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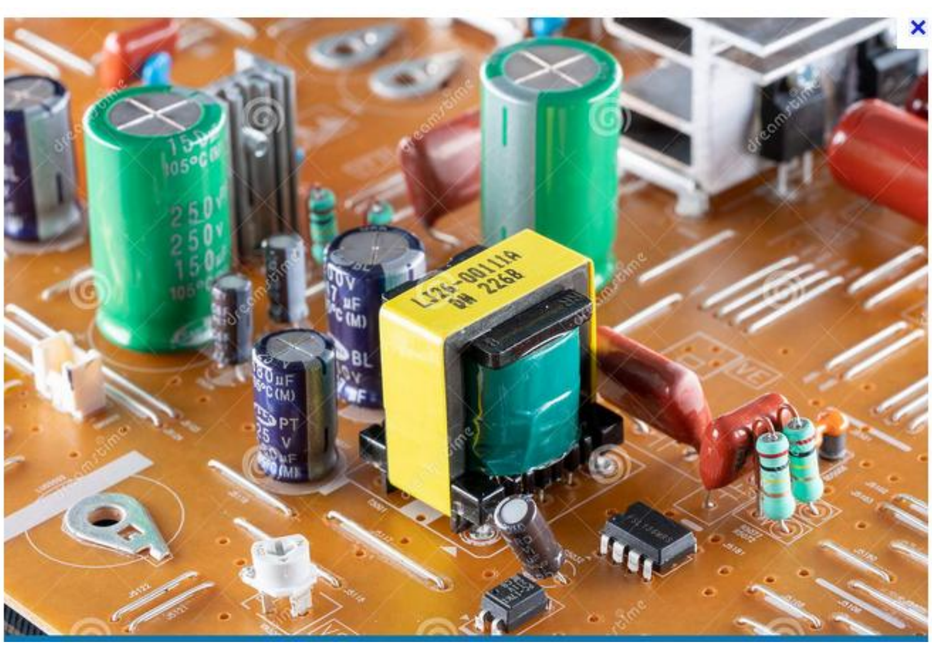
Ministry of Labor and Skills

Industrial Electrical/Electronic Control Technology

LEVEL – II

Based on March, 2022 Curriculum Version 1



Module Title: - Testing and Constructing Linear and Switch Mode Power Supply System

Module code: EIS IEC2 M06 0322

Nominal duration: 50Hour

Prepared by: Ministry of Labour and Skill

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Addis Ababa, Ethiopia

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Ministry of Labor and Skills

Table of Content

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

AC- alternating current
DC- direct current
SMPS –switch mode power supply
LPS-linear power supply

Introduction to the Module

Testing and Constructing Linear and Switch Mode Power Supply System module is developed to equip the trainees with their acquired learning outcomes in Prepare product and work station for troubleshooting, Diagnose faulty parts of power supply, maintain/ repair the power supply unit, and Test and inspect repaired products.

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This module covers the units:

- Prepare product and work station for troubleshooting
- Diagnose faulty parts of power supply.
- Maintain/repair the power supply unit
- Test and inspect repaired products

Learning Objective of the Module

- Prepare product and work station for troubleshooting
- Perform Diagnose faulty parts of power supply.
- Carry out Maintain/repair the power supply unit
- Perform Test and inspect repaired products

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise3.1. Electrical /electronic

Unit one: Prepare product and work station for troubleshooting

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

- Consult responsible person
- Prepare and Check materials, tools and equipment
- Obtain Parts needed to complete the work

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

- Consult responsible person
- Prepare materials, tools and equipment
- Obtain Parts needed to complete the work

1.1 Consult 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.

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.

1.2 Prepare materials, tools and 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

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

Table 1

S.N	**Consumable Materials**
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

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

Table 2

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

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

Table 3

S.N	Equipment’s	Specifications
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

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.

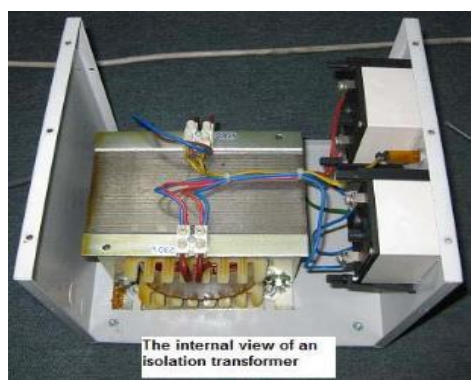

Figure1.1. Isolation Transformer

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.

Figure1.2. 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).

Figure1.3. Digital Capacitance Meter

4. Blue ESR Meter

Figure1.4. Blue ESR Meter

5. Blue Ring tester

Figure1.5. Blue Ring tester

6. Oscilloscope

Figure1.6. Analogue and digital Oscilloscope

1.3 Prepare and obtain 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.

1.3.1 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**

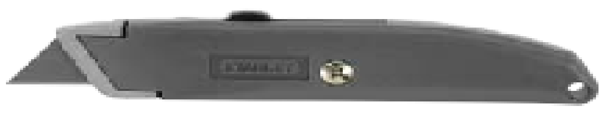

Figure 1.7 Utility knife

- **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.

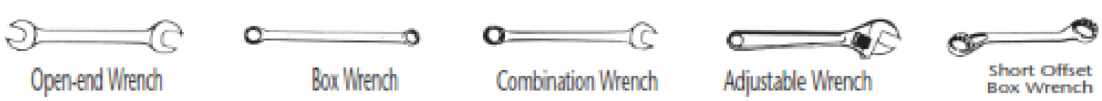

Figure 4.2. Different types of wrenches

- **Allen key**

Figure 1.8. Allen key

- **Screwdrivers**

Screws are made in different sizes, and they’re designed to be turned by screwdrivers of the corresponding sizes.

Figure 1.9 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 1.10 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.

Figure1.11. 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.

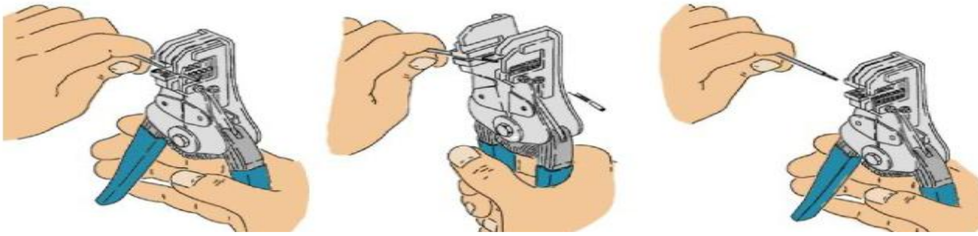

Figure 1.12. Wire Strippers

- **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 1.13 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 1.14 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 1.15. 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.

Figure1.16 Ball Peen Hammer

1.3.2 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.

Figure1.17. 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),

Figure1.18 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.

Figur 1.20 Solder sucker

- **Vernier Caliper**

Figure1.21 Vernier Caliper

- **Micrometer**

Figure1.22 Micrometer

1.3.3 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.

Figure41.23. Solders

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

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

.

Figure1.24. 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.

Figure1.25. PCB rubber

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

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

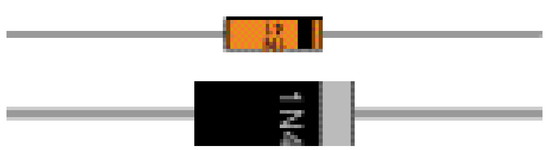

Figure1.26. Rrectifiers diode,

- **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).

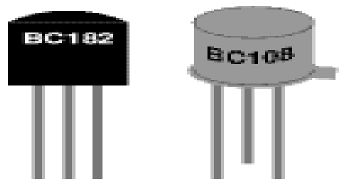

Figure1.27. General purpose NPN transistors

- **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.

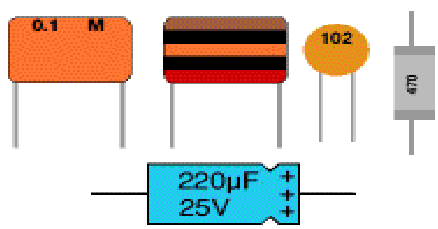

Figure 1.28. Capacitor

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

Figure1.29 Solid Copper-wire

- **Stranded Wires**

Figure1.30. Stranded Wires Copper-wire

Self-Check 1.1

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

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

Unit Two: Diagnose faulty parts of power supply

This unit to provide you the necessary information regarding the following content coverage and topics:

- Follow troubleshooting procedures
- use test instruments
- Identify and explain defects/fault parts
- Advise customers regarding the status of the unit
- Document results of diagnosis and testing

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

- Follow troubleshooting procedures
- use test instruments
- Explain defects/fault parts
- Advise customers regarding the status of the unit
- Carry out Document results of diagnosis and testing

2.1 Follow troubleshooting procedures

2.1.1 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.

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.

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

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.

- **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.

- **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.

2.2 Introduction to testing instruments.

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.

Figure2.1 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.

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. 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.

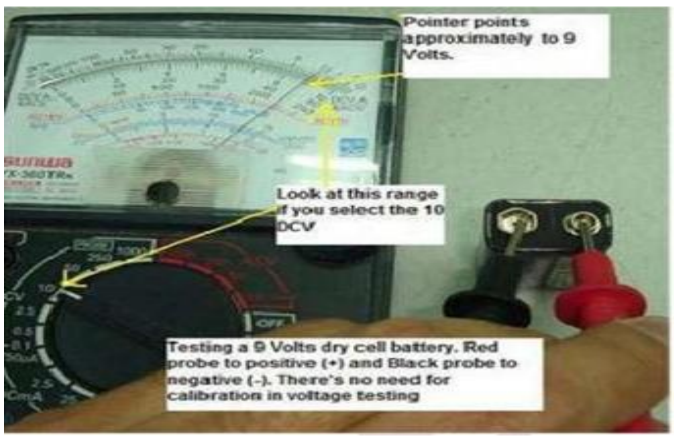

Figure2.2 Measuring the voltage using analogue meter

Figure2.3 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.

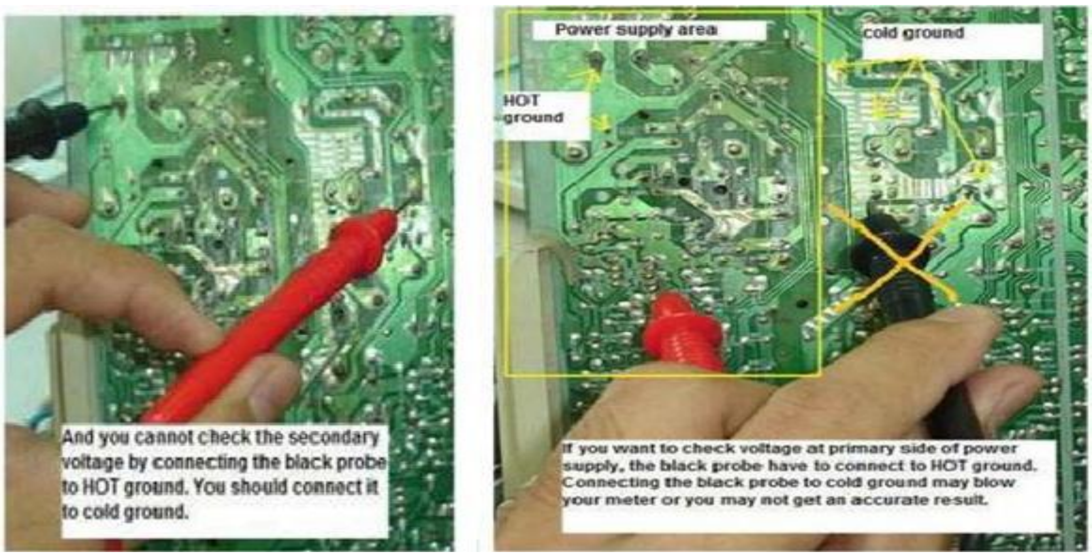

Figure2.4 Measuring Voltage in a circuit

- **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.

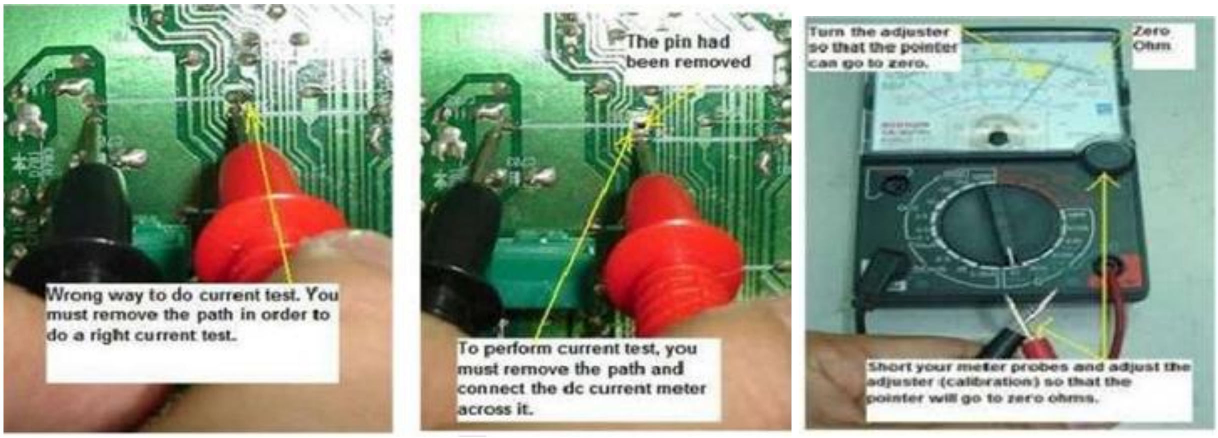

Figure2.5 Measuring current in a circuit

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

Figure2.6. Measuring the resistance (a) in the circuit (b) resistance-wire and (c)a resistor

Figure2.7. 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.

Figure2.8 The clamp-on ammeter

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.

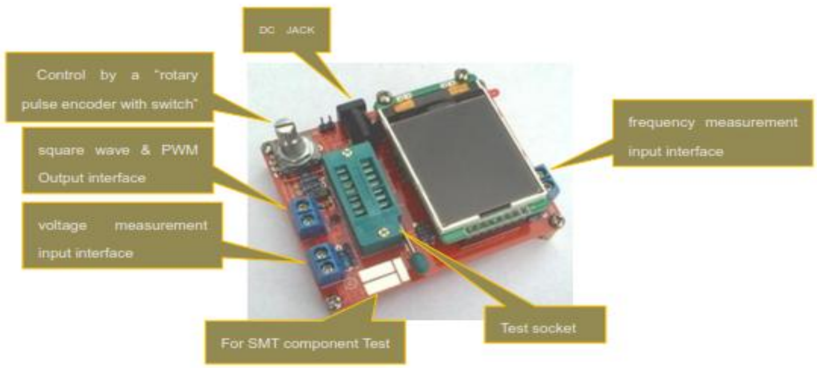

Figure2.9 Parts of Transistor tester

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.

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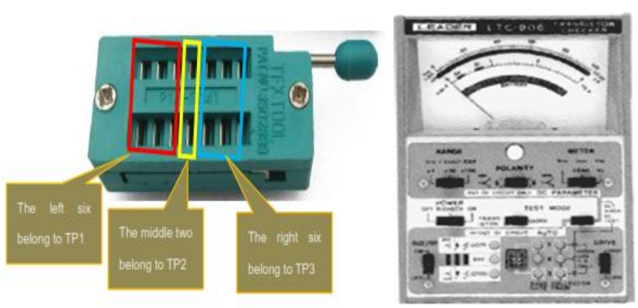


Figure2.10. Transistor Tester and Test points (socket)

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.

Introduction to Power Supply

Power supply

A **power supply** is a device that supplies electric power to an electrical load. The term is most commonly applied to electric power converters that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (mechanical, chemical, solar) to electrical energy. 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.

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.

$$E_p \text{ x } I_p = E_s \text{ x } I_s$$

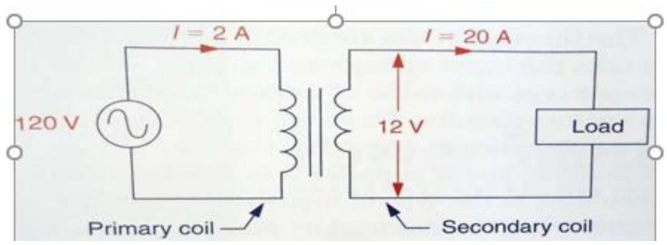


Figure2.11. *Schematic diagram of a Step-Down Transformer*

- **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)

$$E_p \text{ x } I_p = E_s \text{ x } I_s$$

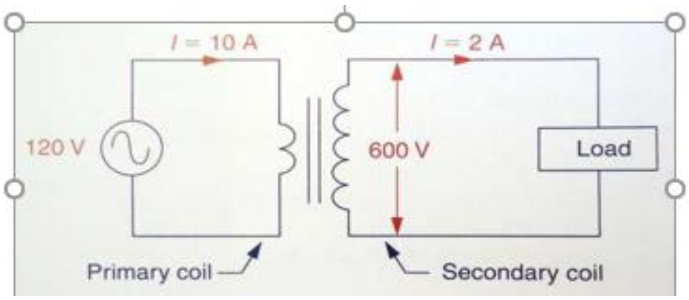


Figure2.12.. *Schematic diagram of Step-Up Transformer*

- **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)

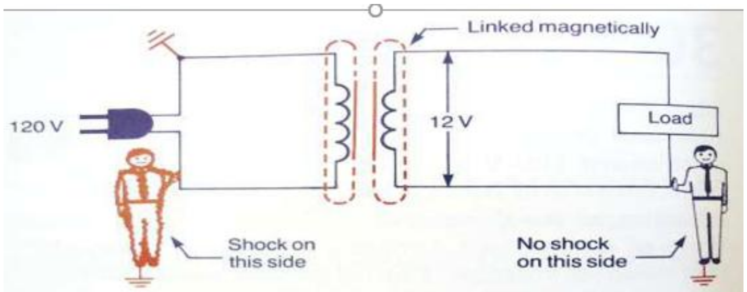


Figure2.13.. *Schematic diagram of an Isolation Transformer*

- **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.

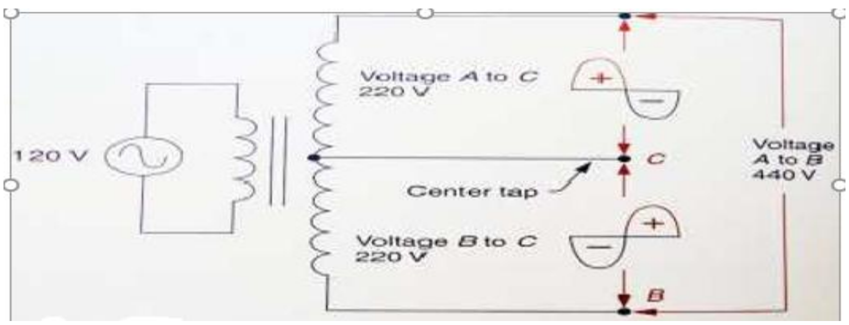


Figure2.14.. *Schematic diagram of a Center-tapped Transformer*

- **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.

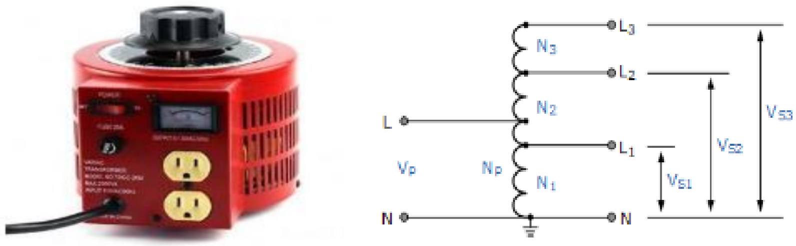


Figure2.15.*Variable AC power supply and Schematic diagram of an autotransformer Transformer*

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.

