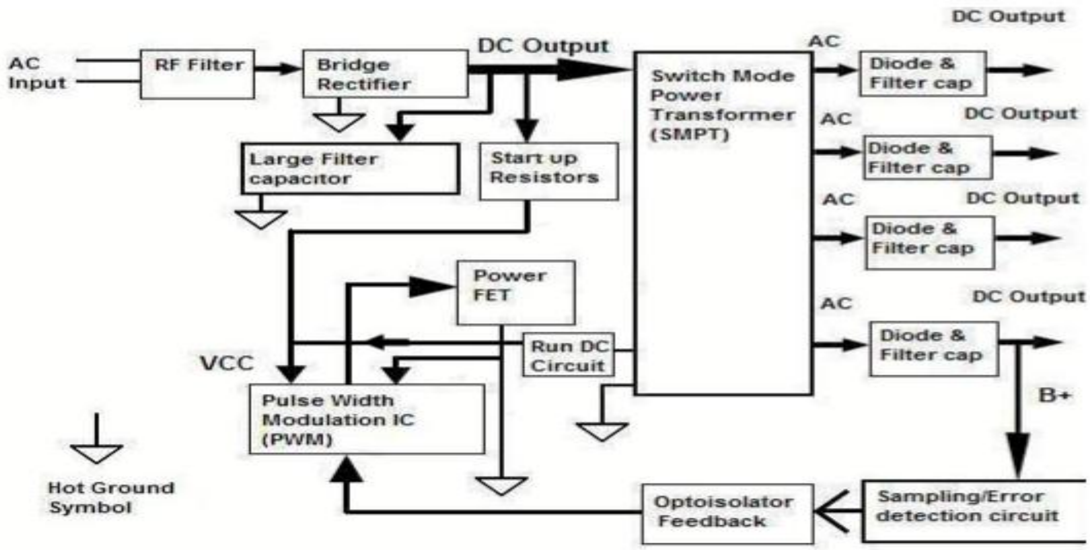


Figure4.57. Block Diagram of a Typical SMPS

Operations

The clean DC voltage will then be given to start up resistors and to the input of switch mode power transformer. Once the voltage passed through the high ohms resistor (start up resistors) the voltage would drop to a value where it then goes to the VCC supply pin of Pulse width modulation (PWM) IC. The **Run DC circuit** that consists of a resistor and a diode will maintain the power IC stable operation.

Once the PWM IC received the voltage, it will produce a signal to drive the transistor (normally FET) and produces a change in the magnetic field in the transformer primary winding. The changing magnetic field induces voltage in the secondary windings.

Each of these AC voltage produced by the secondary windings is then rectified, filtered, and regulated to produce a clean DC voltage. One of the main DC output voltages is the B+ voltage. The output from the B+ voltage supply is then connected, through a sampling error detection circuit and "feedback" loop back to the PWM IC. When the voltage from the B+ supply rises or drop a bit, the PWM IC will act to correct the output.

Note:

Not all SMPS designs are based on the block diagram in Figure4.57. Some older SMPS do not use the PWM IC to drive the FET (some use the bipolar transistor) instead they use an oscillator circuit which consists of some component to drive the FET/ bipolar transistor as seen in the Figure4.58. some do not have sampling error detector/feedback circuit in at the secondary side but instead it was taken from the primary side as seen from Figure4.59. In newer designs, you would not find the power FET because it has been integrated in to the power IC as shown in Figure4.60.

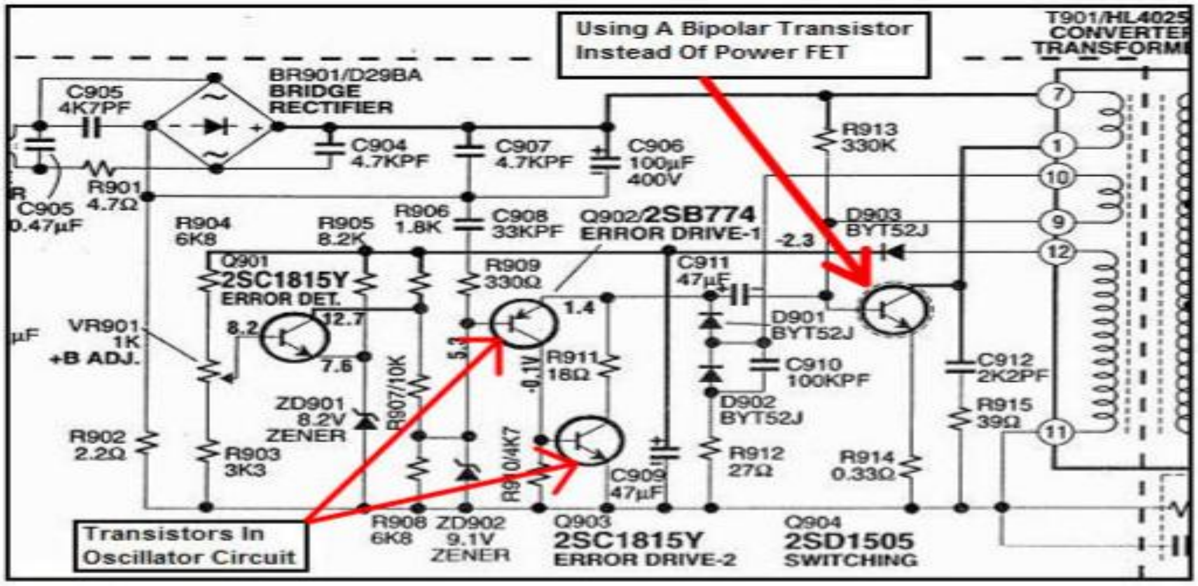


Figure4.58. A Typical Television SMPS without Power IC.

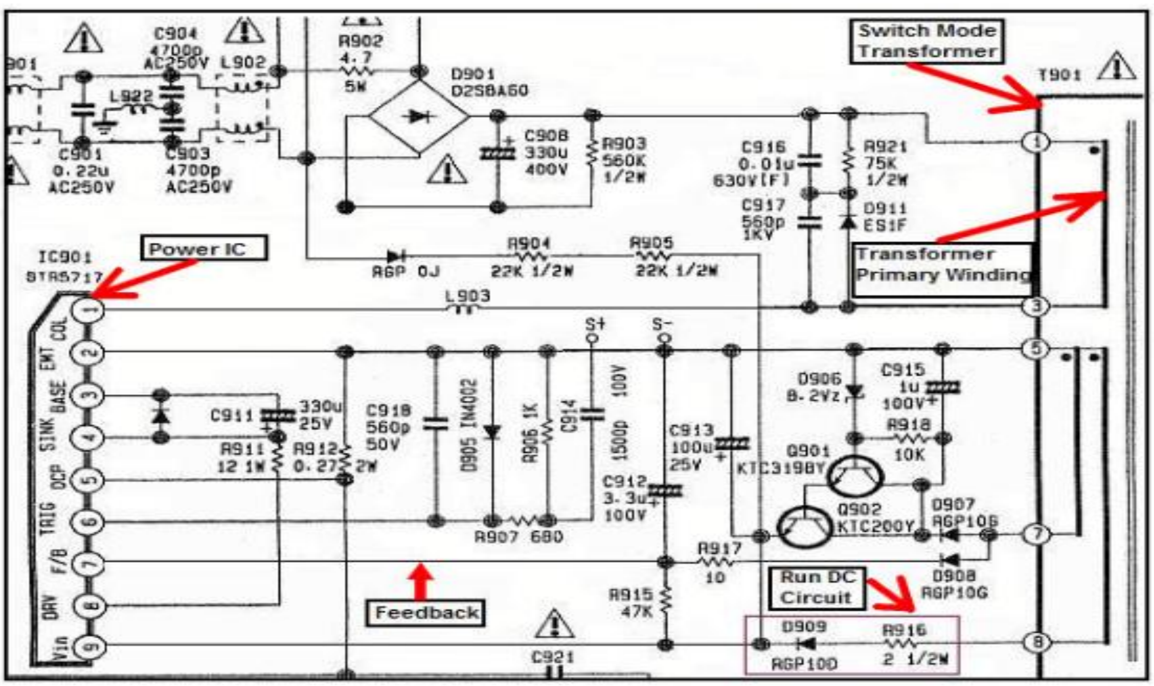


Figure4.59. A Typical CRT monitorTelevision SMPS without Optoisolator IC

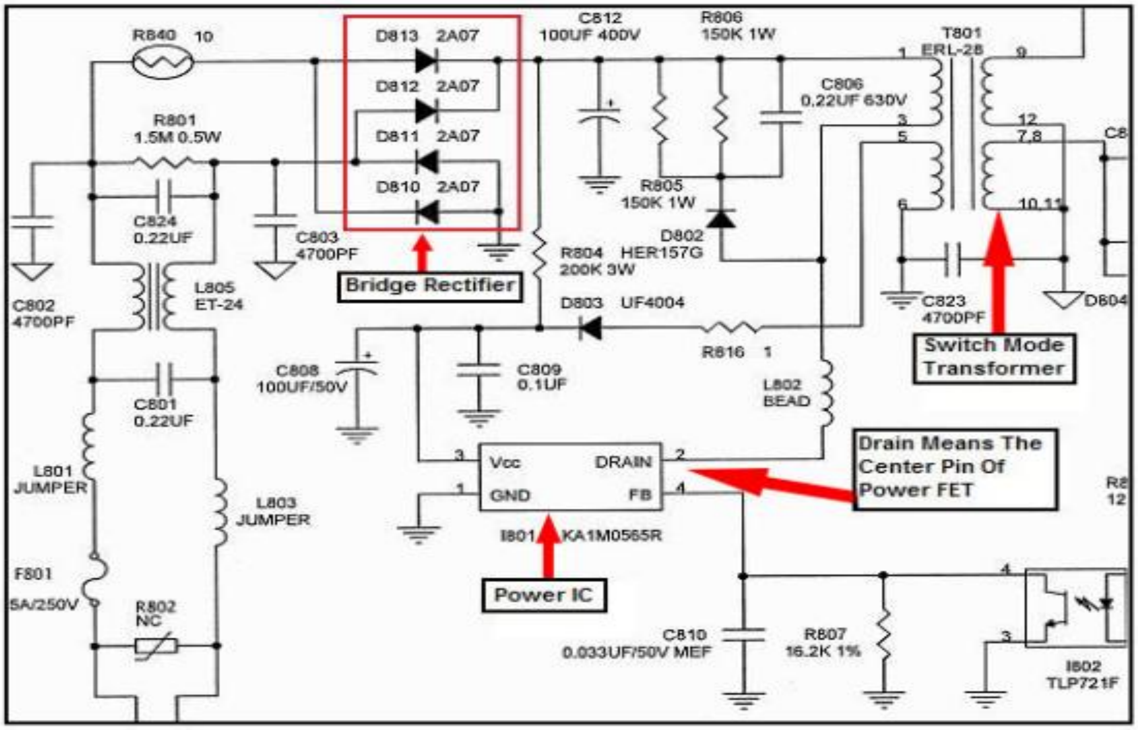


Figure4.60.A Typical LCD Monitor SMPS withFET Integrated into power IC

Although there are some differences between the designs of SMPS, they basically still operate base on the same principle. Please turn to the next chapter to read the full SMPS circuits operation in details.

4.9. Functions and schematic diagrams of SMPS Circuits

There are many types of SMPS in the market and it is impossible to explain all of them in this in topic. However, it will help to guide you with the help of schematic diagram, so that once you have understood how each circuit functions in SMPS then there will be no problem in repairing all types of SMPS because many SMPS in the market are the same, except that some uses more components while others use fewer.

Generally, SMPS consists 11 main circuits in order to form the complete set. Each one of the circuits malfunction could Couse problems in SMPS.

This information sheet uses the LCD Monitor SMPS and some equipment schematic diagrams as a guide to explain how each of these circuit functions and possible causes of faults. The main circuits are:

1. Input protection and EMI Filtering Circuit.
2. Bridge Circuit
3. Start Up and Run DC Circuit.

4. Oscillator Circuit.
5. Secondary output Voltage Circuit.
6. Sampling Circuit.
7. Error Detection Circuit.
8. Feedback Circuit.
9. Protection Circuit.
10. Stand-by Circuit.
11. Power Factor Correction (PFC)Circuit.

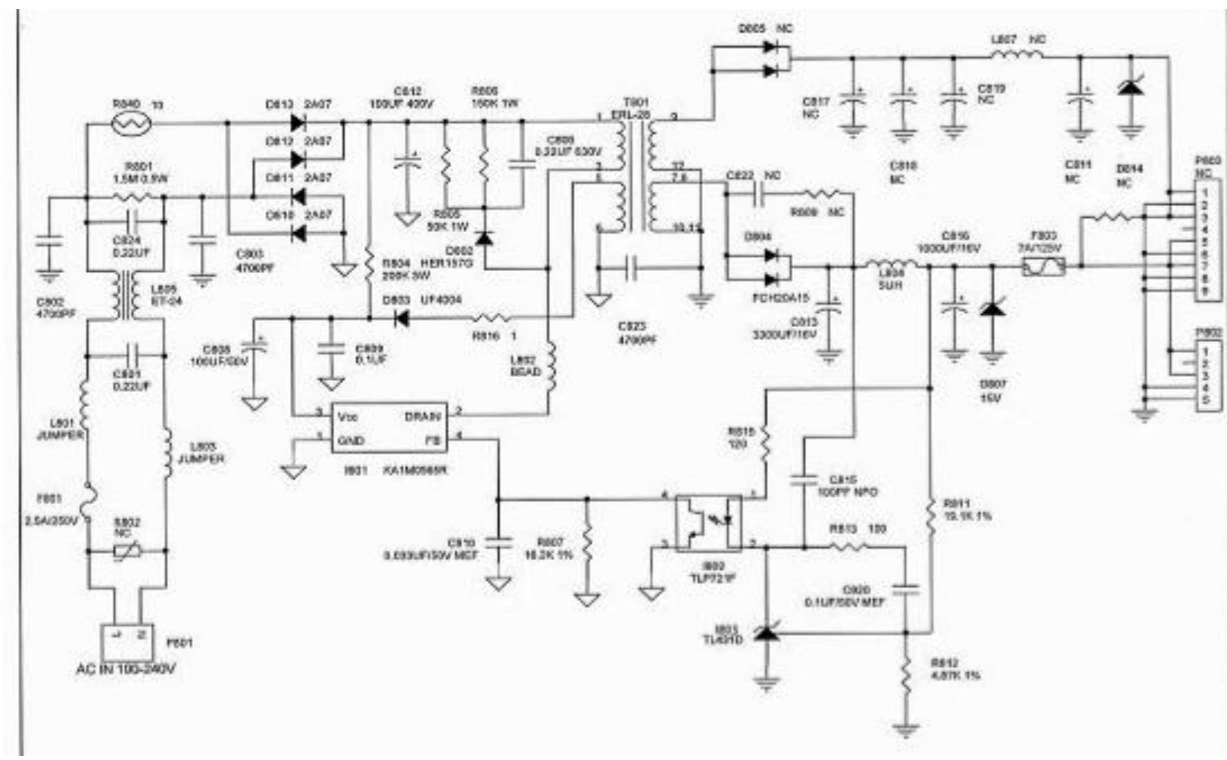


Figure4.61. Schematic diagram of a Typical LCD Monitor SMPS.

1. Input protection and EMI Filtering Circuit.

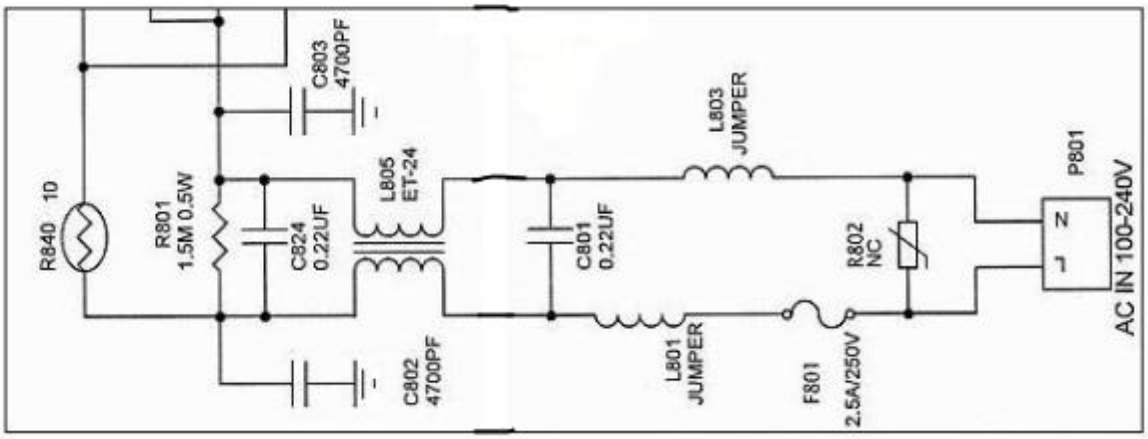


Figure4.62. Input protection and EMI Filtering Circuit.

- ✓ The first circuit where AC supply enters the SMPS.
- ✓ The Varistor, R802 protects the power supply from transient voltage resulting from lightning strikes of power surge.
- ✓ The fuse F801 protects against faults and effectively isolates from the power supply.
- ✓ Capacitor C801 and C824 are X capacitors used to reduce the differential mode EMI.
- ✓ Resistor R801 discharges C801 and C824 on AC removal, preventing potential user shock.
- ✓ Inductor L805 is used in filtering common mode EMI from coupling back to the AC source.
- ✓ Thermistor R840 limits the initial peak inrush current drawn by the circuit at start up.

2. Bridge Circuit

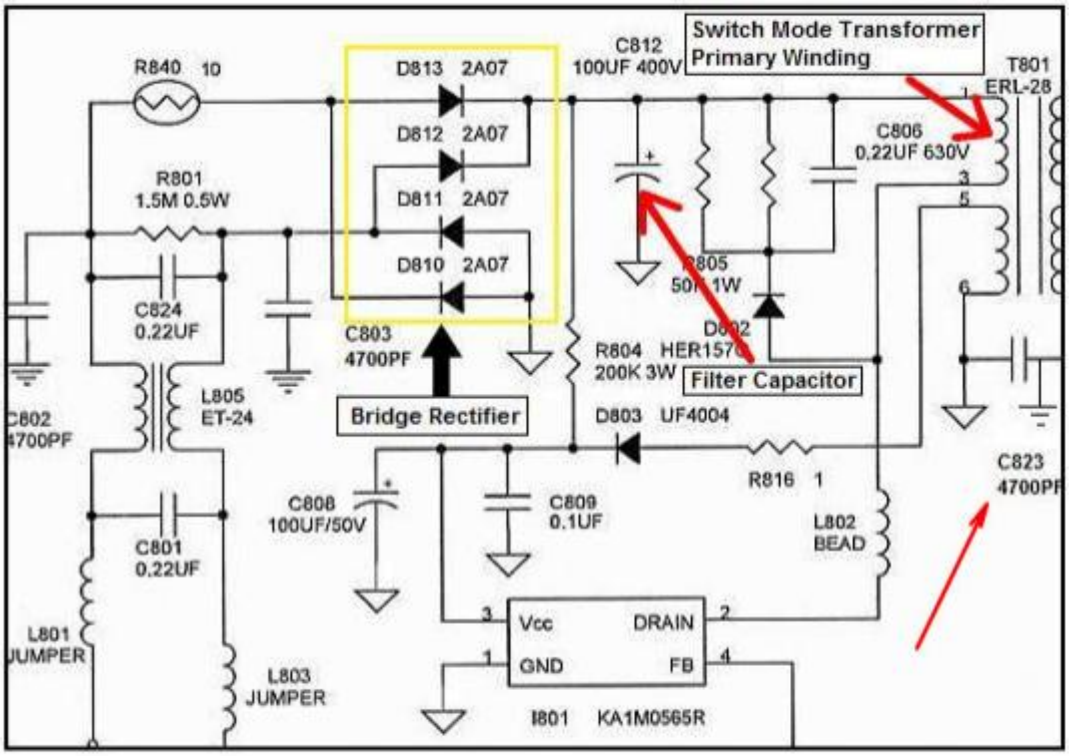


Figure4.63. Bridge Circuit

- ✓ It consists either 4 individual diodes or a single package rectifier and a filter capacitor.
- ✓ It converts the incoming AC to DC voltage and the filter capacitor (usually 220uF,400v) removes the ripples and provides DC to the primary winding of switch mode power transformer.
- ✓ In some power supply capacitors, you could see they are connected across each diode.

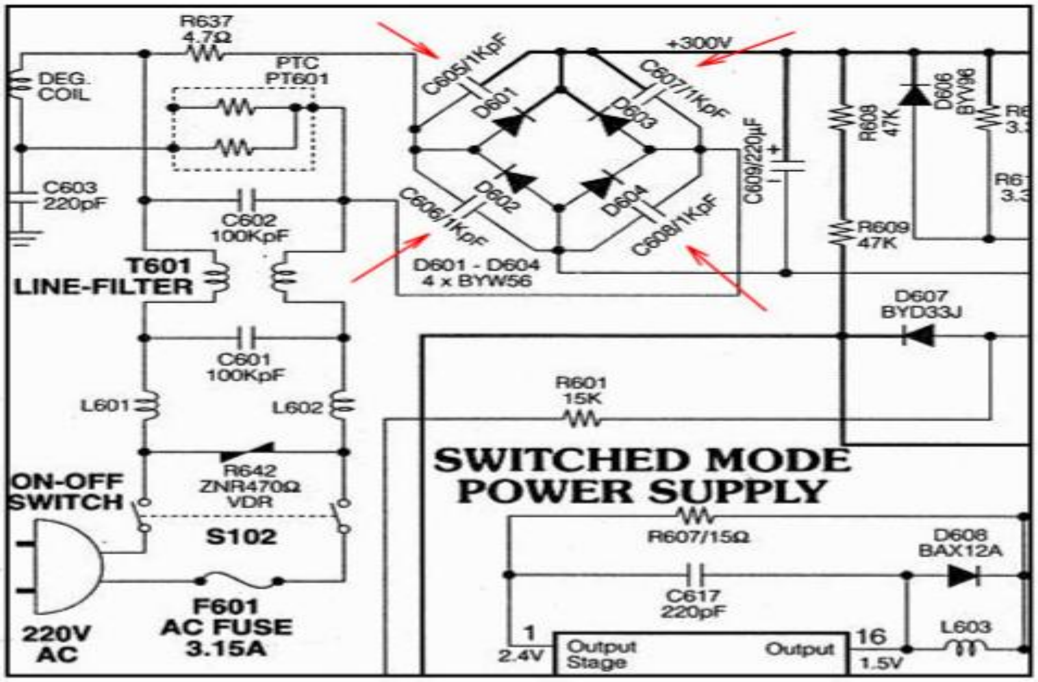


Figure4.64. Capacitors Connected across Bridge Circuit

3. Start Up and Run DC Circuit.

This circuit usually consists of one to three high Ohms resistors (usually from 47K Ohm to several hundred K Ohm) and is connected between the 300VDC voltage line and the supply input of power IC. After the 300 VDC goes through the start up resistors, the voltage will drop to about 16 VDC (start up voltage depends on the type of SMPS design) and this voltage is use to kick on the oscillator in the power IC the first time.

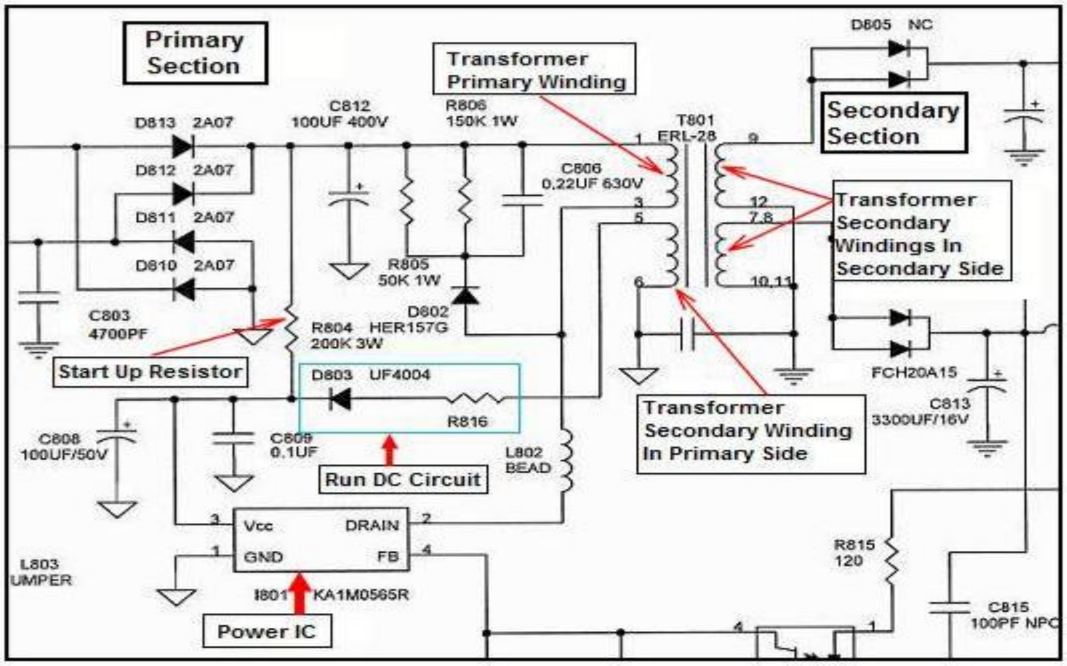


Figure4.65. Start Up and Run DC Circuit.

Note: In some designs, the start up voltage is not derived from the 300VDC source itself, but from one of the AC line as seen from figure 4.6

4. Oscillator Circuit.

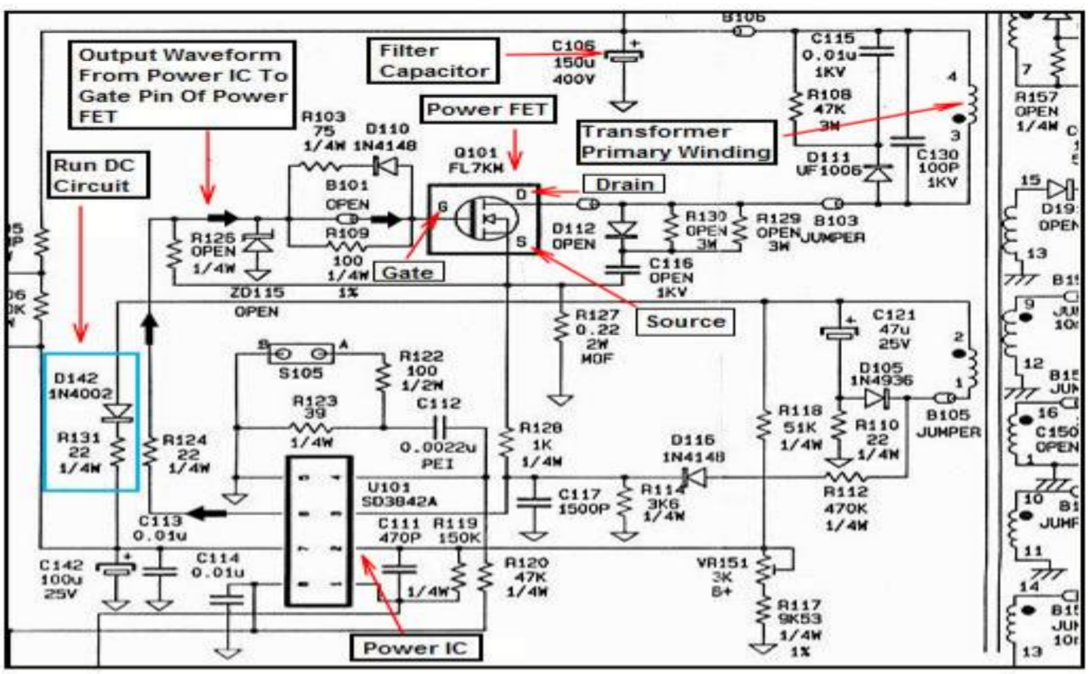


Figure4.66.CRT Monitor SMPS Oscillator Circuit.

5. Secondary output Voltage Circuit.

The secondary output voltage circuit provides various positive or negative DC output voltages to other circuits like Vertical, Horizontal, CPU, Color, Flyback transformer, Computer Motherboard and etc. The secondary output voltage circuits usually consist of diodes (ultra fast recovery diodes-to convert AC to DC), filter capacitors (generally are electrolytic capacitors-to filter off the ripples) and inductors/coils (a coil allows DC to flow through it while restricting AC current flow). With these three components in each of the output line, the outputs generated are clean DC and suitable for various circuits (loads). The amount of

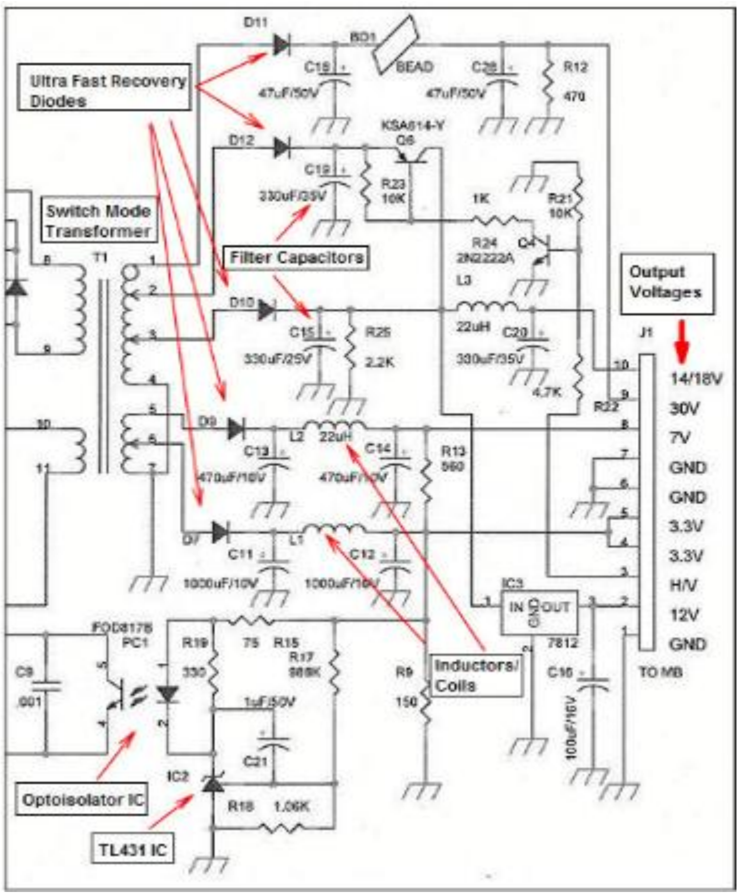


Figure4.67. A typical Satellite Receiver Secondary Output Voltage Side Circuit

6. Sampling Circuit.

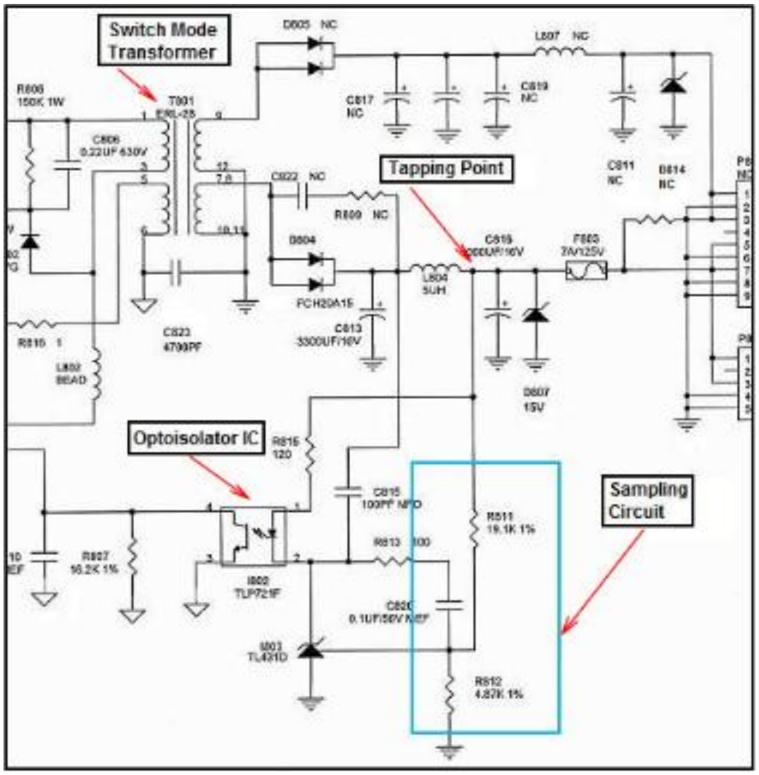


Figure4.68. A typical LCD Monitor SMPS Sampling Circuit.

In order to maintain the output voltages delivered to the load (various circuits), a sample of at least one output voltage source developed by the supply is required. For a CRT Monitor power supply, the sample voltage normally derived from the B+ voltage line that goes to the primary winding of Flyback transformer. Some call this sampling circuit as **sensing** circuit.

Normally only one output voltage source is required to be sampled, because if the particular output voltage source is too low or too high, generally all of the other output voltages may vary too. **The reason for this sampling circuit in SMPS is to provide an input to the error**

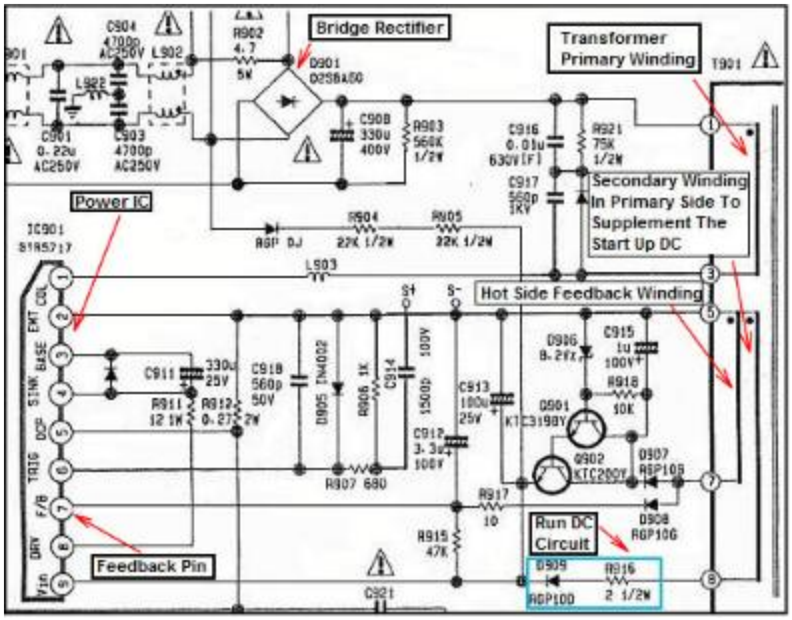


Figure4.69. Sample taken from the primary side.