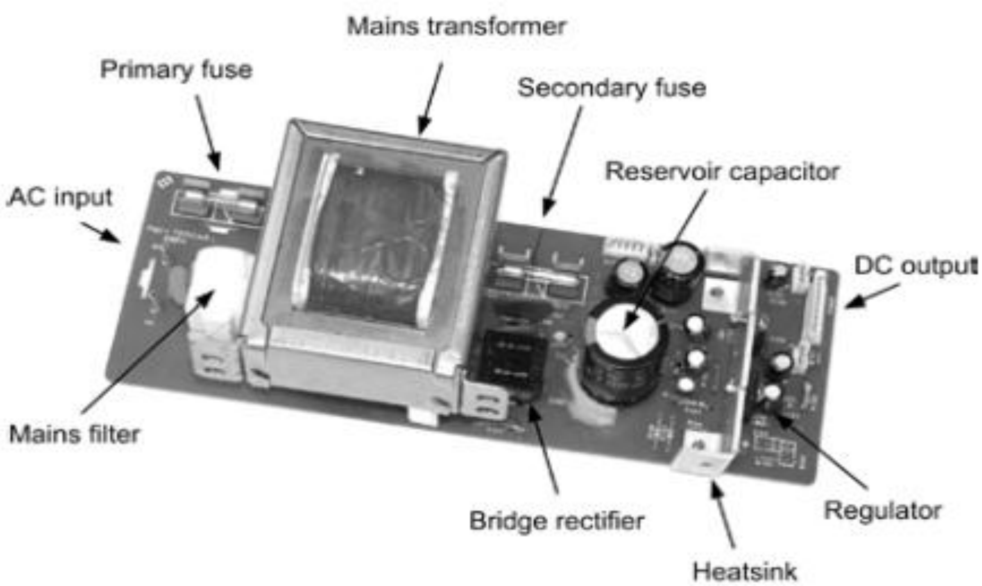


Figure2.16.*A simple and Dual Polarity DC power supply*

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

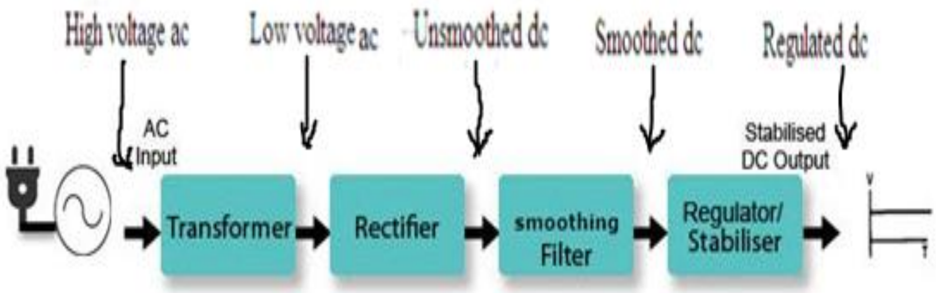


Figure2.17 *Block diagram of regulated dc power supply*

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.

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.

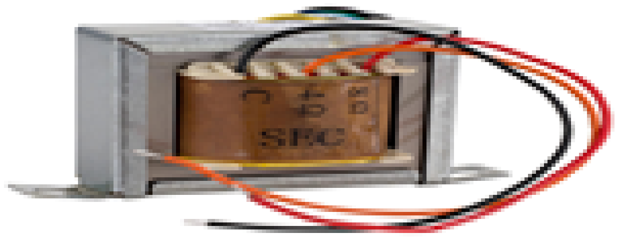


Figure2.18 *Actual Step down transformer*

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.

Table2.1

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.

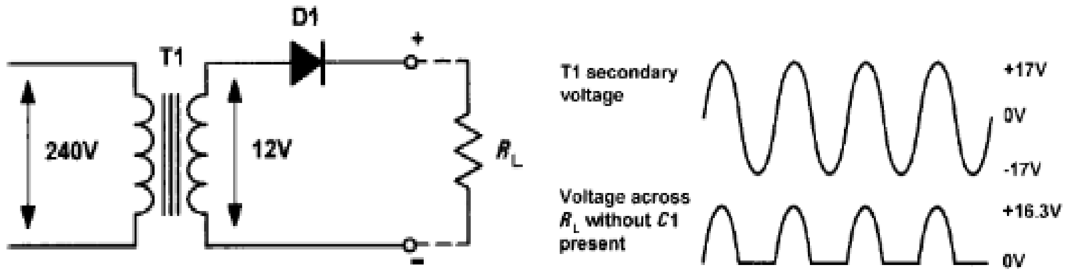


Figure4.33 Half wave Rectifier and its waveform.

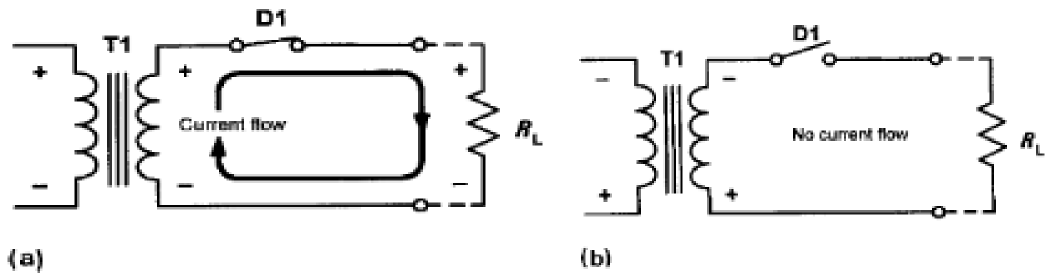


Figure2.19. *(a) Half-wave rectifier circuit with D1and (b) half-wave rectifier with D1 not conducting*

During a positive half cycle of input voltage, the diode conducts and the current flows through RL and the circuit developed VO= $\mathbf{I_L * R_L}$. 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. 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.

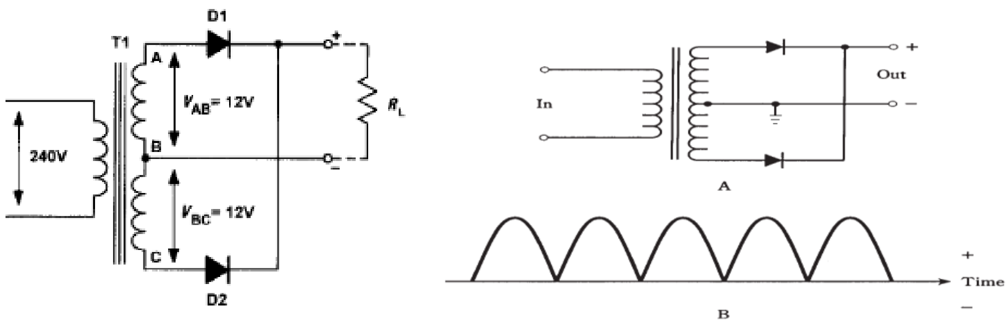


Figure2.20. *Schematic diagram of a full-wave, Center-tap rectifier and its out put*

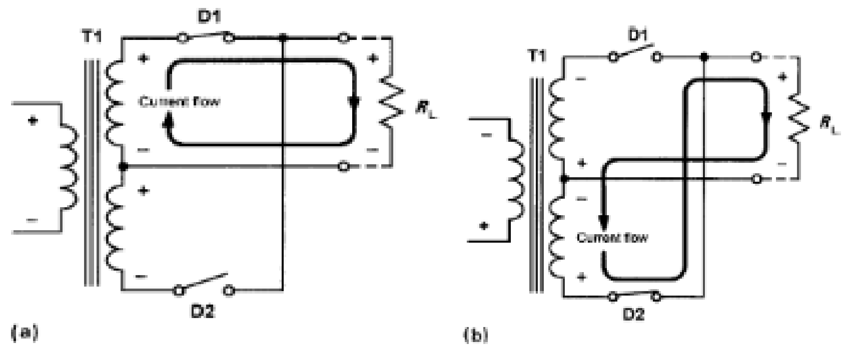


Figure2.21. *Schematic diagram of a full-wave, Center-tap rectifier with (a)D1conducting and D2 non-conducting (b) D2 conducting and D1 non-conducting*

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.

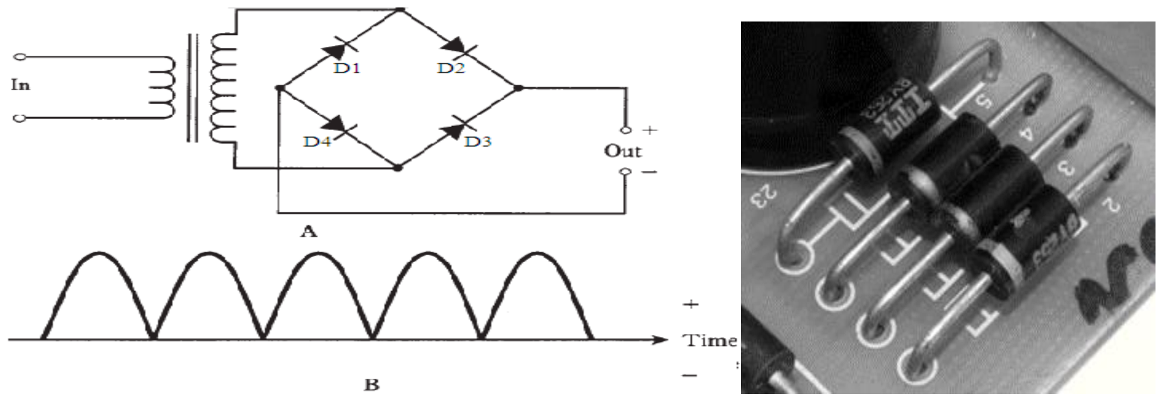


Figure2.22 *Schematic diagram of a full-wave bridge rectifier and its out put*

Figure2.23 *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.

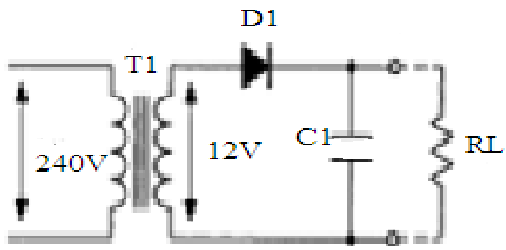


Figure2.24. *A half wave rectifier circuit with filter capacitor*

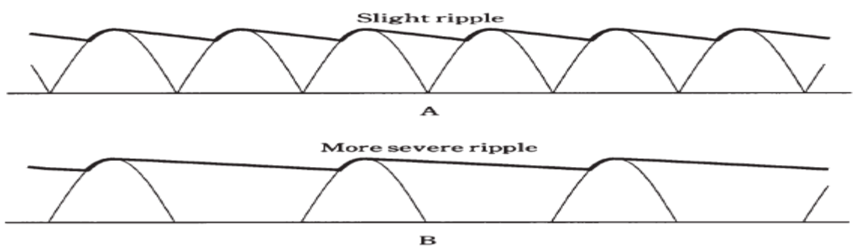


Figure2.25. *Filtered output for: (A) full-wave rectification and (B) half-wave rectification*

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.

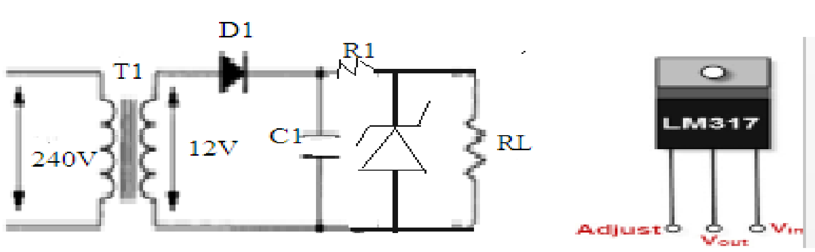


Figure4.42. Voltage regulator

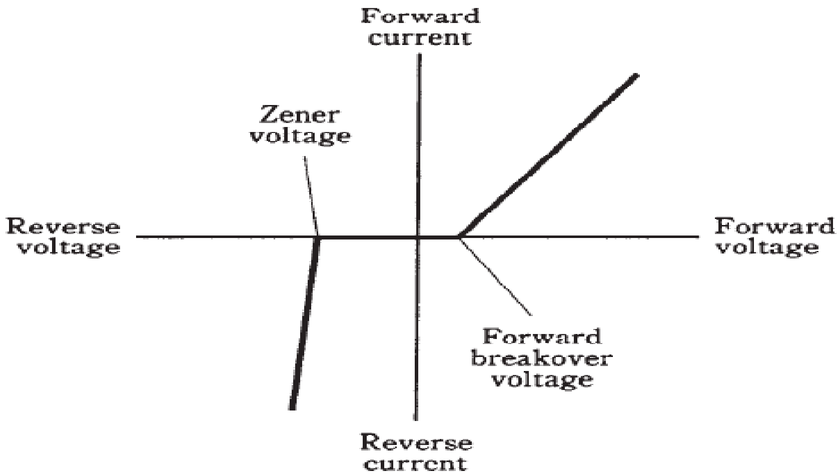


Figure2.26. *Current through a Zener diode, as a function of the bias voltage*

Types of dc power supply

1. **Un-Regulated dc power supply**

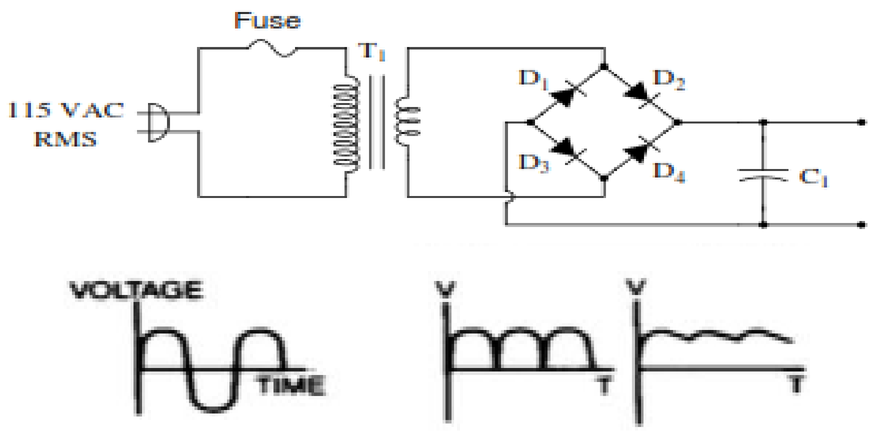


Figure2.27 *Schematic diagram and output of unregulated dc power supply*

2. **Regulated linear dc power supply**

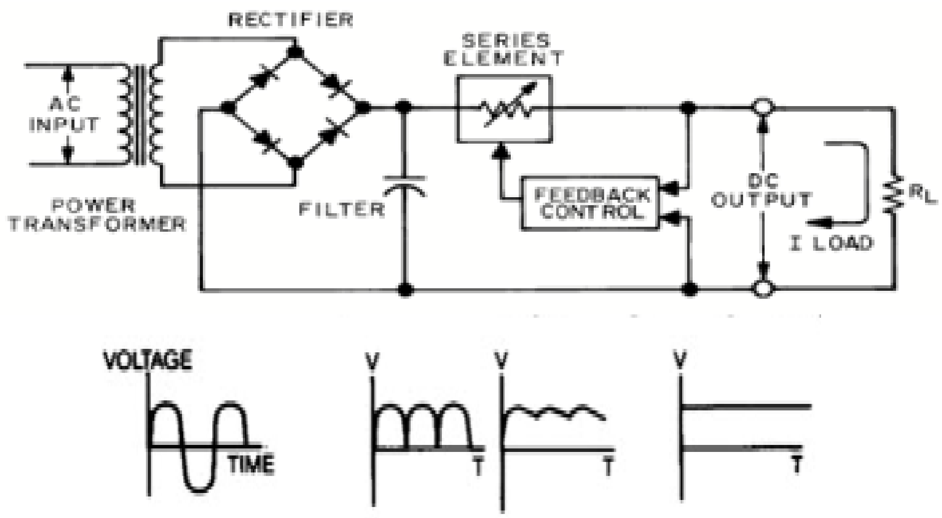


Figure2.28. *Schematic diagram of a regulated linear dc power supply*

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.

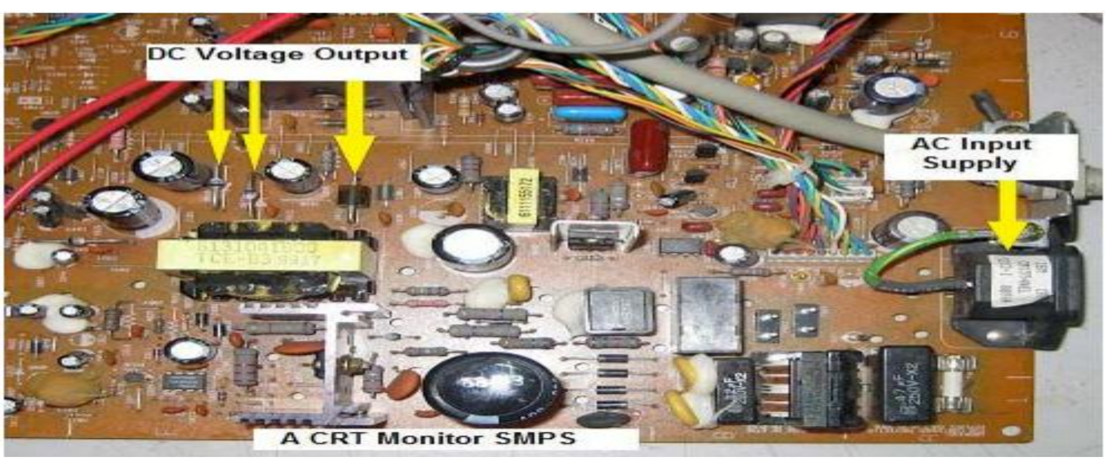


Figure2.29 *A CRT Monitor SMPS Board*

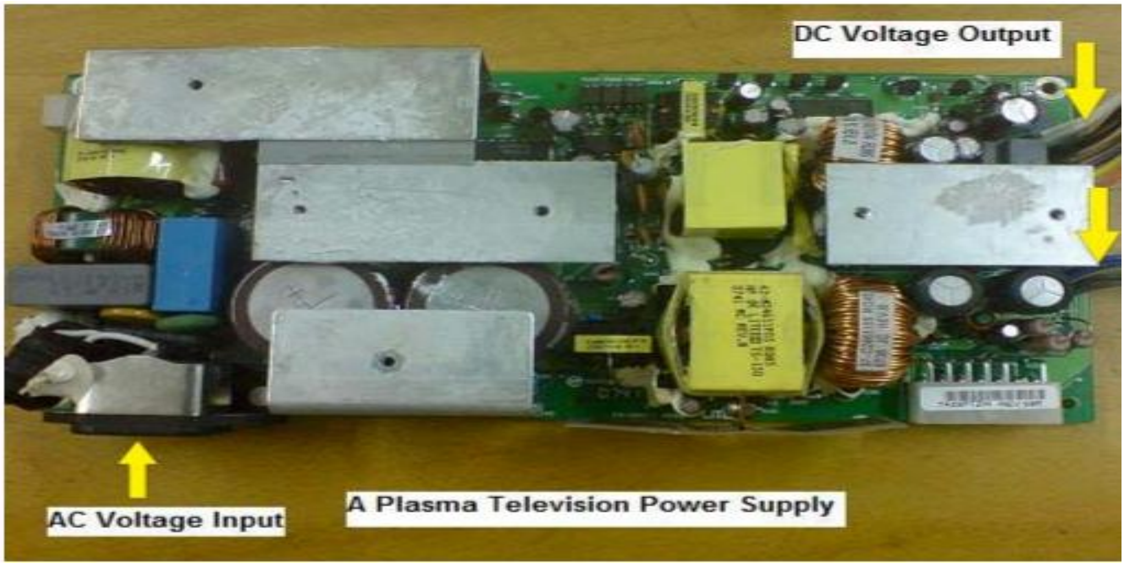


Figure2.30 *A Plasma Television Monitor SMPS Board*

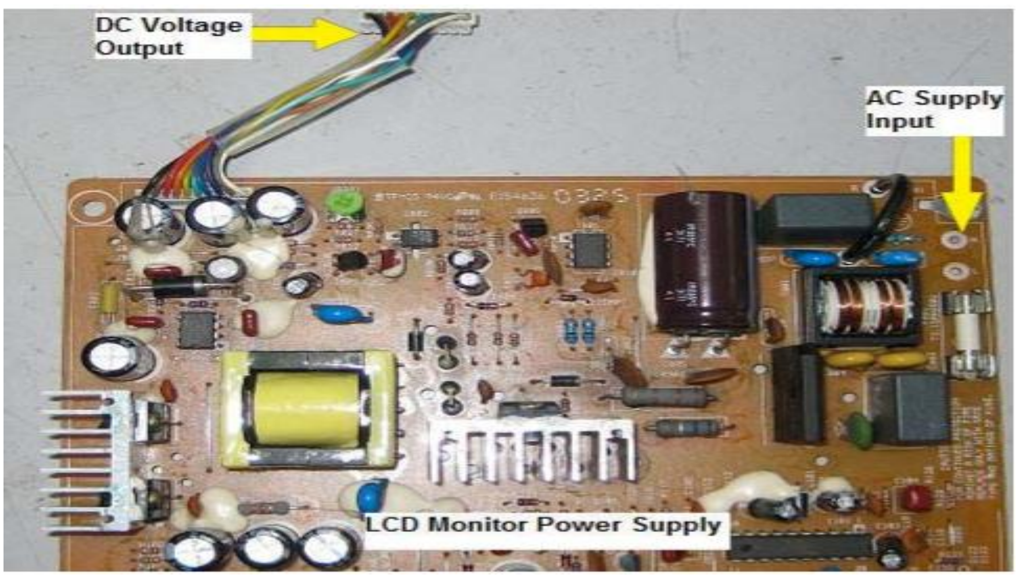


Figure2.31. *LCD Monitor SMPS Board*

Figure2.32. *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.

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.

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.

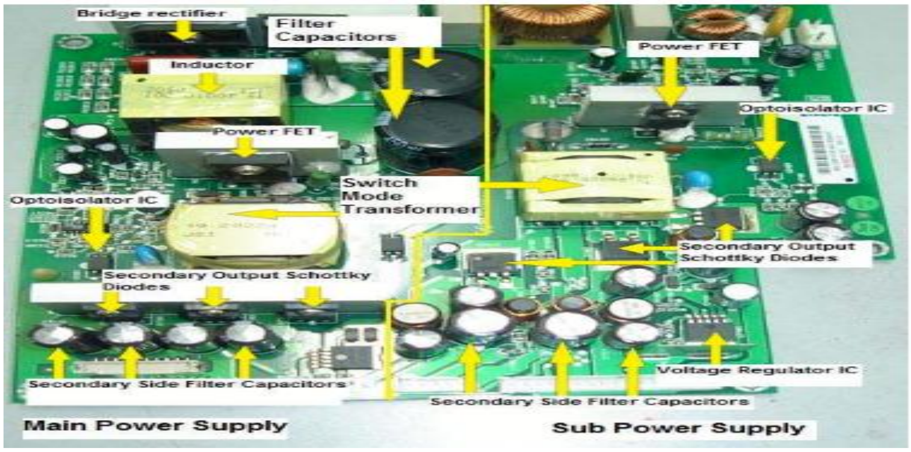


Figure2.33 *typical LCD Monitor SMPS*

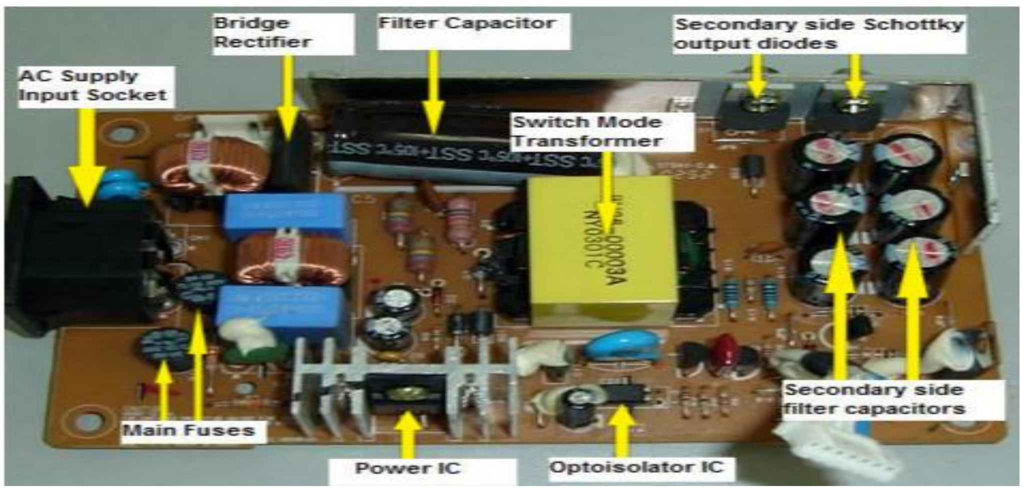


Figure2.34. *A typical Samsung LCD Monitor SMPS Board*

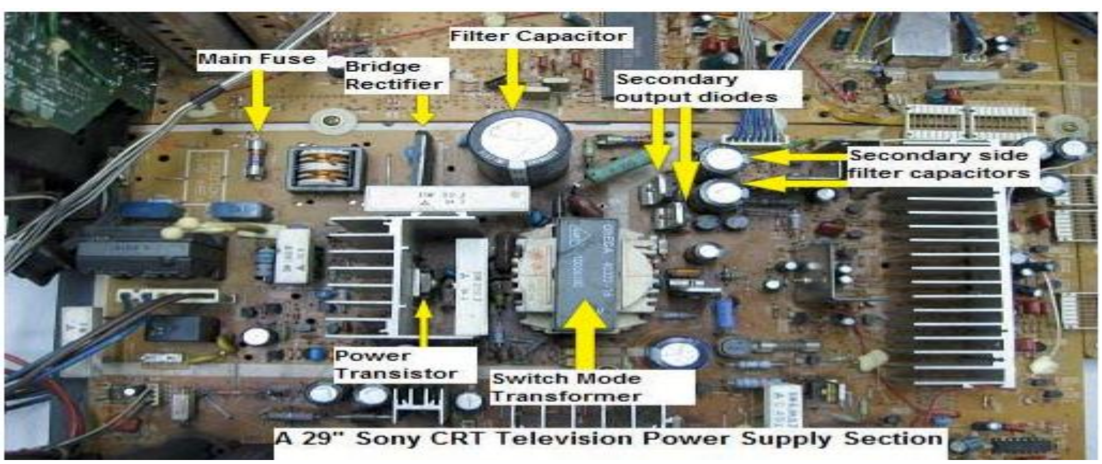


Figure2.35. *A 29 Inch Sony CRT Television SMPS (Primary Side)*

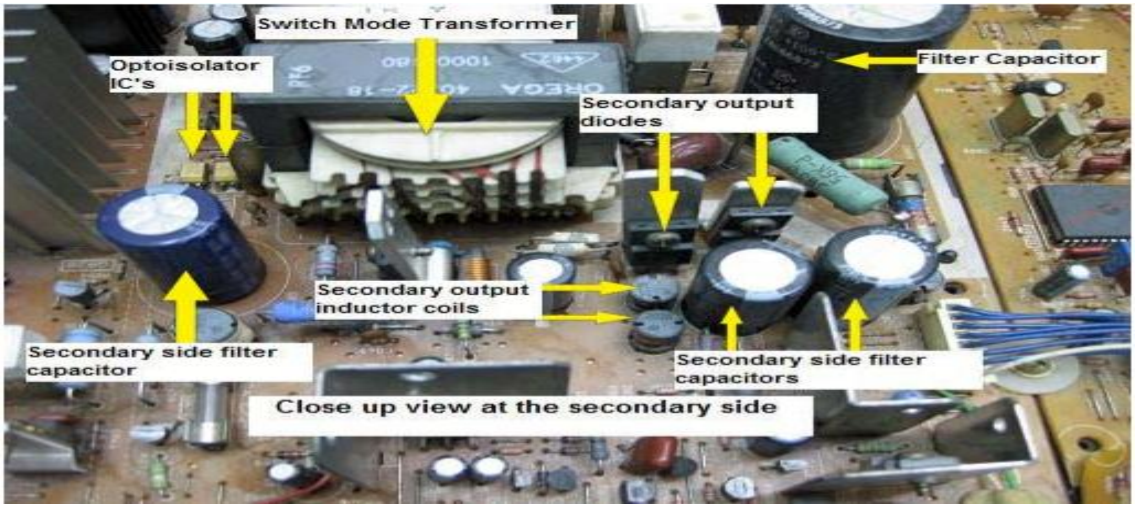


Figure2.36. *A 29 Inch Sony CRT Television SMPS (Secondary Side)*

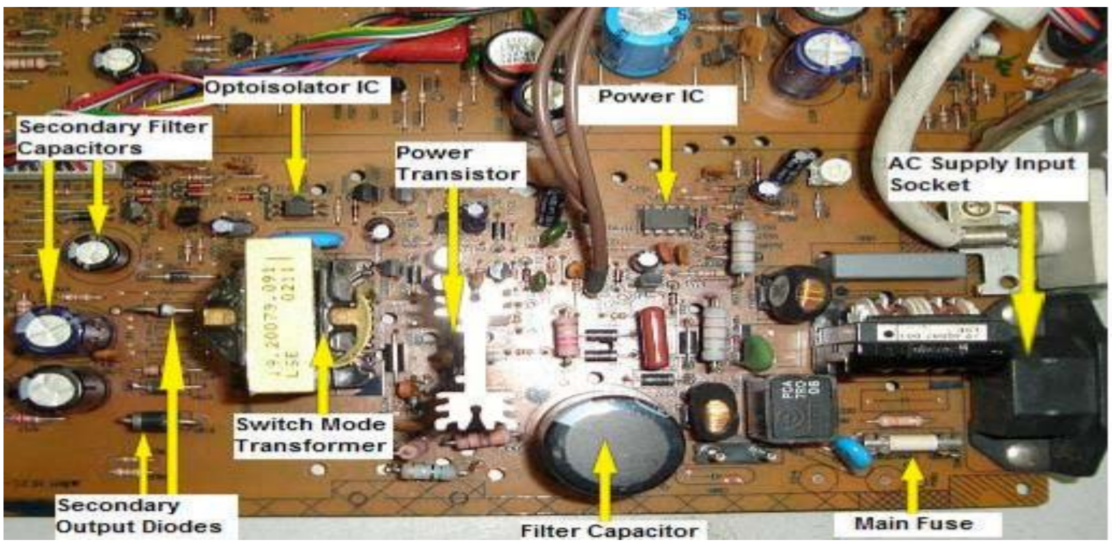


Figure2.37. *A Typical CRT Monitor SMPS Board*

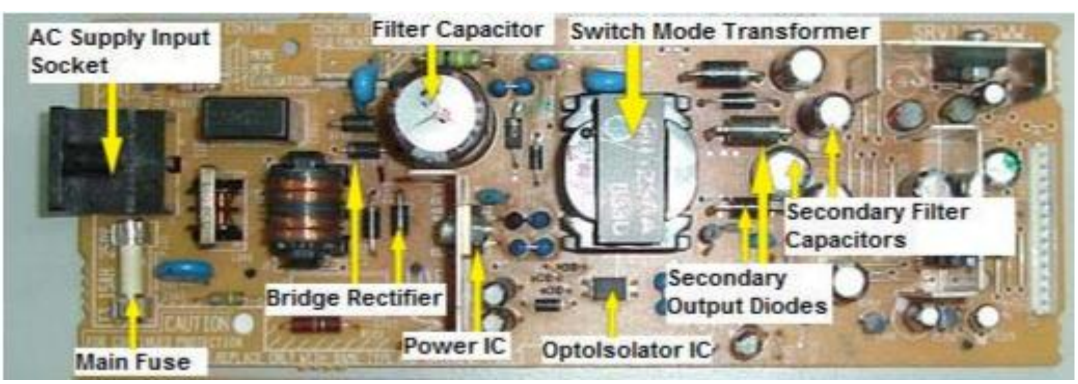


Figure2.38 *A Typical Satellite Receiver SMPS Board*

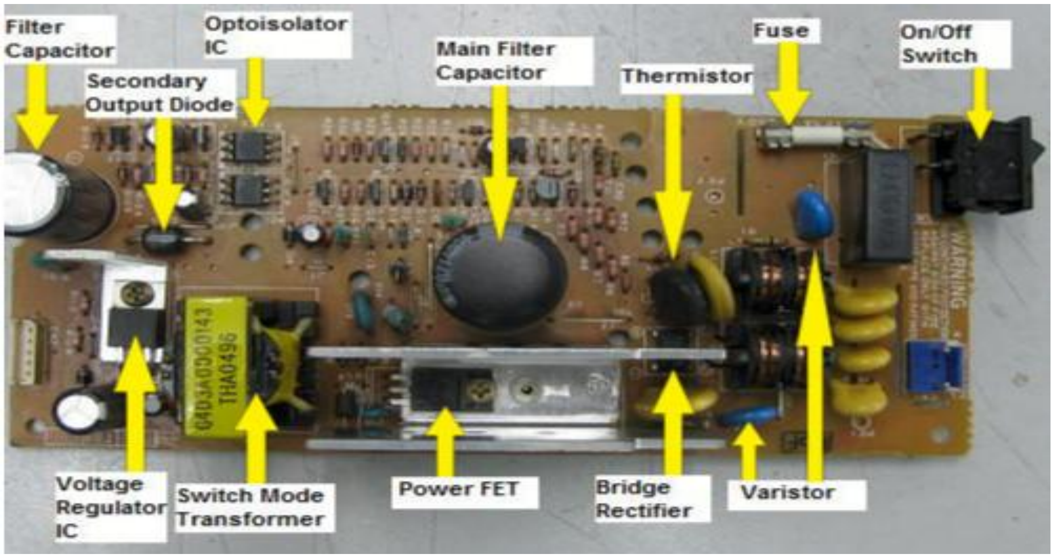


Figure2.39*A Typical Dot matrix Power Supply Board*

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.