7. Error Detection Circuit

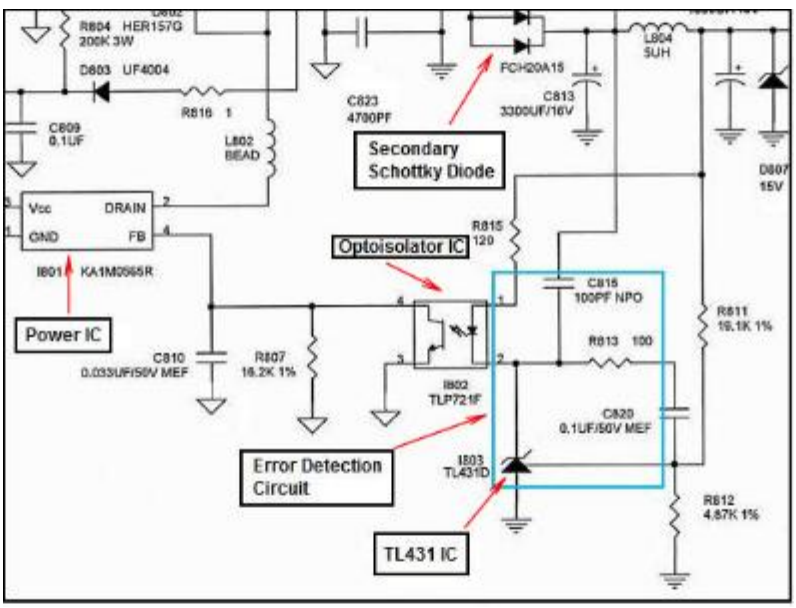


Figure4.70. Error Detection Circuit LCD Monitor SMPS

8. Feedback Circuit.

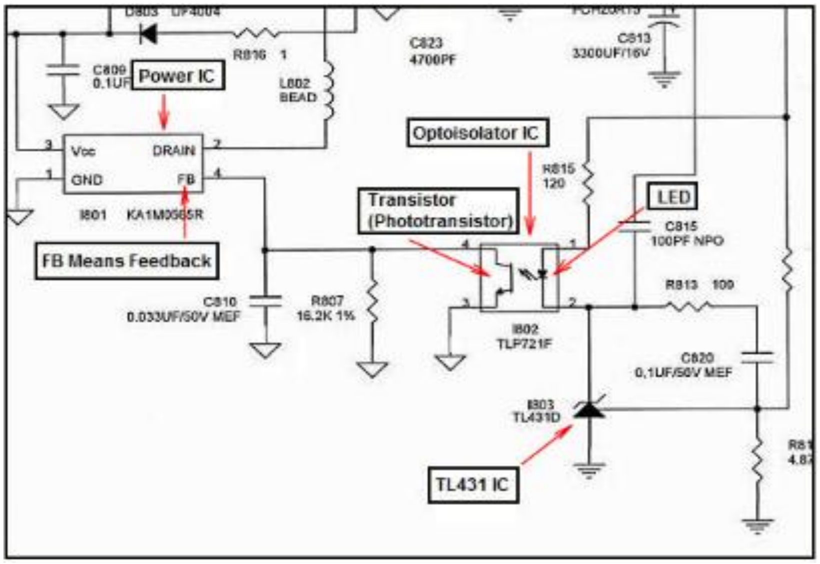


Figure4.71. Feedback Circuit in LCD Monitor SMPS.

9. Protection Circuit.

Do you know that SMPS has one or more protection circuit? The protection circuit is designed to protect the components by shutting down either part or all of the power supply in the event problem occurs. There are four common types of protection circuits that can be used by SMPS designers for circuit protection against the following dangerous conditions. They are Surge Protection (SP), Over voltage protection (OVP), Over current protection (OCP) and Thermal Shut Down protection (TSDP).

A. Surge Protection Circuit

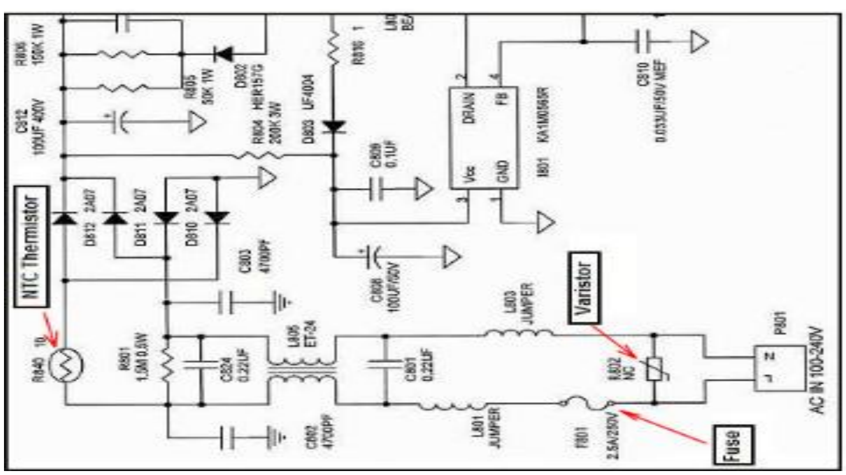


Figure4.72. Surge Protection Circuit in LCD Monitor SMPS.

A. Internal and External Over Voltage Protection Circuit

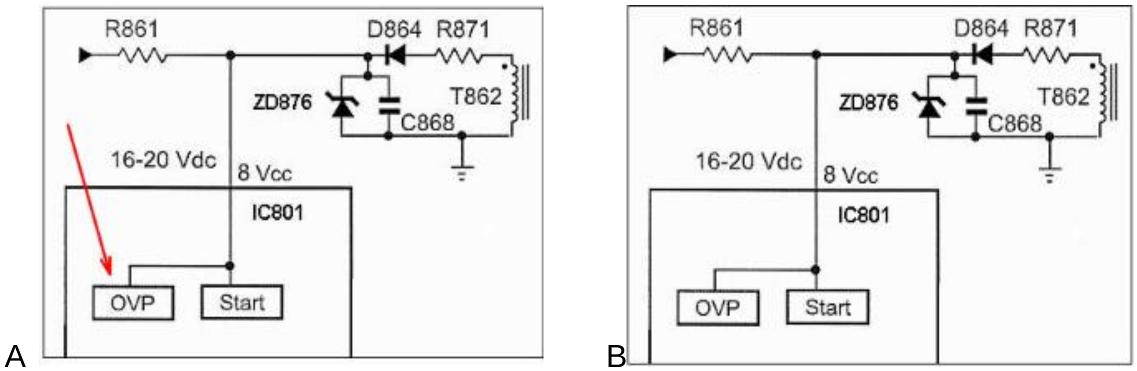


Figure4.73. A) Internal OVP Circuit in Power IC STRZ4117and B) External OVP Circuit

B. Over Current Protection Circuit

Note: The over current sensing resistor can increase in resistance value and cause a false shutdown. The value may be increased slightly and cause an intermittent shutdown condition. The value is usually very small from 0.1 ohm to about 1 ohm and you can test the exact value

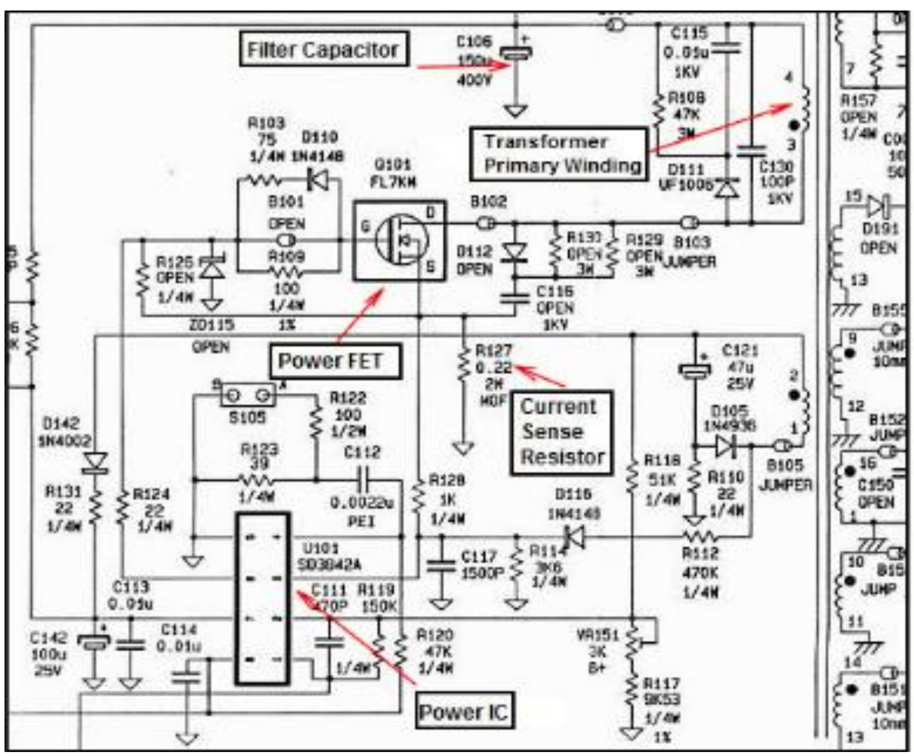


Figure4.74.OCP in primary side of a CRT Monitor SMPS.

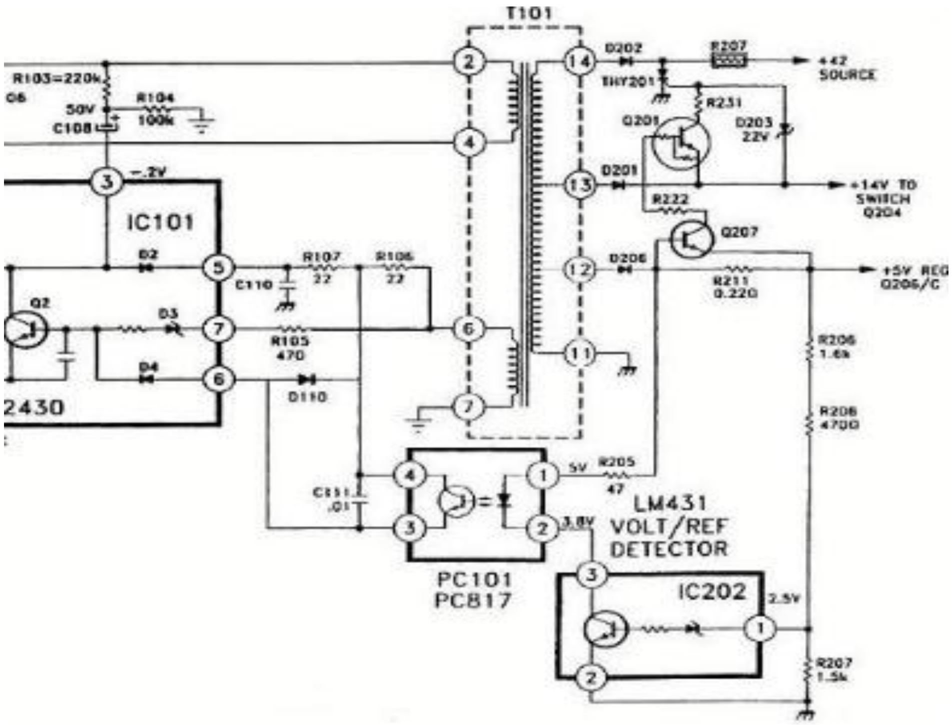


Figure4.75.OCP in Secondary side of a CRT Monitor SMPS.

C. Thermal shutdown Protection Circuit

Because of the amount of current flow through the Power FET, the Power FET generates heat. If the Power IC overheats (exceeding certain temperature, usually 125 to 150 degree Celsius), this circuit (inside power IC) turns off the IC and latches (to close or lock) it. Due to this, we need to unplug the AC supply and turn the power On again to restart the SMPS.

Note: This thermal shut down condition happens most probably due to three reasons:

a) The Power IC itself has overheating problem.
b) There is no or not enough heat compound apply to the IC heatsink causing difficulty in transferring heat.
c) The ventilation in the equipment itself is bad. For example, a faulty fan in the computer power supply could cause the power supply to shut itself off due to the hot air could not be sucked out.

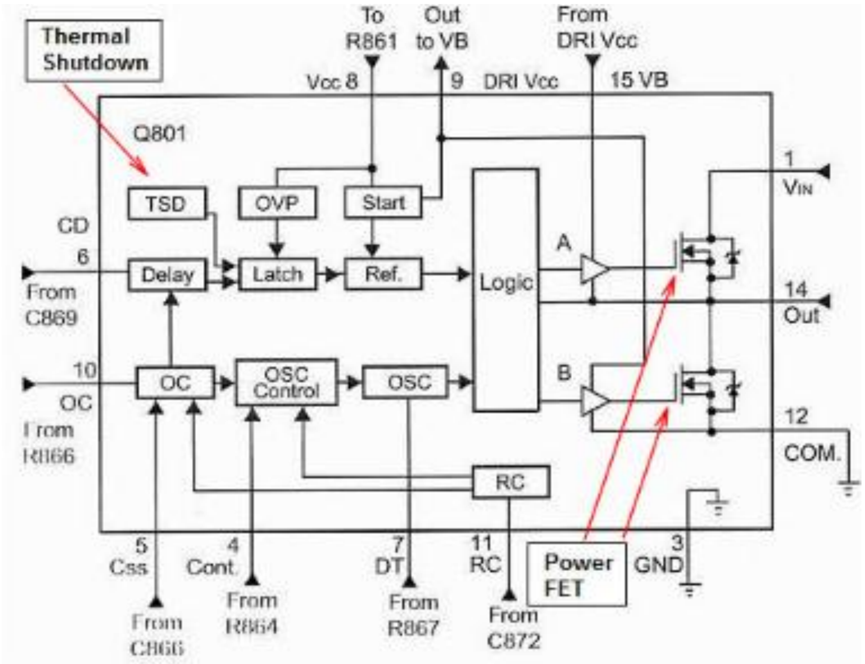


Figure4.76. Block Diagram of a Thermal Shutdown Protection Circuit

10. Standby Circuit

Standby power supply circuit usually can be found in SMPS of electronic equipment like Television but very rare in the stand alone type of SMPS (not all SMPSs have standby power supplies). For your information, the standby circuit is always active when the Television is plugged into an AC line source. This supply is needed to deliver a 5 volt supply and a reset 5 volt to the Microcontroller IC to keep the Microcontroller functioning all the time, even when the Television is not operating (before you turn the Television "ON" using the remote control). These 5 volts are also needed to power the memory circuit (EEPROM IC), and remote control receiver circuitry.

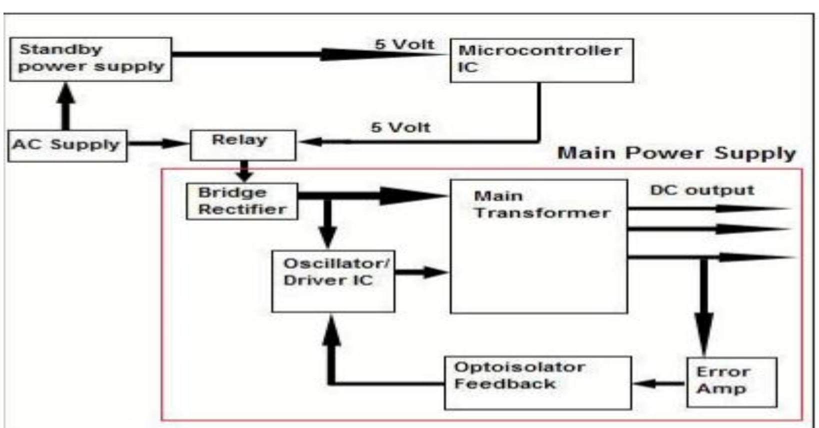


Figure4.77. Block Diagram of a Standby Circuit

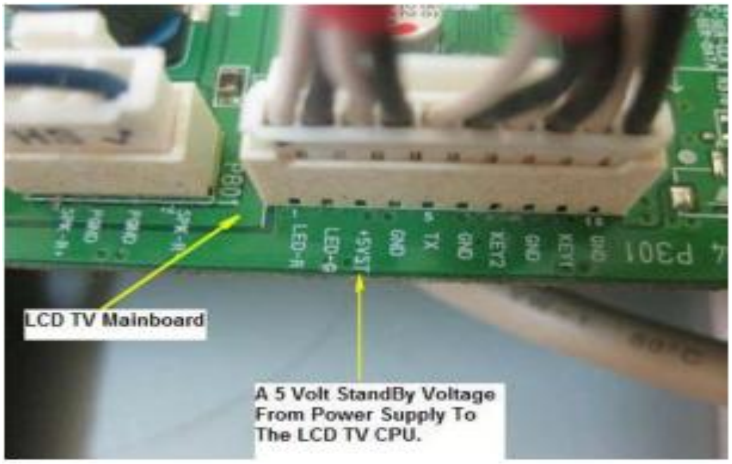


Figure4.78. A 5V Stand by voltage in LCD Monitor SMPS

11. Power Factor Correction (PFC)Circuit.

<u>What is Power Factor?</u>

Power factor (pf) is defined as the ratio of the real power (P) to apparent power (S), or the cosine (for pure sine wave for both current and voltage) that represents the phase angle between the current and voltage waveforms. The power factor can vary between 0 and 1, and can be either inductive (lagging, pointing up) or capacitive (leading, pointing down). When the current and voltage waveforms are in phase, the power factor is 1 (cos (0°) = 1). Since this book is more on troubleshooting, I will only concentrate of its basic functions and will not touch on all the formula about power factor.

<u>What is Power Factor Correction (PFC)</u>

Power Factor Correction is the practice of raising the power factor in order to allow power distribution to operate at its maximum efficiency. There are two types of PFC, Passive PFC and Active PFC. All of our power supplies are either Passive PFC Power Supplies or Active PFC Power Supplies. Those power supplies that do not have the PFC are called as Non-PFC Power Supplies.

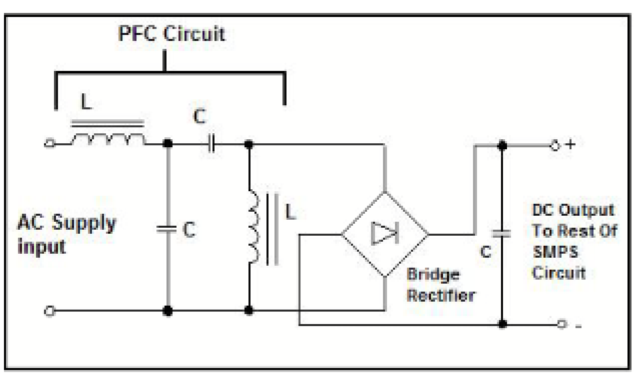


Figure4.79. Passive PFC in LCD Monitor SMPS

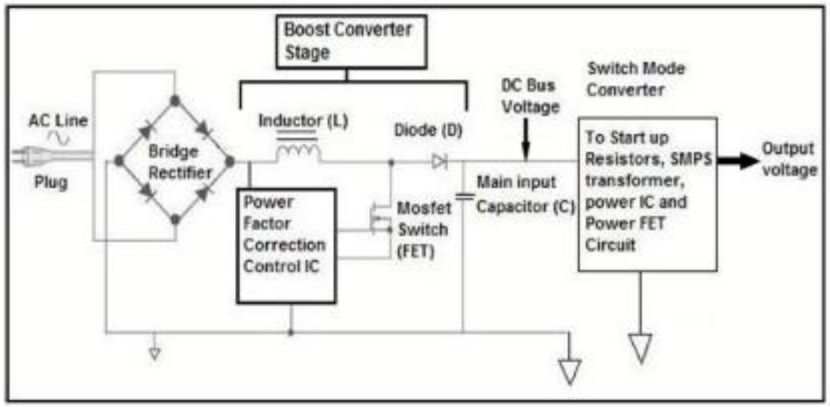


Figure4.80. An Active PFC in LCD Monitor SMPS

4.10. Components found in SMPS and Their Possible Causes of Faults

- **Fuse:** Board location marked as F.

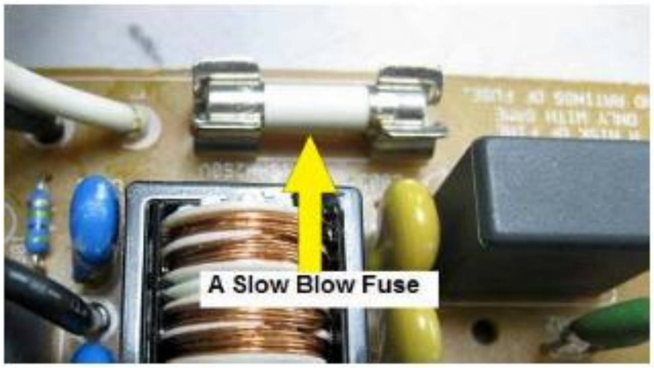


Figure4.81. A Slow Blow Fuse

- **Varistor:** Board location marked as Z or RV or ZNR

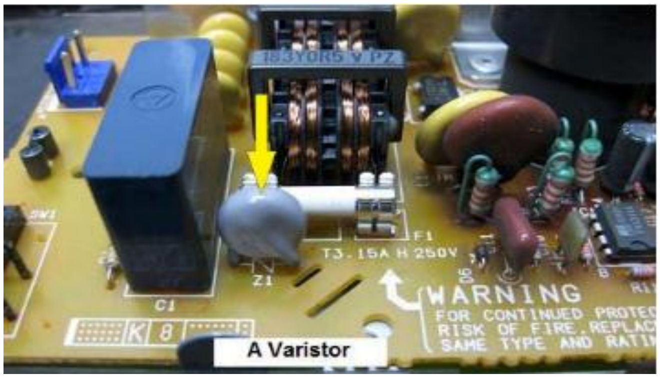


Figure4.82. Varistor

- **EMI/RFI Filter Section**

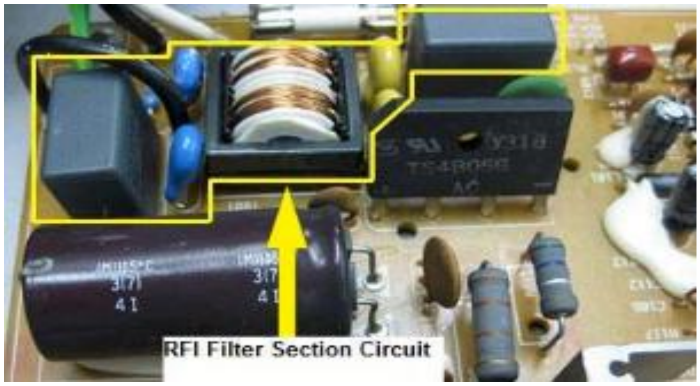


Figure4.83. EMI/RFI Filter Section Circuit

- **NTC Thermistor**

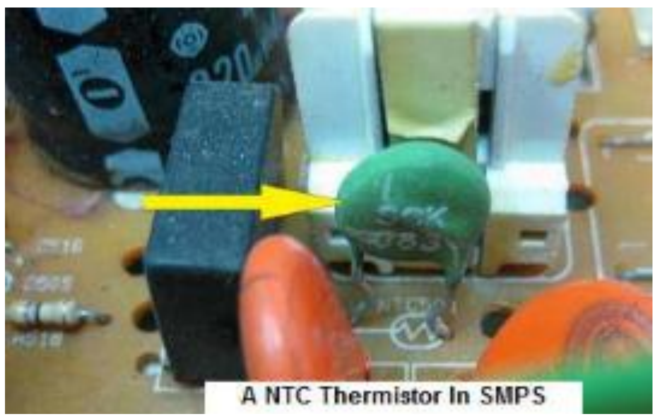
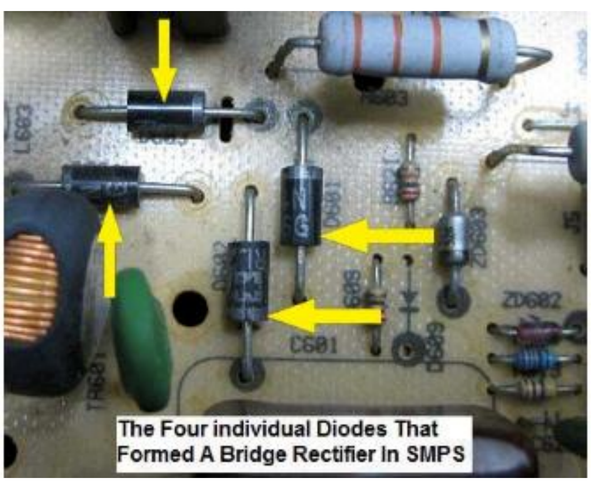


Figure4.84.NTC Thermistor

- **Bridge Rectifier Diodes**



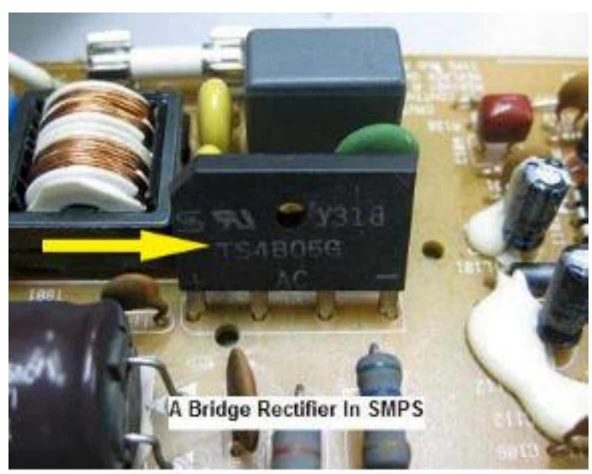


Figure4.85. Bridge Rectifier Diodes in SMPS.