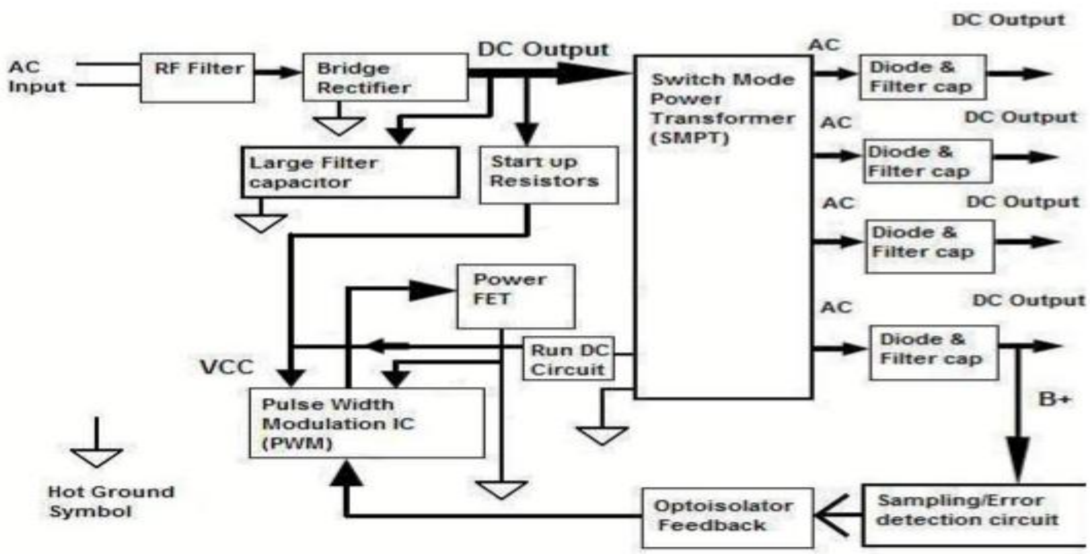


Figure2.40 *Block Diagram of a Typical SMPS*

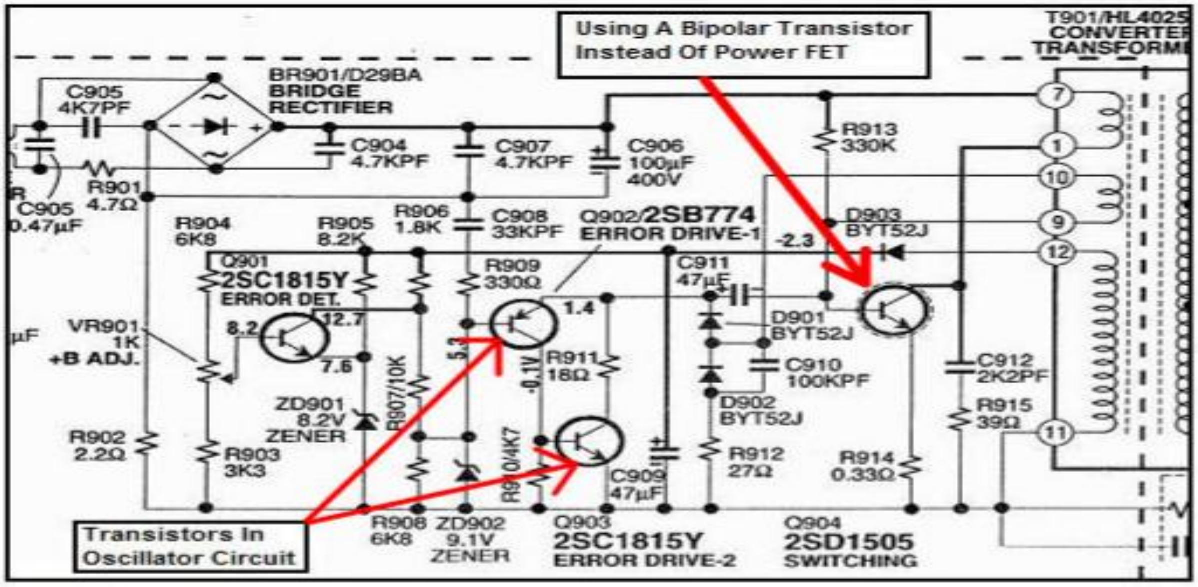


Figure2.41. *A Typical Television SMPS without Power IC.*

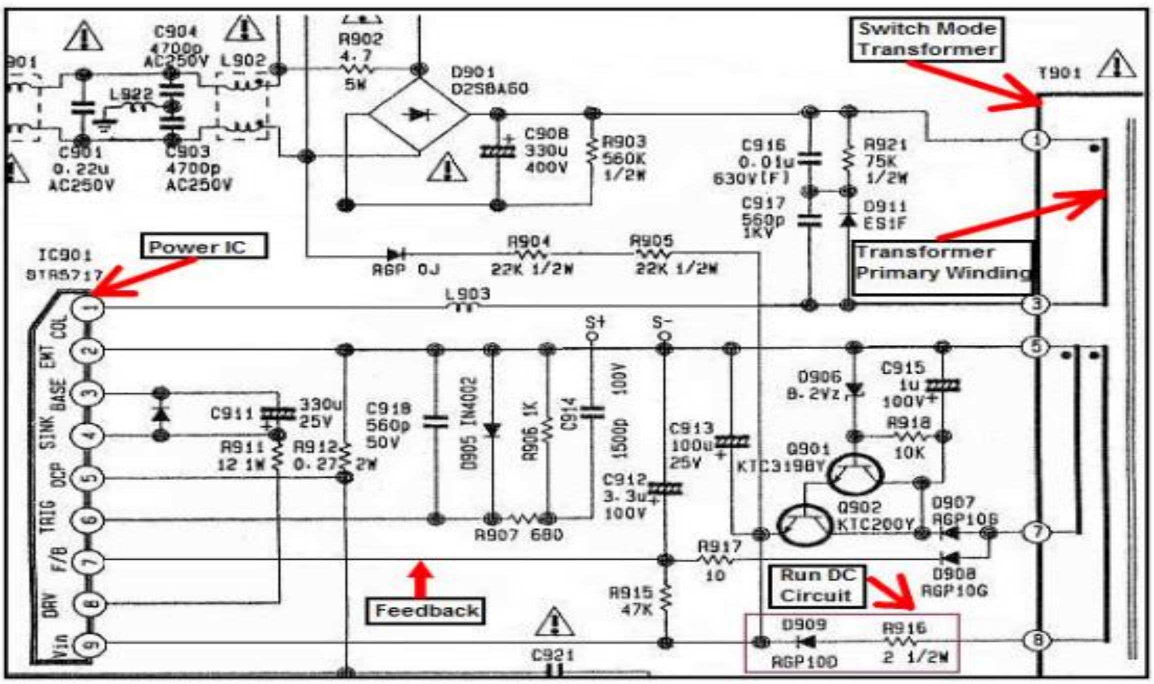


Figure2.42. *A Typical CRT monitorTelevision SMPS without Optoisolator IC*

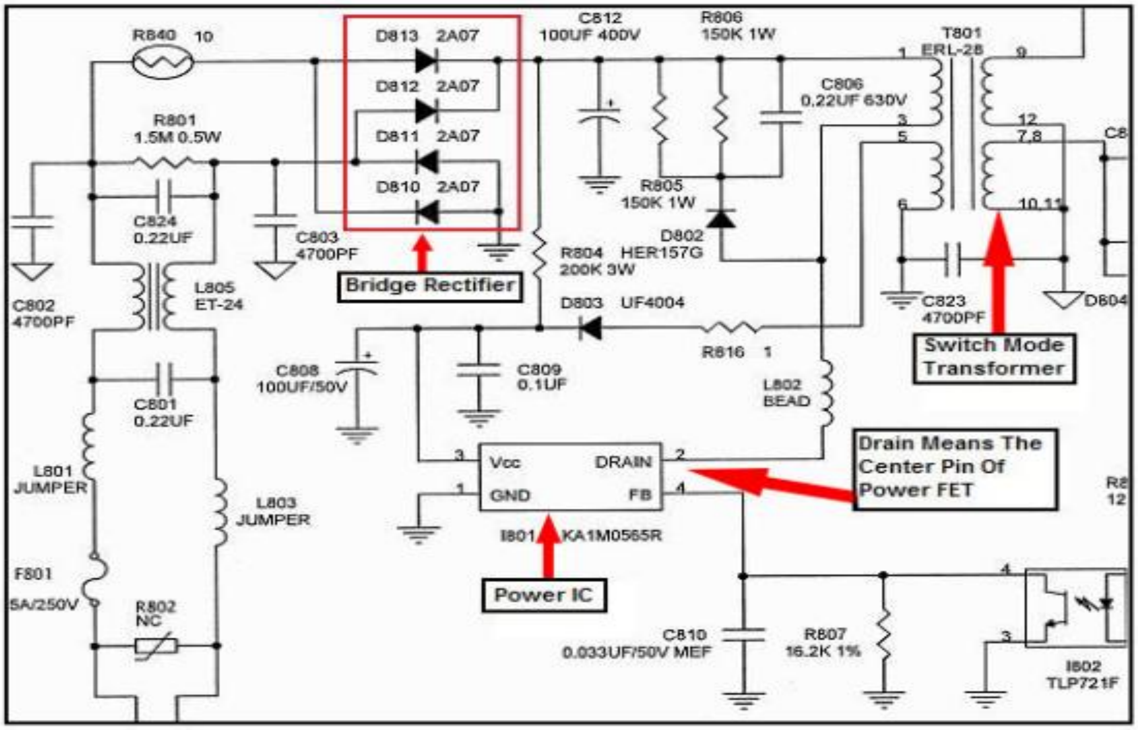


Figure2.43 *A Typical LCD Monitor SMPS withFET Integrated into power IC*

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.

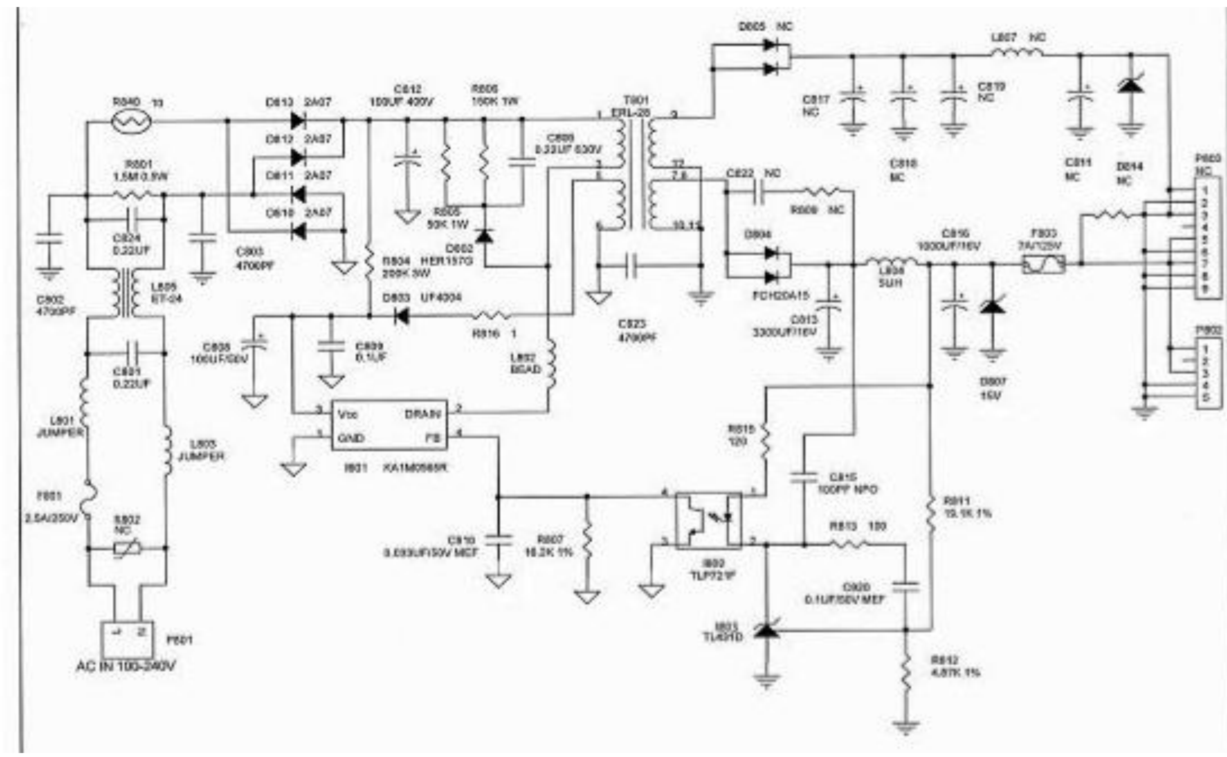


Figure2.44 *Schematic diagram of a Typical LCD Monitor SMPS.*

1. Input protection and EMI Filtering Circuit.

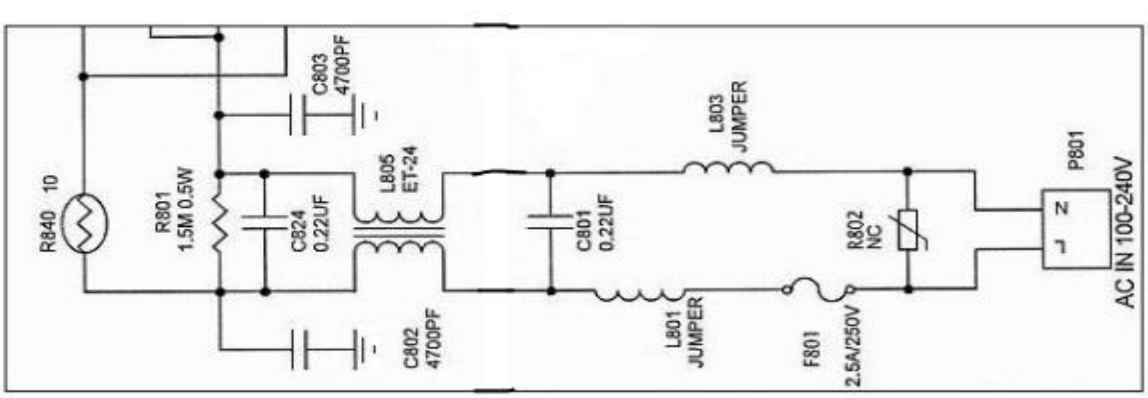


Figure2.45 *Input protection and EMI Filtering Circuit.*

- ✓ 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

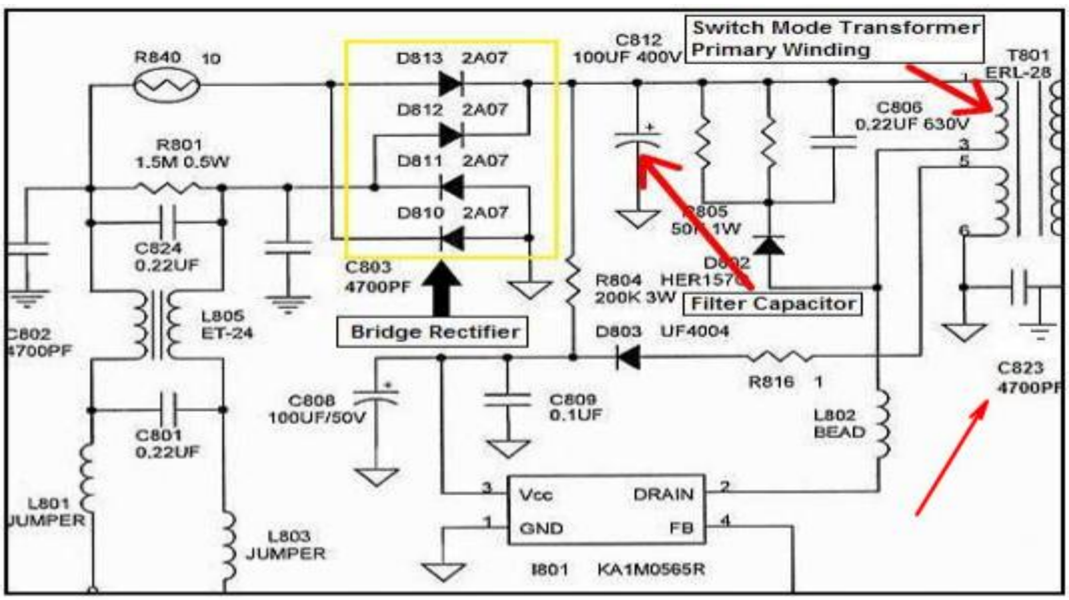


Figure2.46. *Bridge Circuit*

- ✓ 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.

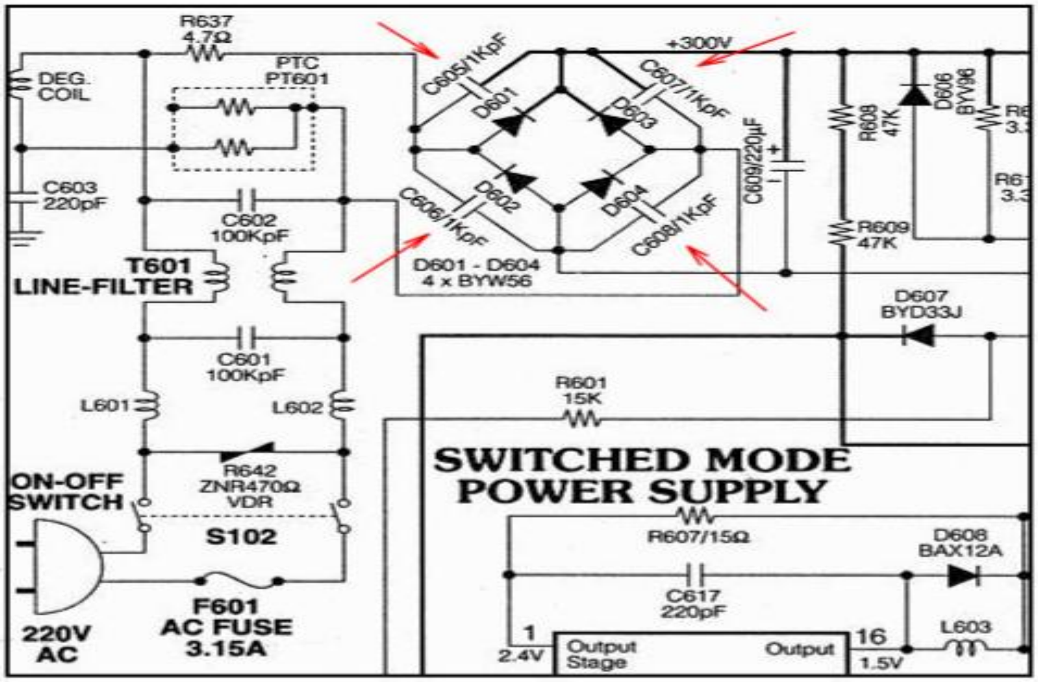


Figure2.47 *Capacitors Connected across Bridge Circuit*

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.