- **Large Filter Capacitor**

Figure4.86. Filter Capacitor

- **Resistor**

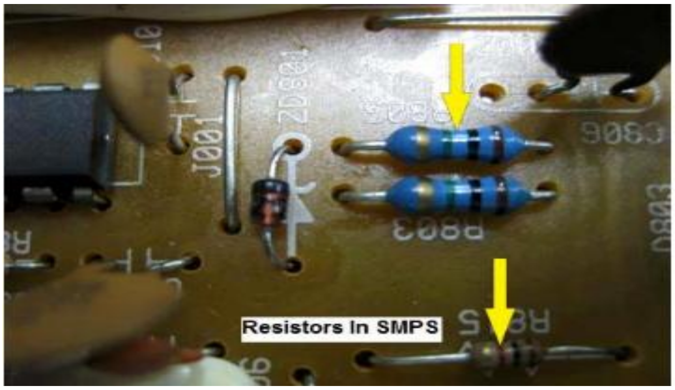


Figure4.87. Resistors

- **Non Polarity Capacitor**

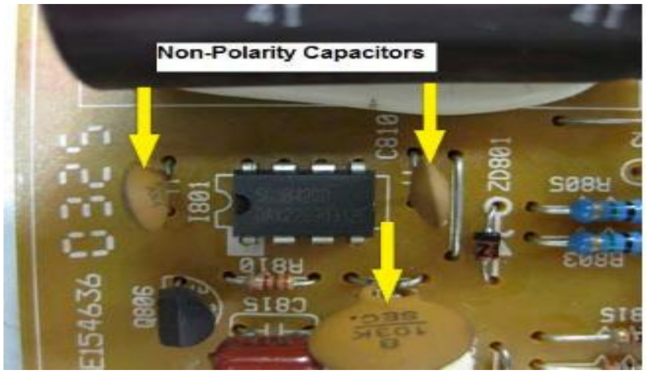


Figure4.88. Non Polarity Capacitor

- **Zener Diode**

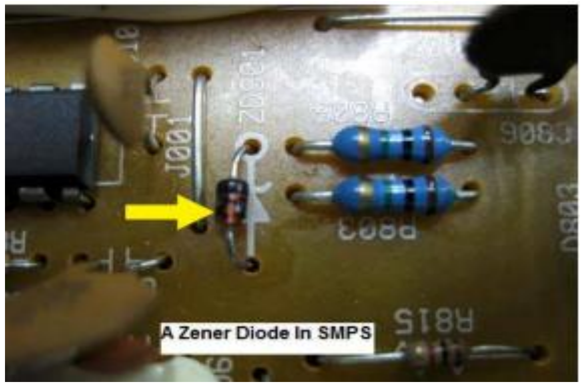


Figure4.89. Zener Diode

- **Diode Secondary Side**

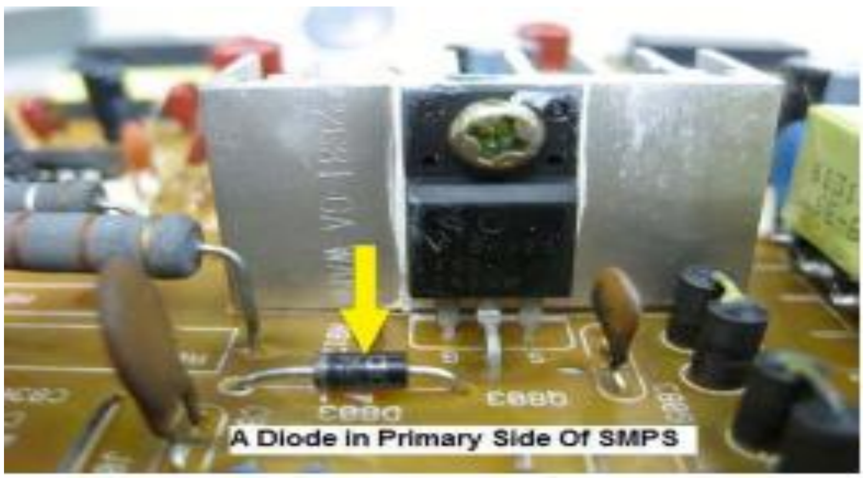


Figure4.90. Diode Secondary Side

- **Bipolar Transistor**

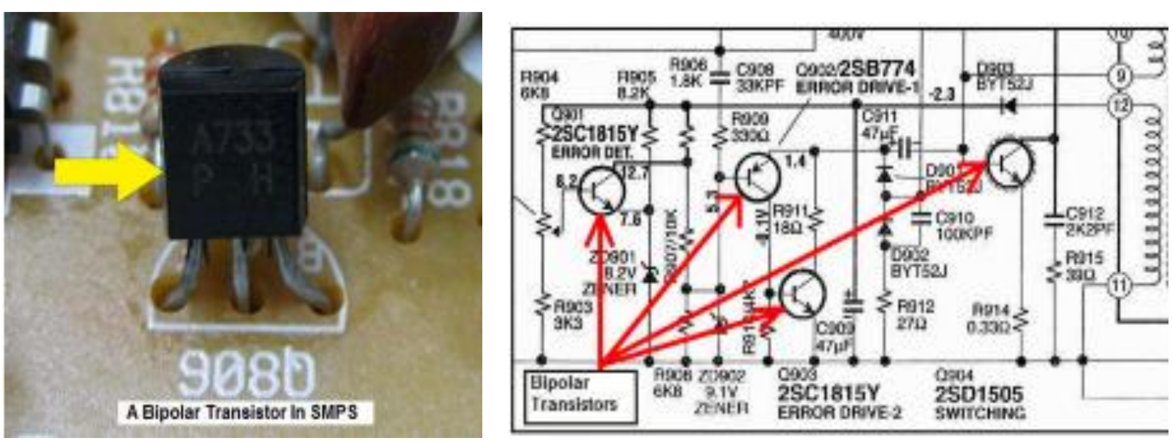


Figure4.91. Bipolar Transistor and Circuit in SMPS

- **IGBT Transistor**

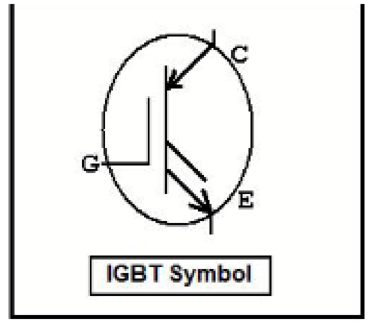


Figure4.92. IGBT Transistor and Symbol

- **Silcom Controlled Rectifier**

Figure4.93. Silcom Controlled Rectifier

- **Power IC**

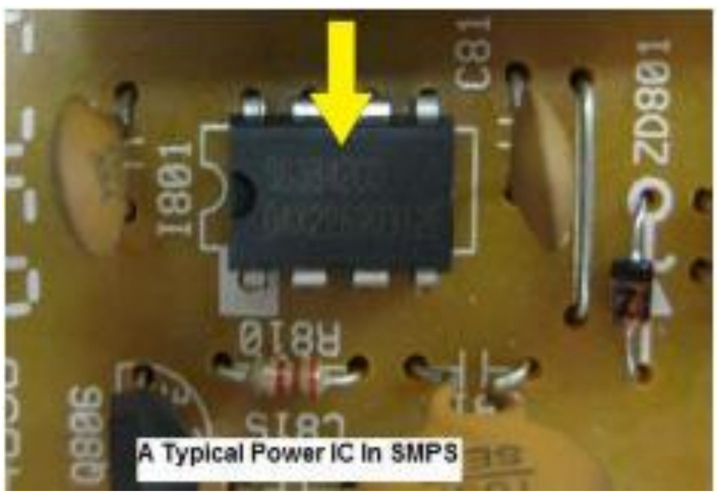


Figure4.94. Power IC

- **Power FET**

Figure4.95. Power FET

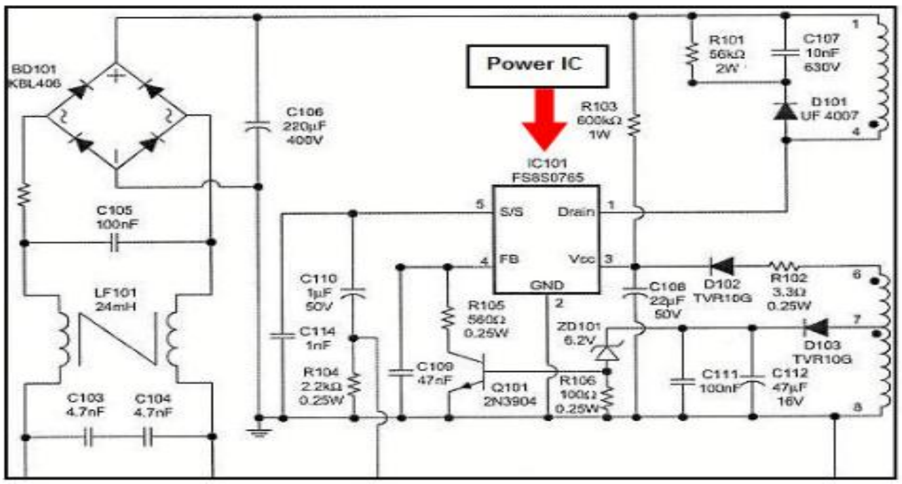


Figure4.96. Schematic Diagram of Power FET Built into Power IC

- **Switch mode Power Transformer**

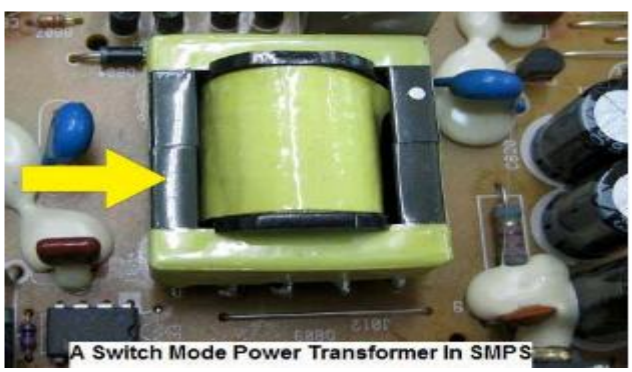


Figure4.97. Switch mode Power Transformer

- **Secondary Output Diode**

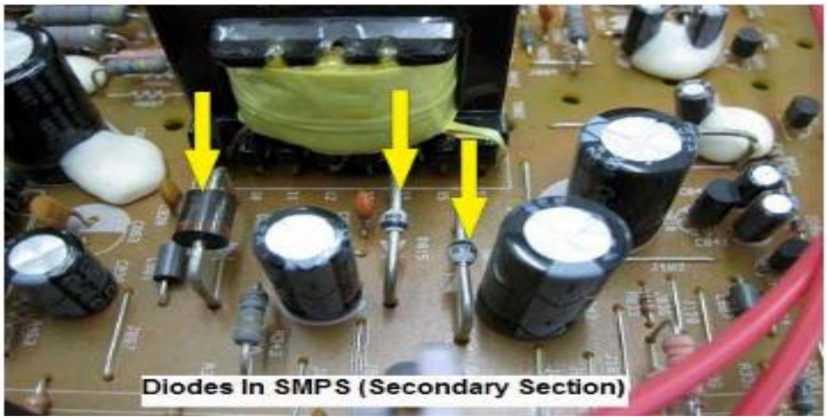


Figure4.98. Secondary Output Diode

- **Secondary Side Filter Capacitor**

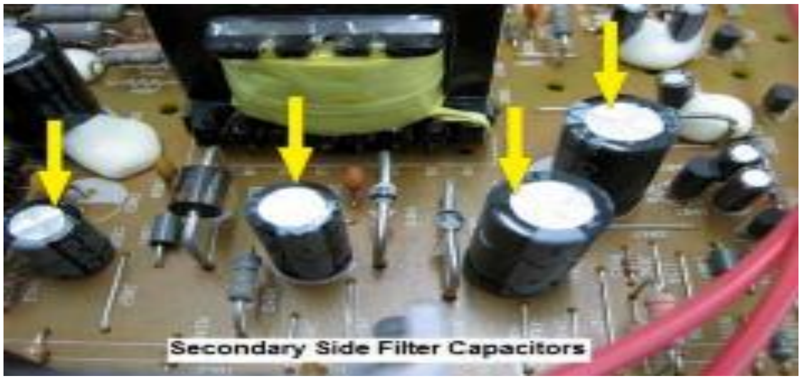


Figure4.99. Secondary Side Filter Capacitor

- **Secondary Output Inductors/Coils**

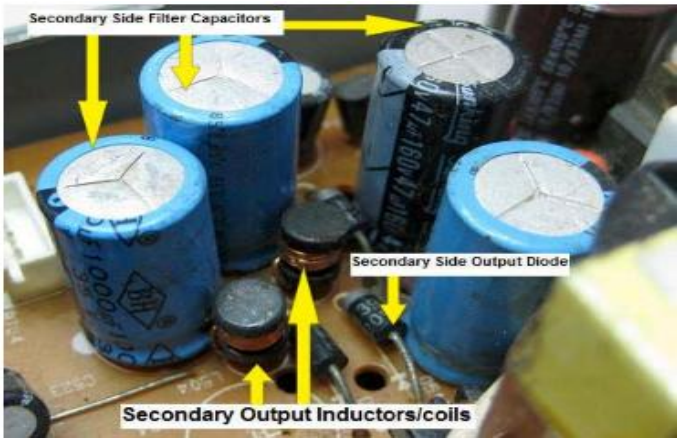


Figure4. 100.Secondary Output Inductors/Coils

- **Optoisolator IC**

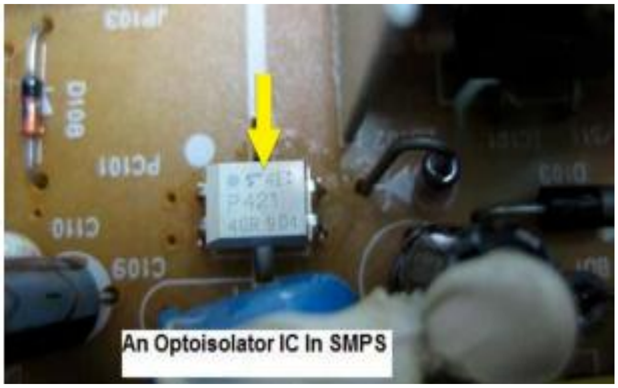


Figure4.101. Optoisolator IC

- **Adjustable Precision Shunt Regulator IC**

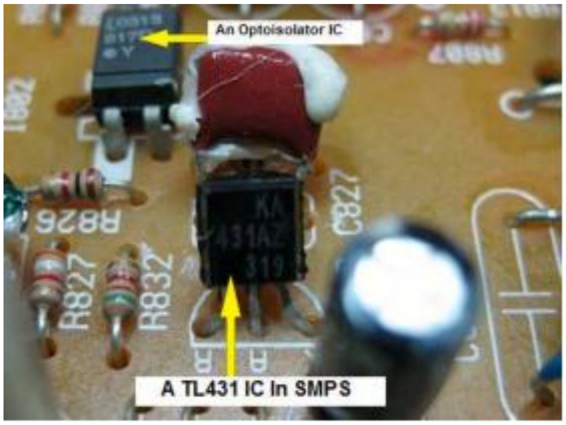


Figure4.102. TL431 IC

- **Small Preset in Secondary Side**

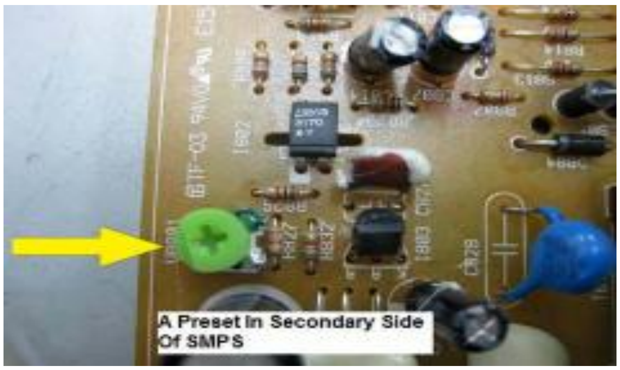


Figure4.103. Small Preset in Secondary Side

- **Voltage Regulator**

Figure4.104. Voltage Regulator IC

Self –Check 4	Written Test

I. Choose the correct answer

1. A single phase transformer has a primary winding of 70turns and it receives 140v from the supply and provides an output voltage of 8v at the secondary winding. Determine the numbers of turns of at the secondary winding.

   A. 40T B.4turns C.400turns D. None

2. A single phase transformer has a primary winding of 150turns and it receives 220v from the supply and provides an output current of 4A at the secondary winding. Determine the numbers of turns of at the secondary winding.

   A B C D

3. Which type of transformer gives a variable voltage output.
   A. Step-Down Transformer
   B. Step-Up Transformer
   C. Isolation
   D. Autotransformer
   E. All of the above

4. Which type of DC Power supply has better voltage regulation.
   A. Ac power supply
   B. Regulated linear dc power supply

C. Switch Mode Power Supply

D. Un-regulated linear dc power supply

E. None

5. __________is used to convert an alternating current (ac) to direct current (pulsating dc).

A. Transformer D. Rectifier

B. Filter E. Capacitor

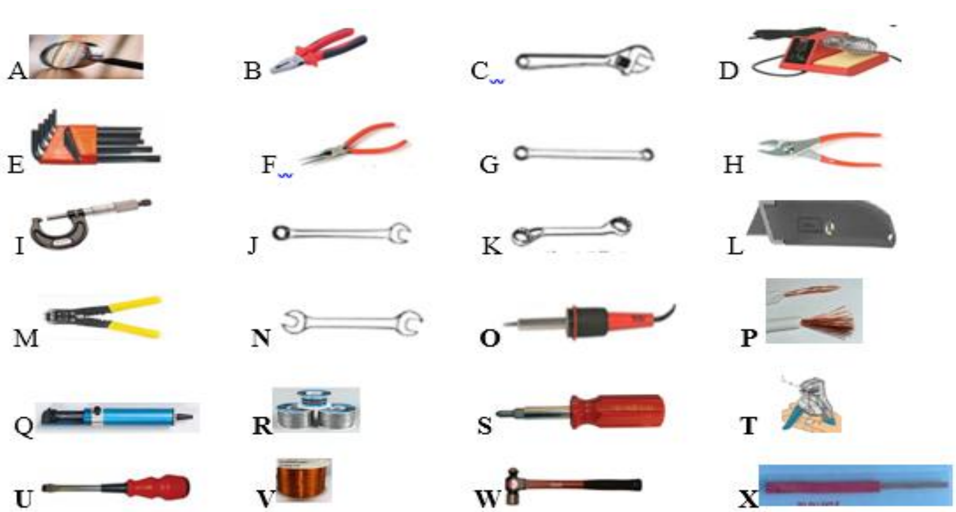
C. Inductor

D.

II. MACTHING

FIGURE	NAME OF THE MATERIAL/TOOL	FIGURE	NAME OF THE MATERIAL/TOOL	FIGURE	NAME OF THE MATERIAL/TOOL
A		**I**		**Q**	
B		**J**		**R**	
C		**K**		**S**	
D		**L**		**T**	
E		**M**		**U**	
F		**N**		**V**	
G		**O**		**W**	
H		**P**		**X**	

FIGURES



Note: Satisfactory rating above 6 and 10 points Unsatisfactory - below 3 and 5 points

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score =________
Rating =________

Name__________________________ **Date____________________**

Instruction Sheet-2	LG36: Diagnose Faulty Parts of Power Supply

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: –

- Following troubleshooting procedures.
- Using the required testing instruments
- Identifying defects/fault parts.
- Explaining identified defects and faults to the responsible person.
- Documenting results of diagnosis and testing accurately and completely within the specified time.
- Advising / informing customers regarding the status and serviceability of the unit.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to: -

- Follow troubleshooting procedures.
- Use the required testing instruments
- Identify defects/fault parts.
- Explain identified defects and faults to the responsible person.
- Document results of diagnosis and testing accurately and completely within the specified time.
- Advise / inform customers regarding the status and serviceability of the unit.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks". in each information sheets.

5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next Learning Guide.

Information Sheet-1	Following troubleshooting procedures

Introduction to Diagnosing and troubleshooting

Diagnosis is the systematic approach to find where and what type of fault occur in a system and troubleshooting/repair is the activity of correcting the fault and enabling the system to restore to its normal operation condition.

To find fault of a system, systematic and logical approach should be followed. The fault of the system should be observed and tested on each sub-system of input and output by following logical order (flow) of the process in the system.

2.1. Troubleshooting Procedures

Trouble shooting procedure is important to reduce the time required for maintenance and troubleshooting is done easily if we have a theoretical knowledge about the equipment. Troubleshooting procedures consists of the following 5 Steps:

- ✓ Step 1 Preparation
- ✓ Step 2 Observation
- ✓ Step 3 Define Problem Area
- ✓ Step 4 Identify Possible Causes
- ✓ Step 5 Determine Most Probable Cause

System recognition is the awareness of some undesirable change in the equipment performance. That is,

- ✓ The equipment displays some sign of poor performance.
- ✓ The performance of the equipment is compared with its normal function.

So here Knowledge of the normal equipment display will enable you to recognize the abnormal display, which provides the trouble symptoms in the first troubleshooting step. Therefore, in order to aware of symptoms, we must have knowledge of the present operating characteristics and the normal design characteristic of the equipment.

Most faults provide obvious clues as to their cause. Through careful observation and a little bit of reasoning, most faults can be identified as to the actual component with very little testing.

When observing malfunctioning equipment, look for visual signs of mechanical damage such as indications of impact, chafed wires, loose components or parts lying in the bottom of the cabinet.

Look for signs of overheating, especially on wiring, relay coils, and printed circuit boards.

- ✓ Don't forget to use your other senses when inspecting equipment.
- ✓ The smell of burnt insulation is something you won't miss. Listening to the sound of the equipment operating may give you a clue to where the problem is located.
- ✓ Checking the temperature of components can also help find problems but careful while doing this, some components may be alive or hot enough to burn you.
- ✓ Pay particular attention to areas that were identified either by past history or by the person that reported the problem.

Caution here!

- ✓ Do not let these mislead you, past problems are just that past problems, they are not necessarily the problem you are looking for now.
- ✓ Also, do not take reported problems as fact; always check for yourself if possible.

The person reporting the problem may not have described it properly or may have made their own incorrect assumptions.

When faced with equipment which is not functioning properly you should:

- ✓ Be sure you understand how the equipment is designed to operate. It makes it much easier to analyze faulty operation when you know how it should operate;
- ✓ Note the condition of the equipment as found. You should look at the state of the relays (energized or not), which lamps are light, which auxiliary equipment is energized or running etc. This is the best time to give the equipment a thorough inspection (using all your senses). Look for signs of mechanical damage, overheating, unusual sounds, smells etc.
- ✓ Test the operation of the equipment including all of its features. Make note of any feature that is not operating properly.
- ✓ Make sure you observe these operations very carefully. This can give you a lot of valuable information regarding all parts of the equipment.

2.2. General troubleshooting Guide lines

The ultimate goal of troubleshooting is to get the equipment back into operation. This is a very important job because the entire production operation may depend on the troubleshooter's ability to solve the problem quickly and economically, thus returning the equipment to service. Although the actual steps the troubleshooter uses to achieve the ultimate goal may vary, there are a few general guidelines that should be followed.

There are often cases where a familiar piece of equipment or system breaks down. In those cases, an abbreviated five-step troubleshooting process can be used to find the fault, get the system up and running. It is important to note that, although it is a five-step approach, the same basic guidelines of the seven-step troubleshooting method are followed. The steps are simply combined to be specific to the problem at hand.

The general guidelines for a good troubleshooter to follow are:

- ✓ Work quickly
- ✓ Work efficiently
- ✓ Work economically
- ✓ Work safely and exercise safety precaution

2.3. Troubleshooting techniques or methods

Once the symptom is identified, the reasons that causes it have to be determined. The choice of which method to use depends on the circuit complexity, on symptoms, and on the personal preferences of the technician. The most common troubleshooting techniques are listed below:

- **Power check**

✓ It is amazing how many times a simple issue such as a blown fuse or a flat battery is the cause of a circuit malfunction. Initially, therefore, ensure that the power cord is plugged in and that the fuses are not blown

✓ If the circuit is battery powered, make sure that the voltage level is acceptable. If a power supply rectifier is present, check the level of the voltage at the output and make sure that the circuit is powered with the correct polarity.

- **Visual inspection**

✓ This inspection is part of the so called sensory checks. Sensory checks rely on the human senses to detect a possible fault.

✓ The visual inspection of the PCB is the simplest troubleshooting technique (which is very effective in many of the cases). The soldered joints have to be inspected thoroughly. If any doubts exist about the quality of a certain joint, it has to be re-soldered.

- ✓ The PCB has to be inspected visually for any burnt components. Sometimes, components that overheat leave a brownish mark on the board. They can be used as 'starting points' in the troubleshooting process and the reasons why they overheat have to be determined.
- ✓ It is bad practice simply to replace such components, without trying to find out what actually caused the component to overheat. In many cases, the reason is a faulty (or out of range) component near the failed component. It also has to be replaced.

- **Using a sense of touch**

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

- **Smell check**

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

- **Component replacement**

- ✓ This troubleshooting method relies mostly on the operator's skills and experience. Certain symptoms are an obvious indication of a particular component failure. This statement is especially true for an experienced electronic technician.

- ✓ For example, some TV service technicians can unmistakably identify the failed component in a TV set (even before opening it), by just briefly examining the symptoms.
- ✓ Component replacement is a good troubleshooting technique for an experienced electronics technician, as it saves a lot of time and money. Moreover, this technique guarantees the success of the repair, because if enough components are replaced, eventually the faulty one will be replaced too. However, it is recommended that the amateur technician initially applies some logical thinking to the troubleshooting process.

- **Signal Tracing**

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

Troubleshooting any piece of equipment involves a systematic approach of observing the symptom, analyzing the possible causes, and checking these failures by test and measurement. Do not completely unload a switched mode power supply while troubleshooting, for this could cause the supply to self-destruct.

Self-check 1	Written Test

Say TRUE if the statement is correct or FALSE, if the statement is incorrect

1. The first step in troubleshooting is Observation.
2. Knowledge of the normal equipment display will enable you to recognize the abnormal display,
3. Visual inspection is part of the so called sensory checks.
4. Component replacement method relies on the skills unexperienced technician.
5. Signal Tracing uses sensor to detect a failed component through smell of smoke.

Note:

Satisfactory rating - 3 and above 5 Points	**Unsatisfactory - below 3 Points**

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** ________________

Information Sheet-2	**Using the required testing instruments**

Introduction to testing instruments.

8) Safety Guidelines

Figure 8.1- A Danger Sign

Whenever you're working on the SMPS, your own safety has to come first. Every electronic technician must always take safety precautions before he or she starts work. Electricity must be handled properly, or else it can injure or cause fatalities. Here are some basic steps that show you how to avoid accidents from occurring.

2.1. Using Multimeter

There are two types: Digital and analogue A Digital multimeter has a set of digits on the display and an analogue multimeter has a scale with a pointer (or needle). You really need both types to cover the number of tests needed for designing and repair work. We will discuss how they work, how to use them and some of the differences between them.

Figure6.3 Digital and Analogue Multimeter

Analogue and digital Multimeters have either a rotary selector switch or push buttons to select the appropriate function and range. Some Digital Multimeters (DMMs) are auto ranging; they automatically select the correct range of voltage, resistance, or current when doing a test. However, you need to select the function.

Precaution

- ✓ Before Making any Measurement, You need to know what you are checking.
- ✓ If You are measuring voltage select the AC range (10v, 50v, 250v, or 1000v) or DC range (0.5v, 2.5v, 10v, 50v, 250v, or 1000v).
- ✓ If you are measuring resistance, select the Ohms range (x1, x10, x100, x1k, x10k). If you are measuring current, select the appropriate current range DCmA 0.5mA, 50mA, 500mA. Every multimeter is different however the photo below shows a low cost meter with the basic ranges**.**

The most important point to remember is this:

- ✓ You must select a voltage or current range that is bigger or HIGHER than the maximum expected value, so the needle does not swing across the scale and hit the "end stop."
- ✓ If you are using a DMM (Digital Multi Meter), the meter will indicate if the voltage or current is higher than the selected scale, by showing "OL" this means "Overload."
- ✓ If you are measuring resistance such as 1M on the x10 range the "OL" means "Open Loop" and you will need to change the range. Some meters show "1' on the display when the measurement is higher than the display will indicate and some flash a set of digits to show over-voltage or over-current. A "-1" indicates the leads should be reversed for a "positive reading."
- ✓ If it is an AUTO RANGING meter, it will automatically produce a reading, otherwise the selector switch must be changed to another range.
- ✓ The black "test lead" plugs into the socket marked "-" "Common", or "Com," and the red "test lead" plugs into meter socket marked "+" or "V-W-mA."
- ✓ The third banana socket measures HIGH CURRENT and the positive (red lead) plugs into this. You DO NOT move the negative "-" lead at any time.

- **Measuring Voltage**

Most of the readings you will take with a multimeter will be Voltage readings. Before taking a reading, you should select the highest range and if the needle does not move up scale (to the right), you can select another range. Always switch to the highest range before probing a circuit and keep your fingers away from the component being tested.

- ✓ If the meter is Digital, select the highest range or use the auto-ranging feature, by selecting "V." The meter will automatically produce a result, even if the voltage is AC or DC.
- ✓ If the meter is not auto-ranging, you will have to select if the voltage is from a DC source or if the voltage is from an AC source. DC means Direct Current and the voltage is coming from a battery or supply where the voltage is steady and not changing and AC means Alternating Current where the voltage is coming from a voltage that is rising and falling.
- ✓ You can measure the voltage at different points in a circuit by connecting the black probe to chassis. This is the 0v reference and is commonly called "Chassis" or "Earth" or "Ground" or "0v."
- ✓ The red lead is called the "measuring lead" or "measuring probe" and it can measure voltages at any point in a circuit. Sometimes there are "test points" on a circuit and these are wires or loops designed to hold the tip of the red probe (or a red probe fitted with a mini clip or mini alligator clip).
- ✓ You can also measure voltages across a component. In other words, the reading is taken in parallel with the component. It may be the voltage across a transistor, resistor, capacitor, diode or coil. In most cases this voltage will be less than the supply voltage.

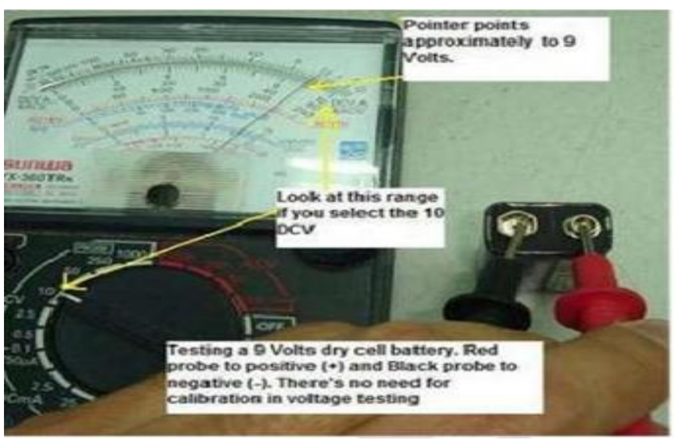


Figure6.4 Measuring the voltage using analogue meter

Figure6.5 Measuring the voltage using digital meter.

If you are measuring the voltage in a circuit that has a high impedance, the reading will be inaccurate, up to 90% !!!, if you use a cheap analogue meter.

- **Measuring Voltage in a circuit**

You can take many voltage-measurements in a circuit. You can measure "across" a component, or between any point in a circuit and either the positive rail or earth rail (0v rail). In the following circuit, the 5 most important voltage-measurements are shown. Voltage "A" is across the electret microphone. It should be between 20mV and 500mV. Voltage "B" should be about 0.6v. Voltage "C" should be about half-rail voltage. This allows the transistor to amplify both the positive and negative parts of the waveform. Voltage "D" should be about 1-3v. Voltage "E" should be the battery voltage of 12v.

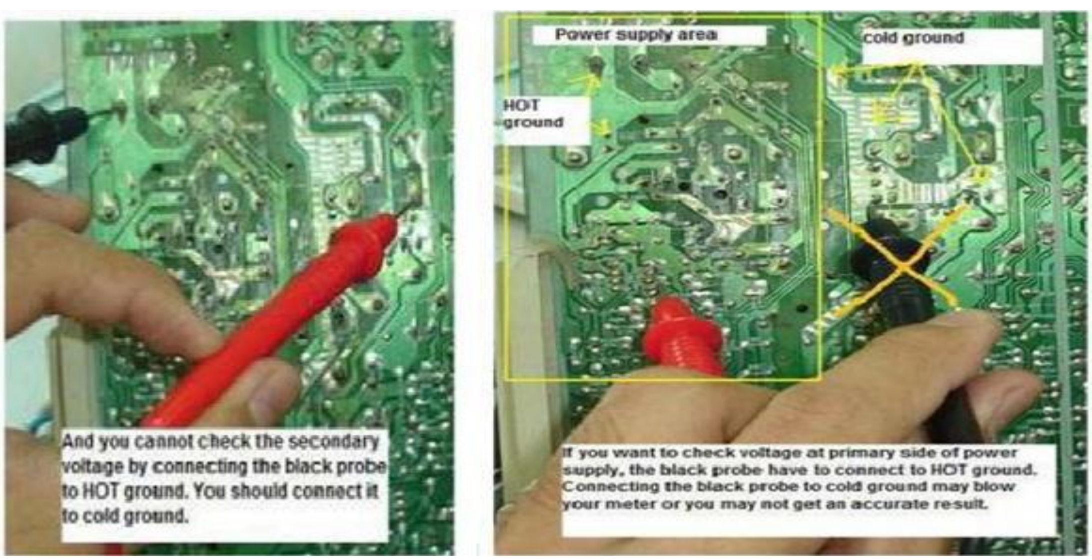


Figure6.5 Measuring Voltage in a circuit

- **Measuring Current in a circuit**

You will rarely need to take current measurements, however most multi-meters have DC current ranges such as 0.5mA, 50mA, 500mA and 10Amp (via the extra banana socket) and some meters have AC current ranges. Measuring the current of a circuit will tell you a lot of things. If you know the normal current, a high or low current can let you know if the circuit is overloaded or not fully operational.

- ✓ Current is always measured when the circuit is working (i.e: with power applied).
- ✓ It is measured IN SERIES with the circuit or component under test.
- ✓ The easiest way to measure current is to remove the fuse and take a reading across the fuse-holder. Or remove one lead of the battery or turn the project off, and measure across the switch.
- ✓ If this is not possible, you will need to remove one end of a component and measure with the two probes in the "opening."
- ✓ Resistors are the easiest things to de-solder, but you may have to cut a track in some circuits. You have to get an "opening" so that a current reading can be taken.
- ✓ Do not measure the current ACROSS a component as this will create a "short-circuit."

The component is designed to drop a certain voltage and when you place the probes across this component, you are effectively adding a "link" or "jumper" and the voltage at the left-side of the component will appear on the right-side. This voltage may be too high for the circuit being supplied and the result will be damage. The following diagrams show how to connect the probes to take a CURRENT reading.

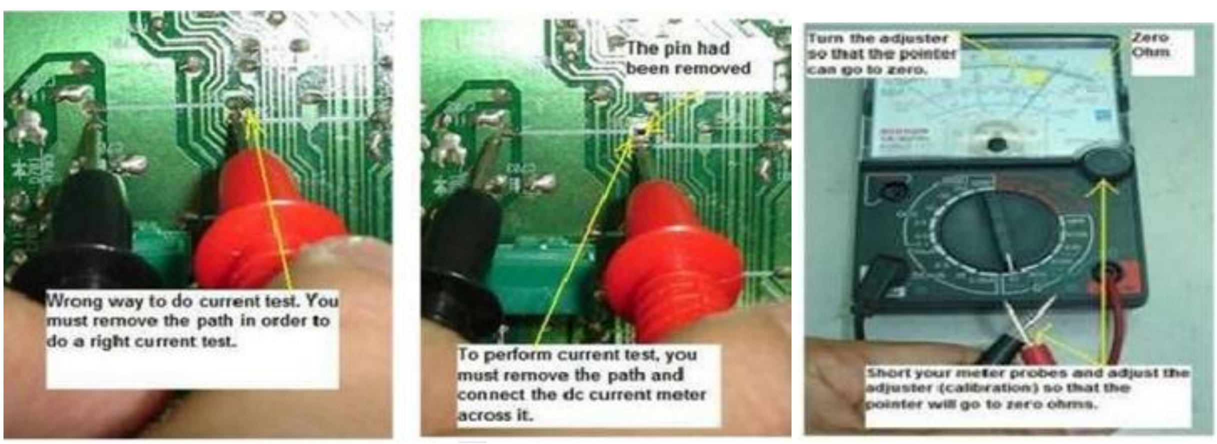


Figure6.5 Measuring current in a circuit

Cautions

✓ Do not measure the "current a battery will deliver" by placing the probes across the terminals. It will deliver a very high current and damage the meter instantly. There are special battery testing instruments for this purpose.

When measuring across an "opening" or "cut," place the red probe on the wire that supplies the voltage (and current) and the black probe on the other wire. This will produce a "POSITIVE" reading.

✓ A positive reading is an upscale reading and the pointer will move across the scale to the right.

✓ A "NEGATIVE READING" will make the pointer hit the "STOP" at the left of the scale and you will not get a reading.

✓ If you are using a Digital Meter, a negative sign "-" will appear on the screen to indicate the probes are around the wrong way. No damage will be caused. It just indicates the probes are connected incorrectly.

✓ If you want an accurate CURRENT MEASUREMENT, use a digital meter.

- **Measuring Resistance**

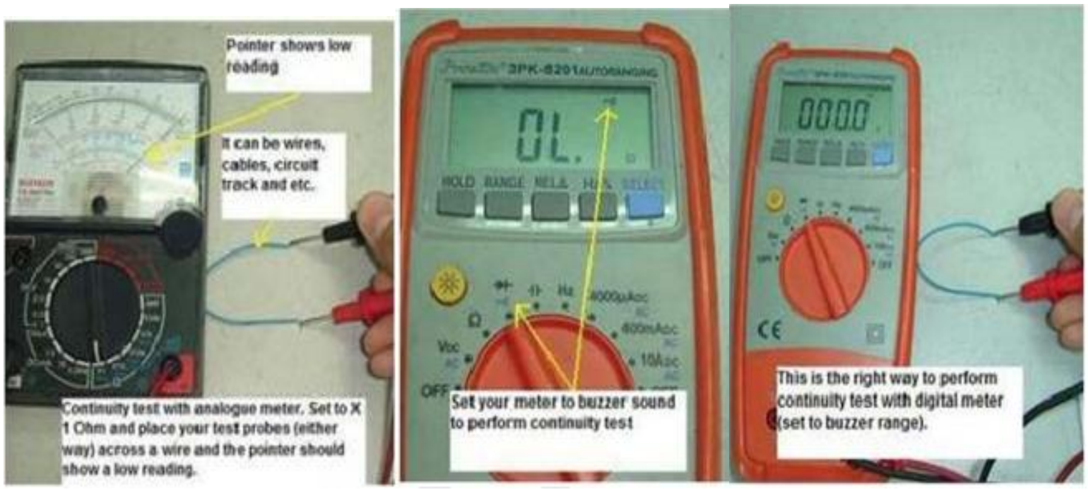
✓ Turn a circuit off before, if any voltage is present, the value of resistance will be incorrect.

✓ In most cases you cannot measure a component while it is in-circuit. This is because the meter is actually measuring a voltage across a component and calling it a "resistance." The voltage comes from the battery inside the meter.

✓ If any other voltage is present, the meter will produce a false reading.

✓ If you are measuring the resistance of a component while still "in circuit," (with the power off) the reading will be lower than the true reading.

Figure6.8. Measuring the resistance (a) in the circuit (b) resistance-wire and (c)a resistor



Precautions

- ✓ Do not measure the "resistance of a battery." The resistance of a battery (called the Internal impedance) is not measured as shown in the figure below. It is measured by creating a current-flow and measuring the voltage across the battery.
  - Placing a multimeter set to resistance (across a battery) will destroy the meter.
- ✓ Do not try to measure the resistance of any voltage or any "supply."

Figure6.9. Caution in measuring resistance

Clamp-on ammeter

The clamp-on ammeter is similar to the voltage tester, except that it is used to measure ac or dc amperage by the industrial troubleshooter. This meter contains transformer jaws that clamp around a conductor without interrupting the circuit. These meters are portable and rugged. Figure 2.10 illustrates a typical clamp-on ammeter. This type of meter can often be used with analog VOMs and DMMs. They generally handle alternating currents from 100 mA to 500 amperes (A). Like the voltage tester, its main advantage is the ability to make quick and accurate current measurements in industrial applications.

Figure6.10. The clamp-on ammeter

2.2. Using Transistor testers

Transistor testers are fairly accurate checkers of diodes and transistors. They also have the capability of checking the performance of these components while in or out of circuit. They are able to measure transistor leakage and beta, and can automatically identify emitter, base, and collector leads (Figure6.10). Transistor checkers are often multipurpose instruments with audible and visual test indications. Leakage currents can be made with transistors when they are out of the circuit. The probes of these meters contain flexible, spring-loaded pointed tips that allow for convenient and quick measurements. Connections to transistors mounted as printed-circuit boards can also be easily checked.

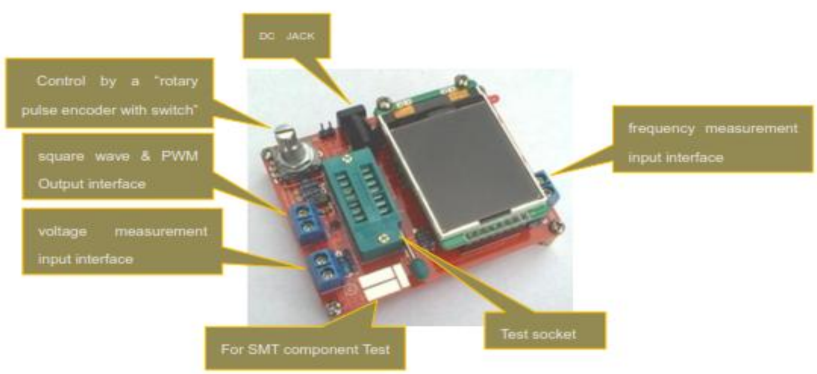


Figure6.11 Parts of Transistor tester

Transistor tester can be powered from 6.8 V – 12V DC, this can be achieving by a 9V layer-built battery. Two 3.7V Lithium-ion battery in series, Or AC adapter. When power on, the current is about 30mA at DC 9V.

Transistor tester is control by a “rotary pulse encoder with switch” (RPEWS) for short, this component has four mode of operation, Short time press, long time press, and Rotation of left or Rotation right.

- When Transistor tester is powered. a Short time press of the RPEWS will switch on the Transistor Tester, and start a Test.
- Transistor Tester will be waiting for user input at the end of a test. During an end of test, before it’s auto switch off.

- A long time press or Rotation of left and right the RPEWS will enter the function menu. In the function menu, a “>” at left column to index the Selected menu item.
- To enter the Specific function, just a short press the RPEWS. Within the Specific function, a long time press will exit and back to the function menu.
- Transistor tester have three test point (TP1, TP2, TP3), within the test socket, the three is allocation as follow.

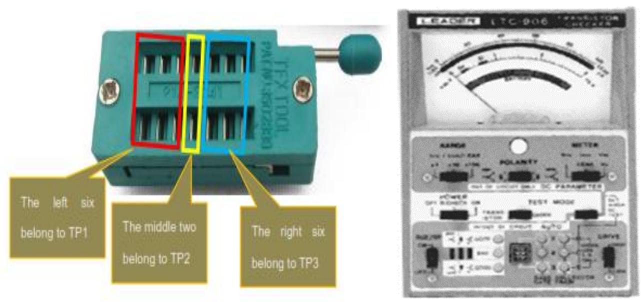


Figure6.12. Transistor Tester and Test points (socket)

When test two lead component (resistor, capacitor, inductor), the two lead can select any two test point. if TP1 and TP3 is selected, the Test will enter to” series test mode” when the test is Completes. Else the test is start again by a short press RPEWS.