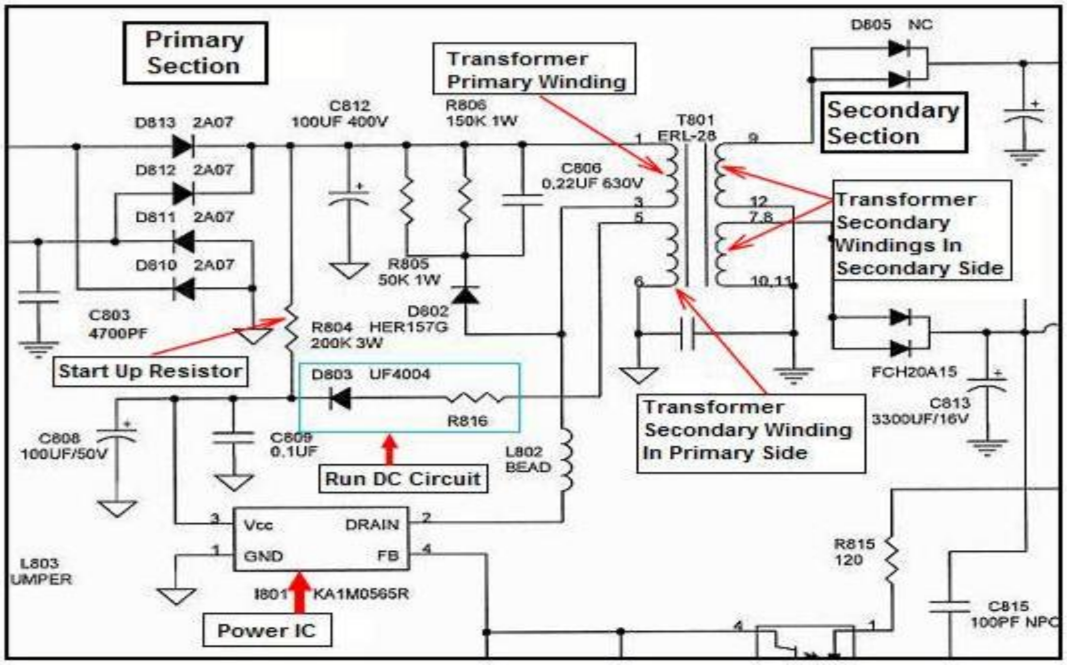


Figure2.48. *Start Up and Run DC Circuit.*

4. Oscillator Circuit.

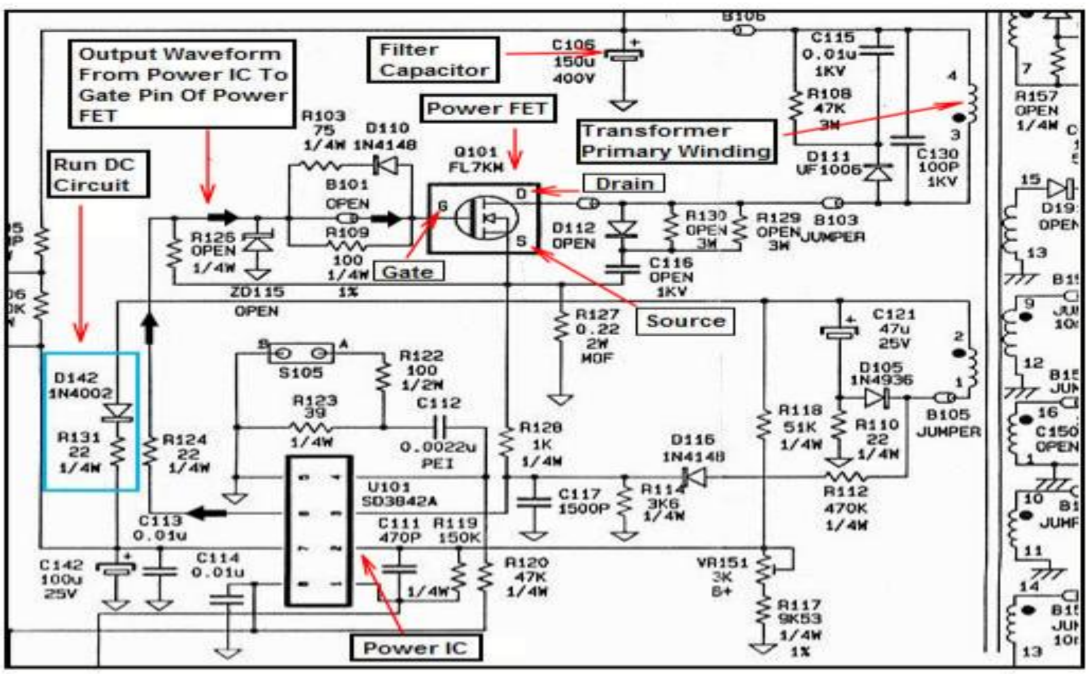


Figure2.49 *CRT Monitor SMPS Oscillator Circuit.*

5. Secondary output Voltage Circuit.

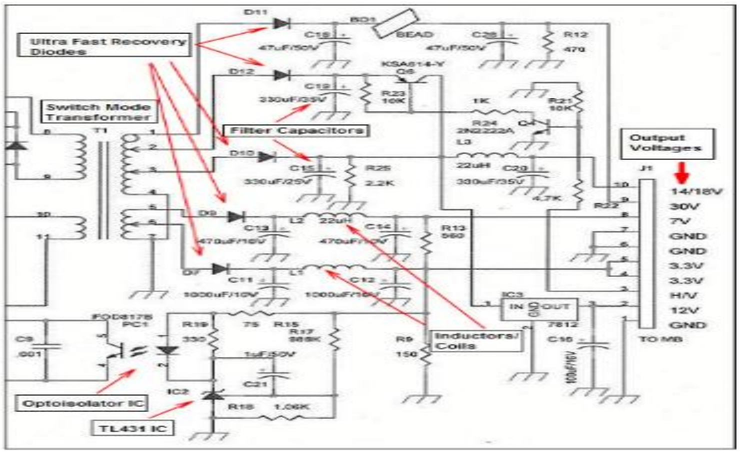


Figure2.50. *A typical Satellite Receiver Secondary Output Voltage Side Circuit*

6. Sampling Circuit.

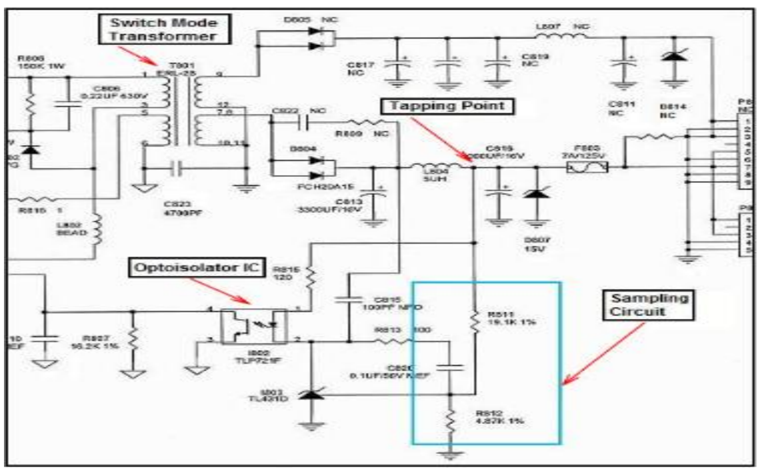


Figure2.51 *A typical LCD Monitor SMPS Sampling Circuit.*

7. Error Detection Circuit

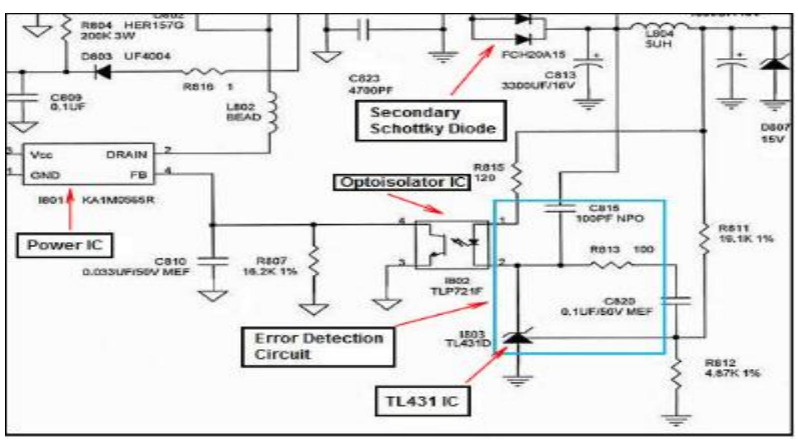


Figure2.52. *Error Detection Circuit LCD Monitor SMPS*

8. Feedback Circuit.

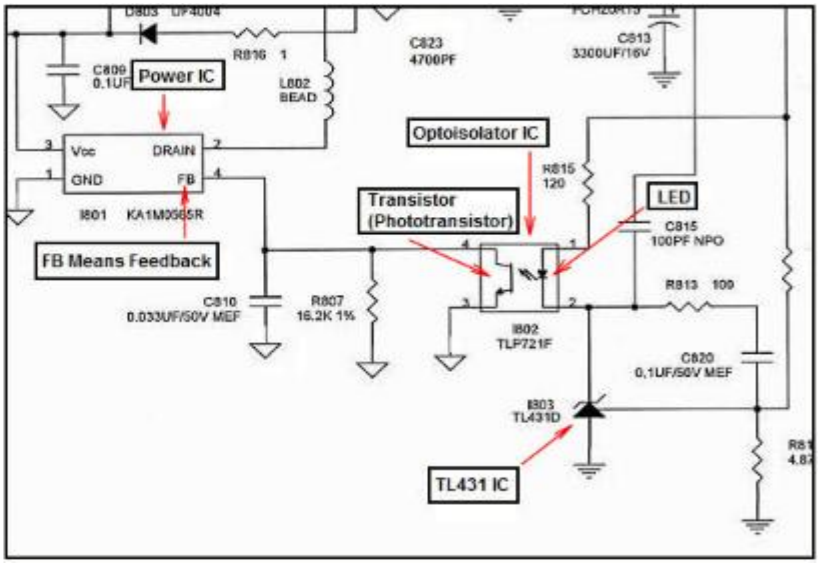


Figure2.53. *Feedback Circuit in LCD Monitor SMPS.*

9. Protection Circuit.

A. Surge Protection Circuit

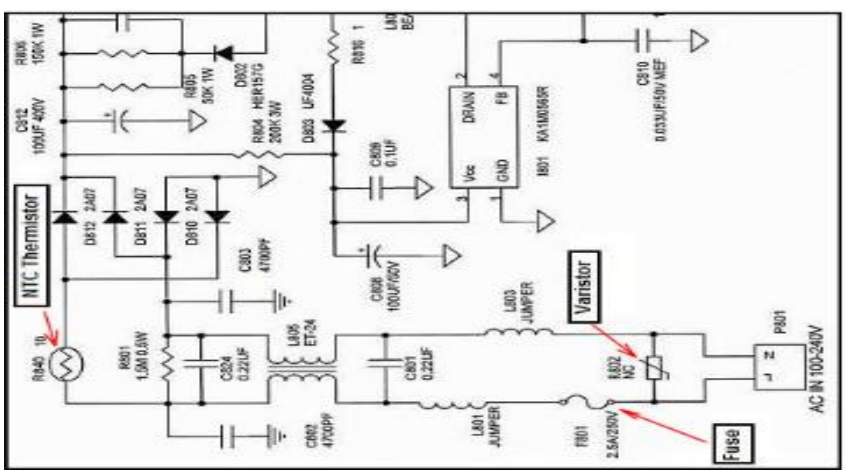


Figure2.54. *Surge Protection Circuit in LCD Monitor SMPS.*

A. Internal and External Over Voltage Protection Circuit

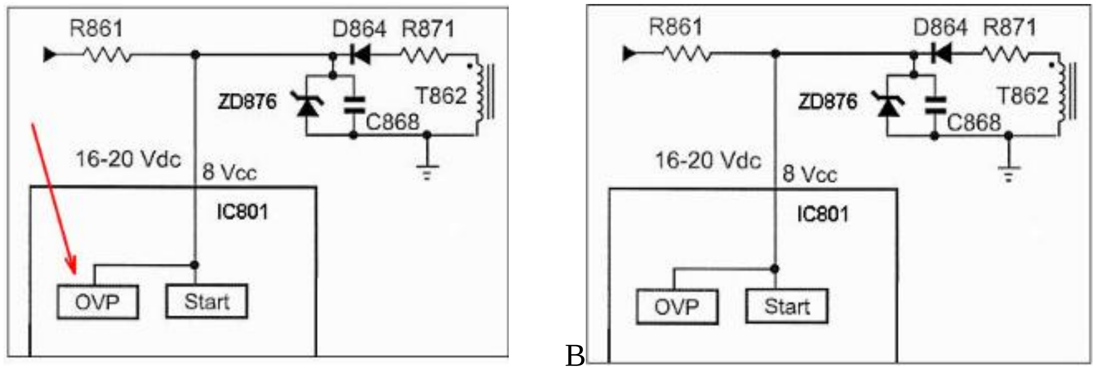
A B


Figure2.55. *A) Internal OVP Circuit in Power IC STRZ4117and B) External OVP Circuit*

B. Over Current Protection Circuit

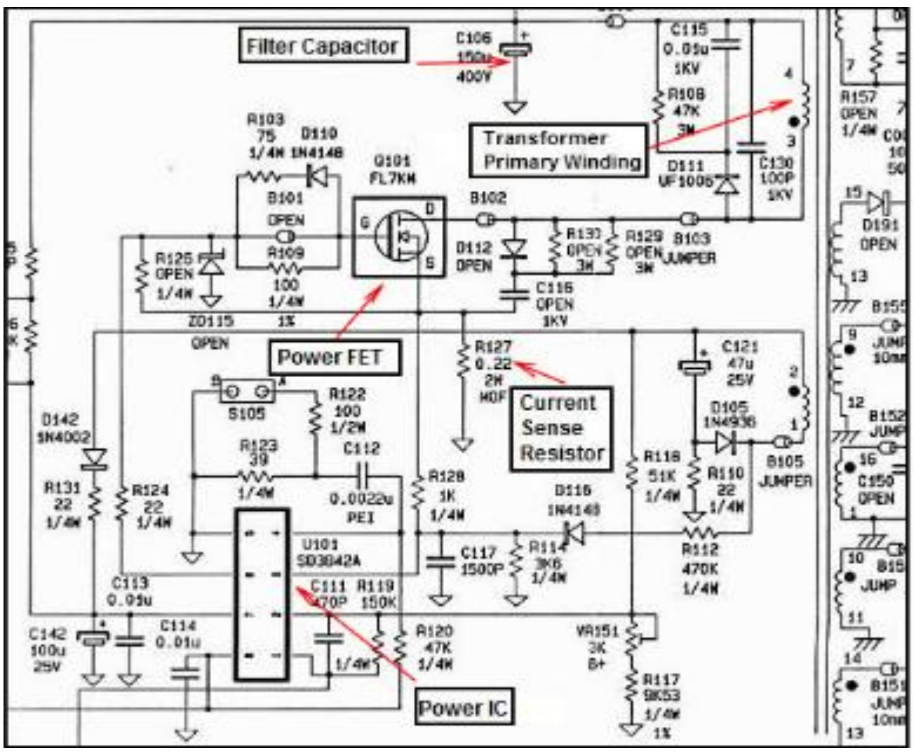


Figure2.56.*OCP in primary side of a CRT Monitor SMPS.*

C. Thermal shutdown Protection Circuit

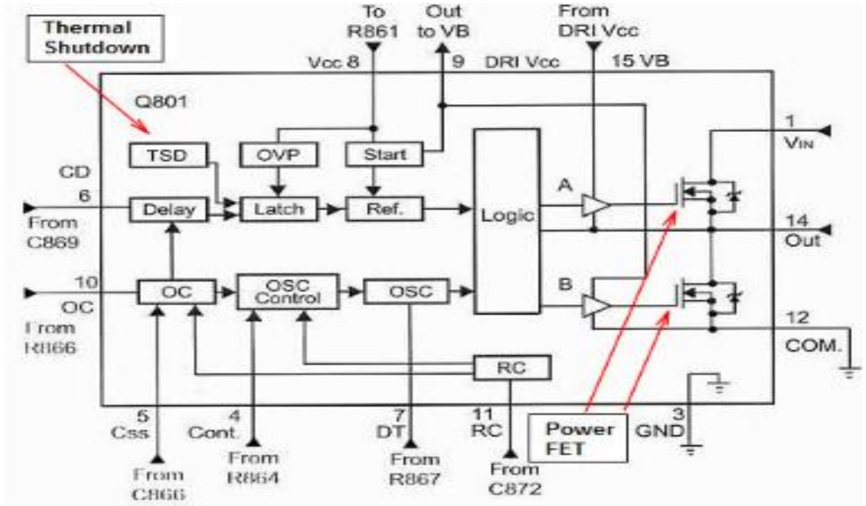


Figure2.57 *Block Diagram of a Thermal Shutdown Protection Circuit*

Components found in SMPS and Their Possible Causes of Faults

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

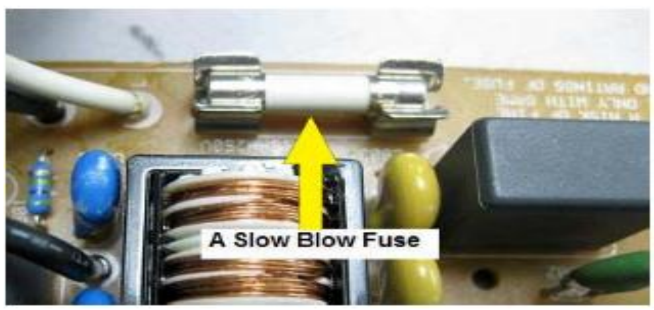


Figure2.58. *A Slow Blow Fuse*

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

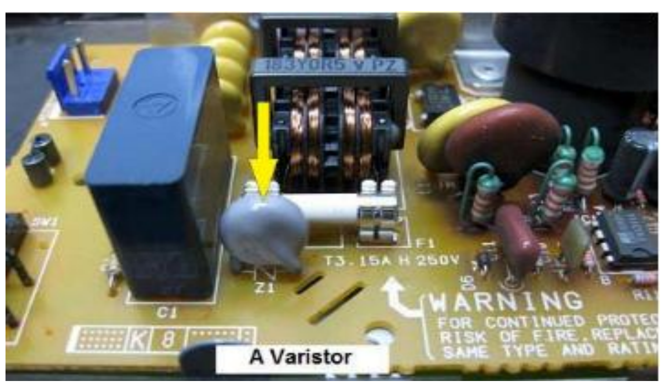


Figure2.59 *Varistor*

- **EMI/RFI Filter Section**

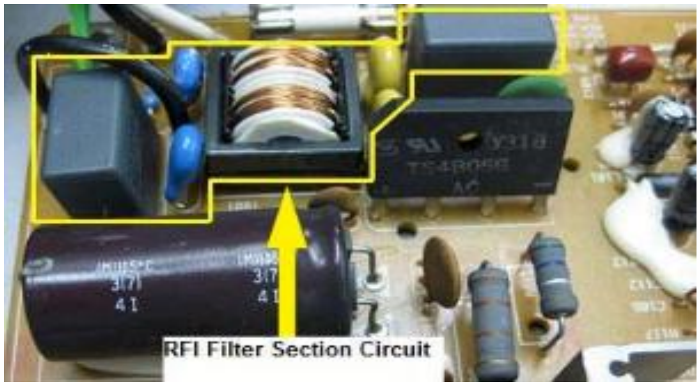


Figure2.60 *EMI/RFI Filter Section Circuit*

- **NTC Thermistor**

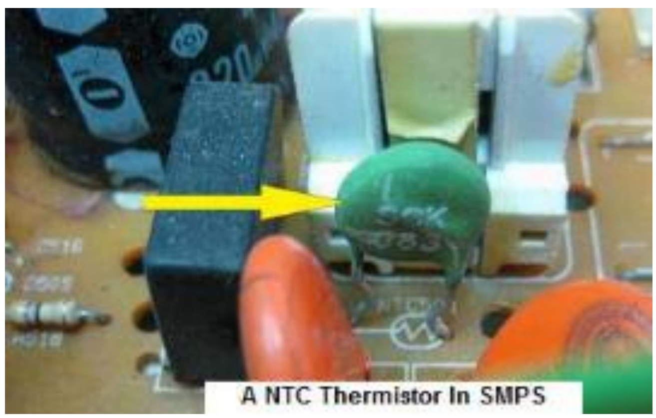
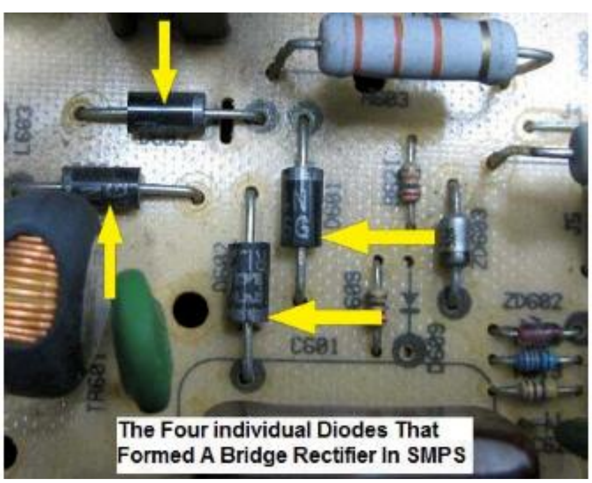


Figure2.61*NTC Thermistor*

- **Bridge Rectifier Diodes**



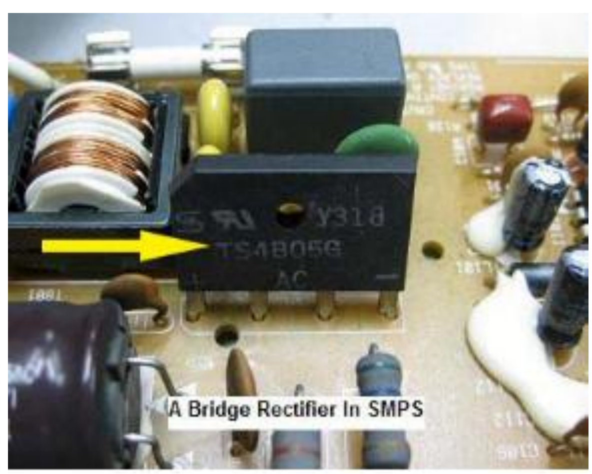


Figure2.62. *Bridge Rectifier Diodes in SMPS.*

- **Large Filter Capacitor**

Figure2.63. *Filter Capacitor*

- **Resistor**

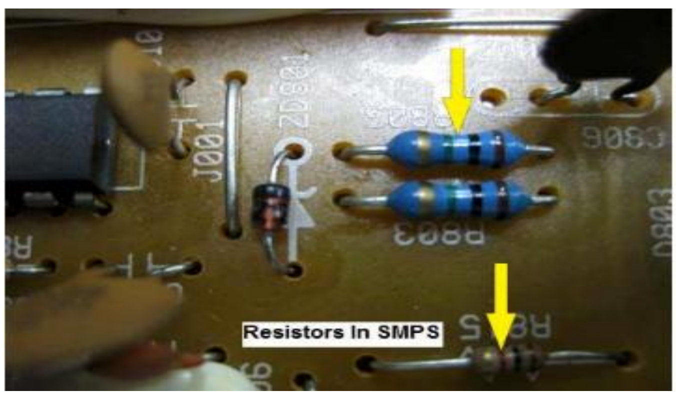


Figure2.64 *Resistors*

- **Non Polarity Capacitor**

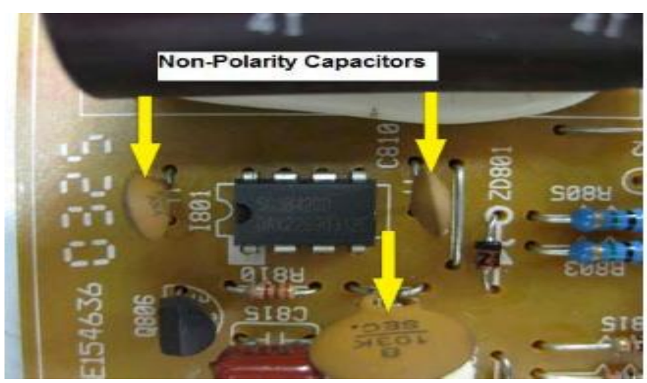


Figure2.65. *Non Polarity Capacitor*

- **Zener Diode**

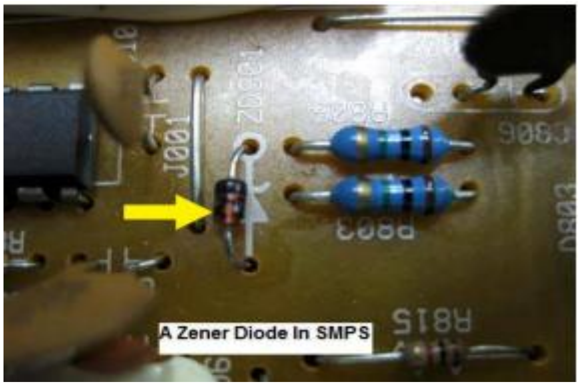


Figure2.66. *Zener Diode*

- **Diode Secondary Side**

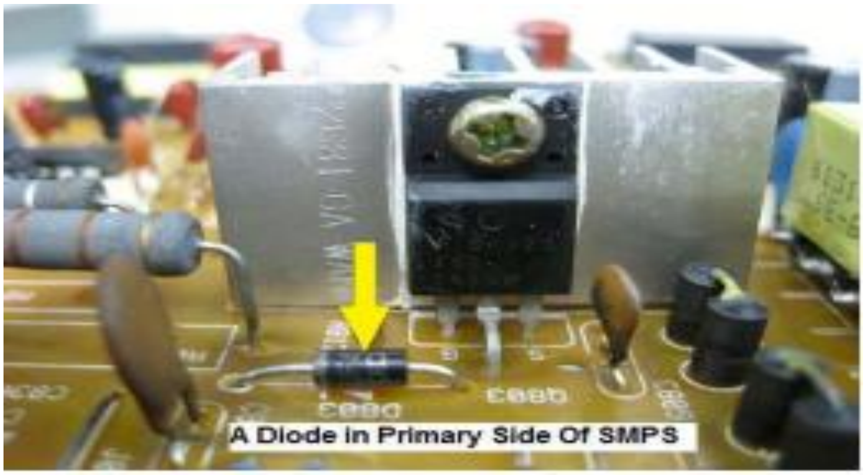
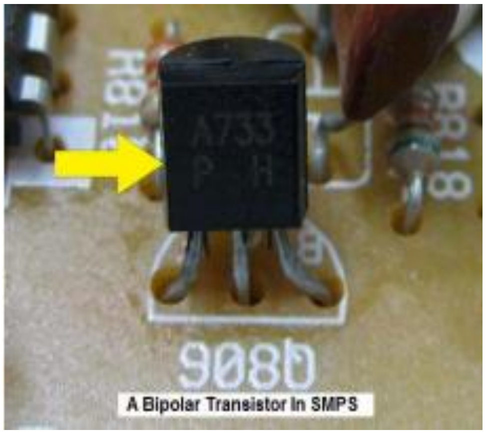


Figure2.67 *Diode Secondary Side*

- **Bipolar Transistor**



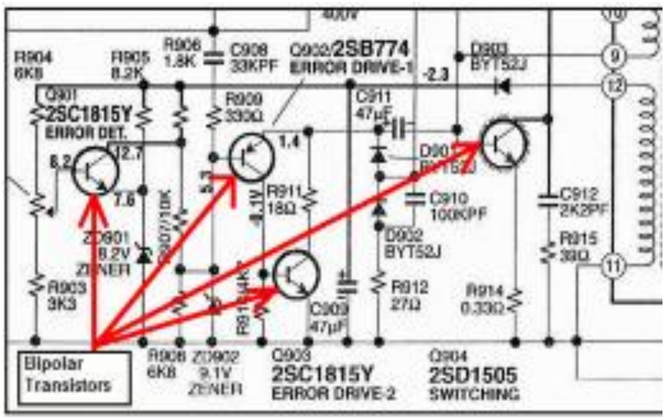


Figure2.68. *Bipolar Transistor and Circuit in SMPS*

- **IGBT Transistor**

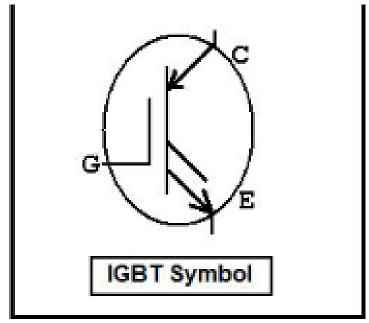


Figure2.69. *IGBT Transistor and Symbol*

- **Silcom Controlled Rectifier**

Figure2.70 *Silcom Controlled Rectifier*

Power IC

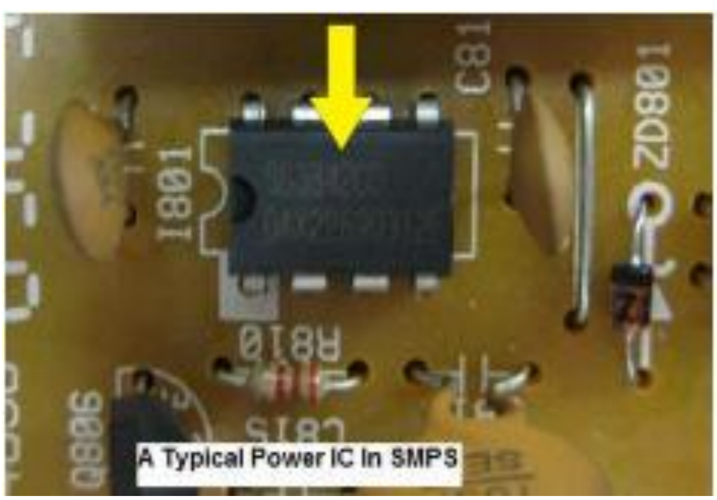


Figure2.71. *Power IC*

- **Power FET**

Figure2.72*Power FET*

- **Switch mode Power Transformer**

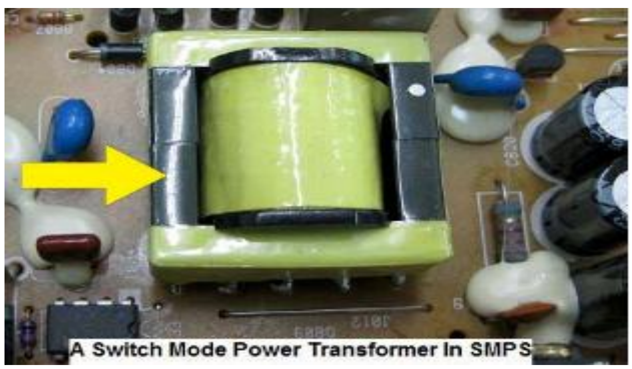


Figure2.73. *Switch mode Power Transformer*

- **Secondary Output Diode**

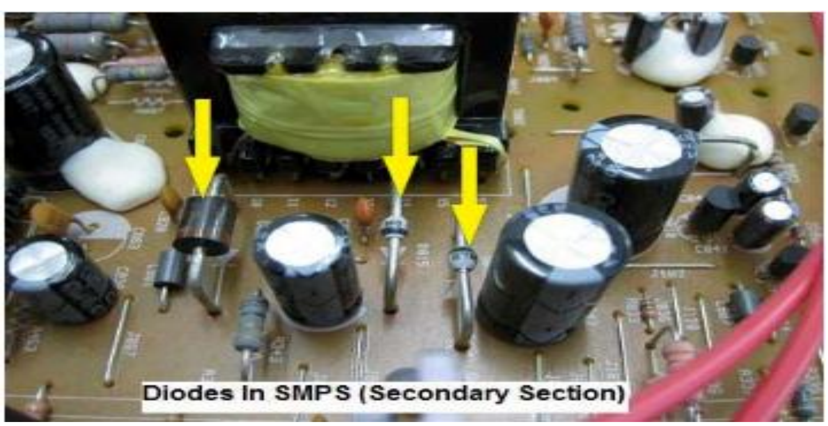


Figure2.74. *Secondary Output Diode*

- **Secondary Side Filter Capacitor**

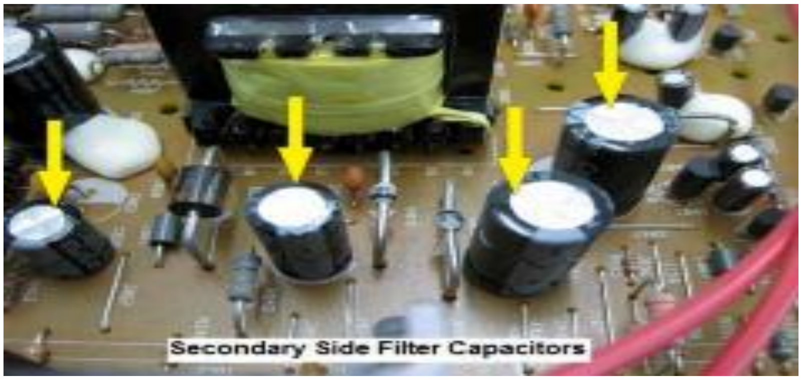


Figure2.75. *Secondary Side Filter Capacitor*

- **Secondary Output Inductors/Coils**

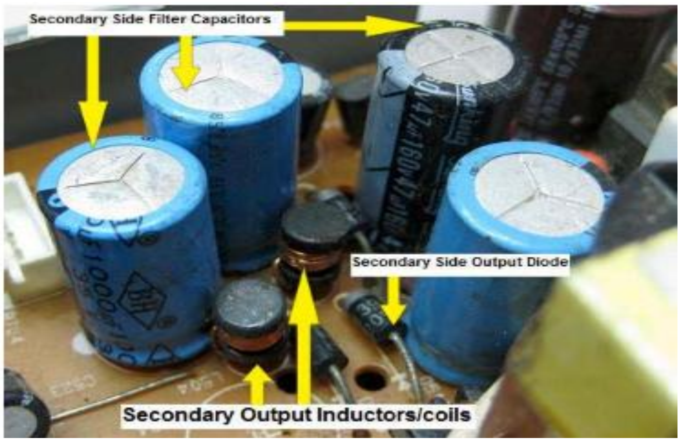


Figure2.76.*Secondary Output Inductors/Coils*

- **Optoisolator IC**

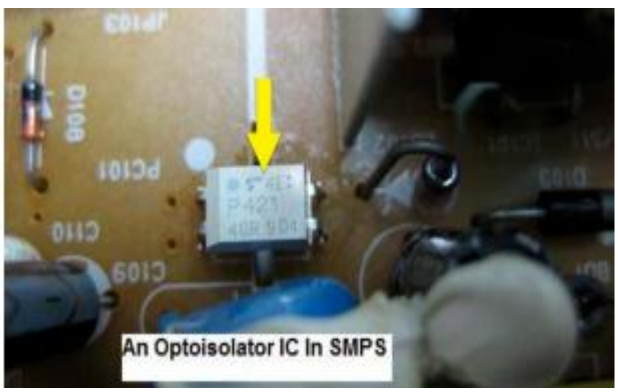


Figure2.77 *Optoisolator IC*

- **Adjustable Precision Shunt Regulator IC**

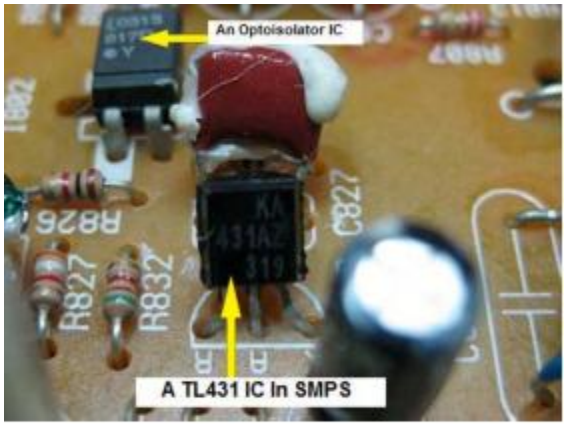


Figure2.78 *TL431 IC*

- **Small Preset in Secondary Side**

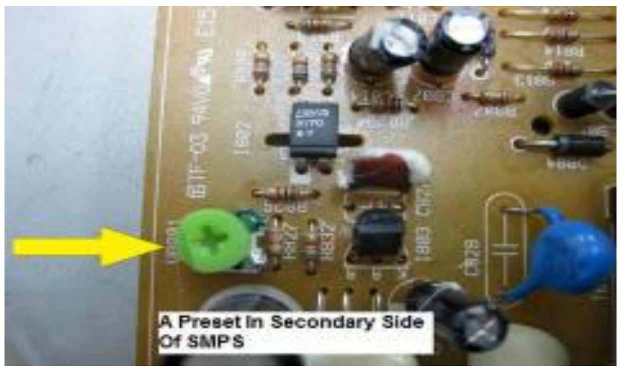


Figure2.79 *Small Preset in Secondary Side*

- **Voltage Regulator**

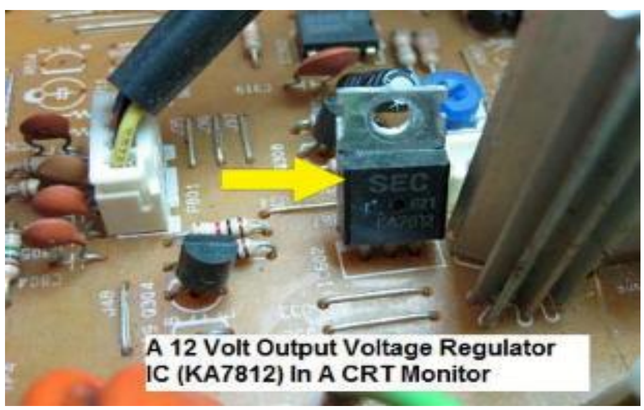


Figure2.80. *Voltage Regulator IC*

2.3 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.

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.

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.

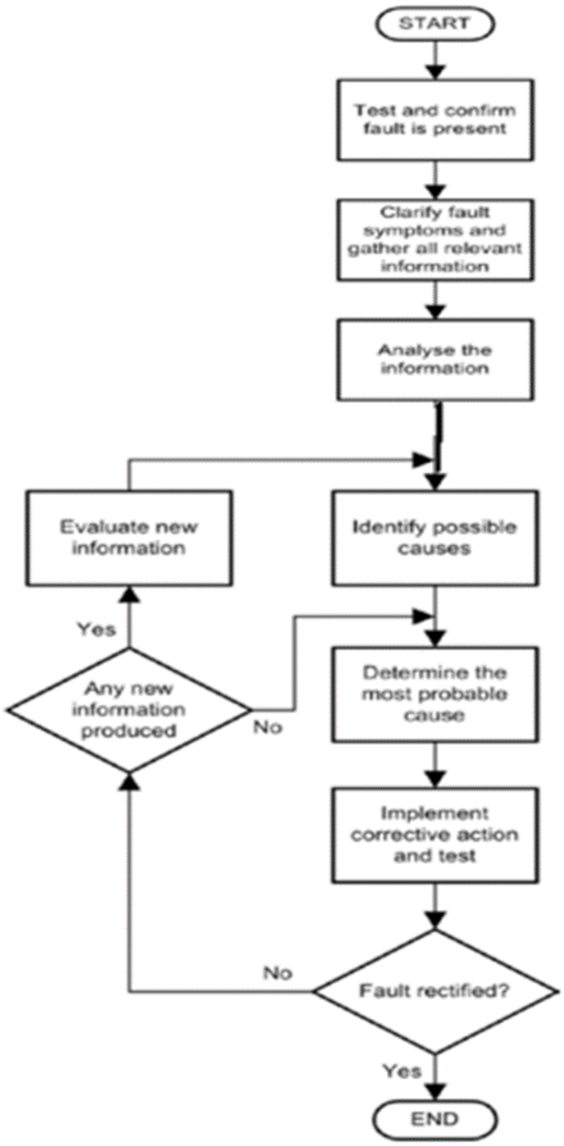


Figure2.81. *the flowchart*

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.

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.

Figure2.82. *Basic Way of fault finding for no power*

b) Low Output Voltage

The Symptom:

- ✓ Low power output
- ✓ No LED light

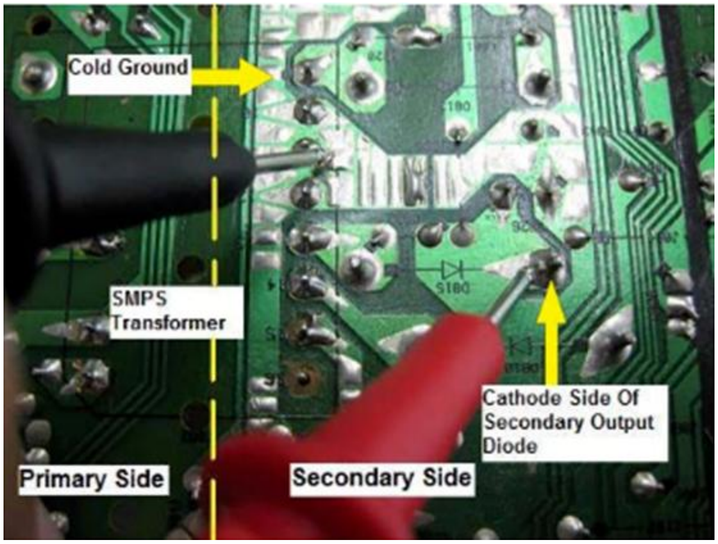


Figure2.83. *Low Output Voltage test*

c) High Output Voltage

Symptoms

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

Test Steps

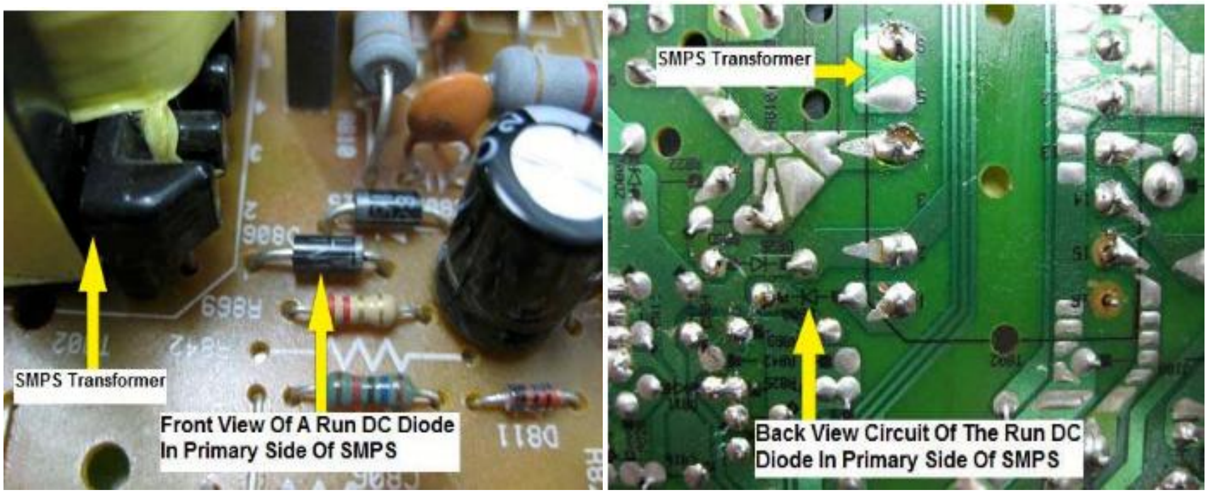


Figure2.84 *Run DC Circuit Diode and Its location In the primary side of SMPS*.

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.

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.