- **Measuring PNP and NPN transistors:**

For normal measurement the three pins of the transistor will be connect in any order to the measurement inputs of the Transistor Tester. After pushing the RPEWS, the Tester shows in row1 the type (NPN or PNP), a possible integrated protecting diode of the Collector - Emitter path and the sequence of pins. The diode symbol is shown with correct polarity. Row 2 shows the current amplification factor (hfe=...) and the Base - Emitter threshold voltage.

You should know, that the Tester can measure the amplification factor with two different circuits, the common Emitter and the common Collector circuit (Emitter-follower). Only the higher result is shown on the LCD.

With Germanium transistors often a Collector cutoff current ICEO with current less base or a Collector residual current ICES with base hold to the emitter level is measured.

Self-check 2	

1. Which One of the following is not true about voltmeter?
   A. It is always connected in parallel
   B. It measures resistance of a component.
   C. It measures a voltage across a component
   D. It displays the shape of the output.
   E. B and C

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ___________________________ **Date:** ________________

Introduction to electrical Defect/fault

Fault in electrical equipment or apparatus is defined as an imperfection in the electrical circuit due to which current is deflected from the intended path. In other words, the fault is the abnormal condition of the electrical system which damages the electrical equipment and disturbs the normal flow of the electric current.

3.1. Safety considerations

Before we outline the basic steps for fault finding on some simple electronic circuits, it is vitally important that you are aware of the potential hazards associated with equipment which uses high voltages or is operated from the a.c. mains supply.

Whereas many electronic circuits operate from low voltage supplies and can thus be handled quite safely, the high a.c. voltages present in mains operated equipment represent a potentially lethal shock hazard.

The following general rules should always be followed when handling such equipment:

1. Switch off the mains supply and remove the mains power connector whenever any of the following tasks are being performed:
   - ✓ Dismantling the equipment.
   - ✓ Inspecting fuses.
   - ✓ Disconnecting or connecting internal modules.
   - ✓ De-soldering or soldering components.
   - ✓ Carrying out continuity tests on switches, transformer windings, bridge rectifiers, etc.
2. When measuring a.c. and d.c. voltages present within the power unit take the following precautions:
   - ✓ Avoid direct contact with incoming mains wiring.
   - ✓ Check that the equipment is connected to an effective earth.
   - ✓ Use insulated test prods.
   - ✓ Select appropriate meter ranges before attempting to take any measurements.
   - ✓ If in any doubt about what you are doing, switch off at the mains, disconnect the mains connector and think.

3.2. Fault Finding Procedures

Fault finding is a disciplined and logical process in which 'experimental fixing' should never be anticipated. The generalized process of fault finding is illustrated in the flowchart of Figure7.1.

First you need to verify that the equipment really is faulty and that you haven't overlooked something obvious (such as a defective battery or disconnected signal cable). This may sound rather obvious but in some cases a fault may simply be attributable to maladjustment or misconnection. Furthermore, where several items of equipment are connected together, it may not be easy to pinpoint the single item of faulty equipment.

The second stage is that of gathering all relevant information. This process involves asking questions such as:

- ✓ In what circumstances did the circuit fail?
- ✓ Has the circuit operated correctly before and exactly what has changed?
- ✓ Has the deterioration in performance been sudden or progressive?
- ✓ What fault symptoms do you notice?

The answers to these questions are crucial and, once the information has been analyzed, the next stage involves separating the 'effects' from the 'causes'. Here you should list each of the possible causes. Once this has been done, you should be able to identify and focus upon the most probable cause. Corrective action (such as component removal and replacement, adjustment or alignment) can then be applied before further functional checks are carried out. It should then be possible to determine whether or not the fault has been correctly identified. Note, however, that the failure of one component can often result in the malfunction or complete failure of another.

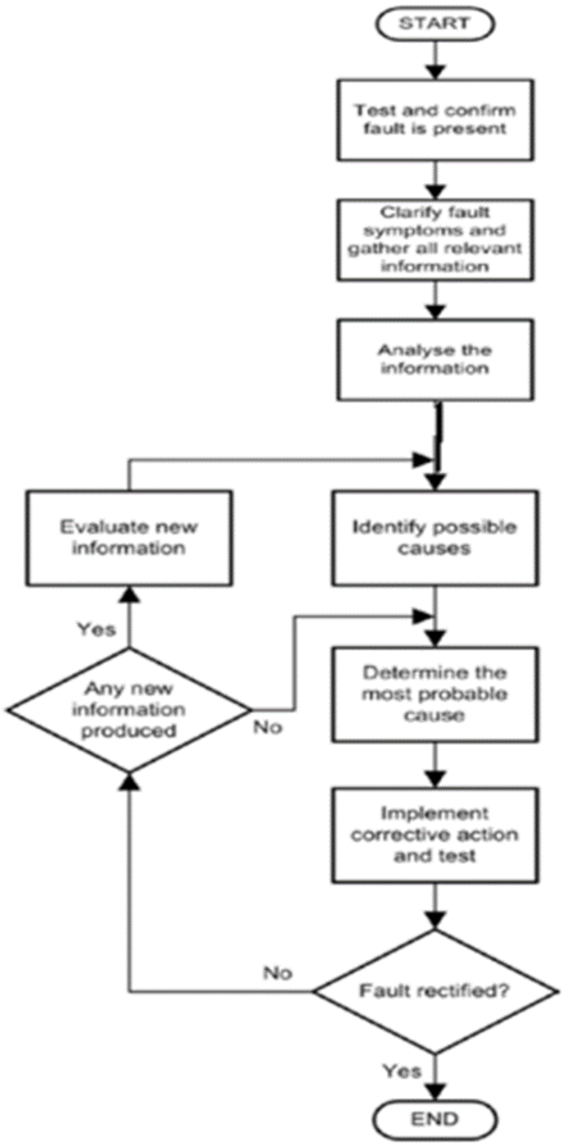


Figure3.1. the flowchart

As an example, a short-circuit capacitor will often cause a fuse to blow. When the fuse is replaced and the supply is reconnected the fuse will once again blow because the capacitor is still faulty. It is therefore important to consider what other problems may be present when a fault is located.

3.3. Common Faults Categories in a Power Supplies

No matter what type of power supply you are repairing the faults (problems) fall into the following six categories: -

a) No Power

b) Low Output Voltage

c) High Output Voltage

d) Power Cycling/Blinking

e) Power Shutdown and

f) Intermittent Power Problem

Once you have understood the Common Faults or problems, then you can use the necessary step to isolate, troubleshoot and repair any power supplies.

a) No Power

In SMPS this fault has two categories

i. Dead and Silent with fuse Blown and

ii. Dead and Silent with fuse Good

To identify this problem, the following symptom are existing

- ✓ Switch on the equipment (SMPS)
- ✓ Make sure that the AC Power cord is properly connected
- ✓ Observe the LED light indicator.
- ✓ If there is no light you got the symptom then,

Test procedures:

- ✓ Open the cover observe the fuse.
- ✓ Test the fuse with your ohmmeter.
- ✓ Test The bridge rectifier and The power FET and
- ✓ The secondary diode.

Figure3.2. Basic Way of fault finding for no power

b) Low Output Voltage

The Symptom:

- ✓ Low power output
- ✓ No LED light

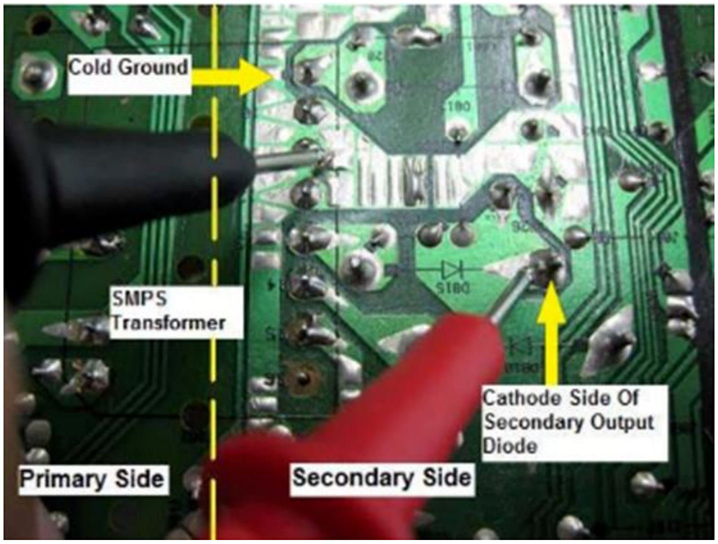


Figure3.3. Low Output Voltage test

c) High Output Voltage

Symptoms

- ✓ An increased value of secondary output voltage (Example, from 12V to 15V.)

Test Steps

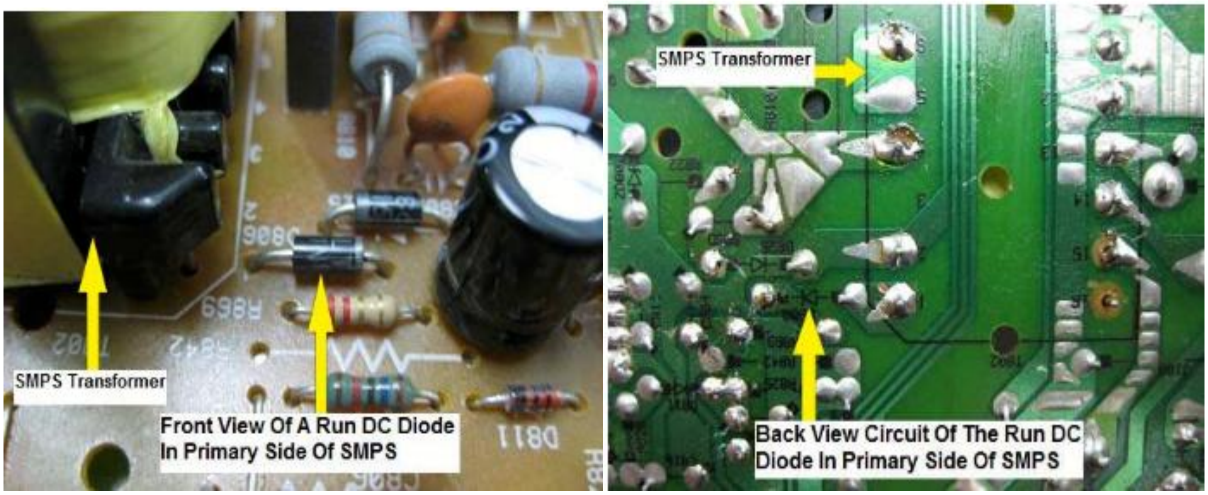


Figure3.4. Run DC Circuit Diode and Its location In the primary side of SMPS.

d) Power Cycling/Blinking

Symptoms

- ✓ The equipment LED Blinks.

e) Power Shutdown

Symptoms

- ✓ Producing too HIGH output voltage that can burn the equipment and other electronic circuitry.
- ✓ The SMPS shutdown itself while you ON.

f) Intermittent Power Problem

Symptoms

- ✓ The SMPS sometimes works and sometimes don't work properly.

7.3. Fault analysis

Fault analysis requires a good theoretical knowledge and analytical thinking. It is not something which can be studied from books, but has to be acquired through constant troubleshooting and experimenting. The basic question in fault analysis is: 'What would the symptoms in the circuit be, if the component X is faulty?' For each specific application, there are no ready answers to this question. If there were, many books devoted to industrial electronics would be meaningless. However, there are certain rules, which can be adhered to, during the troubleshooting process. One of the tasks of this manual is to teach you some of these basic rules.

As an example, let us examine a bridge rectifier, to illustrate the process of fault analysis. The block circuit of a bridge rectifier that is working properly is shown in Figure 7.2. It consists of a transformer, a rectifier, and a filter. The voltages, taken with an oscilloscope at each test point are depicted in the figure.

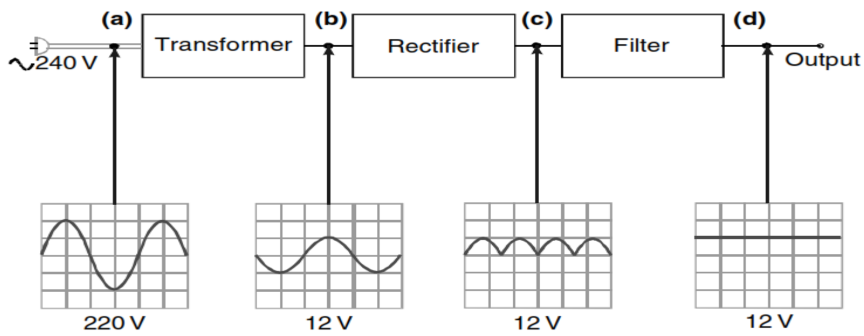


Figure3.5. Block diagram of a rectifier in good working order

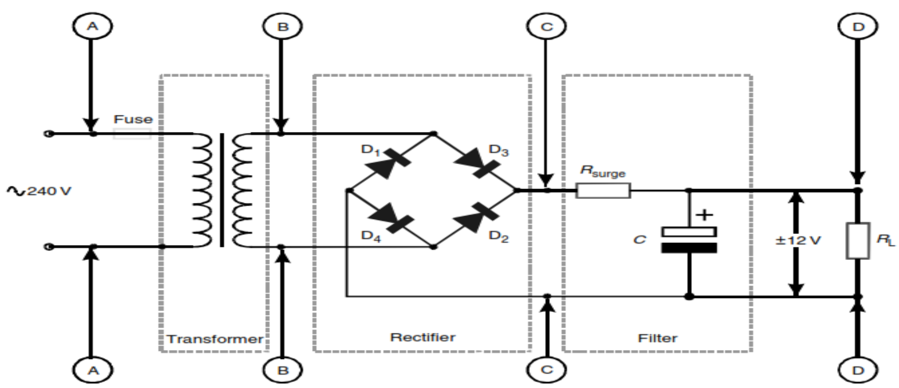


Figure3.6. A circuit diagram of the bridge rectifier

3.4. An analysis of all possible faults in this circuit are given below:

- **Faulty capacitors**

There are three possible problems. The capacitor could be shorted, opened, or leaky. If the capacitor is shorted, it effectively brings both terminals of the load resistor together and therefore the output voltage is zero. This is illustrated in Figure7.4 (a). If the capacitor is open (Figure7.4 (b)), it does not filter the output voltage supplied from the rectifier. The waveform of the voltage, at the output, remains the same as the waveform of the voltage, after the rectifier. Therefore, the waveforms at points C and D are identical. The only difference is that the amplitude of the voltage at the point D is smaller, due to the voltage drop across the resistor R surge. Finally, if the capacitor is leaky the output voltage will appear with increased ripples on the output (Figure7.4 (c)).

A leaky capacitor appears as if there is a leakage resistor, connected to it in parallel. The leakage resistor decreases the time for a discharge, thus the voltage ripples increase at the output.

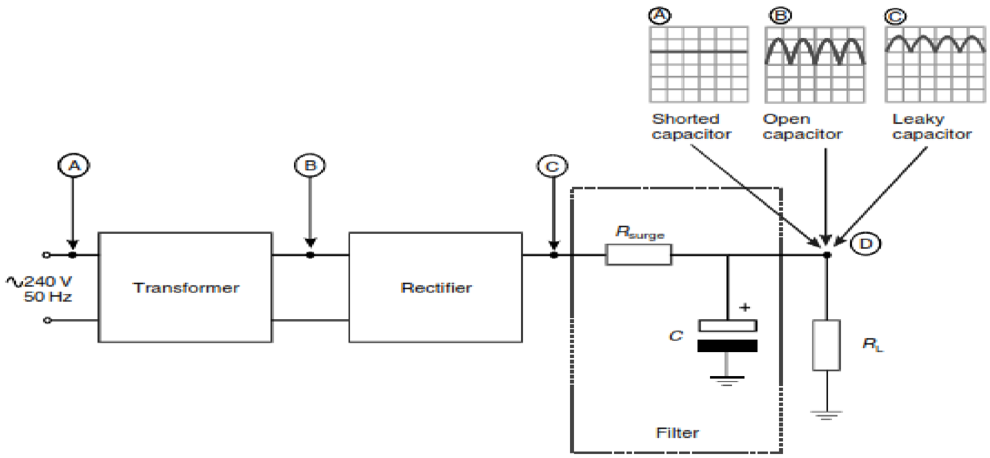


Figure3.7. Symptoms of a faulty capacitor

Faulty Resistor (R_{surge})

There is only one possible faulty condition, namely a blown resistor $\mathbf{R_{surge}}$ ($\mathbf{R_{surge}}$ appears as an open circuit). This occurs, when an excessive current flows through it. An excessive current flows through Rsurge if the output terminals are short-circuited or if the capacitor is shorted. In both cases when R surge blows, it brakes the circuit and prevents the diodes (which are more expensive than the resistor) from burning too. The output voltage in this case is zero. Before replacing R surge, ensure that the capacitor, or the output terminals of the circuit, is not shorted and that the conductive paths of the PCB are not shorted out.

Shorted diode

shorted diode appears as a jumper between the points of the connection, as it conducts the current in both directions. Figure 3.8 illustrates the current that flows in the circuit, when the diode D4 is shorted out. During the positive half-period, the current flows through D3 and D4 as normal. The shortened diode exhibits a zero resistance in both directions and it appears for the circuit, as if it is simply forward-biased. Thus, the positive half-period appears as normal at the point C. However, during the negative half-period the picture changes. The current now flows through D1 and D4 instead of flowing through the rest of the circuit, because these two diodes, connected in series, provide a path of least resistance. Effectively the secondary winding is short-circuited and an excessive current flows through it. Thus, the diode D4 can be damaged quickly, due to overheating. The increase in the current in the secondary winding increases the current in the primary winding. If the circuit is properly fused, the fuse on the primary winding should blow. If this is not the case, the diode D 1 overheats (and even possibly burns) and the voltage at the test point C has the form shown in Figure 7.5. Analytical thinking is required to analyze what happens in the circuit when some other diode shorts out, or when two or more diodes short out simultaneously.

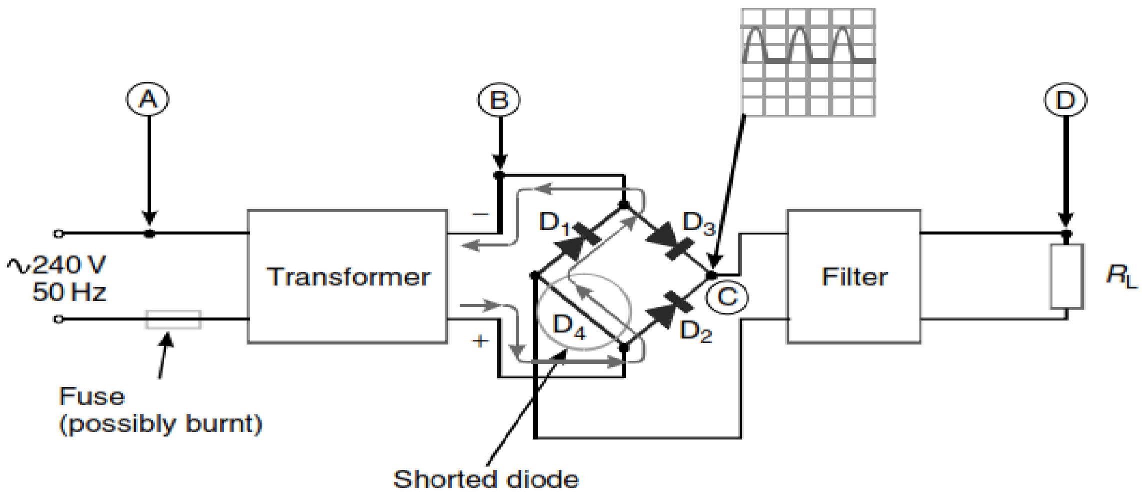


Figure3.8. Symptoms of a shortened diode

- **Open diode**:

Let us assume that the same diode (D4) is open. No current flows through an open diode in both directions. During the negative half period, this diode appears to the circuit to be reverse-biased, and therefore it has no impact on the output voltage. However, during the positive half-period, the path for the current is broken and no voltage appears at the output. In other words, the circuit works as a half-wave rectifier. This can be detected by, the larger ripples in the output voltage. In addition, the frequency of the ripples is 50Hz Instead of 100Hz. This Is illustrated in Figure3.9 Similarly, the circuit can be analysed for other open diodes.

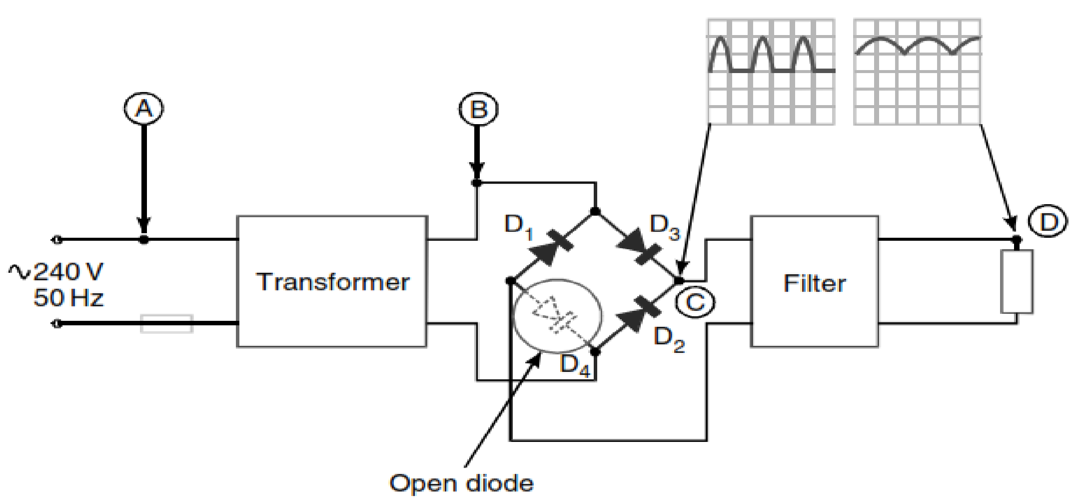


Figure3.9. Symptoms of an open diode

- **Faulty transformer:**

This is not a common fault, though if the rest of the circuit appears in a good working order, the transformer has to be checked. Several faults are possible: the primary or the secondary windings can be open or partially shorted. If one of the windings is open, no voltage is applied to the rest of the circuit. This obviously results in 0 V at the output. If the primary winding is partially shorted, the turns ratio of the transformer is effectively increased. The voltage on the secondary winding is also increased; thus, the level of the voltage at the output of the circuit is higher. A partially shorted secondary winding decreases the turn ratio of the transformer. The voltage supplied to the rectifier is lower; thus, the level of the circuit output voltage is also lower.

- **Blown fuse:**

As was mentioned earlier, this occurs when one of the diodes is shorted. Thus, before replacing the fuse, the diodes have to be checked. A partially shorted primary or secondary winding of the transformer can also increase the current to a level, where the fuse blows. Thus, the transformer also has to be tested before replacing the fuse.

Testing BJTs

Sometimes the transistor itself may not be faulty, but due to faults in the external circuitry, it may not operate correctly. For example, a cold junction on the transistor base terminal effectively isolates the base from the rest of the circuit. Therefore, the bias voltage on the transistor is 0 V, which will drive it into a cutoff. When checking such a transistor from the component side of the PCB, it will appear to be functioning correctly. Yet, the signal is not present at the output.

To better understand how to troubleshoot a biased BJT, consider the amplifier stage example shown in Figure B.6. It is built on the transistor 2N3946. According to the data sheets, *bDC* for this transistor is in the range of 50–150. Therefore, we can assume that *bDC* for the specified transistor is 100. The bias voltages are chosen VBB = 3 V and VCC = 9 V. Performing some simple calculations, we can determine that:

$$V_{BE} = 0.7\ \mathrm{V}$$

$$I_B = \frac{3\ \mathrm{V} - 0.7\ \mathrm{V}}{56\ \mathrm{K\Omega}} = \frac{2.3\ \mathrm{V}}{56\ \mathrm{K\Omega}} = 41.4\ \mu\mathrm{A}$$

$$I_C = \beta_{DC} I_B = 100(41.1\ \mu\mathrm{A}) = 4.1\ \mathrm{mA}$$

$$V_C = 9\ \mathrm{V} - I_C R_C = 9\ \mathrm{V} - (4.1\ \mathrm{mA})(1\ \mathrm{K\Omega}) = 4.9\ V$$

The voltages and the component values are specified in the Figure7.6. All the measured voltages are with respect to the ground. If the circuit operates correctly, the following voltages should be measured: +0.7 V in point A, +4.9 V in point B, and 0 V in point C.

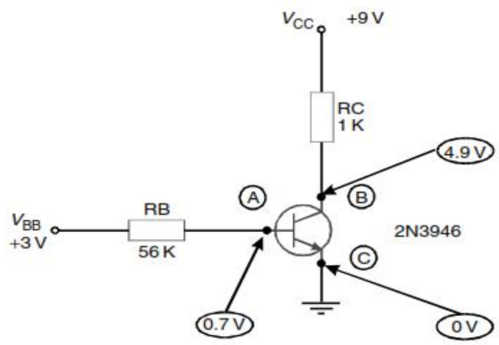


Figure7.7 Troubleshooting a single amplifier stage

First, the transistor has to be checked. If the transistor is not defective, the PCB has to be inspected visually for mechanical defects, burned components, and badly soldered joints. Finally, the voltages on the transistor terminals have to be measured.

Three typical abnormal conditions may occur due to faults in the external circuitry. They are illustrated in Figure7.8. Measuring the voltages on the transistor terminals can help to more effectively detect these faults. If the voltage at point B is only several mV instead of the normal +0.7 mV, then this is an indication that the base of the transistor is open (Figure 7.8(a)). The soldered joints at the base of the transistor and at RB have to be checked. The value of the RB has to be measured. Any external circuitry, leading to the base of the transistor has to be inspected for badly soldered joints and for components that are out of tolerance.

If the meter reads a few mV on the collector terminal (point B) it is an indication that the collector is not connected to the rest of the circuitry (Figure 7.8(b)). At the same time, the voltage on the base terminal should be around 0.7 V, as the base-emitter PN junction is forward-biased. The soldered joints on the collector and the collector resistor to the PCB have to be inspected. The value of RC has to be measured. Any component, connected to the collector resistor, has to be checked.

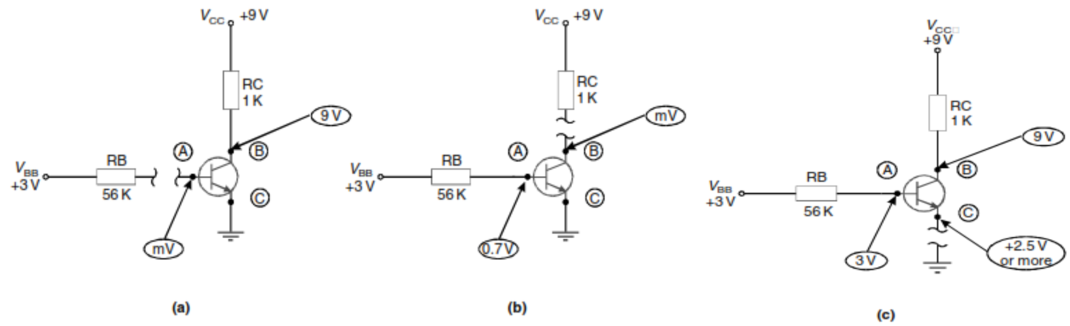


Figure 7.8 Typical abnormal conditions in a biased BJT: (a) Open base; (b) Open collector; (c) Open emitter

If there is an open ground connection, the symptoms are as follows: +3 V at the base terminal and +9 V at the collector terminal, as there is no collector and no emitter currents (Figure7.8(c)). The voltage measured at the emitter is +2.5 V or more. This occurs because the internal resistance of the measuring voltmeter provides a forward current path. It flows from VBB, through RB, the base-emitter junction and through the measuring voltmeter to the ground. Thus, the voltmeter registers the voltage drop across the PN junction. The soldered joint on the emitter has to be checked. All external circuitry connected to the emitter also has to be checked and tested.

3.5. Testing electronic components

Several components are common to most electrical and electronic devices. Understanding how to test the most common components is essential for the troubleshooter.

Resistors are manufactured in various shapes, sizes, and values. The main purpose of the resistor is to limit current flow and/or reduce voltage. Most resistors are made of carbon or wire and are manufactured in prescribed ohmic values. For example, a 1000-ohm (Ω) resistor at 10 percent tolerance is color-coded brown, black, red, and silver. Therefore, on an ohmmeter the resistor should measure between 900 and 1100 Ω. An open resistor will have infinite resistance, and a defective resistor could have any value below 900 Ω or above 1100 Ω.

Resistors are rated in watts, which determines the ability of the resistor to absorb the heat produced within the resistor. The actual physical size of the resistor determines its wattage rating. A larger resistor can simply absorb more heat than a smaller one.

The most common defects of resistors are physical cracking and charring. When excessive current and heat tend to increase the resistance, the resistor opens. A charred or discolored resistor should be replaced, since the resistor will often check good with an ohmmeter but will break down (open) under voltage in the circuit.

The ohmmeter is one of the most important meters used in servicing components. This meter is used to measure continuity or resistance in resistors or other components. A component having continuity has a resistance near zero. On the other hand, a component having no continuity has infinite resistance.

When testing basic components, the troubleshooter is mostly concerned with the resistance of the component or continuity measurement. For example, when a troubleshooter is checking a fuse, a good fuse will read 0 Ω, but an open (blown) fuse will read infinite resistance (Fig. 1.6).

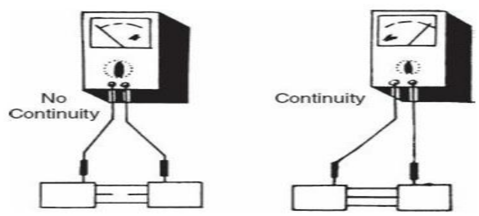


Figure7.10 Checking a fuse for continuity by using an ohmmeter.

Testing wires

As for checking a fuse, when you are testing cables, cords, or wiring harnesses, a good wire will have continuity and a broken wire (open) will have no continuity. When checking a wire for a possible defect, while the ohmmeter is connected, gently bend the wire at various points, especially along common faults such as near connections. Since wires often contain intermittent defects, breakdowns occur during movement.

To test a switch, the same procedure is used. A single-pole, single-throw switch should have continuity one way and not the other (Figure3.10.). As with wires, when you check a switch with an ohmmeter, gently rock the switching mechanism to identify potential intermittent circuit faults. This procedure will also allow you to evaluate the mechanical quality of the switch. Switches should have a smooth, firm operation, not a sloppy action with play and looseness. Some defective switches can easily be repaired by tightening a screw or by cleaning; however, they generally need to be replaced.

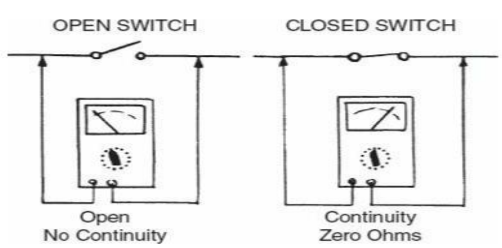


Figure3.10. Checking a wire for continuity by using an ohmmeter.

Testing a potentiometer

Variable resistors are called potentiometers, and they can be measured and tested in two simple ways. (1) One way is to use an ohmmeter to measure the value of the potentiometer across the two end terminals. The value should equal the value printed on the potentiometer. Place one lead on the center terminal and the other lead on one of the end terminals. The potentiometer, when turned, should vary the resistance accordingly (Figure7.12). (2) Another way to test a potentiometer is to turn the potentiometer while it is in the circuit. If a scratchy, rough sound is heard in the speaker, the potentiometer needs cleaning or replacing. To clean the potentiometer, turn off the power and spray an electronic component cleaner in the sliding contact area while turning the control back and forth.

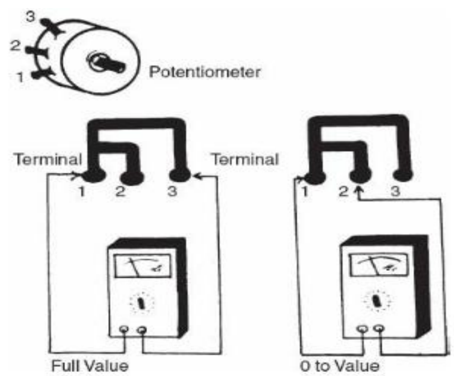


Figure3.11. Testing a potentiometer

- **Testing Capacitor**

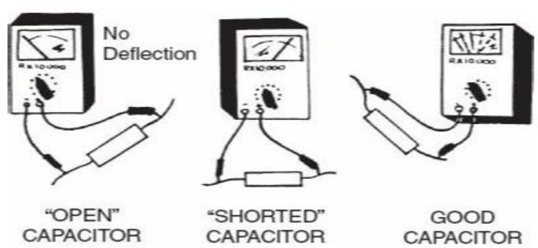
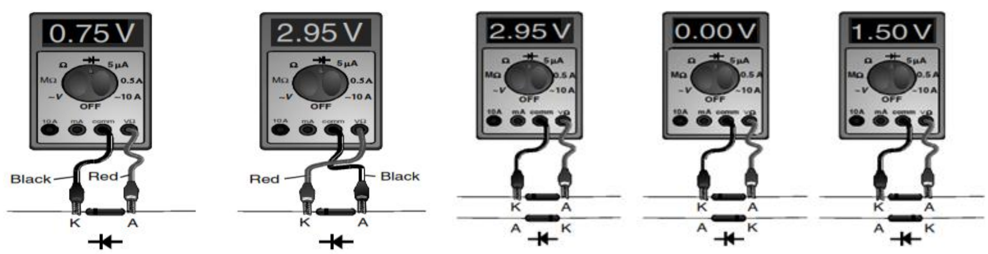


Figure3.12. Testing a Capacitor

- **Testing diodes**

As was discussed in the previous learning module, the diode is a semiconductor device, which conducts direct current in one direction only. In other words, the diode exhibits a very low resistance when it is forward-biased and an extremely high resistance when it is reverse-biased. In the previous learning module, it was mentioned that an ohmmeter applies a known voltage from an internal source (batteries) to the measured resistor. Theoretically, this voltage can reach 1.5 or 3 V. The diode requires a voltage of 0.7 V to become forward-biased. Therefore, if the positive test leads of the ohmmeter is connected to the anode and the negative test lead of the ohmmeter is connected to the cathode, the diode becomes forward-biased. In this case, the ohmmeter reads a very low resistance. If the test leads are reversed with respect to the anode and the cathode, the diode becomes reverse-biased. Then, the ohmmeter reads a very high resistance.