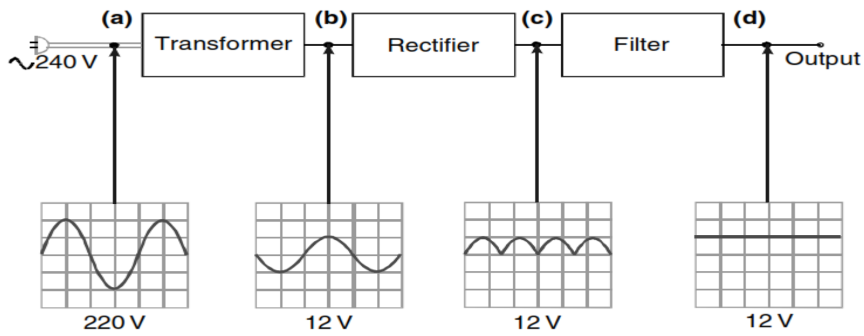


Figure3.5. Block diagram of a rectifier in good working order

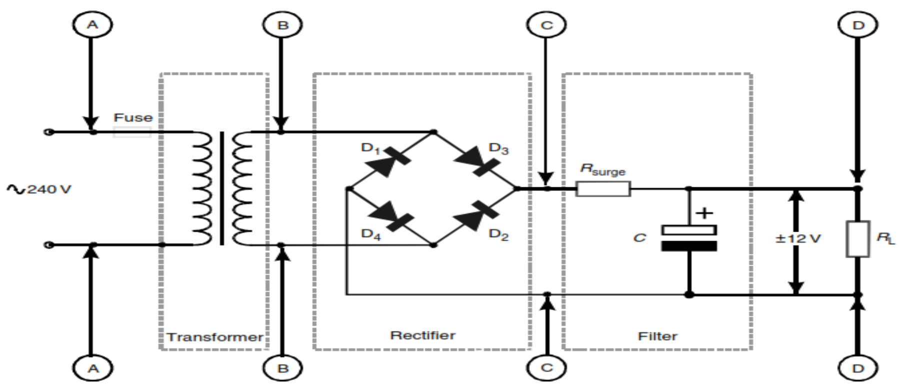


Figure2.85 *A circuit diagram of the bridge rectifier*

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.

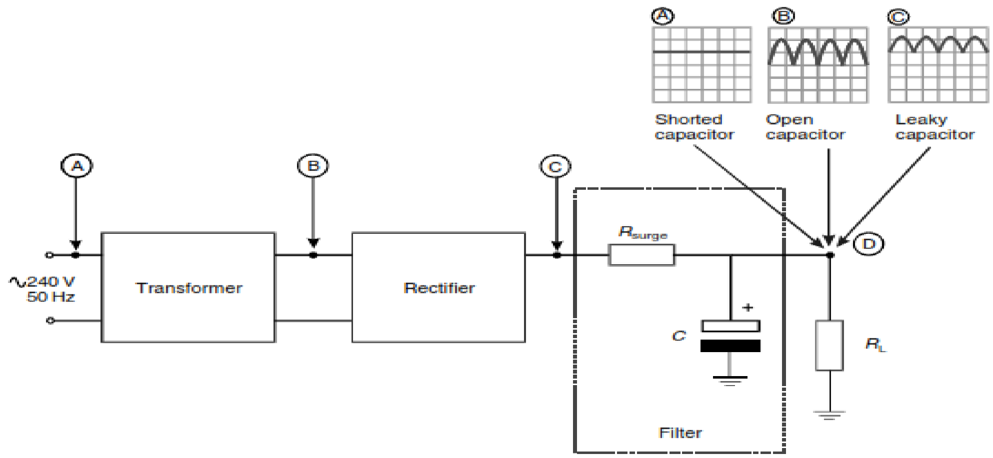


Figure2.86 *Symptoms of a faulty capacitor*

Faulty Resistor (R $_{surge}$)

There is only one possible faulty condition, namely a blown resistor **R$_{surge}$** (**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.

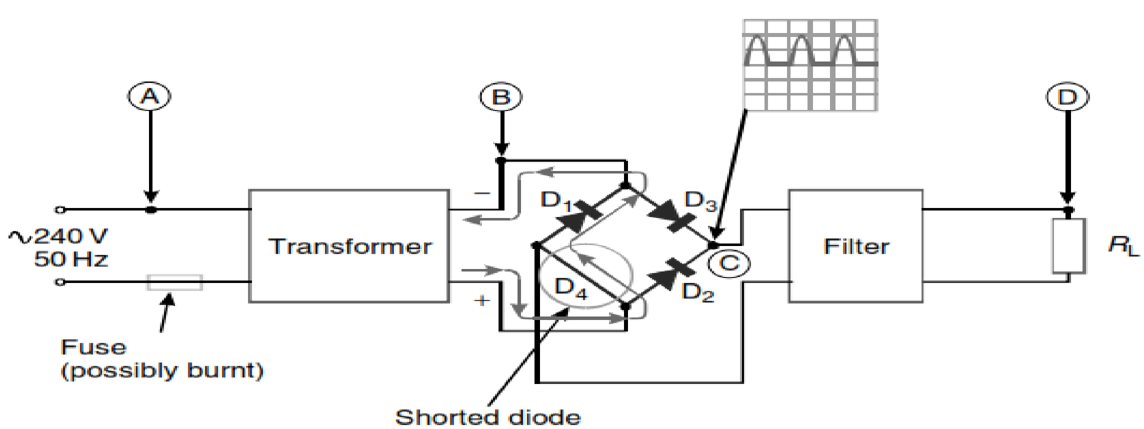


Figure2.87Symptoms of a shortened diode

- **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.

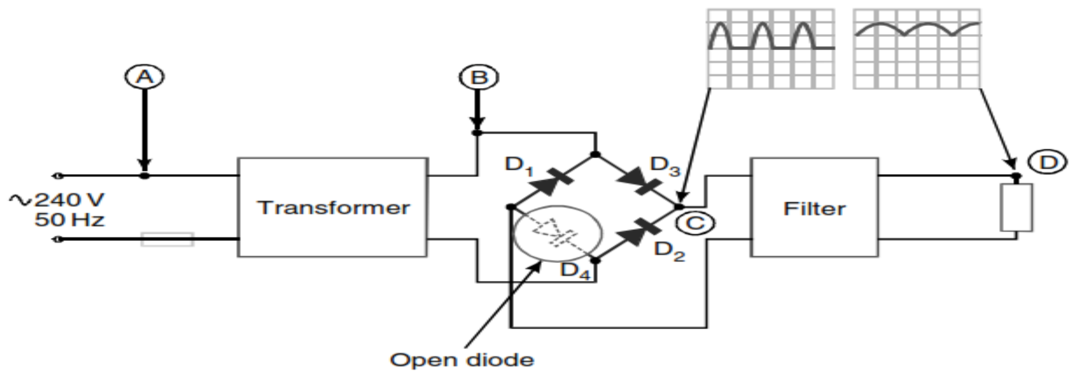


Figure2.88. *Symptoms of an open diode*

- **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.

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.

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).

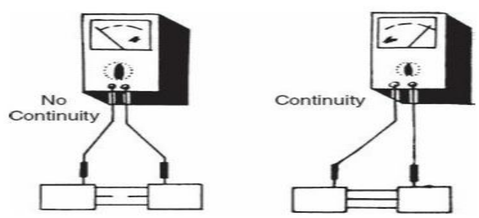


Figure2.89. Checking a fuse for continuity by using an ohmmeter.

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.

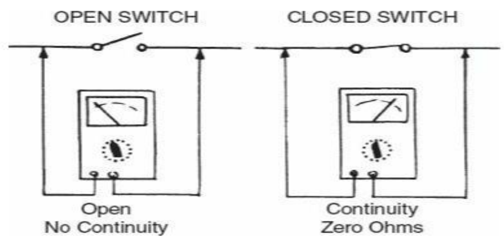


Figure2.90.*Checking a wire for continuity by using an ohmmeter.*

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.

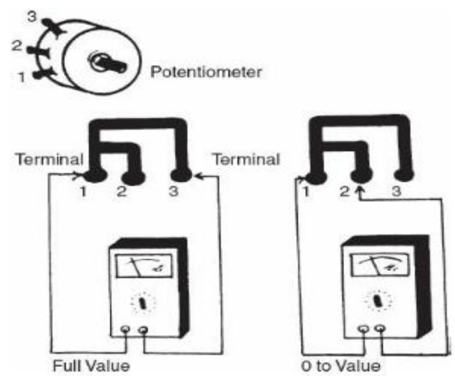


Figure2.91. *Testing a potentiometer*

- **Testing Capacitor**

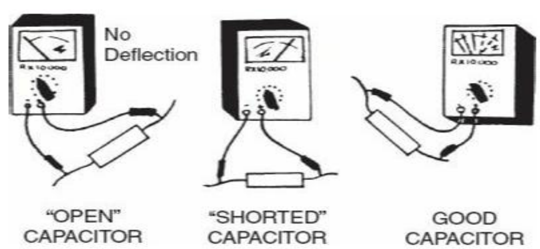
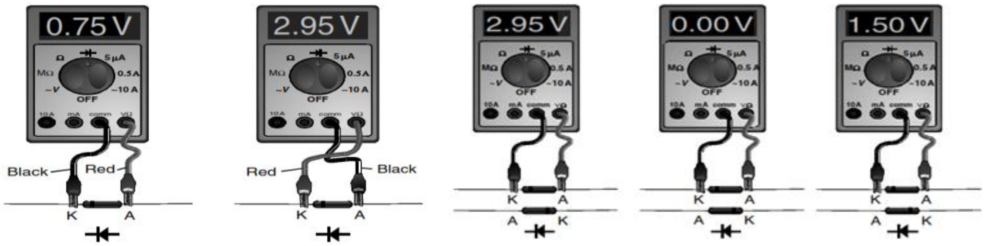


Figure2.92 *Testing a Capacitor*



(a) (b)

Figure2.93 (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.

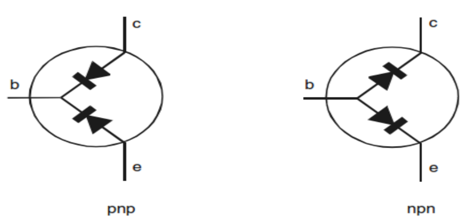


Figure2.94 *A transistor, represented as two diodes*

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.

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.

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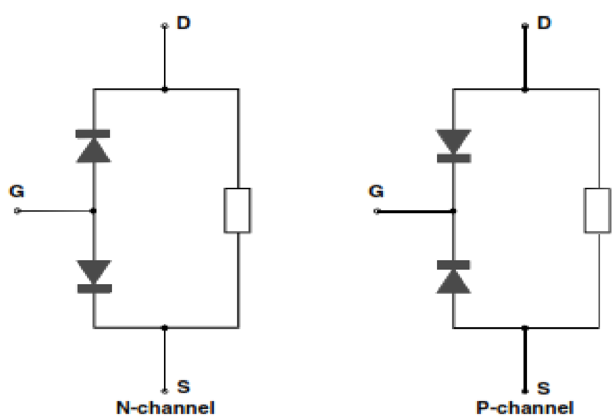


Figure2.95 *A JFET, representation with two diodes and a resistor*

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.

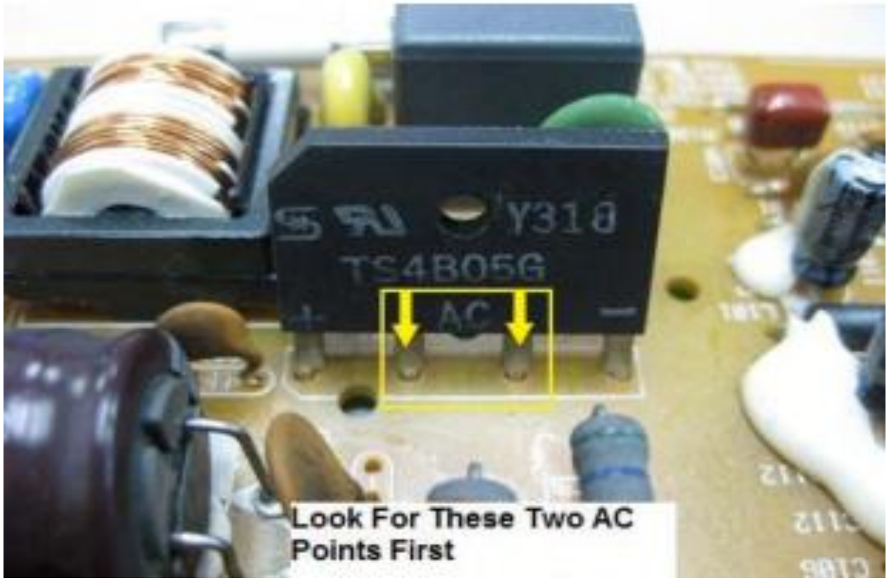


Figure2.96. *Two AC Pins of a Bridge Rectifier on a Single Package.*

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.

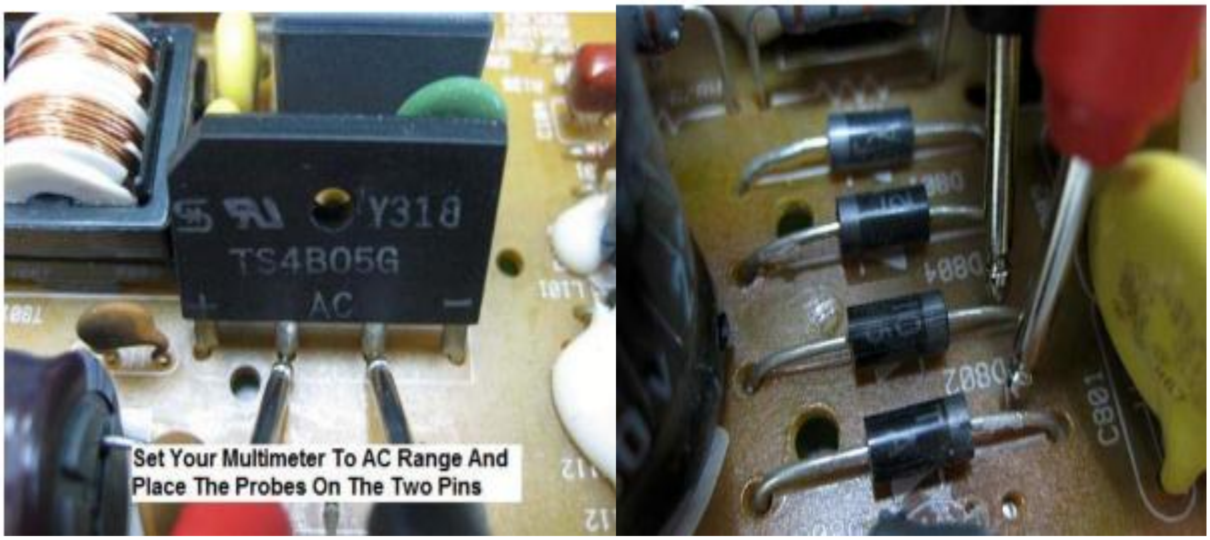


Figure2.97 *Placing the test probes to Two AC Pins (a) Single Package and (b) individual Diode.*

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.

Figure2.98 *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

Figure2.99 *Placing the RED test probe to the positive pin of the Filter Capacitor.*

Figure2.100 *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.

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.

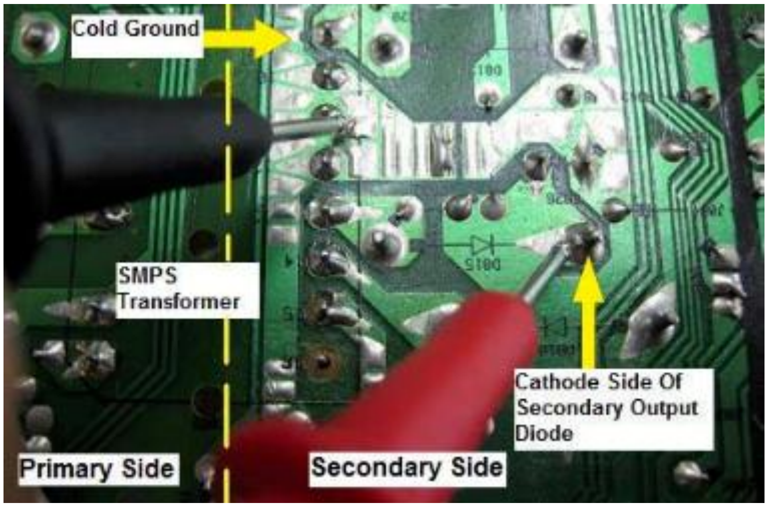


Figure2.101 *the right way to measure DC voltage at the secondary side of SMPS.*

Figure2.102. *Placing the RED test probe to the Secondary Output Diode Cathode Side.*

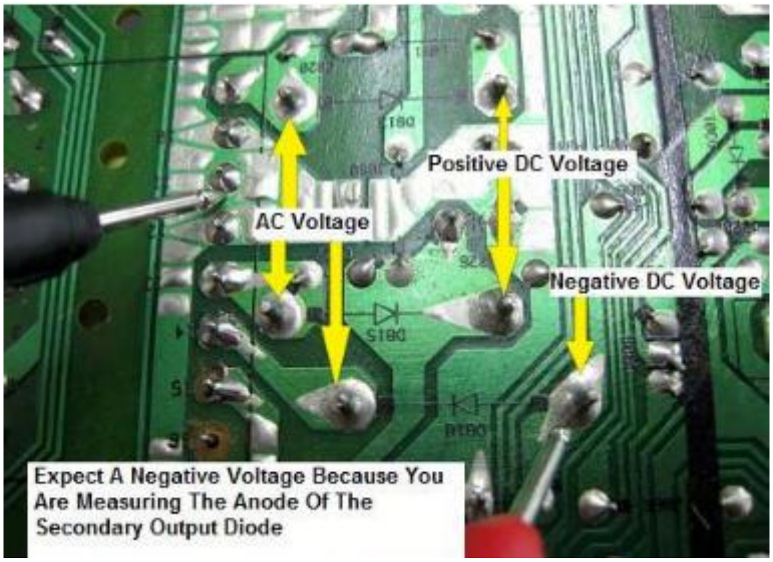


Figure2.103 *The right way to measure the negative voltage at the secondary side of SMPS.*

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

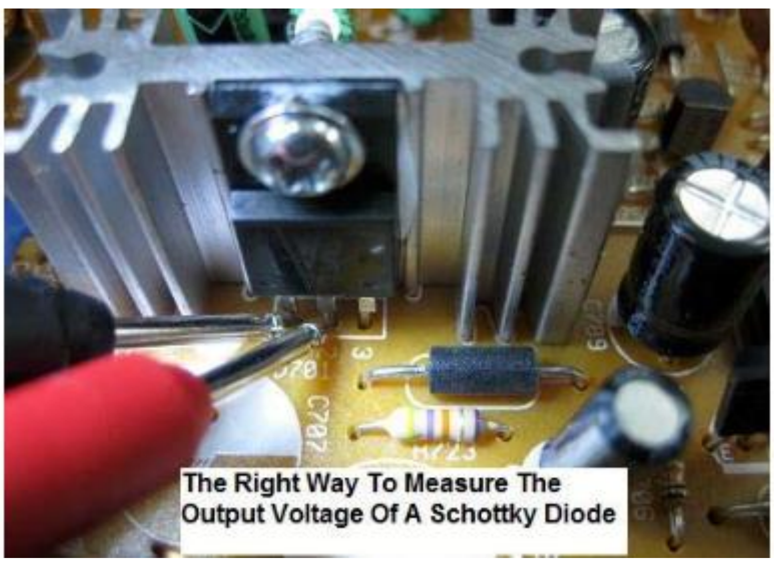


Figure2.104 .*the right way to measure the negative voltage at the Schottky diodes.*

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.