Therefore, an ordinary ohmmeter can be used to test a diode. A defective diode appears either as an open circuit or as a closed circuit in both directions. The first case is more common and it is mainly caused by an internal damage of the PN junction due to overheating. Such a diode exhibits a very high resistance when it is both forward-biased and reverse-biased. On the other hand, the multi-meter reads 0 V in both directions, if the diode is shorted. Sometimes a failed diode may not exhibit a complete short circuit (0 V) but may appear as a resistive diode, in which case the meter reads the same resistance in both directions (for example, 1.5 V). This is illustrated in Figure3.13.



(a) (b)

Figure3.13. (a)Properly functioning and(b) Defective diodes

If a special diode-test function is not provided in a particular multi-meter, the diode still can be checked, by measuring its resistance in both directions. The selector switch is set to Ohms. When the diode is forward-biased, the meter reads from a few hundred to a few thousand ohms. The actual resistance of the diode normally does not exceed 100 Ω, but the internal voltage of many meters is relatively low in the Ohms range and it is not sufficient to forward-bias the PN junction of the diode completely. For this reason, the displayed value is higher. When the diode is reverse-biased, the meter usually displays some type of out-of-range indication, such as ‘OL’, because the resistance of the diode in this case is too high and cannot be measured from the meter. The actual values of the measured resistances are unimportant. What is important, though, is to make sure that there is a major difference in the readings, when the diode is forward-biased and when it is reverse-biased. In fact, this is all that is important to note, for this indicates that the diode is working properly.

Testing BJTs

As discussed the previous learning module, the BJTs are devices, consisting of three layers of semi-conductive material and can be either of p-n-p or n-p-n type. Therefore, each transistor can be represented as a combination of two diodes, connected as shown in Figure3.14. The equivalent base of p-n-p-type transistors appears as connected to the cathodes of both the diodes. If the transistors are of the n-p-n type, the equivalent base appears as connected to the anodes of both the diodes. The two remaining terminals of the diodes represent the emitter and the collector. Both the PN junctions of the transistor are tested separately as two independent diodes. If both of them show no defects, the transistor is working properly.

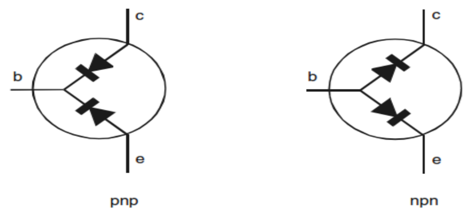


Figure3.14. A transistor, represented as two diodes

The diode test function of a DMM can be also used to test the transistors. Let us assume that a p-n-p-type transistor has to be tested. The negative test lead (black) of the multi-meter is applied to the base of the transistor. The positive test lead (red) is applied first to the emitter and then to the collector. In this arrangement, both the junctions will be forward-biased when tested. The DMM should read a low resistance in both cases. Then the red test lead is applied to the base of the transistor instead of the black one. The procedure is repeated. Both the PN junctions are now reverse-biased, when tested. The multi-meter reads high resistance in both cases. The procedure for testing the n-p-n transistors is identical. The difference is that the DMM will now read a high resistance, when the black lead is applied to the base, and a low resistance, when the red lead is connected to it.

If a multi-meter without a diode-test mode is used, the transistor can be tested with the OHMs function. The test operations are similar to the OHMs function diode checking, described in the previous section. It is important to emphasize again, that the reading of a few hundred to a few thousand ohms for the forward-bias condition does not necessarily indicate a faulty transistor. It is rather a sign that the internal power supply of the meter is not sufficient to completely forward-bias the PN junction. The out-of-range indication for reverse-biasing of the same transistor clearly shows that the device is functioning properly. The important consideration here is the difference between the two readings and not their actual value.

The transistor is faulty if both the PN junctions exhibit approximately the same resistance in both directions. In a similar way to diodes, the PN junctions of the defective transistors exhibit either a very high resistance in both directions (an internal open-circuit), or a zero resistance in both directions (an internal short-circuit). Sometimes the faulty PN junction exhibits a small resistance, which is equal in both directions. For example, the meter readings in both directions are 1.2 V instead of the correct 0.7 V and the 2.9 V readings, respectively. In this case, the transistor is defective and has to be discarded.

Most DMMs are capable of measuring the current gains of the transistor *bDC*. The three transistor terminals are placed in special slots, marked E, B, and C, respectively. Then, a known value of IB is applied to the transistor and the respective *IC* is measured. As you know, the ratio *IC/IB* is equal to *b*DC. Though this is a convenient and quick method to check the transistor, one should be aware that some DMMs measure the value of *b*DC with a low accuracy. The specifications of the DMM have to be checked before relying on the measured value of the current gain. Some testers have the useful feature of an in-circuit *b*DC check. Here there is no need to disconnect the suspected transistor from the rest of the circuit and it can be tested directly on the PCB.

Testing FET

FETs are difficult to test than BJTs. Before testing a FET, it must be ascertained if the transistor is a JFET- or a MOSFET-type. Thereafter, it has to be clear whether it is a p-channel or an n-channel device. JFETs can be tested with an ordinary ohmmeter. Figure6.5 shows an equivalent circuit of a JFET. It appears to the ohmmeter as two diodes connected in series between the drain and the source.

The polarity of the diodes is inverted and the gate terminal is taken from the midpoint between them. In the case of an n-channel type, the gate is connected to the anodes of both the diodes. If the transistor is a p-channel type, the gate is connected to the cathodes of both the diodes. The insulation layer of SiO2 appears to the ohmmeter as a resistor connected between the drain and the source in parallel to both the diodes.

Therefore, the JFET transistors can be checked using an ohmmeter, by testing the PN junctions between the gate and the drain on one side and the gate and the source on the other. If the JFET is in good working order, both PN junctions should behave as ordinary diodes, exhibiting a high resistance in one direction and a low resistance in the other. Then the resistance between the drain and the source is measured. The meter should indicate some amount of resistance, which depends on the JFET properties.

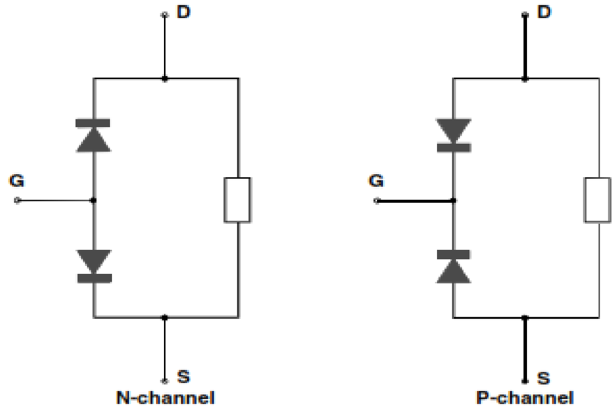


Figure3.15. A JFET, representation with two diodes and a resistor

Open Circuit.

The opposite to a short circuit is an OPEN CIRCUIT. This is generally a broken lead or contact or a wire that has "burnt-out" or been "eaten-away" by acid attack or galvanic action by water and voltage (current).

- No current will flow when an OPEN CIRCUIT exists.
- The voltage on each end of the OPEN CIRCUIT will not be the same.
- Measure the current across the OPEN CIRCUIT and determine if excess current is flowing.
- Join the two ends of the OPEN CIRCUIT and see if the circuit operates normally.

Performing Voltage test on SMPS

Checking the voltage in SMPS is one of the best way to repair SMPS problem. With just a simple voltage test on a certain components or area in the SMPS, You can easily conclude whether the component or the circuit section is faulty or not.

PRECAUTIONS/WARNING

Before you begin this test, make sure the main AC Voltage is from the main from the isolation transformer otherwise stop this test. If you accidentally touch the hot sides the power supply and ground, you will get a sever electrical shock.

- Your AC Must be from the isolation transformer.

There are four points in SMPS where you can perform the test. The points are:

1) The AC input
2) The Filter Capacitor
3) The Supply Voltage of Power IC
4) The Secondary Output Voltages

These are the four critical test points that one should test in order to know where the SMPS problem is.

1. The AC Input

The best point to test the AC supply input is at the two pins (two AC inputs) of the bridge rectifier. Testing this point will quickly let you know if the AC input is present or not. Do follow the pictures shown in the next page on how to perform the voltage test on bridge rectifier.

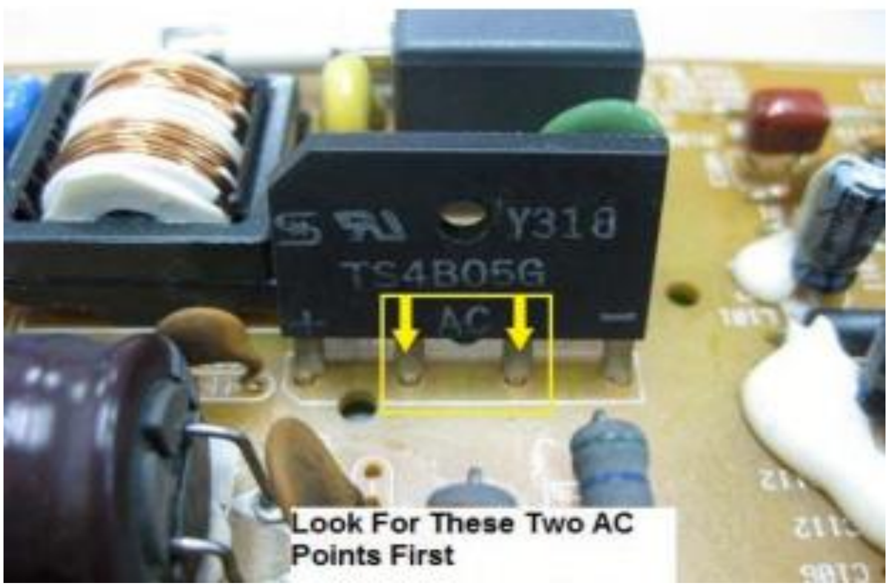


Figure3.17. Two AC Pins of a Bridge Rectifier on a Single Package.

PRCEDURES

1) Identify the two AC pins of the Bridge Rectifier.
2) Set Your Voltmeter in AC range.
3) Place the test probes to the two AC pins of the Bridge Rectifier.
4) Read the voltage measurement properly.

5) Interpret the readings.

PRECAUTIONS

- ✓ Hold the test probes tightly otherwise, if it touches other parts it can blow the main fuse and may create a loud bang that can harm you.

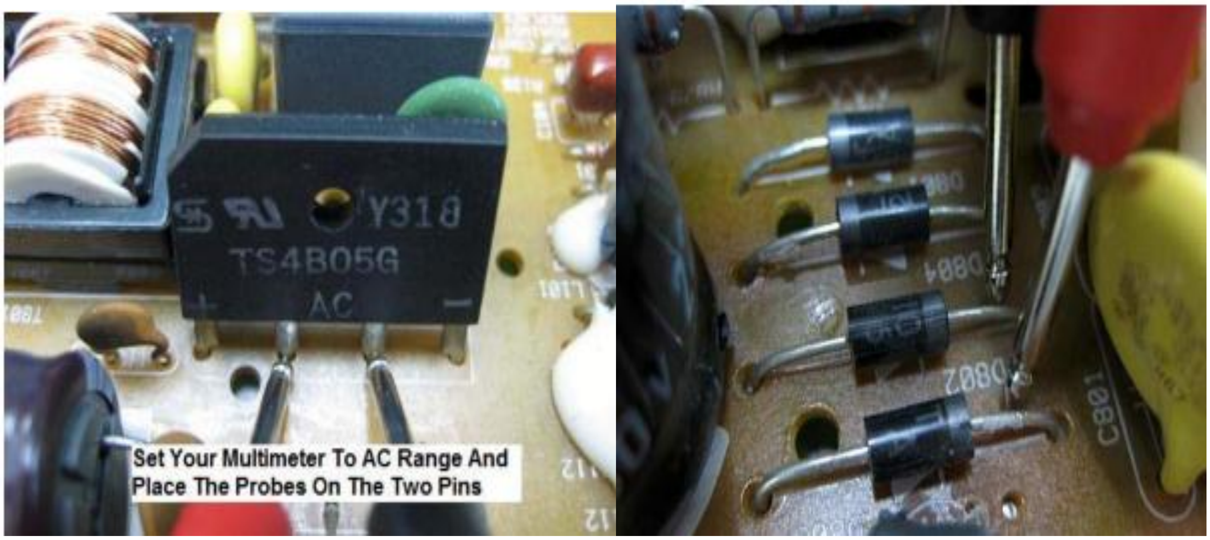


Figure3.18. Placing the test probes to Two AC Pins (a) Single Package and (b) individual Diode.

TEST RESULT

If you get a reading of about 230 Volts AC (in USA is 110 Volts) then this proved the AC voltage is good from the AC outlet. If you get zero voltage (or very less voltage) then you have to **check the circuit before the bridge rectifier.** Suspect these problems if there is no AC input to the bridge rectifier:

a) The Main AC outlet Switch is not "On."
b) The On/Off switch of the SMPS is not "On" or have problem.
c) The AC power cable has broken internally.
d) Main fuse open circuit or loosen.
e) Circuit track opens or have dry joints.
f) The EMI coil may have open circuit.

2. The Filter Capacitor

Once you have confirmed that the bridge rectifier has AC supply input, you should now expect about 300 Volts DC present (for USA about 150 Volts DC) at the positive pin of the filter capacitor. In order to test the voltage at the filter capacitor, **the black probe has to be at the negative pin side and the red probe to positive side** as shown in figure.

Figure3.19. Testing voltage at the filter capacitor

If you get zero volts when measuring the filter capacitor then troubleshoot the area to locate if there is any problem with the circuit like dry joints, broken track and etc. If the DC voltage measured is lower then it should be, a high chance that the filter capacitor may have problem and you have to test it off board with a Blue ESR meter or a digital capacitance meter to check on the capacitance value.

PRCEDURES

1) Discharge the big Filter Capacitor.
2) Set Your Voltmeter in DC range.
3) Identify the positive and negative pins of the Filter Capacitor.
4) Place the RED test probe to the positive pin of the Filter Capacitor see Figure3.20
5) Place the BLACK test probe to the negative pin of the Filter Capacitor.
6) Read the voltage measurement properly.
7) Interpret the readings.

PRECAUTIONS

- ✓ Hold the test probes tightly otherwise, if it touches other parts it can blow the main fuse and may create a loud bang that can harm you.
- ✓ Discharge the big Filter Capacitor before you test or remove it otherwise, you will blow the meter.

3. The Supply Voltage(Vcc) of Power IC

Figure3.20. Placing the RED test probe to the positive pin of the Filter Capacitor.

Figure3.21. Placing the BLACK test probe to the negative pin of the Filter Capacitor.

PRCEDURES

1) Find the part number of the Power IC from the schematics diagram or data book.
2) Locate the Vcc pin of the Power IC.

3) Set Your Voltmeter in DC range.
4) Place the RED test probe to the Vcc pin of the Power IC
5) Place the BLACK test probe to HOT Ground (the negative pin of the Primary Filter Capacitor).
6) Switch on the power carefully.
7) Read the voltage measurement properly.
8) Interpret the readings.

PRECAUTIONS

- ✓ Hold the test probes tightly otherwise, if it touches other parts it can blow the main fuse and may create a loud bang that can harm you.
- ✓ Discharge the big Filter Capacitor before you test or remove it otherwise, you will blow the meter.

Possible test Results

- ✓ If the voltage measured is according to the specification of the power IC, this means the bridge rectifier, filter Capacitor, and the startup resistor are working properly and proceed to the next test.
- ✓ If you get zero volts and the filter capacitor has the full voltage, then suspect either the startup resistor has open circuit or the power IC shorted that pulled down the Supply Voltage.
- ✓ If you get half of the required voltage and the filter capacitor has the full voltage, then suspect either the startup resistor has gone high in ohm value, Leaky power IC and bad corresponding components at the power IC such as Capacitor, Diode, transistor and Zener diode.

Note: If the power IC has pins that are too close with each other (like SMD power IC legs) then I suggest that you place your red probe along the supply voltage soldering pad and not on the supply voltage

4. The Secondary Output Voltage

Among all the tests, it is considered the safest test because the location is in the secondary side. Therefore, there is no chance for accident to touch the HOT side. However, be careful even you knew that the secondary side is not as dangerous as primary side.

Before you start checking on the output voltage you should know the expected output voltage. That means if you expect 12V and you get 3V then the SMPS have problem.

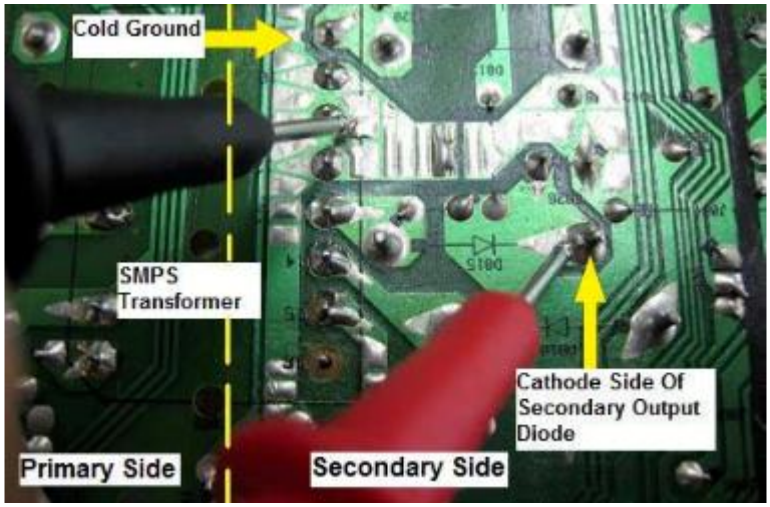


Figure3.22. The right way to measure DC voltage at the secondary side of SMPS.

Figure3.23. Placing the RED test probe to the Secondary Output Diode Cathode Side.

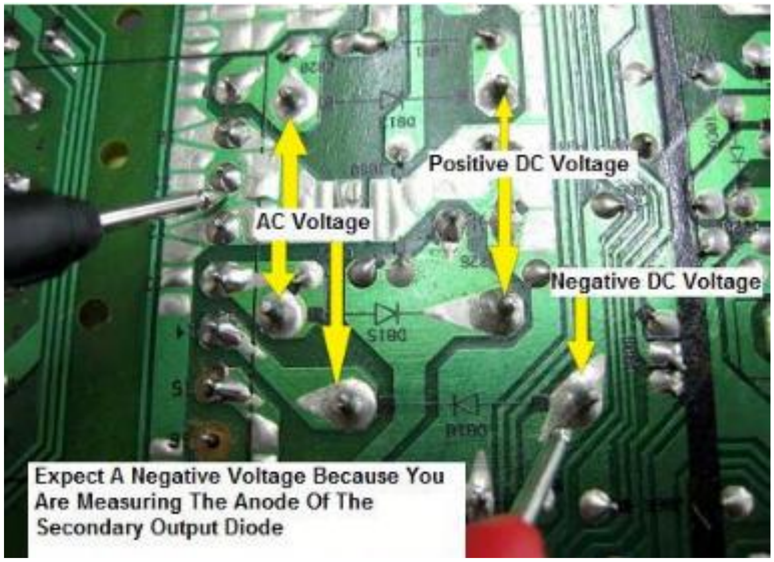


Figure3.24. The right way to measure the negative voltage at the secondary side of SMPS.

Nowadays, many SMPS uses dual Schottky diodes then you can measure it as shown below.

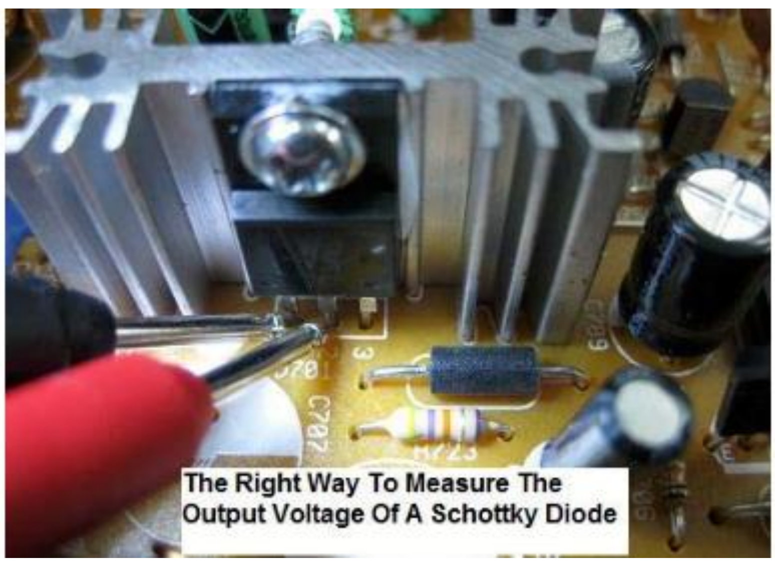


Figure3.25. The right way to measure the negative voltage at the Schottky diodes.

PRCEDURES

1) Set Your Voltmeter in DC range.
2) Identify the Secondary Output Diode Cathode Side.
3) Place the RED test probe to the Secondary Output Diode Cathode Side.

4) Place the BLACK test probe to Cold (Chassis)Ground
5) Switch on the power carefully.
6) Read the voltage measurement properly.
7) Compare the readings and the expected output voltage.

PRECAUTIONS

- ✓ Hold the test probes tightly otherwise, if it touches other parts it can blow the main fuse and may create a loud bang that can harm you.
- ✓ Discharge the big Filter Capacitor before you test or remove it otherwise, you will blow the meter.

Self-check 3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I. **Choose the best answer.**

1. What will happen the output the of bridge rectifier, if one of the diode in open.
   A. It will give a half wave output.
   B. No/zero output voltage
   C. It will give a half wave output.
   D. High output voltage.
   E. None
2. What will happen the output the of bridge rectifier, if one of the diode in Shorted.
   A. It will give a half wave output.
   B. Zero output voltage
   C. It will give a half wave output.
   D. High output voltage.
   E. None
3. The first step in measuring voltage at the filter capacitor
   A. Identify the positive and negative pins of the Filter Capacitor.
   B. Discharge the big Filter Capacitor.
   C. Set Your Voltmeter in DC range.
   D. Place the BLACK test probe to the negative pin of the Filter Capacitor.
   E. Read the voltage measurement properly.
4. The best point to test the AC input is___________
   A. At the teminals of the power cable
   B. At the two pins of the capacitor
   C. At the two pins of the zener diode
   D. At the two pins of the bridge rectifier

E. None

5. _______________Courses to a Blow fuse in Switch Mode Power Supply.

A. One of the diodes is shorted.

B. A partially shorted primary of the transformer

C. A partially shorted secondary winding of the transformer

D. High Current flow in the fuse

E. ALL of the above

Note:

Satisfactory rating - 3 and above 5 Points	**Unsatisfactory - below 3 Points**

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** ________________

Operation Sheet 1	**Measuring the AC Input of a Switch Mode Power Supply.**

Measuring the AC Input of a Switch Mode Power Supply.

PRCEDURES

1. Identify the two AC pins of the Bridge Rectifier.
2. Set Your Voltmeter in AC range.
3. Place the test probes to the two AC pins of the Bridge Rectifier.
4. Read the voltage measurement properly.
5. Interpret the readings.

PRECAUTIONS

- ✓ Hold the test probes tightly otherwise, if it touches other parts it can blow the main fuse and may create a loud bang that can harm you.
- ✓ Discharge the big Filter Capacitor before you test or remove it otherwise, you will blow the meter.

Operation Sheet 2	**Measuring theSecondary Output Voltage a Switch Mode Power Supply.**

Measuring theSecondary Output Voltage a Switch Mode Power Supply.

1) Set Your Voltmeter in DC range.
2) Identify the Secondary Output Diode Cathode Side.
3) Place the RED test probe to the Secondary Output Diode Cathode Side.
4) Place the BLACK test probe to Cold (Chassis)Ground
5) Switch on the power carefully.
6) Read the voltage measurement properly.
7) Compare the readings and the expected output voltage.

PRECAUTIONS

- ✓ Hold the test probes tightly otherwise, if it touches other parts it can blow the main fuse and may create a loud bang that can harm you.
- ✓ Discharge the big Filter Capacitor before you test or remove it otherwise, you will blow the meter.

Information Sheet-4	Explaining identified defects and faults

Explaining common Faults found on SMPS Using Pictures

1. **No Power Fault.**

Case No 1

- **Couse**

✓ Shorted Non-Polar Capacitor

Figure4.1 Shorted Non Polar Capacitor at CRT Board.

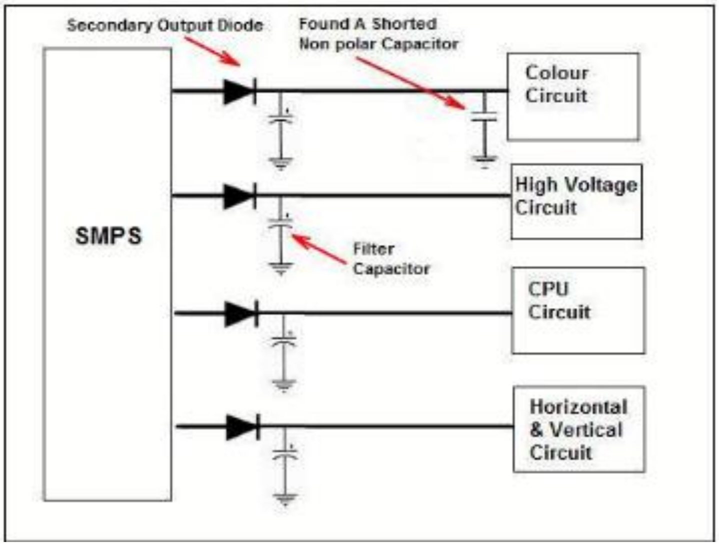


Figure4.2. The Location of a Shorted Non Polar Capacitor

Case 2 No Power

- **COUSE**

✓ Startup resistor is opened.

✓ Shorted Power IC

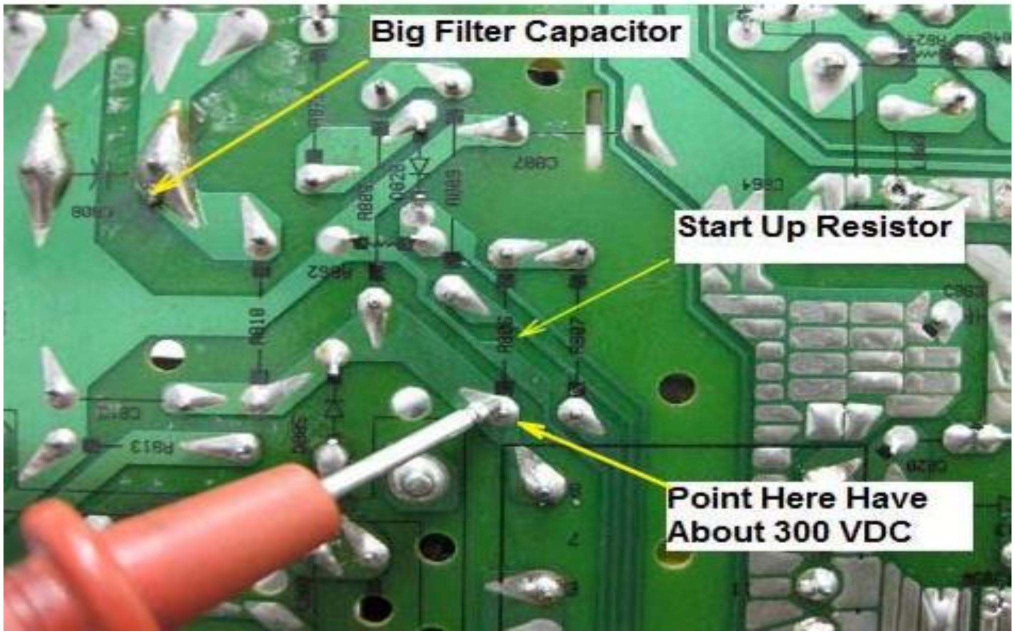


Figure4.3. Voltage tracing at point of star up resistor

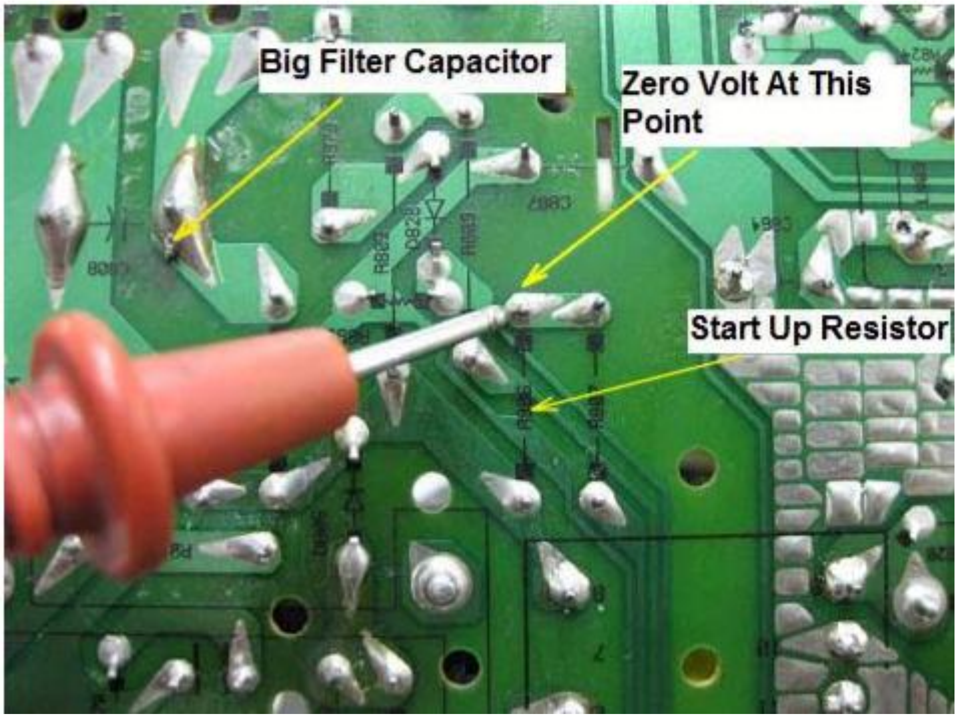


Figure4.4. Zero Volt After the Star Up Resistor

Case 3 No Power

- **COUSE**

- ✓ Shorted Zener diode
- ✓ Shorted Power IC
- ✓ Optoisolator IC Breakdown

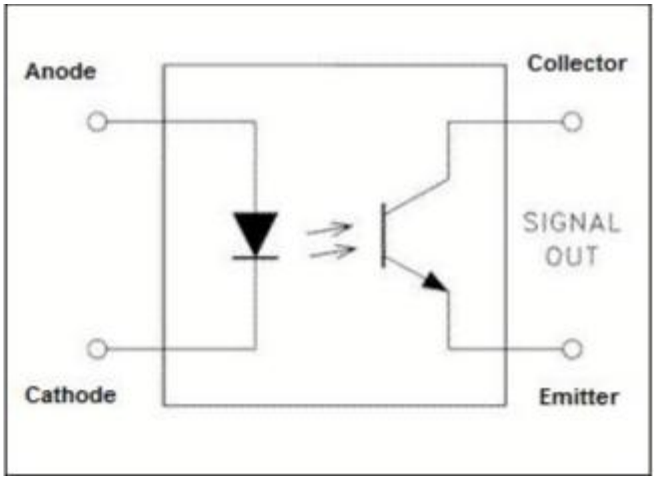


Figure4.5. Optoisolator IC

Case 4 Low Output Voltage

- **COUSE**
- ✓ Shorted or bad Component in the down stream
- ✓ Leaky transistor at the secondary side.
- ✓ Partial shorted primary winding
- ✓ Bad Electrolytic capacitor
- ✓ Shorted emitter collector pin of Optoisolator IC

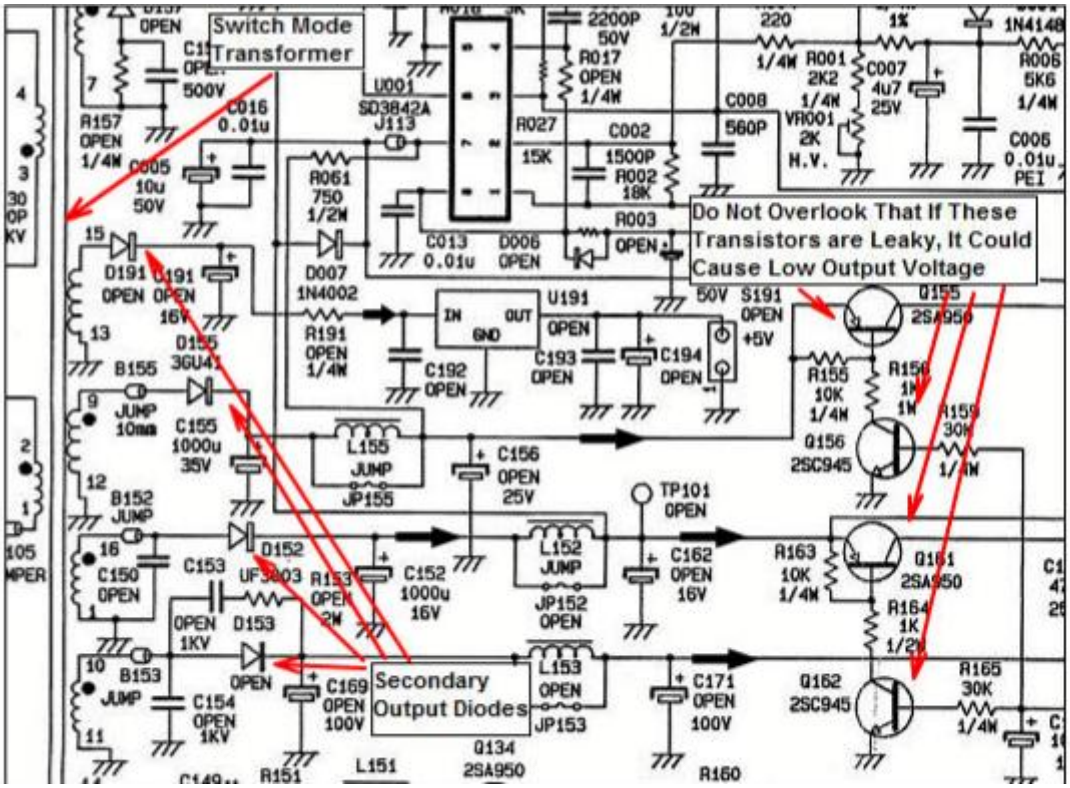


Figure4.6. Bad Component in the downstream

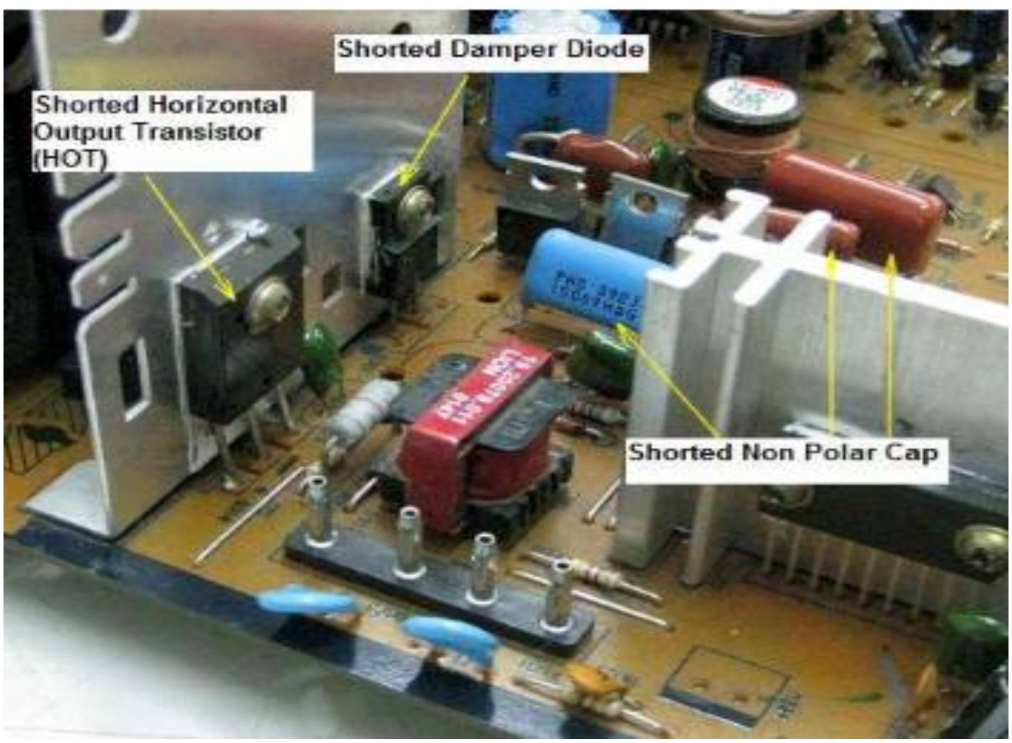


Figure4.7Shorted Component in the downstream

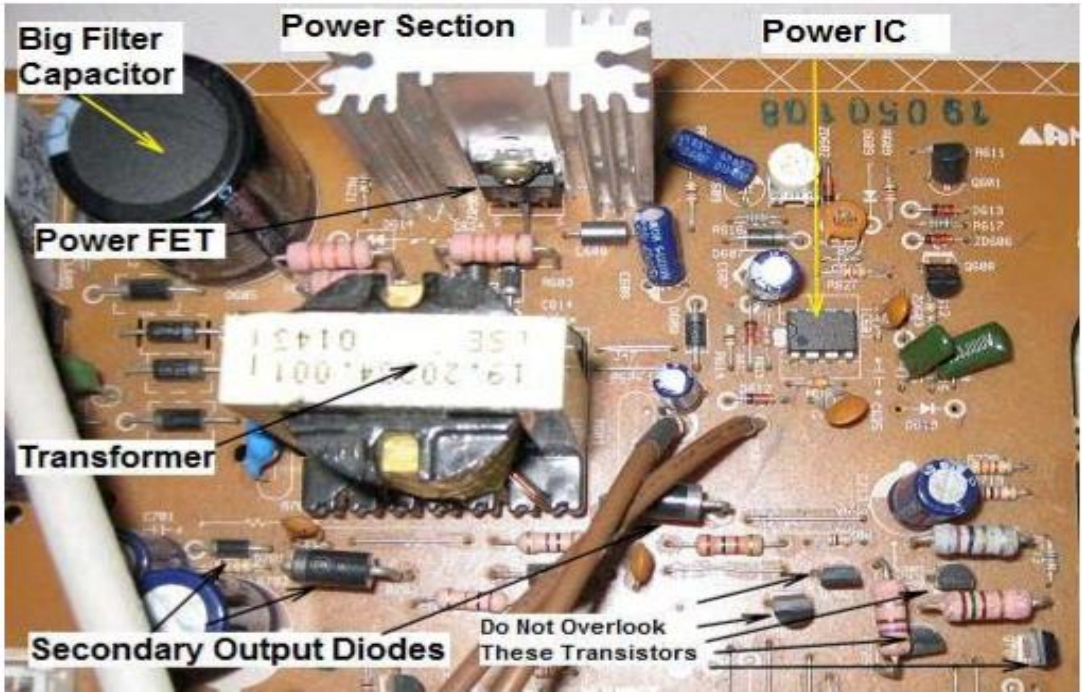


Figure4.8Leaky transistor at the secondary side

Case No.5 No Power

- **COUSE**

✓ Tiny break in one of the secondary line.

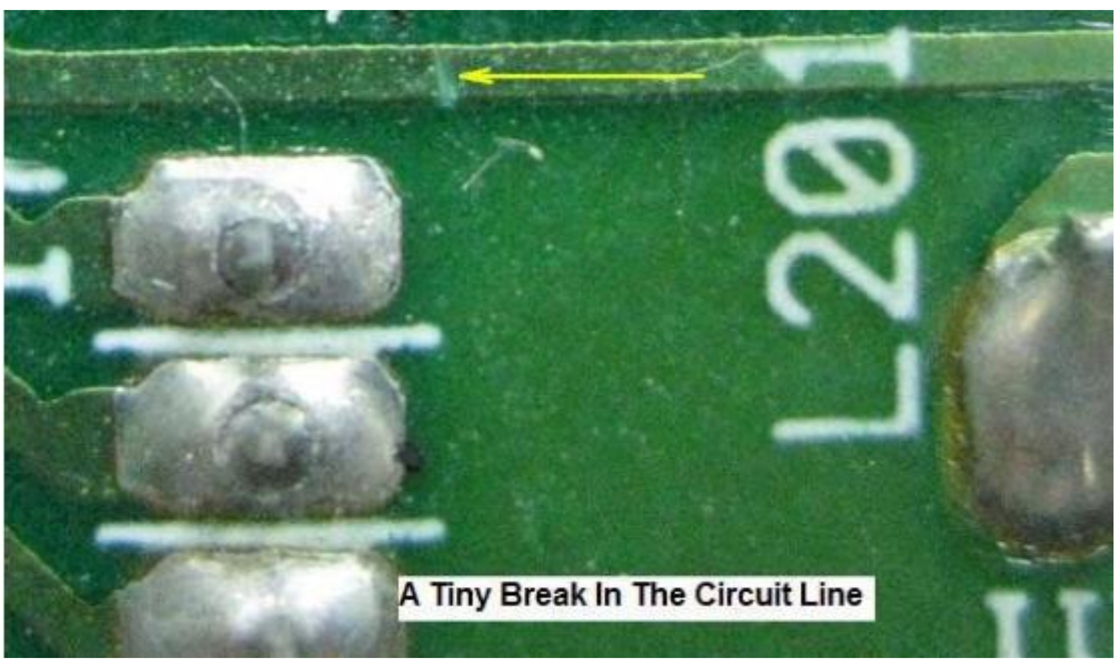


Figure4.9 Tiny break in one of the secondary line or Circuit.

Case No.6 No Power

- **COUSE**

Here are some other causes that can blow the main fuse:

Shorted bridge rectifier-If one of the diodes in this bridge circuit shorted, the main fuse will surely blow.

Shorted Posistor- If you are repairing a CRT Monitor or Television, you will definitely see a square black box around the main supply section. If this posistor had shorted, it will take a way the fuse too. Posistor can't be test with multimeter, the best is to replace it with a working unit and retest the set.

Big filter capacitor breakdown when under full load- This capacitor can be tested good when check with an ESR or a Digital Capacitance Meter but will fail when under full operating voltage. Sometimes it can go shorted and can be detected by an ohmmeter.

Shorted Power FET- A shorted power Mosfet (FET) will immediately blow the main fuse.

Shorted power IC- A shorted power IC will also blow the main fuse.

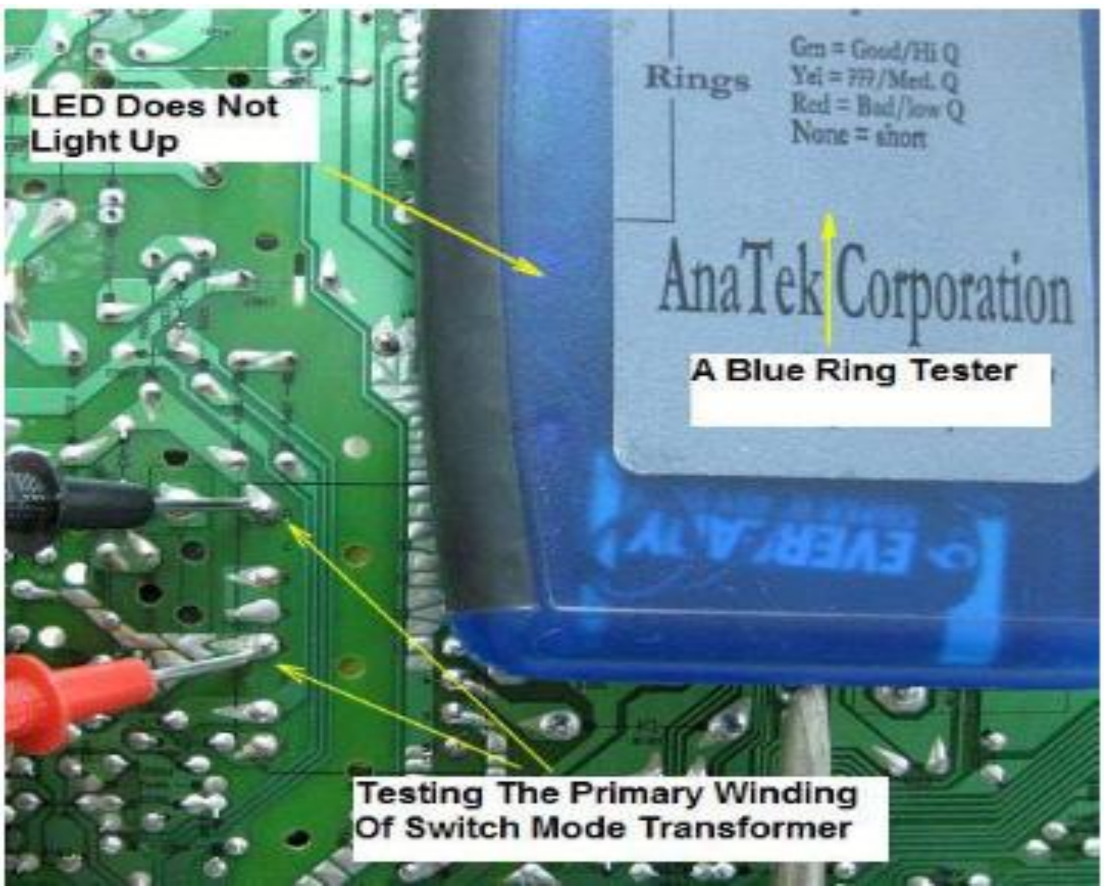


Figure4.10 Testing primary winding of SMPS

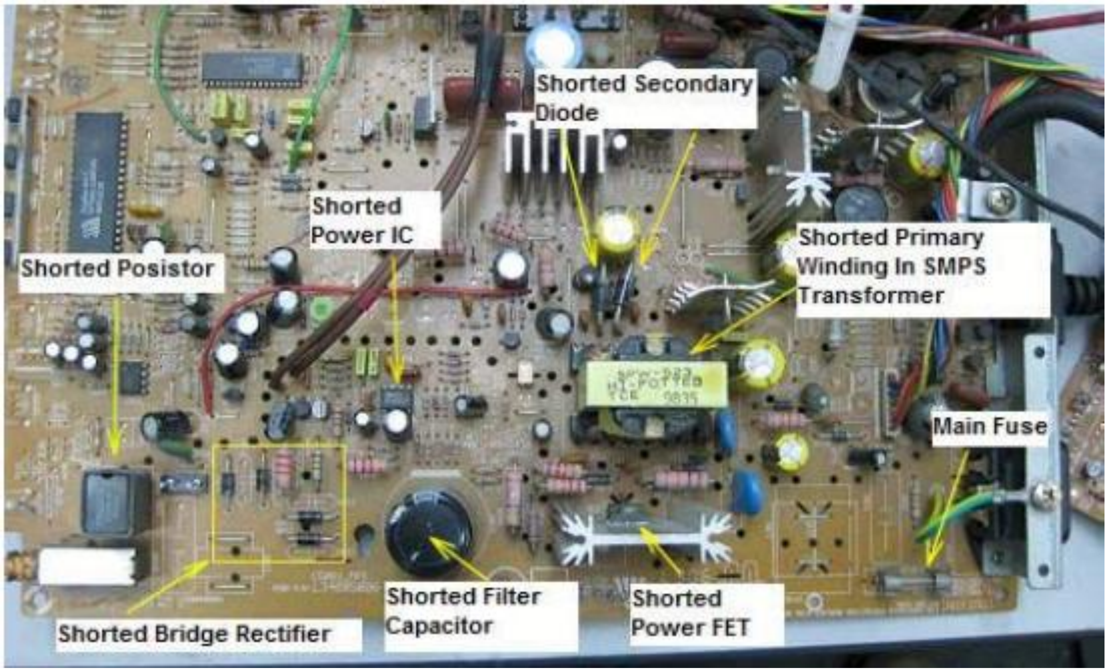


Figure4.11 Possible shorted components that can blow the main fuse

Self Check 4	Written Test

Give Short answer

1. Explain the common Faults occurs on SMPS. (5pts)

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** ________________

Information Sheet-5	Documenting results of diagnosis and testing.

Introduction

Documentation: is a record or the capturing of some event or thing so that the information will not be lost.

Maintenance documentation

Preventive maintenance is documented, Maintenance performed at other times, with the exception of routine cleaning, is documented.

The documentation includes:

- description of the maintenance;
- date it was done; and
- name of the service representative and company, or name of
- the analyst if maintenance provided internally.

Documenting Repair equipment

The documentation includes:

- initials of the analyst, and the date the problem was observed,
- description of the problem;
- date and initials of the analyst or service represent at performing the repair;
- synopsis of the repair; and
- cost of repair, copy of the invoice and any additional information (not required).

Document report

1. The establishment of the report and recording of the condition and repair of the transformers is required for a good maintenance program.
2. A preventive maintenance system will operate satisfactorily with the following records.

- An equipment record

- ✓ This may be simply a card, which contains the basic information of a transformer itself such as the serial number, the location, size, etc.

- A repair record card

- ✓ This may keep a running record as to costs of maintaining a transformer. It is the essential diagnostic record for avoiding future difficulties.

3. Without these records it would be very difficult for a preventive maintenance program to work,

Self Check 5	Written Test

I. Give Short and Clear answer

1. Define Documentation:*2pts*
2. Maintenance document includes: *5pts*

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

E. ______________________________

Note:

Satisfactory rating - 4 and above 7 Points	Unsatisfactory - below 4 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** ________________

Information Sheet-10	Advising / informing customers

Customer advise

Assuming that your customer has SMPS with kinds of problems, what would you do? What is your decision? what is your next step? and repair or return to the customer? This information sheet helps you to solve such kind of problems or faults in professional way, especially when dealing with the Customer either now or in the future.

First inform them about the problem in the SMPS and tell them that the chance of it being fully repaired are quite slim due to the problems or faults mentioned above. Inform your customer you will impose a price or a fee for the time spent on solving the complicated problems or faults.

From the conversation b/n you and the customer, he/she may say Yes or No answer. Some may say I will think first about it. If the customer says No, then you return the SMPS to the customer and impose a small diagnostic labor charge (it depends on whether you want to charge the customer or not.) That means you can straight away return the SMPS back to the customer. If you have decided not to charge the customer.

If the customer says yes or agreed with the repair price, then there are two things that you need to inform the customer:

- **Time:**

✓ Let the customer know in advance that you need a longer time to repair the SMPS otherwise they would be calling you every day (pressuring you).

- **Successful repair rate:**

✓ Inform the customer successful repair rate is not 100% as you are trying your best to make the equipment work again. Otherwise, if you can't repair the equipment then you will be in the hot soup.

✓ You have to inform them that you are trying your best to save the equipment and if it can't be repaired after many attempts then you will return the equipment to them.

Instruction Sheet-3	LG37: Maintain/Repair the Power Supply Unit

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: –

- Using personal protective equipment’s
- Replacing defective parts/components with identical or equivalent ratings.
- Soldering/mounting repaired or replaced parts/components
- Performing control settings/adjustments.
- Performing repair activity within the required timeframe.
- Performing cleaning of unit is in accordance with standard procedures

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Use personal protective equipment’s
- Replace defective parts/components with identical or equivalent ratings.
- Solder/mount repaired or replaced parts/components
- Perform control settings/adjustments.
- Perform repair activity within the required timeframe.
- Perform cleaning of unit is in accordance with standard procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks”. in each information sheets.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next Learning Guide.

Information Sheet-1	Using personal protective equipment’s

Introduction

Maintenance: - is actions performed to keep some machine or system functioning or in service while, repair is the act of repairing something or repair can be the act of repairing or resorting to a place.

Maintenance: - typically refers to basic conservation to prevent the deterioration of the facilities, such as annual servicing, repainting, or washing.

Repairs: - Generally keep the property in its ordinary, efficient, operating condition or restore the property to its original operating condition. "Improvements" can include new permanent structures, such as fencing, that materially enhance the value of the property or substantially prolong its useful life. A capital improvement materially enhances or prolongs the life of the property

1.1. Maintenance methods

As any other equipment's and machineries, Electrical Equipment can be maintained by applying one or all of the common types of maintenance type. The commonly used type maintenances are: preventive, predictive, and corrective.

1. **Preventive maintenance: -**is the Schedule of planned maintenance actions aimed at the prevention of breakdowns and failures.
   - ✓ The Primary goal is to Preserve and enhance equipment reliability.
   - ✓ It is activity of cleaning dust and dirt, tightening loosen bolts, screw and belts, change grease, oil and filter.

Benefit of preventive maintenance

- ✓ Increases life of equipment
- ✓ Reduces failures and breakdowns
- ✓ Reduces costly down time
- ✓ Decreases cost of replacement
- ✓ Runs more efficiently

2. **Predictive maintenance:** It is techniques that help determine the condition of in-service equipment in order to predict when maintenance should be performed

- ✓ The Primary goal is to minimize disruption of normal system operations, while allowing for budgeted, scheduled repairs.
- ✓ Examples of such types of maintenance are:

- ✓ Inspection of the equipment: operation, quality and quantity of inputs and outputs loosen, wear out, damage parts/component
- ✓ Vibration analysis
- ✓ Taking fast remedial action for any observed, sensed, heard, abnormal symptoms

1.2. Benefits of Predictive maintenance

- ✓ Provides increased operational life
- ✓ Results in decrease of downtime
- ✓ Allows for scheduled downtime
- ✓ Allows for money to be budgeted for repairs
- ✓ Lowers need for extensive parts inventory
- ✓ Save cost

3. **Corrective Maintenance** is repair of equipment/machinery in order to bring it back to original operating condition. It an activity of correcting or replacing wear out, broken, damaged parts.

1.3. Using personal protective equipment's

For the safety of electronics personnel, wearing the correct protective gear is always advisable. Some of the PPEs are used in maintaining a dc power supply are discussed below: -

- **Electrical Safety Shoes**

For safety, one should always wear and take care of electrical safety shoes whenever one works in the vicinity of energized equipment's. Unlike regular safety shoes, electrical safety shoes do not have any exposed metal parts. These are specially designed using non-conducting materials to provide insulation from electric shock.

Figure1.1 Electrical Safety Shoes

- **Rubber Gloves**

Based on the wall thickness and maximum safe voltage rating, the rubber insulating gloves are classified in various categories. Some of the generally used gloves are shown below in Fig.4.

Figure1.2. Rubber Gloves

- **Safety Shorting Probe**

Some electronic equipment uses large capacitors to filter the electrical power. These capacitors must be discharged before working on the equipment. A safety authority probe will be required for this. The procedures to be minimally followed are:

- ✓ Ensure that input power has been unplugged.
- ✓ Open the equipment to discharge the capacitors.
    - ▪ Don’t touch any naked terminals without safety gloves on.

Figure1.3 Safety Shorting Probe

- **Safety goggles**

An electronics technician must protect his eyes for this, he needs to know:

- ✓ When to wear eye protection.

- ✓ Which eye protection to wear.
- ✓ Whenever you are doing something that could potentially damage your eyes, you must have eye protection on.

Figure1.4. Safety goggles

- **Face/dust mask**

Whenever you work with materials that can possibly lead to respiratory issues, one must take precautions and wearing safety masks is advisable. Some of the masks used in industry are shown in Figure1.5.

Figure1.5Face/dust mask

The work area should be well-aerated and good ventilation. Make certain to protect your airways and pulmonary anatomy vital to have good air entry to lungs. If the victim is unconscious due to blockage or obstruction to lungs, check to see if breathing and have a pulse. If the person is unconscious, initiate and follow step rules as below;

- ✓ If the victim is not breathing, begin rescue breathing.
- ✓ If it is needed, begin cardiopulmonary resuscitation.
- ✓ Do not attempt to move the victim as other injuries may have occurred that one is unaware off.

- **Working clothes/apron**

Figure1.6. Working clothes/Apron

Self-Check 1	Written Test

I. Give Brief Answer for the Following questions

1. Define Maintenance
2. List the benefits of Maintenance

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: _________________________ **Date:** _______________

Information Sheet-2	**Replacing defective parts/components with identical or equivalent ratings.**

Introduction

Troubleshooting and repairing SMPS can be easy but you will get frustrated if you could not locate the spare parts. Sometimes the repair job can be done in few minutes. However, when finding the original parts, you may end up spending more time to locate the parts than when you do the repair work on SMPS. In order to make things easier, You may visit the blog at http://www.JestineYong.com under the category of Electronic suppliers to get the components you want.

If possible, get back the same part number to avoid repeating failure in SMPS that you have repaired and also to maintain the specifications within acceptable limits with respect to line isolation and to minimize fire hazards. However, if you still could not get the exact replacement part for substitution please refer to any semiconductor data books to search for replacement.

In data books there would be suggestions as to which part numbers are suitable for replacement. This kind of data book is a must for anyone who works in electronic repair line. Apart from that, you could also find your own replacement by comparing the specification between the original and the replacement transistor. Always look for the replacement that has the same or higher specification in terms of voltage and Ampere and Wattage.

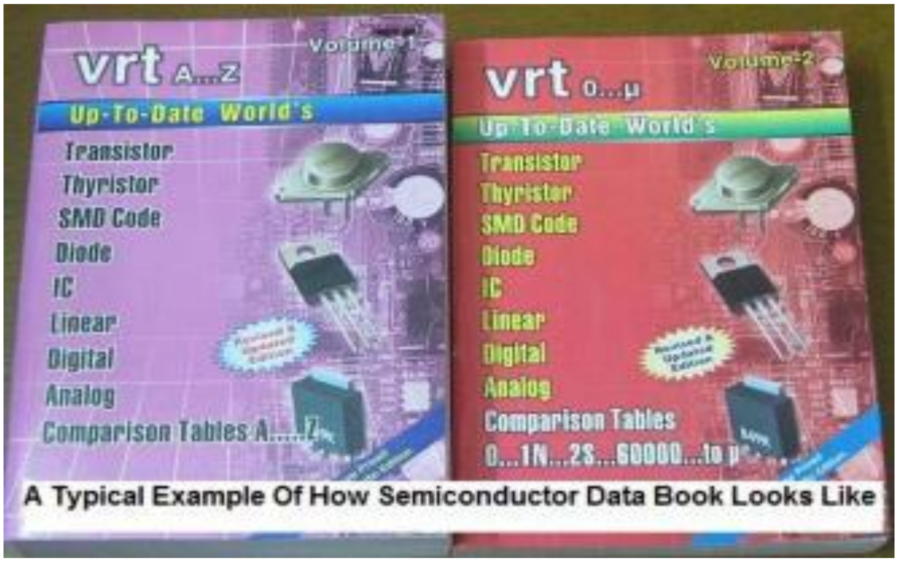


Figure2.1 Semiconductor Replacement data book

Note: Always use original part numbers for replacement purposes!

Replacing defective parts/components

Once the fault location and the type of faulty component is identified in the fault diagnosis section, obviously the next task is to correct (trouble shoot) it. It is act of connecting the disconnecting circuit or replacing the faulted component with the same type, rate and size components. The selection of components according to their correct specification and soldering skill are determining factor for the replacement is effective.

To replace the defective component:

- ✓ Prepare soldering tools and equipment's, new component to be replaced
- ✓ Remove the defective one by applying correct disordering technique.
- ✓ Put in place the new component in the correct direction (keep correct polarity)
- ✓ Solder it by applying good soldering technique

Safety

- ✓ Take care of not to touch high voltage side
- ✓ Wear apron, Glove, safety shoe
- ✓ Follow all cautions, warnings, and instructions marked on the equipment.
- ✓ Ensure that the voltage and frequency rating of the power outlet matches the electrical rating labels on the system.

- ✓ Use properly grounded power outlets.
- ✓ Disconnect the power before you replace/repair the faulty device
- ✓ Discharge capacitor first before replacing it.

Replacing a capacitor

Always replace a capacitor with the exact same type. A capacitor may be slightly important in a circuit or it might be extremely critical. A manufacturer may have taken years to select the right type of capacitor due to previous failures.

A capacitor just doesn't have a "value of capacitance." It may also have an effect called "tightening of the rails." In other words, a capacitor has the ability to react quickly and either absorb or deliver energy to prevent spikes or fluctuations on the rail.

This is due to the way it is constructed. Some capacitors are simply plates of metal film while others are wound in a coil. Some capacitors are large while others are small. They all react differently when the voltage fluctuates. Not only this, but some capacitors are very stable and all these features go into the decision for the type of capacitor to use.

You can completely destroy the operation of a circuit by selecting the wrong type of capacitor. No capacitor is perfect and when it gets charged or discharged, it appears to have a small value of resistance in series with the value of capacitance. This is known as "ESR" and stands for Equivalent series resistance. This effectively makes the capacitor slightly slower to charge and discharge.

We cannot go into the theory on selecting a capacitor as it would be larger than this book so the only solution is to replace a capacitor with an identical type. However, if you get more than one repair with identical faults, you should ask other technicians if the original capacitor comes from a faulty batch. Some capacitor are suitable for high frequencies, others for low frequencies.

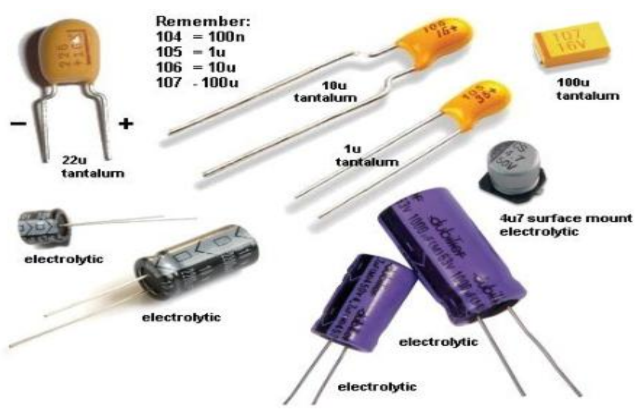


Figure12.1. Different types Capacitors

Remember:

- ✓ Please do not use any replacement that has smaller capacitance value and lower Voltage than the original one. Otherwise the equipment may not work and in worst cases, it could blow up the Capacitor.

Replacing Transistor

If you can't get an exact replacement, refer to a transistor substitution guide to identify a near equivalent.

The important parameters are:

- Voltage
- Current
- Wattage
- Maximum frequency of operation

The replacement part should have parameters equal to or higher than the original. Points to remember:

- Polarity of the transistor i.e. PNP or NPN.
- At least the same voltage, current and wattage rating.
- Low or high frequency type.
- Check the pinout of the replacement part
- Use a de-soldering pump to remove the transistor to prevent damage to the printed circuit board.
- Fit the heat sink.
- Check the mica washer and use heat-sink compound
- Tighten the nut/bolt - not too tight or too loose.
- Horizontal output transistors with an integrated diode should be replaced with the same type.

Replacing a Diode

It is always best to replace a diode with the same type but quite often this is not possible. Many diodes have unusual markings or colours or "in-house" letters.

This is only a general guide because many diodes have special features, especially when used in high frequency circuits. However, if you are desperate to get a piece of equipment working, here are the steps:

- Determine if the diode is a signal diode, power diode, or zener diode.
- For a signal diode, try 1N4148.
- For a power diode (1 amp) try 1N4004. (for up to 400v)
- For a power diode (3 amp) try 1N5404. (for up to 400v)
- For a high-speed diode, try UF4004 (for up to 400v)
- If you put an ordinary diode in a high-speed application, it will get very hot very quickly.
- To replace an unknown zener diode, start with a low voltage such as 6v2 and see if the circuit works.
- The size of a diode and the thickness of the leads will give an idea of the current capability of the diode.
- Keep the leads short as the PC board acts as a heat-sink.
- You can also add fins to the leads to keep the diode cool.

Replacing IGBT/SCR:

As for these component use the explanation of The bipolar transistors to find the equivalent part number or replacement.

Replacing Power IC

It is always recommended to Replace Power IC with the original part number, in fact if you carefully study the internal specification of the Power IC, you could get a replacement.

Although there are some successes in finding a replacement and you can face a problem with replacement Power IC.

Switch Mode Power transformer(SMPT)

There is no Equivalent SMPT in the market because every SMPT are created unique in terms of winding. Some SMPT have tow out puts while some have many outputs and the volt/ampere produced are also different. The only way you can get is through the equipment distributors.

Secondary Output Diodes

- ✓ Output diodes are a common failure in the switch mode power supply.

Secondary Output Filter Capacitors

- ✓ Output Filter Capacitors are a common failure in the switch mode power supply.

Secondary Output Coils

- ✓ If the Secondary Coils are small, you can replace it with a jumper wire. However, if the Secondary Coils are big coil(B+) in the CRT Monitor circuit, you have to get back the same inductance value. You can rewind your own coil by removing out the burnt wire. Measure the length and Diameter of the original wire then wind it back using new wire to its ferrite core.

Optoisolator IC

- ✓ By referring the data sheet download from the internet; you can find the equivalent part number. The famous 4N35 part number can easily substituted by many other Optoisolator IC part number. This 4N35 IC is quite common and can be easily found from any electronic shops.

Self-Check 2	Written Test

Short Answer

1. What are the important paramters of a transistor?
2. List Safety rules in component replacement.

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ___________________________ **Date:** _______________

Information Sheet-3	Soldering/mounting repaired or replaced parts/components.

Safety Precautions:

- Never touch the element or tip of the soldering iron.
  - ✓ They are very hot (about 400°C) and will give you a nasty burn.
- Take great care to avoid touching the mains flex with the tip of the iron.
  - ✓ The iron should have a heatproof flex for extra protection. An ordinary plastic flex will melt immediately if touched by a hot iron and there is a serious risk of burns and electric shock.
- Always return the soldering iron to its stand when not in use.
  - ✓ Never put it down on your workbench, even for a moment!
- Work in a well-ventilated area.
  - ✓ The smoke formed as you melt solder is mostly from the flux and quite irritating. Avoid breathing it by keeping you head to the side of, not above, your work.
- Wash your hands after using solder.
  - ✓ Solder contains lead which is a poisonous metal.

Preparing the soldering iron:

- Place the soldering iron in its stand and plug in.

- ✓ The iron will take a few minutes to reach its operating temperature of about 400°C.

- Dampen the sponge in the stand.
  - ✓ The best way to do this is to lift it out the stand and hold it under a cold tap for a moment, then squeeze to remove excess water. It should be damp, not dripping wet.
- Wait a few minutes for the soldering iron to warm up.
  - ✓ You can check if it is ready by trying to melt a little solder on the tip.
- Wipe the tip of the iron on the damp sponge.
  - ✓ This will clean the tip.
- Melt a little solder on the tip of the iron.
  - ✓ This is called 'tinning' and it will help the heat to flow from the iron's tip to the joint. It only needs to be done when you plug in the iron, and occasionally while soldering if you need to wipe the tip clean on the sponge.

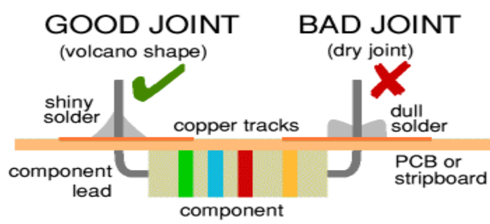


Figure3.1

You are now ready to start soldering:

- Hold the soldering iron like a pen, near the base of the handle.
  - ✓ Imagine you are going to write your name! Remember to never touch the hot element or tip.
- Touch the soldering iron onto the joint to be made.
  - ✓ Make sure it touches both the component lead and the track. Hold the tip there for a few seconds and...
- Feed a little solder onto the joint.
  - ✓ It should flow smoothly onto the lead and track to form a volcano shape as shown in the diagram. Apply the solder to the joint, not the iron.

- Remove the solder, then the iron, while keeping the joint still.
    - ✓ Allow the joint a few seconds to cool before you move the circuit board.
- Inspect the joint closely.
    - ✓ It should look shiny and have a 'volcano' shape. If not, you will need to reheat it and feed in a little more solder. This time ensure that both the lead and track are heated fully before applying solder.

Using a heat sink

Some components, such as transistors, can be damaged by heat when soldering so if you are not an expert it is wise to use a heat sink clipped to the lead between the joint and the component body. You can buy a special tool, but a standard crocodile clip works just as well and is cheaper.

Figure3.2. A standard crocodile clip

Soldering Advice for Components

It is very tempting to start soldering components onto the circuit board straight away, but please take time to identify all the parts first. You are much less likely to make a mistake if you do this!

1. Stick all the components onto a sheet of paper using sticky tape.
2. Identify each component and write its name or value beside it.
3. Add the code (R1, R2, C1 etc.) if necessary.
4. Resistor values can be found using the resistor colour code which is explained on our Resistors page. You can print out and make your own Resistor Colour Code Calculator to help you.
5. Capacitor values can be difficult to find because there are many types with different labelling systems! The various systems are explained on our Capacitors page.

Some components require special care when soldering. Many must be placed the correct way round and a few are easily damaged by the heat from soldering. Appropriate warnings are given in the table below, together with other advice which may be useful when soldering.

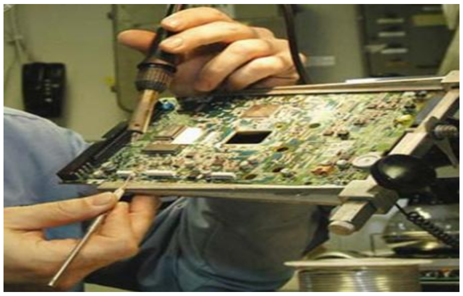


Figure3.3. Soldering a component

Self-Check 3	Written Test

I. Shor Answer

1. Explain the purpose of a soldering sink.2pts
2. List safety rules for soldering.3pts

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** ________________

Operation Sheet 1	Preparing the soldering iron

Preparing the soldering iron:

1. Place the soldering iron in its stand and plug in.
2. Dampen the sponge in the stand.
3. Wait a few minutes for the soldering iron to warm up.
4. Wipe the tip of the iron on the damp sponge.
5. Melt a little solder on the tip of the iron.

Operation Sheet 2	Soldering a component

Soldering a component

1. Hold the soldering iron like a pen, near the base of the handle.
2. Touch the soldering iron onto the joint to be made.
3. Feed a little solder onto the joint.
4. Remove the solder, then the iron, while keeping the joint still.
5. Inspect the joint closely.

Information Sheet-4	Performing control settings/adjustments.

Oscilloscopes control settings/adjustments

Control	*Adjustment*
Cathode ray tube display	
Focus	Provides a correctly focused display on the CRT screen.
Intensity	Adjusts the brightness of the display.
Astigmatism	Provides a uniformly defined display over the entire screen area and in both x and y-directions. The control is normally used in conjunction with the focus and intensity controls.
Trace rotation	Permits accurate alignment of the display with respect to the graticule.
Scale illumination	Controls the brightness of the graticule lines.
Horizontal deflection system	
Timebase (time/cm)	Adjusts the timebase range and sets the horizontal time scale. Usually this control takes the form of a multi-position rotary switch and an additional continuously variable control is often provided. The CAL position is usually at one, or other, extreme setting of this control.
Stability	Adjusts the timebase so that a stable displayed waveform is obtained.
Trigger level	Selects the particular level on the triggering signal at which the timebase sweep commences.
Trigger slope	This usually takes the form of a switch that determines whether triggering occurs on the positive or negative going edge of the triggering signal.
Trigger source	This switch allows selection of one of several waveforms for use as the timebase trigger. The options usually include an internal signal derived from the vertical amplifier, a 50 Hz signal derived from the supply mains, and a signal which may be applied to an External Trigger input.
Horizontal position	Positions the display along the horizontal axis of the CRT.

Vertical deflection system

Vertical attenuator (V/cm)	Adjusts the magnitude of the signal attenuator (V/cm) displayed (V/cm) and sets the vertical voltage scale. This control is invariably a multi-position rotary switch; however, an additional variable gain control is sometimes also provided. Often this control is concentric with the main control and the CAL position is usually at one, or other, extreme setting of the control.
Vertical position	Positions the display along the vertical axis of the CRT.
a.c.-d.c.-ground	Normally an oscilloscope employs d.c. coupling throughout the vertical amplifier; hence a shift along the vertical axis will occur whenever a direct voltage is present at the input. When investigating waveforms in a circuit one often encounters a.c. superimposed on d.c. levels; the latter may be removed by inserting a capacitor in series with the signal. With the a.c.-d.c.-ground switch in the d.c. position a capacitor is inserted in the input lead, whereas in the DC position the capacitor is shorted. If ground is selected, the vertical input is taken to common (0 V) and the oscilloscope input is left floating. This last facility is useful in allowing the accurate positioning of the vertical position control along the central axis. The switch may then be set to d.c. and the magnitude of any d.c. level present at the input may be easily measured by examining the shift along the vertical axis.
Chopped-alternate	This control, which is only used in dual beam oscilloscopes, provides selection of the beam splitting mode. In the chopped position, the trace displays a small portion of one vertical channel waveform followed by an equally small portion of the other. The traces are, in effect, sampled at a relatively fast rate, the result being two apparently continuous displays. In the alternate position, a complete horizontal sweep is devoted to each channel alternately.

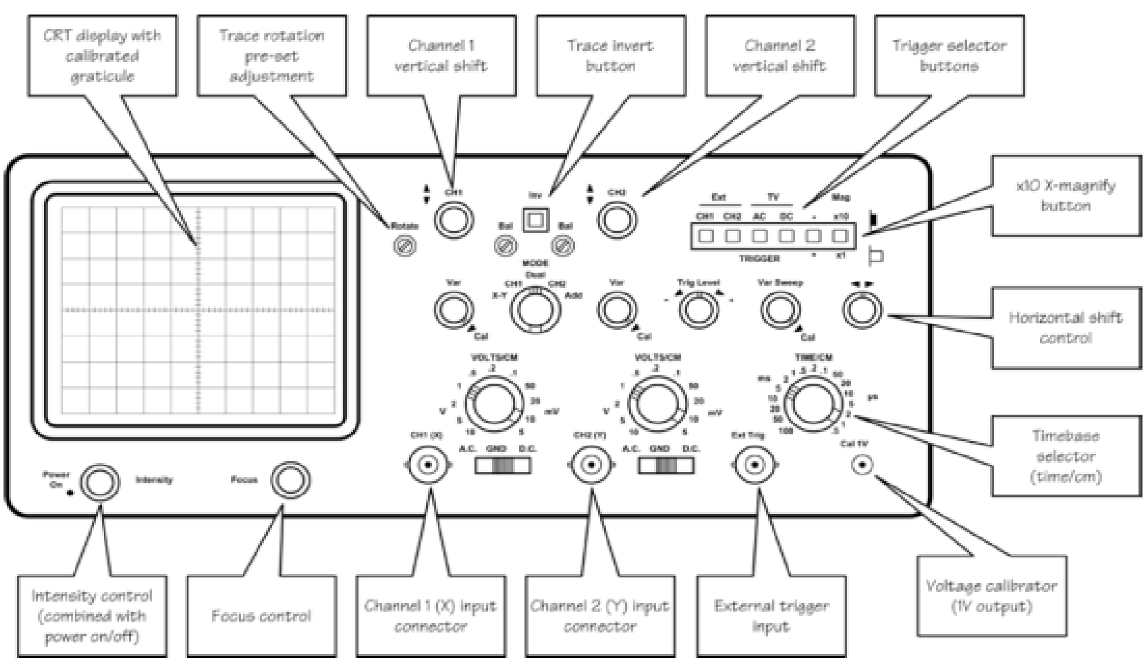


Figure4.1 Front panel controls and displays on a typical dual-channel oscilloscope

Adjusting the controls to display sinusoidal waveforms (single-channel operation)

The procedure for displaying a repetitive sine wave waveform is shown in Fig.4.1. The signal is connected to the Channel 1 input (with 'AC' input selected) and the mode switch in the Channel 1 position. 'Channel 1' must be selected as the trigger source and the trigger level control adjusted for a stable display. Where accurate measurements are required it is essential to ensure that the 'Cal' position is selected for both the variable gain and time controls.

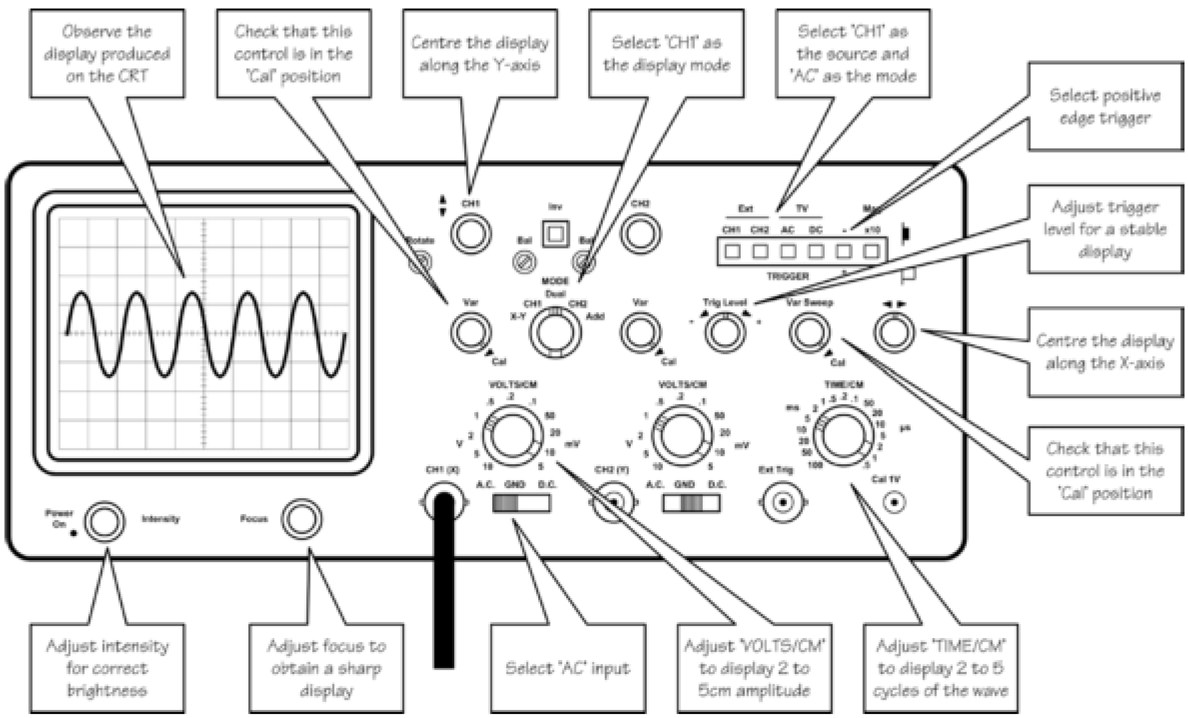


Figure4.2 Procedure for adjusting the controls to display a sinusoidal waveform (single-channel mode)

Adjusting the controls to display square waveforms (single-channel operation)

The procedure for displaying a repetitive square waveform is shown in Fig. 4.2. Once again, the signal is connected to the Channel 1 input (but this time with 'DC' input selected) and the mode switch in the Channel 1 position. 'Channel 1' must be selected as the trigger source and the trigger level control adjusted for a stable display (which can be triggered on the positive or negative going edge of the waveform according to the setting of the trigger polarity button). Any DC level present on the input can be measured from the offset produced on the Y-axis. To do this, you must first select 'GND' on the input selector then center the trace along the Y-axis before switching to 'DC' and noting how far up or down the trace moves (above or below 0 V). This may sound a little difficult but it is actually quite easy to do! The same technique can be used for measuring any DC offset present on a sinusoidal signal.

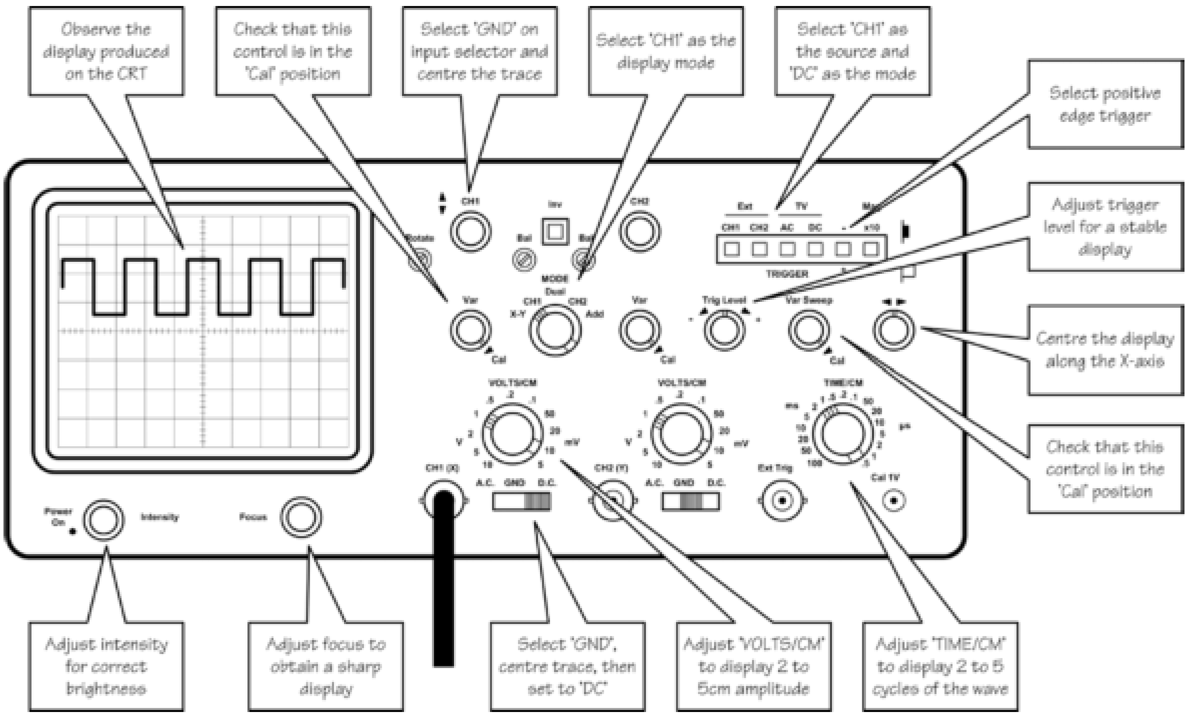


Figure7.8 Procedure for adjusting the controls to display a square waveform (single-channel mode)

Adjusting the controls to display sine or square waveforms (dual–channel operation)

The procedure for displaying two waveforms (either sine or square or any other repetitive signal) simultaneously is shown in Fig. 14.29. The two signals are connected to their respective inputs (Channel 1 and Channel 2) and the mode switch set to the 'Dual' position. The oscilloscope can be triggered by either of the signals (Channel-1 or Channel-2) as desired. Once again, the display can be triggered on the positive or negative-going edge of the waveform depending upon the setting of the trigger polarity button. Dual-channel operation can be invaluable when it is necessary to compare two waveforms, e.g. the input and output waveforms of an amplifier.

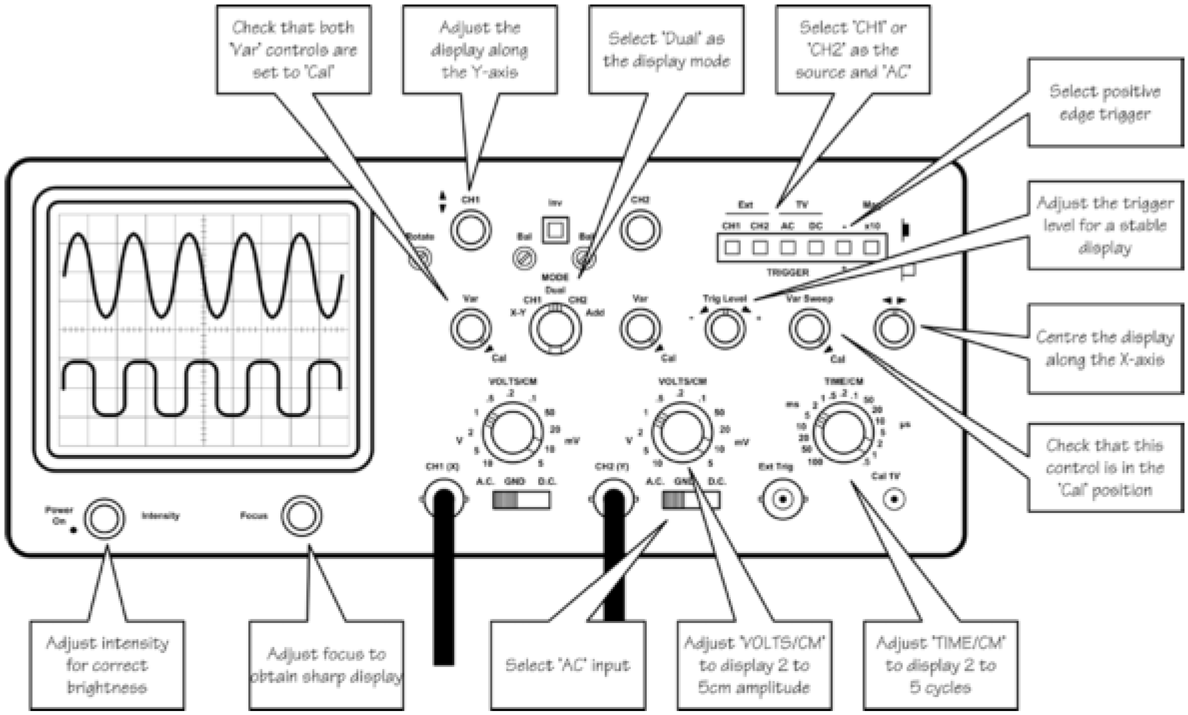


Figure7.8 Procedure for adjusting the controls to display two waveforms (dual-channel mode)

Checking distortion

Oscilloscopes are frequently used to investigate distortion in amplifiers and other electronic systems. Different forms of distortion have a different effect on a waveform and thus it is possible to determine which type of distortion is present. A 'pure' sine wave is used as an input signal and the output is then displayed on the oscilloscope. Figure 14.31 shows waveforms that correspond to the most common forms of distortion.

Checking frequency response

An oscilloscope can also be used to provide a rapid assessment of the frequency response of an amplifier or other electronic system. Instead of using a sine wave as an input signal a square wave input is used. Different frequency response produces a different effect on a waveform and thus it is possible to assess whether the frequency response is good or poor (a perfect square wave output corresponds to a perfect frequency response). Figure7.8 shows waveforms that correspond to different frequency response characteristics.

Self-Check 4	Written Test

I. Short answer

1. List and explain the control systems of an oscilloscopes.*4pts*
2. List the horizontal deflection systems of an oscilloscopes.3*pts*

Note:

Satisfactory rating - 4 and above Points	Unsatisfactory - below 4Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ___________________________ **Date:** ________________

Information Sheet-5	Performing repair activity within the required timeframe.

Simple method to Repair any Types of SMPS

For the successful repair of any SMPS you must have the skill of testing electronic components or visit the website at *http://www.TestingElectronicComponents.com.*

1. **Checking The secondary side first**

Step 1 Discharge The Big Capacitor

Figure5.1 Discharging the Big Capacitor

Figure5.2 Discharging the Big Capacitor with a 2.2Kohm 10watt resistor

Step 2 Remove SMPS

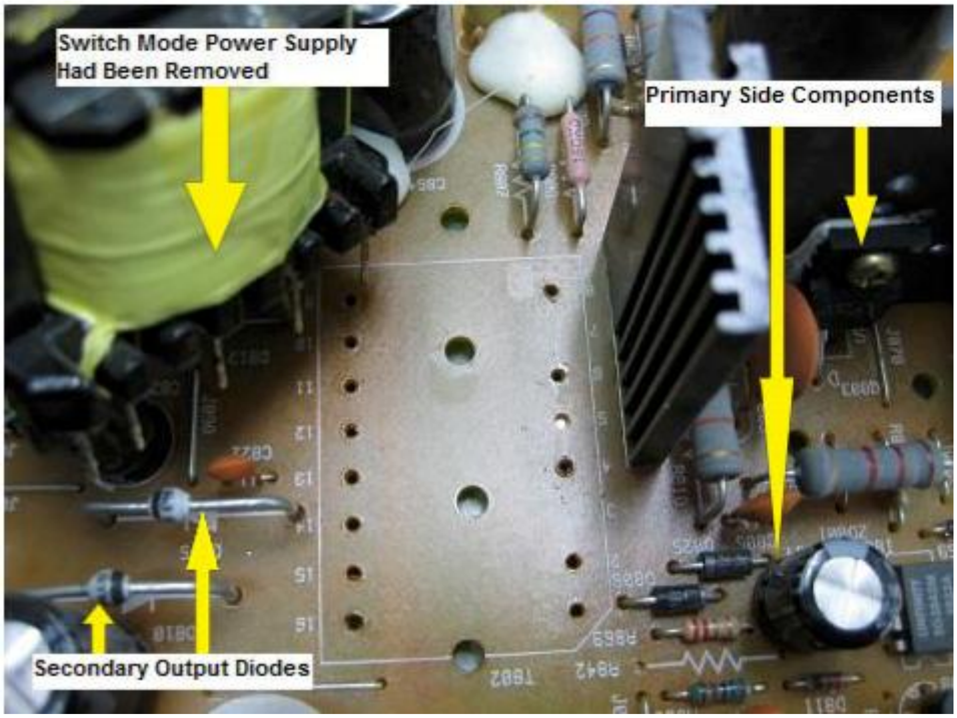


Figure5.3. Removal of SMPS

Step 3 Test The Secondary diode or Schottky Diode of SMPS

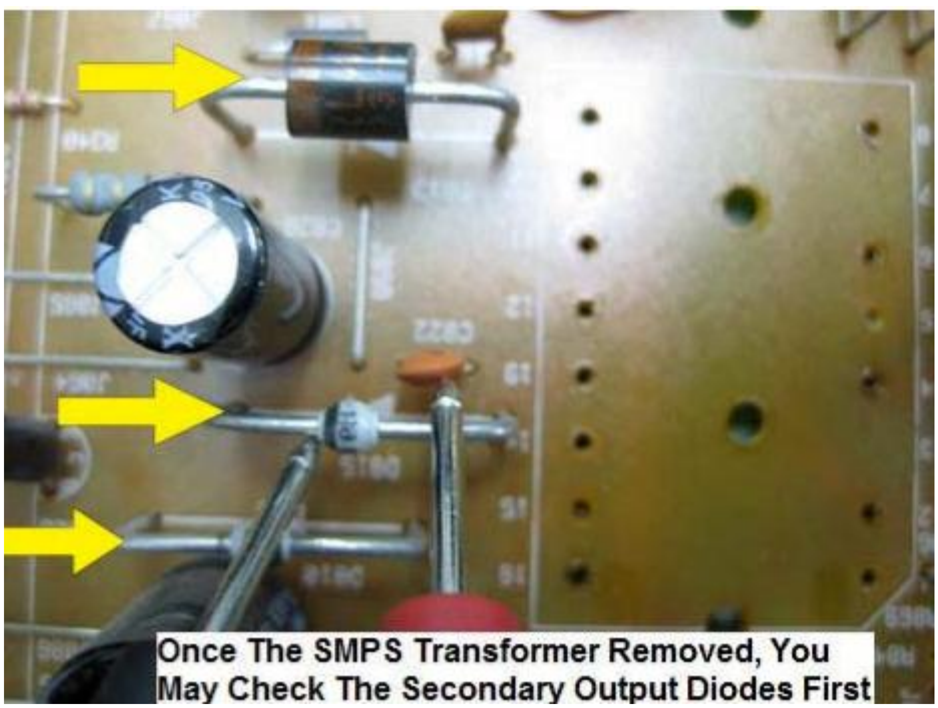


Figure5.4. Testing The Secondary diode of SMPS

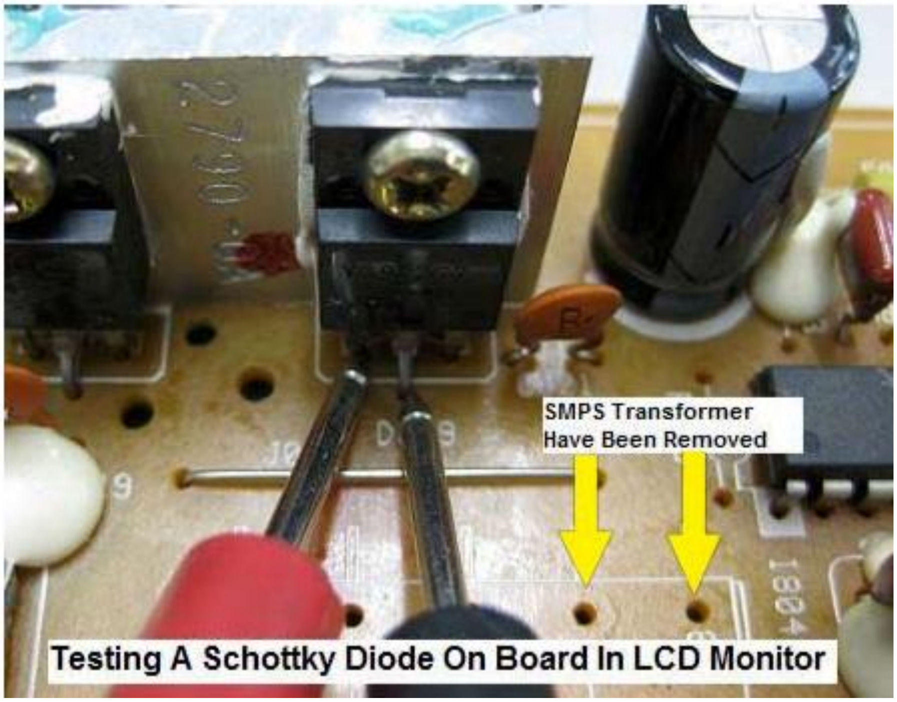


Figure5.5. Testing The Secondary Schottky Diode of SMPS

Step 4 Checking the electrolytic capacitor using Blue ESR meter

Figure5.6. Checking the electrolytic capacitor using Blue ESR meter

Step 5 Checking the Feedback circuit

✓ It consists resistor capacitor optoisolator IC and TL431IC

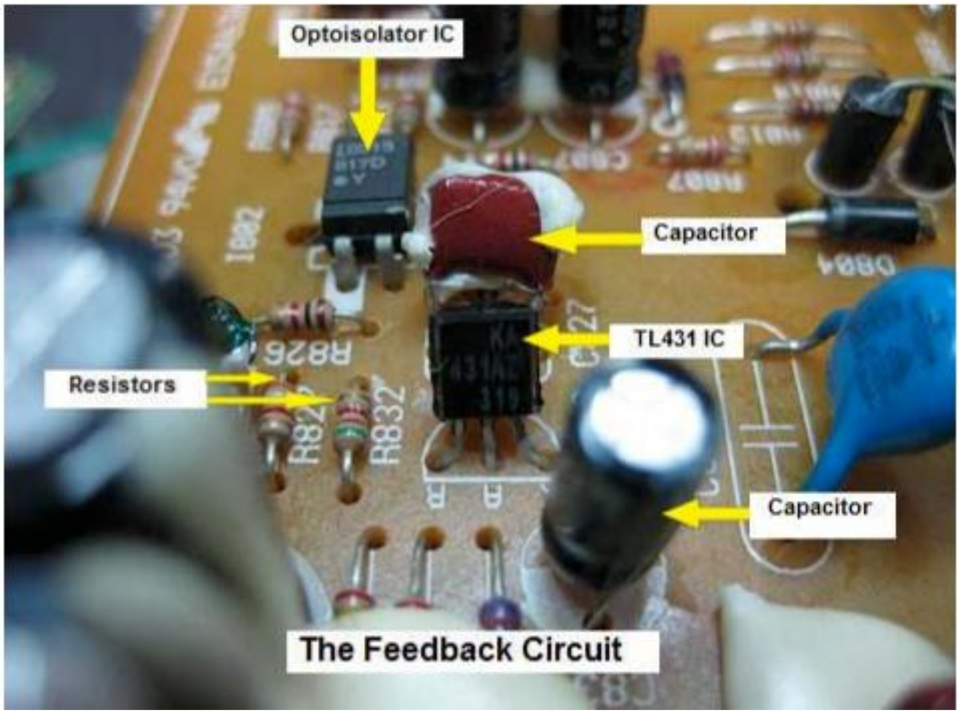


Figure5.7 Checking the Feedback circuit

Now if you have completed checking the components in the secondary side, move on to test the components in the primary side of the power supply.

2. **Checking The primary side next.**

Step 7 De-soldering all the components of the primary side

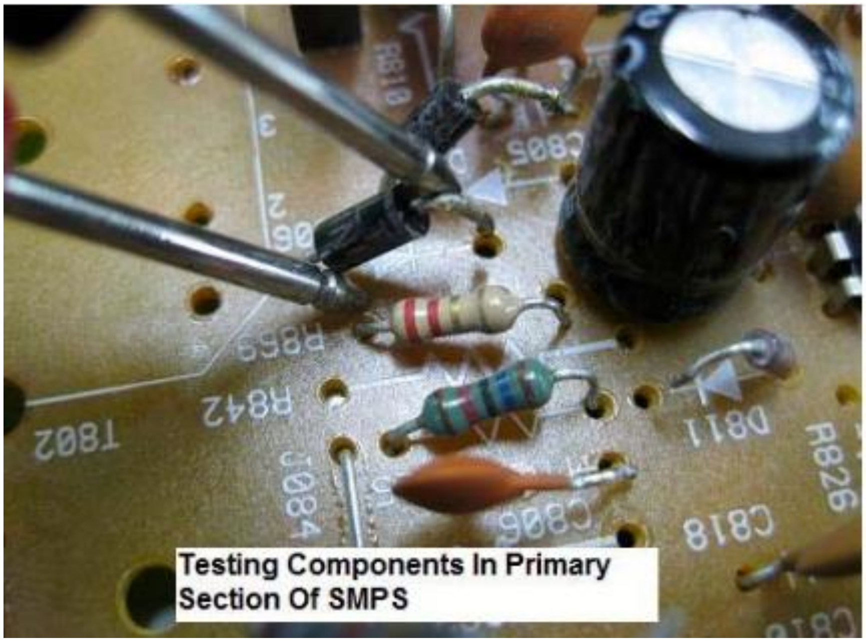


Figure5.8 De-soldering all the components of the primary side

Step 8 Looking dry joints in a circuit

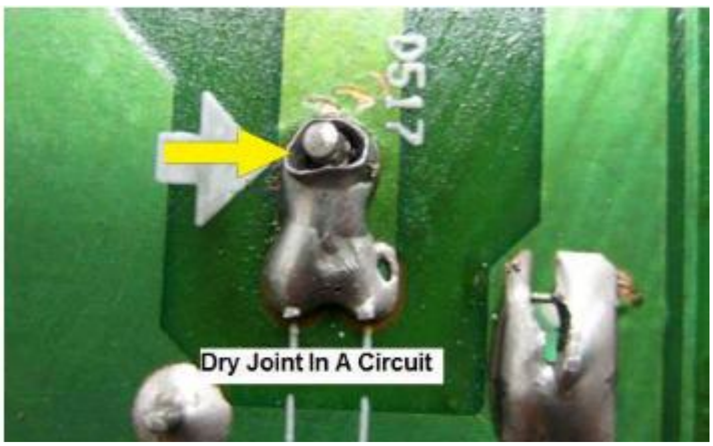


Figure5.9Looking dry joints in a circuit

Step 9 checking the board

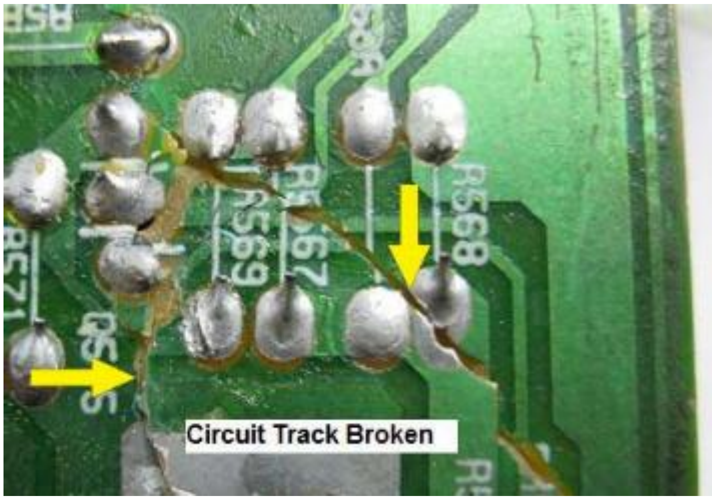


Figure5.10 checking the board

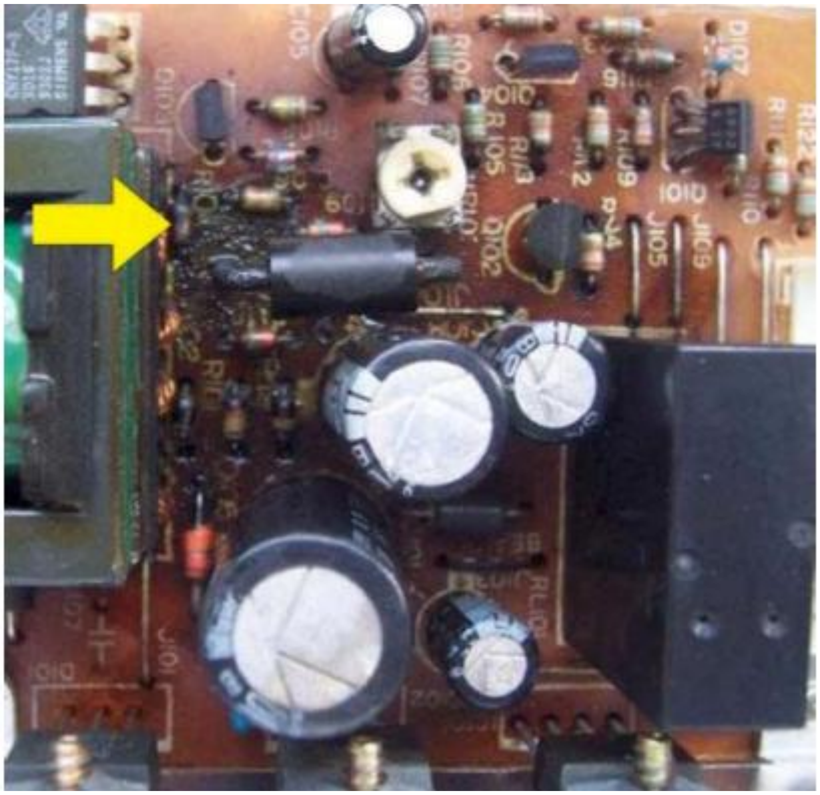


Figure5.10 damaged board

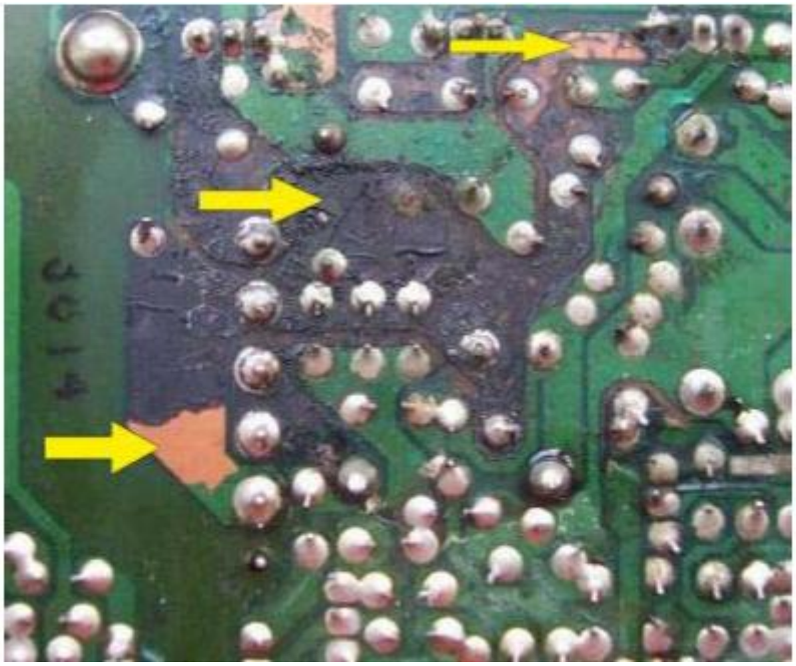


Figure5.10 Rusted board

3. **Replace and repair the faulty part**

Self-Check 5	Written Test

i. Short answer

1. Describe the general and easy methods of repairing. *5pts*

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** _________________

Operation Sheet 1	Perform repair activity

Performing repair activity

Procedures

1. Discharge The Big Capacitor
2. Remove SMPS
3. Test the Secondary diode or Schottky Diode of SMPS
4. Check the electrolytic capacitor using Blue ESR meter
5. Check the Feedback circuit
6. De-soldering all the components of the primary side
7. Look dry joints in a circuit
8. check the board
9. Replace and repair the faulty part

Procedures to clean Units of SMPS

Step 1

Shut down and unplug your computer. Never clean the inside of your PC while it is running or plugged in; this can result in accidental electric shock or other such injuries. Wait for your computer to cool down if it has been running for a prolonged period prior to shut down. This action will help you avoid burning yourself. Wait at least 1 hour to ensure that all internal components are cooled off.

Step 2

Unscrew and remove your computer's access panel. Generally speaking, PCs have 1 main, large access panel. It is located at different positions, depending on your computer's model. The access panel is easy to identify; it is basically a large removable sheet of metal or plastic screwed onto your PC's main body.

Step 3

Find the power supply by looking for the place that your computer's power cable goes into. The power supply is also recognizable because of the large fan it contains. This fan is visible both on the inside and outside of the computer. Its external, grated face will typically be about the size of a compact disc.

Step 4

Use a 12-oz. can of compressed air with a nozzle to blow dust and dirt off the power supply. Hold the nozzle about 2 inches from the surface you're cleaning and always blow from the inside of the PC outward. Blow the air through the natural holes and air channels of the power supply's fan, shooting dust out of the PC. Dust for about 1 to 2 minute, using short bursts of air.

Step 5

Let the dust settle, and then shoot air through the power supply again to see if more dust comes out. If there is still dust, use the compressed air duster for another minute and wait for the dust to settle again. Repeat dusting until no visible dust comes out of the power supply. Place the access panel back on your computer and screw it back in

Self-check 6	Written Test

Short Answer

1. List the procedures to clean SMPS units.

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** ________________

Instruction Sheet-4	LG38: Rewind low-power transformer

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: –

- Performing rewinding process.
- Checking the process according to established standards and requirements.
- Using testing instruments to test the required parameters.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to: -

- Perform rewinding process.
- Check the process according to established standards and requirements.
- Use testing instruments to test the required parameters.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks”. in each information sheets.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next Learning Guide.

Information Sheet-1	Performing rewinding process.

Introduction

Most of the time the primary side (high voltage side) of low voltage transformer (step down transformer) is damaged because of excessive heat developed due to overload or short circuit current can easily burn thin turns of windings than the thick turns of windings. But to be sure which winding is failed, it needs to identified easily by visual inspection, or it needs continuity or resistance test.

Rewinding Process

Step 1: Reading and recording the name plate data of the burnt transformer.

- The name plate data contains the following information

Step 2: Preparing the materials, Tools and equipment's needed.

S.N	materials	Specifications	Amount	Remark
1	Insulating tape	black		
2	Copper wire	Enameled		
3	Wood Former			
4	Insulation paper			
5	Varnish			
6				
7				

S.N	Tools	Specifications	Amount	Remark
1	mallet			
2	Chisel			
3	Plier			
4	Wrench			
5	Ball peen hammer			
6	Utility knife			
7	Wire brush			
8				

S.N	Equipment's	Specifications	Amount	Remark
1	Transformer			

2	Multimeter			
3	Megger			
4	Soldering iron			
5	Vernier caliper			
6				

Step 2: Disassembling Core laminations.

The core is made up of steel laminations E and I shape. If you are lucky, you get a transformer where all the E's are stuck together, and all the I's are stuck together. It's far more common however to find that they alternate.

A 

B 

Figure1.1 A) Stepdown Transformer B) Removed E-I Laminations

Steps

1. Remove the case of the transformer by cutting the bolts.
2. Crack the glue or adhesives from the winding.
3. Split the laminations from the stack by using a woodworking chisel and mallet hammer.
4. Get the first E lamination.
5. Pull out the first E lamination by gripping the edge of its lamination using plier.
6. Pull out the I lamination by gripping the edge of its lamination using plier.
7. Once all the laminations are out, put them somewhere safe.

Precautions

- ✓ Getting the first E out is the hard part because all the laminations will be stuck together and tightly wedged into the bobbin.
- ✓ Try not to bend them so much that they are no longer flat, though. There is a trade-off between speed and how much you end up bending them.
- ✓ In the end, we will want them to be as compact a bundle as possible, to optimize the quality of the transformer. It took about an hour to disassemble.

Step 3: Remove the burnt winding.

Usually the primary and secondary windings are separated and insulated each other covering layers of paper filled with varnish. The thick wire of lower voltage secondary windings is mostly found on the outside or top of the primary coil.

A  B 

Figure1.2. a) Burned transformer coil and b) Exposed winding

Procedures

1. Remove any tape and other insulation
2. Identify the flying terminal leads of the primary and secondary windings.
3. Unwind and count turns of secondary winding
4. Unwind and count turns of the primary winding
5. Obtain a turns per volt ratio

Precautions

- ✓ There are two HV wires because that is the center of the two halves of the HV primary.
- ✓ The HV primary wire looks thin compared to the already thin primary wire. Varnish diffuses the transformer.

Note that

- ✓ Save any useful looking bits of insulation, you can re-use them.
- ✓ Carefully wind the wire onto something, since you may need to re-use it, for either re-winding this transformer,
- ✓ Notice how the leads seem secured by an underlying glue

Step 4: Determine the thickness of the Wire

Wire is specified as having "ampacity". This means the current it can safely carry without getting dangerously hot. This figure is generally given for conditions of normal wiring, and is far too high for transformer winding. The reason this figure is far too high is because in a transformer, many current carrying turns of wire are tightly packed side by side, all generating heat in a parallel manner. Ampacity ratings are given for the wire laid out in a cable run, where it is far easier for the heat to escape.

Since we will need to order the special, ultra-fine wire needed for the higher voltage windings, we need to know what wire size will be required. Also, as you will see, the wire size affects the calculations of the number of turns required.

Procedures

1. Identify the primary and secondary windings
2. Measure the thickness of the existing secondary wire.
3. Measure the thickness of the existing of primary wire.
4. Select the nearest wire from the table given below.

Note that

- ✓ The best tool to measure wire size is a regular Vernier caliper. In inch mode, it has a resolution of 0.5mil or about 0.013mm. In millimeter mode, the resolution is
- ✓ The measurements and the nearest wire sizes came up with are listed in the table 17.1.
- ✓ An important piece of information which we need from the original transformer is the number of volts per turn, for which it was designed. To get that, we must count the number of turns of one of the windings.

Table 17.1

Winding	Thickness	AWG
HV	3.5mil, 0.09mm	40
Primary	7.1, 0.18	34
Filament-1	17, 0.43	26
Filament-2	32, 0.81	20

Step 5: Preparing or making a Bobbin

The design for the bobbin is shown Figure17.4, It’s made from the chipboard of a carton and fitted the core tightly around the tongue of the transformer, with a carefully measured and cut butt joint.

Figure1.3 Bobbin Insulations

Procedures

1. Measure the width of the lamination.
2. Measure the height of the lamination.
3. Measure the thickness of the lamination.
4. Calculate the cross-sectional area of the core.
5. Transfer the measurements on an insulation paper.
6. Fold the insulation paper based on your measurements.
7. Make the corners smooth and rounded.
8. Secure the corners by using an electrical tape

Precautions

- ✓ Use an electrical tape to secure it.
- ✓ If there is a sharp or rough spot on the side, it might catch the wire. The ultra-thin HV wire might actually break, forcing you to start that winding over.

Step 5: Preparing or making a wood former(winder).

In this process you may not find the winder machine then you have to look other options to replace or modify it therefore you can prepare the former from woods.

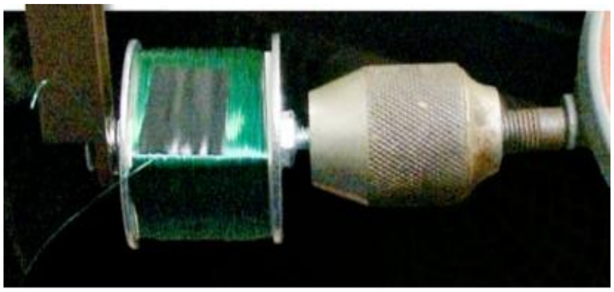


Figure1.4 Homemade winder

Steps

1. Measure the window of your bobbin.
2. Transfer the measurement on the wood.
3. File the wood to the specific dimensions.
4. Remove rough surface from the wood.

Step 6: Rewinding the new coil.

Steps

1. Insert or mount your bobbin on the former.
2. Fix one of the leads of the primary on the bobbin.
3. Wind and test the primary coil first.
4. Wind and test the secondary coil.
5. Check the insulation resistance b/n primary and secondary coils.

Figure1.5

Step7: Cleaning and Coating the laminations

The laminations are coated with a thin varnish to prevent them from shorting together. Without the coating, eddy currents, generated in the lams would cause losses and heating. Unfortunately, the coating has now been compromised by the high temperatures from the shorted windings and by having to pry the lams apart.

Steps

1. Immerse the lamination into tray of lacquer thinner overnight.
2. Scribe the lamination using a wire brush
3. Dry the lamination completely.
4. Paint the lamination with coats of varnish.

Precautions

- ✓ You need care not to flip any of the pieces over.
- ✓ Protective gloves are essential

Step 8: Reassembling

Put the core back together the same way it was built originally, slotting E's in from alternate sides. Put in the 3rd and 2nd to the last pieces the same way, then you can slot the last piece between them, rather than up against the bobbin. You may need to file the edges a bit so it will go in. A tight fit I ended up driving one of the I pieces in the other way to open up the gap, pulling it out when the final piece was part-way in. I squirted in some switch cleaner as a lubricant to help things along.

Hole the I pieces in, then tap it all together with a hammer. You don't want to see any gaps between the edges of the E's and the I's.

And there you have it. You can see the transformer connected to a 100 ohm load. With the full 2A load connected the voltage dropped to about 23.5 volts, which although not ideal, is adequate for my needs. Another couple of turns per winding would have been a good idea. The load (a soldering iron) gets nice and hot, and whilst the transformer laminations get warm - I suspect due to the iron loss having gone up due being dismantled and reassembled, but the winding stays nice and cool - just what is needed!

You can also see that the bobbin is quite full. I was wildly optimistic about how many turns would fit! If it was a single winding, the amount I reckoned on may have been more realistic.

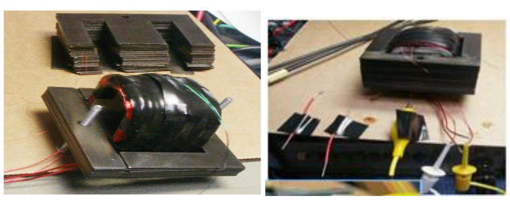


Figure1.6 Temporarily and loosely assembled laminations of the transformer

Step 9: Impregnation

- ✓ The next step is to impregnate the transformer with resin, to fill air spaces and dampen buzzing made by the lams.
- ✓ The resin cannot be air cured type, because it would be very slow to cure in the tiny voids which must be filled. That leaves heat-cured and two-part resins.

Figure1.7 Epoxy-based clear resin

Step 10: Connecting winding Leads

- ✓ The tongue of the transformer is mounted vertically in the finished product and the coil winds around that you can designated one side of the coil to be the top and it is at left in the pictures. The ends of each winding are brought to that side.
- ✓ As shown in the Figure of the original at the bottom of Figure17.5.the external leads will be brought up from the bottom end of the coil and will connect to the winding wires coming from the top of the coil.
- ✓ The connections will be secured on the side of the coil as was done in the original.

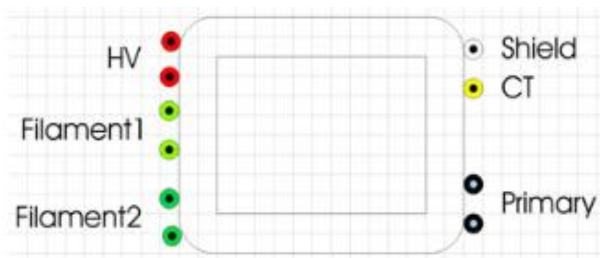


Figure1.8 Terminal leads

- ✓ The lead wire positions are shown at left. The positions of the leads match the original.
- ✓ Ends of winding wires are brought to the top end at the positions where the leads will be, in the figure.
- ✓ Notice the shield connection. That is a strip of copper foil, covering the primary. It is covered with electrical tape to insulate it. The ends of the foil must be insulated from each other, to keep the strip from becoming a shorted turn on the transformer.
- ✓ Except for the center tap (CT), windings start/end at same compass position.
- ✓ HV/CT: Wind the first half, starting at the HV (red) corner. The turn count is reached at the red corner. Continue to the CT (yellow) corner and bring the end out. Wind the second half, starting at the CT (yellow) corner. The turn count is

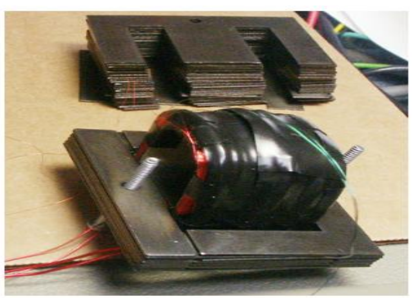
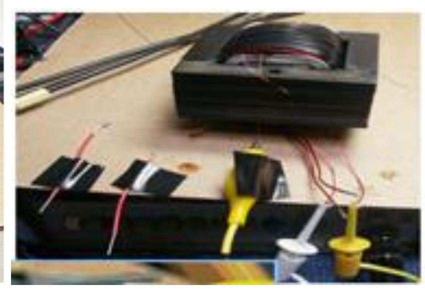
reached at the CT (yellow) corner. Continue to the HV (red) corner and bring the end out.

- ✓ Secure the winding ends with tape. Tape over the wire as it runs up the side of the bobbin.
- ✓ Tape over the primary and each HV secondary winding.

The completed coil is shown at right. Please note though, that this was taken of the first try, which did not have sides on the bobbin.

Step11: Testing and Finishing

- ✓ The next step is to temporarily assemble the laminations of the transformer as started below, so the coil can be tested.
- ✓ The loosely assembled transformer is shown below, being tested.

As shown in the Figure17.8, after applying two layers of 3M 9465PC transfer adhesive to the coil, leads are soldered to the winding wires and covered with heat shrink. The leads are now firmly affixed to the transformer coil.

Self check 1	Written test

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ___________________________ **Date:** ________________

Operation sheet 1	Disassembling Core laminations.

Disassemble core laminations.

Procedure

1. Follow safety procedure.
2. Remove the case of the transformer by cutting the bolts.
3. Crack the glue or adhesives from the winding.
4. Split the laminations from the stack by using a woodworking chisel and mallet hammer.
5. Get the first E lamination.
6. Pull out the first E lamination by gripping the edge of its lamination using plier.
7. Pull out the I lamination by gripping the edge of its lamination using plier.
8. Once all the laminations are out, put them somewhere safe.

Note that: Getting the first E out is the hard part because all the laminations will be stuck together and tightly wedged into the bobbin.

Precautions

- ✓ Try not to bend them so much that they are no longer flat, though. There is a trade-off between speed and how much you end up bending them.
- ✓ In the end, we will want them to be as compact a bundle as possible, to optimize the quality of the transformer. It took about an hour to disassemble.

Operation sheet 2	Preparing a Bobbin

Operation title- Preparing Bobbin

Procedures

1. Measure the width of the lamination.
2. Measure the height of the lamination.
3. Measure the thickness of the lamination.
4. Calculate the cross-sectional area of the core.
5. Transfer the measurements on an insulation paper.
6. Fold the insulation paper based on your measurements.
7. Make the corners smooth and rounded.
8. Secure the corners by using an electrical tape

Precautions

- ✓ Use an electrical tape to secure it.
- ✓ If there is a sharp or rough spot on the side, it might catch the wire. The ultra-thin HV wire might actually break, forcing you to start that winding over.

Rewinding the new coil.

Procedures

1. Insert or mount your bobbin on the former.
2. Fix one of the leads of the primary on the bobbin.
3. Wind and test the primary coil first.
4. Wind and test the secondary coil.
5. Check the insulation resistance b/n primary and secondary coils.

Introduction

Winding resistance measurements are an important diagnostic tool for assessing possible damage to transformers resulting from poor design, assembly, handling, unfavorable environments, overloading or poor maintenance.

The main purpose of this test is to check for gross differences between windings and for opens in the connections. Measuring the resistance of transformer windings assures that each circuit is wired properly and that all connections are tight.

Winding resistance in transformers will change due to shorted turns, loose connections, or deteriorating contacts in tap changers. Regardless of the configuration, the resistance measurements are normally made phase-to-phase and the readings are compared with each other to determine if they are acceptable.

Transformer winding resistance measurements are obtained by passing a known DC current through the winding under test and measuring the voltage drop across each terminal (Ohm's Law). Modern test equipment for this purposes utilizes a Kelvin bridge to achieve results; you might think of a winding resistance test set as a very large low-resistance ohmmeter (DLRO).

SINGLE-PHASE IMPEDANCE MEASUREMENTS

The purpose of impedance (as well as ratio) measurements is to detect the damage by comparison with nameplate values and with future diagnostic tests. Percent impedance measurements will differ for each tap position and nameplate comparisons can only be made for the nominal voltage taps. An Impedance test is useful for determining loose or high-resistance connections. In some cases, this test will indicate if the core and coils have been shifted, either by mechanical or electrical damage. See Fig. 53, below.

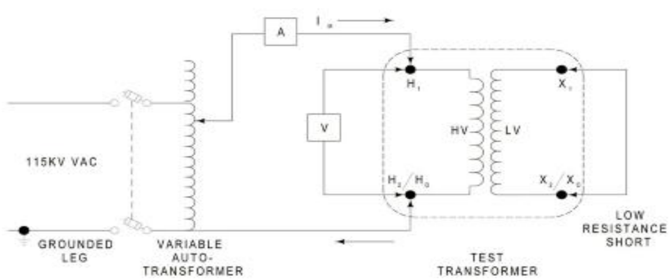


Figure2.1: Single-Phase Transformer Impedance

Self check 2	Written test

Short answer

1. What are the test conducted in checking of a transformer?

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** ________________

Transformer parameters

Common electrical tests on power transformers

Regularly performing a range of standard electrical tests has proven an effective way to gain a reliable insight into the operating condition of your transformers and can extend their lifespan. Mechanical changes to windings, contact problems in the tap changer or at other connections, shorted windings/coils, as well as interruptions or short-circuit of parallel lines can all be diagnosed early by using conventional testing methods. Severe and costly damage can be thereby prevented.

These conventional testing methods include measuring a number of parameters, such as the short circuit impedance, transformers ratio, magnetizing current, winding resistance and dynamic winding resistance of the tap changer. With our testing system, you can use a single device to determine all of these parameters in an easy way. Once you have completed the testing, you can also demagnetize the transformer.

We also offer solutions for testing bushing-type current transformers for measurement deviations or phase faults.

It is often the case, in circuits which use a transformer, that the performance of the circuit is significantly dependent on the characteristics of the transformer. This is true not only in power circuits, but in the case of RF circuits as well. For example, a multi-output fly back power supply uses a coupled inductor as the "transformer." In this topology, the regulation, ripple, stability, and component stresses are all related to the magnitude, as well as the location of, the various leakage inductance terms, as well as, the mutual inductance of the transformer.

Self-check 3	Written test

Short Answer

1. What are the parameters of a transformer?

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** _________________

Instruction Sheet-5	LG39: Assemble Low-Power Transformer

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: –

- Performing assembling processes.
- Checking process.
- Checking assembled products.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to: -

- Perform assembling processes.
- Check process.
- Check assembled products.

Learning Instructions:

9. Read the specific objectives of this Learning Guide.
10. Follow the instructions described below
11. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
12. Accomplish the "Self-checks". in each information sheets.
13. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
14. If you earned a satisfactory evaluation proceed to "Operation sheets and LAP Tests if any". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
15. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
16. Then proceed to the next Learning Guide.

Information Sheet 1	Performing assembling processes

1.1 Assembling low-power transformer

- **Safety: Wear gloves, apron and safety shoe.**

The process of assembling is the reveres process of disassembling the product. The following steps can be used as main guide lines of assembling procedures the previous rewind transformer

1. Prepare the laminations for assembly. Clean and straighten them up.
2. Prepare stack E type of lamination together

3. Insert it in the bobbin.
4. In similar fashion assemble I type lamination and fix from the 4th open side of the core.

5. Assemble the frame (case)
6. Perform open circuit test, short circuit test
7. Perform power test

Self-check 1	Written Test

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ___________________________ **Date:** ________________

1. Checking Insulation resistance of transformer windings

Measure the insulation resistance between a pair of windings, and between each winding and ground with a 1,000 or 2,000-volt megger data periodical inspection.

The megger test should be made to check if the transformer is in suitable condition for operation or application of the dielectric test.

The insulation resistance is subject to wide variation with temperature, humidity and cleanness of bushing porcelains.

It may be low due to the leakage current through the weakest point of inferior insulation, in which case gases dissolved in oil should be analyzed.

Self-check 2	Written Test

Short Answer

1. What are the steps to assembling processes?

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** _________________

The transformer is ready to install to its place in the equipment do that:

- ✓ Disconnect power from the equipment
- ✓ Place the repaired transformer to its place in correct position
- ✓ Fix it with its fixing accessories, i.e. install securely the mechanical installation.
- ✓ Perform the electrical connection, i.e. connect the primary and secondary leads to its previous connection points.
- ✓ Clean the equipment with blowers and cleaning rags (clothes)
- ✓ Inspect the repaired and any other components of the equipment.

Check for wear out, broken, burned parts and any sign of abnormality electrical components or mechanical parts. If there something seems to be wrong(abnormal), perform additional investigation closely to prove or disprove the expectation. If there is loosen part, components which need replacement, or mechanical moving parts which need lubrication...take for all appropriate remedial action.

- ✓ Connect the equipment to power source and perform input output voltage measurement. Test the equipment for correct operation (functional test of the equipment).

Self-check 3	Written Test

Note:

Satisfactory rating - 3 and above 5 Points	Unsatisfactory - below 3 Points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score	
Rating	

Name: ____________________________ **Date:** ________________

Instruction Sheet-6	LG40:Test and Inspect Repaired Products

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: –

- Inspecting and test repaired products.
- Documenting and informing work completion to a responsible person.
- Observing housekeeping procedure.
- Disposing waste materials.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to: -

- Inspect and test repaired products in accordance with quality standards, procedures and requirements.
- Document and inform work completion to a responsible person.
- Observe housekeeping procedure.
- Dispose waste materials.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks". in each information sheets.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets and LAP Tests if any". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next Learning Guide.

Information sheet 1	Inspecting and testing repaired products.

Introduction to inspection

It is an organized examination or formal evaluation exercise. In engineering, inspection involves the measurements, tests, and gages applied to certain characteristics in regard to an object or activity.

The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets.

Some inspection methods are destructive; however, inspections are usually nondestructive. Nondestructive examination (NDE), or nondestructive testing (NDT), are a number of technologies used to analyze materials for either inherent flaws (such as fractures or cracks), or damage from use. Some common methods are visual, microscopy, liquid or dye penetrant inspection, magnetic particle inspection, eddy current testing, x-ray or radiographic testing, and ultrasonic testing.

1.1 Final Visual Inspection

Visual inspection provides a means of detecting and examining a variety of surface flaws, such as corrosion, contamination, surface finish, and surface discontinuities on joints (for example, welds, seals, and solder connections).

Visual inspection is also the most widely used method for detecting and examining surface cracks that are particularly important because of their relationship to structural failure mechanisms. Even when other inspection techniques are used to detect surface cracks, visual inspection often provides a useful supplement.

For example, when the eddy current examination of process tubing is performed, visual inspection is often performed to verify and more closely examine the surface disturbance. In some instances, acid etching can be used to reveal structures that would not be visible to the naked eye. Given the wide variety of surface flaws that may be detectable by visual examination, the use of visual inspection can encompass different techniques, depending on the product and the type of surface flaw being monitored.

The methods of visual inspection involve a wide variety of equipment, ranging from examination with the naked eye to the use of interference microscopes for measuring the depth of scratches in the finish of finely polished or lapped surfaces.

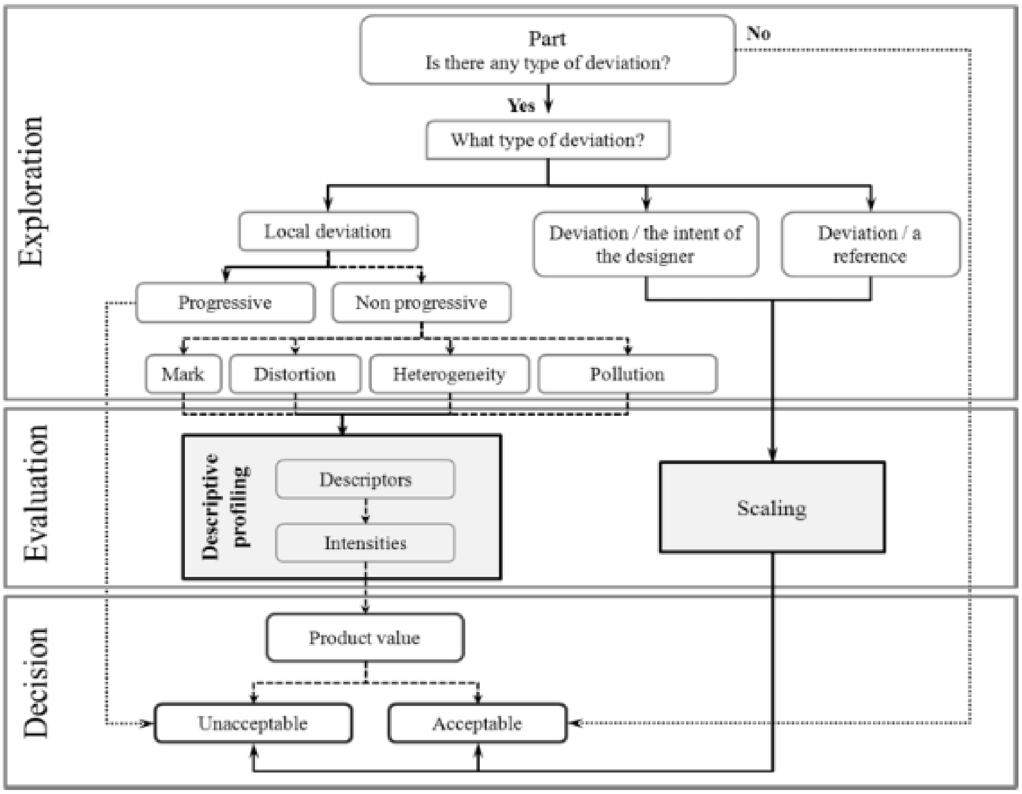


Figure 4. Visual inspection process

1.2 Inspection records

1. The establishment of the report and recording of the condition and repair of the transformers is required for a good maintenance program.
2. A preventive maintenance system will operate satisfactorily with the following records.
   - An equipment record
     - ✓ This may be simply a card, which contains the basic information of a transformer itself such as the serial number, the location, size, etc.
   - A repair record card
     - ✓ This may keep a running record as to costs of maintaining a transformer. It is the essential diagnostic record for avoiding future difficulties.
   - An inspection checks list or inspector's record
     - ✓ This may be simply a listing of the points to be checked on a transformer and the establishment of the time that these checks should be made.

3. Without these records it would be very difficult for a preventive maintenance program to work, because the knowledge gained form regular inspections would be quickly lost.

1.3. Testing quality standards

The transformer is ready to install to its place in the equipment do that:

- ✓ Disconnect power from the equipment
- ✓ Place the repaired transformer to its place in correct position
- ✓ Fix it with its fixing accessories, i.e. install securely the mechanical installation.
- ✓ Perform the electrical connection, i.e. connect the primary and secondary leads to its previous connection points.
- ✓ Clean the equipment with blowers and cleaning rags (clothes)
- ✓ Inspect the repaired and any other components of the equipment.

Check for wear out, broken, burned parts and any sign of abnormality electrical components or mechanical parts. If there something seems to be wrong(abnormal), perform additional investigation closely to prove or disprove the expectation. If there is loosen part, components which need replacement, or mechanical moving parts which need lubrication...take for all appropriate remedial action.

- ✓ Connect the equipment to power source and perform input output voltage measurement. Test the equipment for correct operation (functional test of the equipment).

Checklist 7-3: Transformers

✔	Item	Inspection Activity	*NEC* Reference	Comments
☐	1.	Identify transformers that are covered by Article 450.	450.1, 450.2	
☐	2.	Verify that overcurrent protection for transformers over 1000 volts is provided and properly sized.	Table 450.3(A)	
☐	3.	Verify that overcurrent protection for transformers 1000 volts or less is provided and properly sized.	Table 450.3(B)	
☐	4.	Verify that overcurrent protection is provided for transformer primary conductors.	240.4, 240.21(B), 240.100	
☐	5.	Verify that overcurrent protection is provided for transformer secondary conductors.	240.4, 240.21(C), 240.100	
☐	6.	Check transformer installations for adequate ventilation and spacing from walls and obstructions.	450.9, 450.10(A)	
☐	7.	Check transformers for ready access or proper installation in the open or in hollow spaces.	450.13	
☐	8.	Verify that transformers are supplied with a disconnecting means.	450.14	
☐	9.	Check indoor dry-type transformers for separation from combustibles or, based on ratings, installation in fire-resistant rooms or vaults.	450.21	
☐	10.	Check outdoor dry-type transformers for weatherproof enclosures.	450.22	
☐	11.	Verify that liquid-insulated transformers are installed in accordance with the requirements for the location and type of insulating liquid.	450.23 through 450.28	
☐	12.	Check transformer vaults for adequate construction, access, ventilation, and drainage and for foreign systems in vaults.	450.41 through 450.48	

Self Cheack1	Written Test

Short Answer

1. Define Inspection
2. Inspection records Includes

Note:

Satisfactory rating above 5 out of 8 points **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score =________
Rating =________

Name__________________________ **Date** ____________________

2.1. Introduction to Documentation

It is a record or the capturing of some event or thing so that the information will not be lost.

Maintenance documentation

Service contract or in-house preventive maintenance is documented. This documentation is required for annual maintenance. Maintenance performed at other times, with the exception of routine cleaning, is documented.

The documentation includes:

- description of the maintenance;
- date it was done; and
- name of the service representative and company, or name of
- the analyst if maintenance provided internally.

Repair equipment are documented.

The documentation includes:

- initials of the analyst, and the date the problem was observed,
- description of the problem;
- date and initials of the analyst or service represent at performing the repair;
- synopsis of the repair; and
- cost of repair, copy of the invoice and any additional information (not required).

Reading the service manual

It is difficult to repair any piece of complicated equipment without some service literature. It is possible to repair electronic equipment without the service manual, but it can be very time-consuming. You can lose a lot of valuable servicing time if you are without a good service manual. The service manual is a set of document prepared by the manufacturer to help the service technician to repair or service that set of equipment. A well written manual is the best servicing aid. It contains the following information:

- ✓ Describe how a circuit works

- ✓ Block diagram of the equipment
- ✓ Circuit diagrams
- ✓ Signal and voltage test points
- ✓ Adjustment procedure
- ✓ List of accessories
- ✓ List of spare parts with the part numbers, values, tolerances and ratings
- ✓ Fault diagnosis steps, generally in the form of flow charts
- ✓ Preventive maintenance layout
- ✓ Safety precautions to be observed while handling the equipment.

A service manual can be very expensive, but it is worth the investment. With the help of a service manual, a service technician or engineer can:

- ✓ Align, calibrate and test the equipment correctly to get the optimum output
- ✓ Locate a fault quickly
- ✓ Use the correct replacement part Conduct preventive maintenance correctly

By using the right service manual, as well as with the assistance of good tools, testing equipment and your own experience, you are set to multiply your troubleshooting power!!!

Self Cheack2	Written Test

Short Answer

1. Repair equipment documentation includes:

Note:

Satisfactory rating above 5 out of 8 points **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score =________
Rating =________

Name__________________________ **Date** ____________________

Information sheet 3	Observing housekeeping procedure

Self Cheack3	Written Test

Note:

Satisfactory rating above 5 out of 8 points **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score =________ Rating =________

Name_________________________ **Date** ____________________

Information sheet 4	Disposing waste materials.

Introduction

Electronic waste (sometimes called e-waste) is a term used to describe electronics that are nearing the end of their useful life and are discarded, donated, or recycled. Although donating and recycling electronic devices conserves natural resources, you may still choose to dispose of e-waste by contacting your local landfill and requesting a designated e-waste drop off location. Be aware that although there are many options for disposal, it is your responsibility to ensure that the location chosen is reputable and certified

Disposal of E-waste is electronic waste.

This includes old computers and their components, cell phones, digital cameras and other electronic gadgets. There often are heavy metals and other hazardous components inside the electronics that require special care when disposing of them. They may also have personal information on the hard drives that can be copied, putting your identity at risk. This will require preparing the items for disposal.

Contact the manufacturer of the product and ask if it accepts e-waste for disposal. Apple, for example, will accept your old computer for disposal when you purchase a new one from them. Some manufacturers accept other brands' e-waste for a small fee.

Contact a nearby electronics retailer and inquire into its disposal programs. Best Buy in its stores such small items as cell phone batteries and hosts recycling weekends for e-waste. Other retailers also offer similar programs.

Contact your city, county or private waste management office. Many offer e-waste programs or have e-waste events for customers. Contact private waste companies and recyclers to see if they accept e-waste.

Research donation options. Such charities as Goodwill may accept your old electronics and computers as a donation. Some cell phone companies accept old phones and then donate them.

Prepare your item for disposal. Remove any memory cards from phones or cameras. Reset the memory on the phone following the instructions in your model's manual. Erase everything on your computer's hard drive. Some recyclers will do this for you, but inquire about this service before bringing your e-waste to them.

Self Cheack1	Written Test

Short Answer

1. What is E-Waste?
2. List E-Waste.

Note:

Satisfactory rating above 5 out of 8 points **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score =________
Rating =________

Name__________________________ **Date** ____________________