Identify and explain defects/fault parts

Explaining common Faults found on SMPS Using Pictures

1. **No Power Fault.**

Case No 1

- **Couse**

✓ Shorted Non-Polar Capacitor

Figure2.105 *Shorted Non Polar Capacitor at CRT Board.*

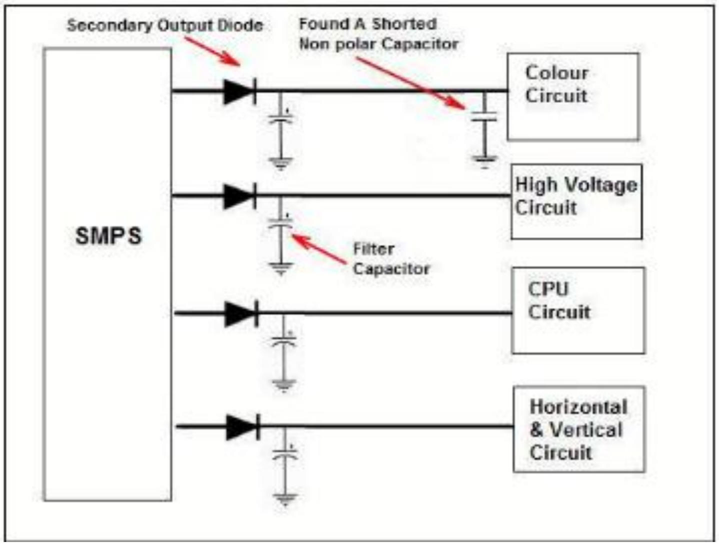


Figure2.106 *The Location of a Shorted Non Polar Capacitor*

Case 2 No Power

- **COUSE**

✓ Startup resistor is opened.

✓ Shorted Power IC

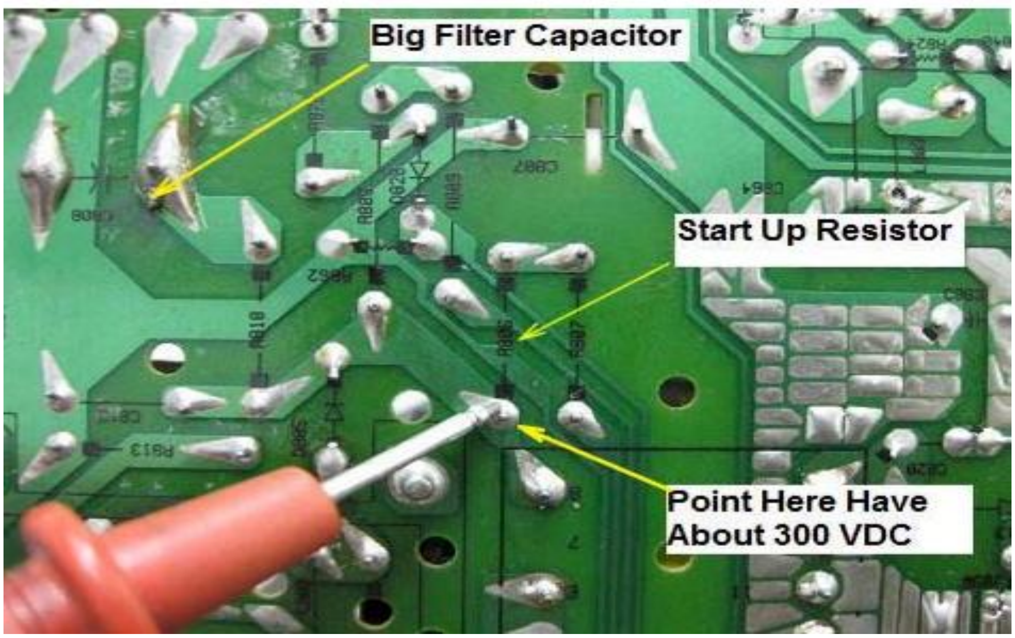


Figure2.107 *Voltage tracing at point of star up resistor*

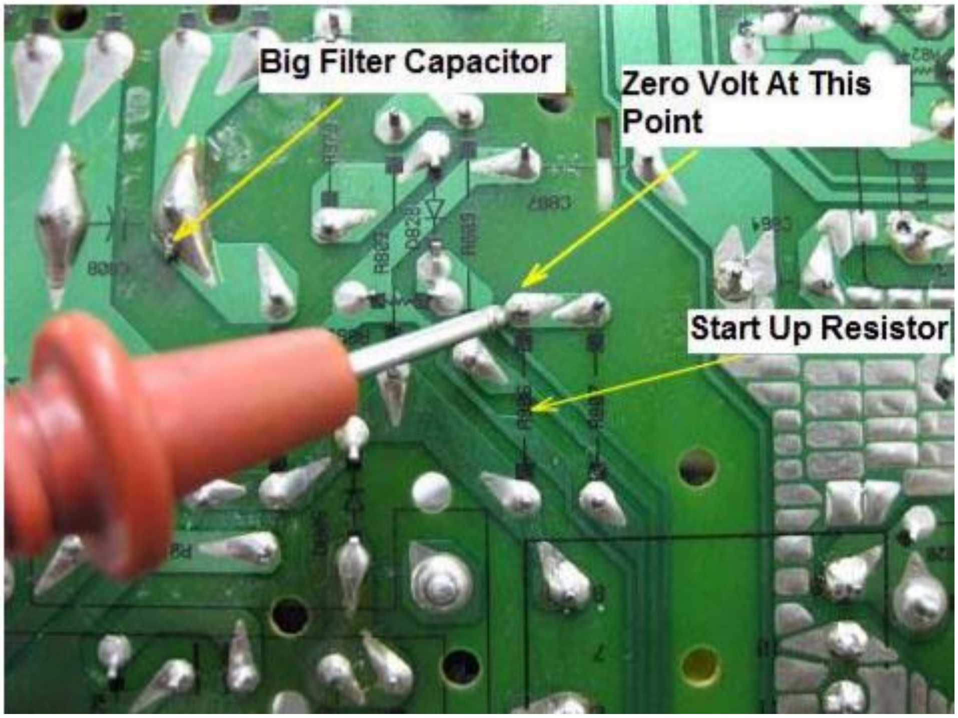


Figure2.107. *Zero Volt After the Star Up Resistor*

Case 3 No Power

- **COUSE**

✓ Shorted Zener diode

✓ Shorted Power IC

✓ Optoisolator IC Breakdown

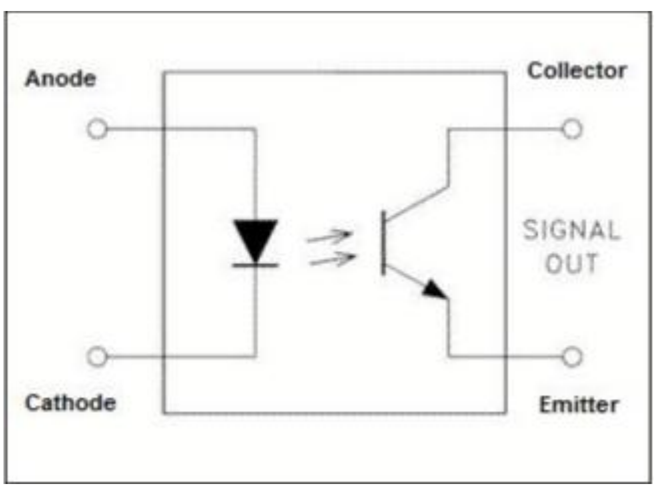


Figure2.108 *Optoisolator IC*

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

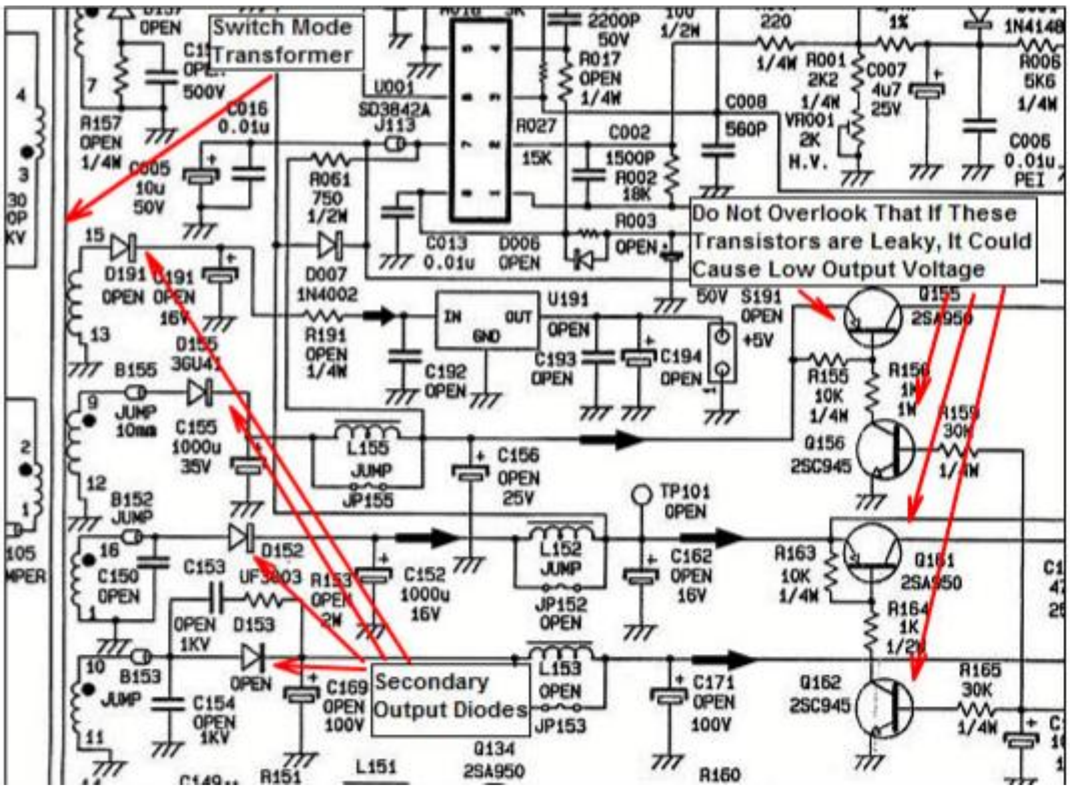


Figure2.109 *Bad Component in the downstream*

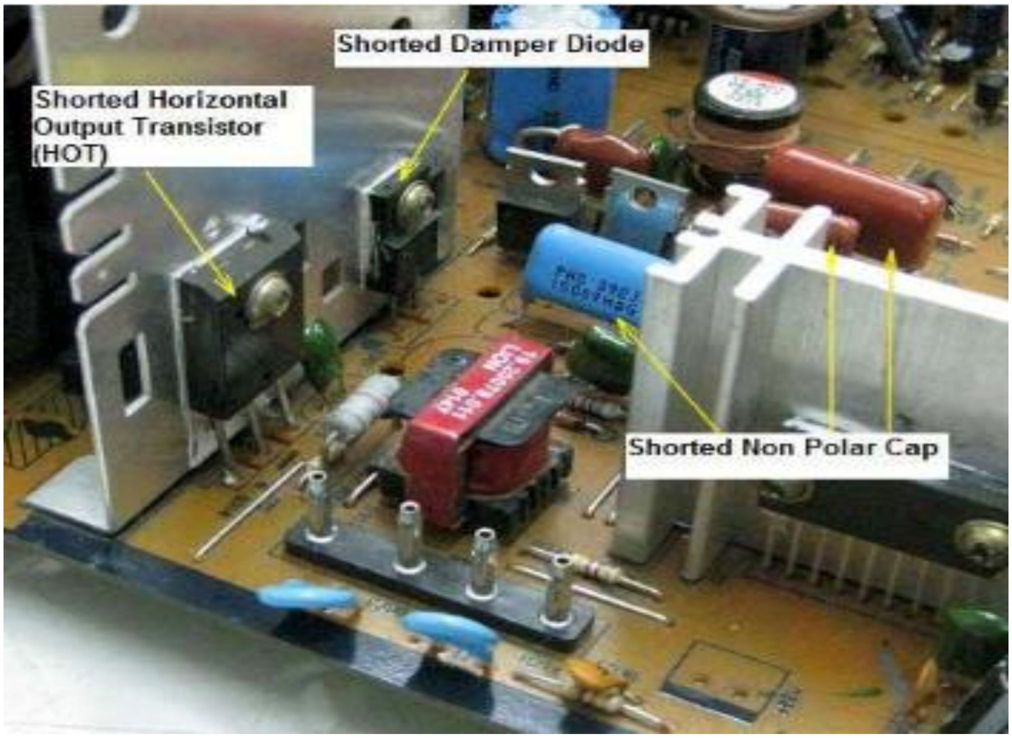


Figure2.110 *Shorted Component in the downstream*

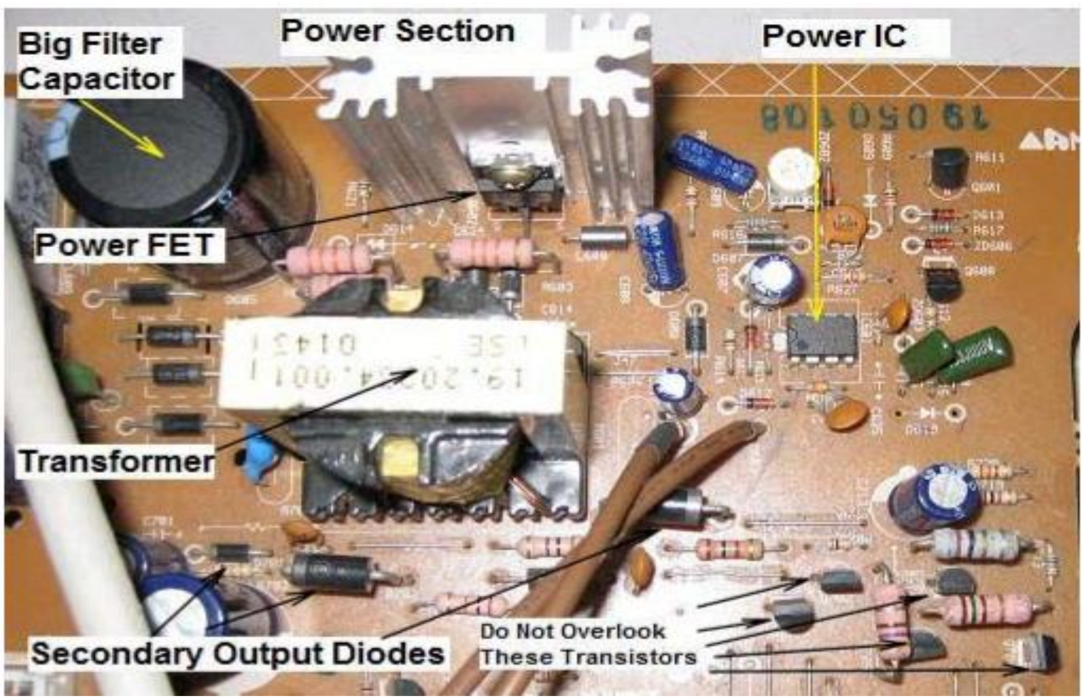


Figure2.111 *Leaky transistor at the secondary side*

Case No.5 No Power

- **COUSE**

✓ Tiny break in one of the secondary line.

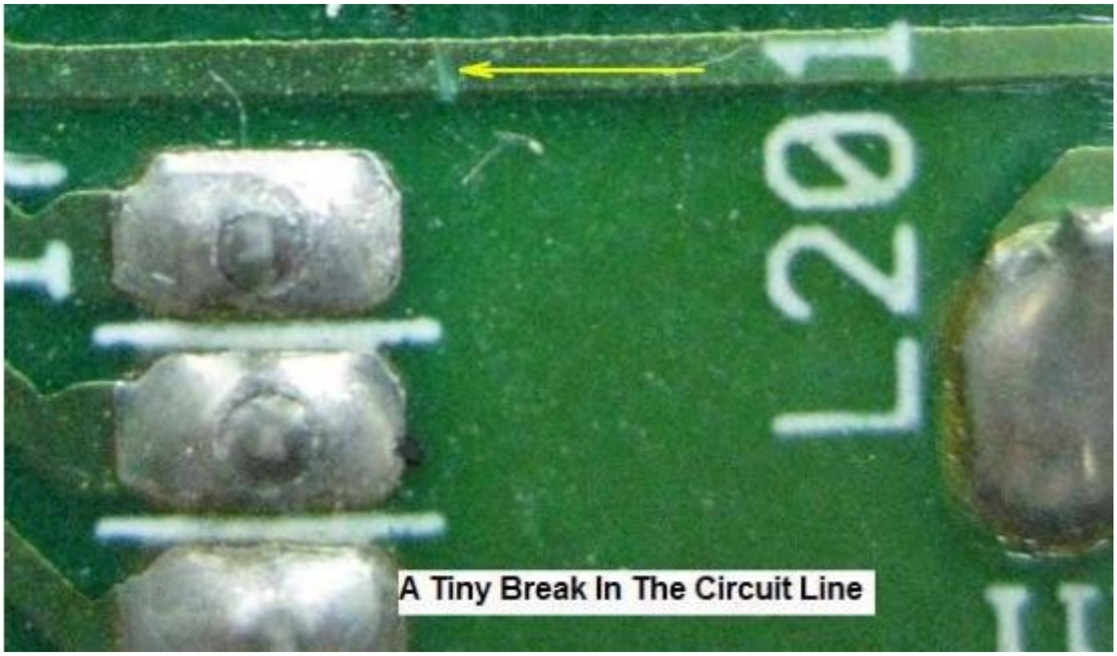


Figure2.112 *Tiny break in one of the secondary line or Circuit.*

Case No.6 No Power

Figure2.113 *Testing primary winding of SMPS*

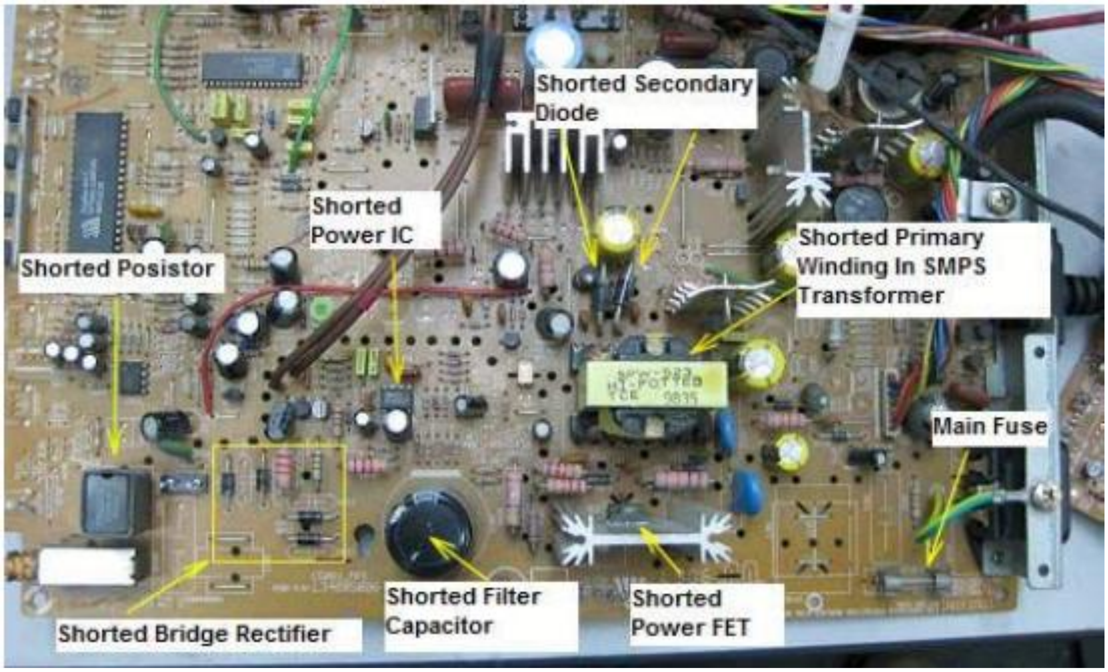


Figure2.114*Possible shorted components that can blow the main fuse*

Advise customers regarding the status of the unit

2.4 Customer advice

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.

2.5 Document results of diagnosis and test

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 2.1 WRITTENTEST1

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

<u>Say TRUE if the statement is correct or FALSE, if the statement is incorrect</u>

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.

SELF CHECK 2.2 WRITTEN TEST2

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

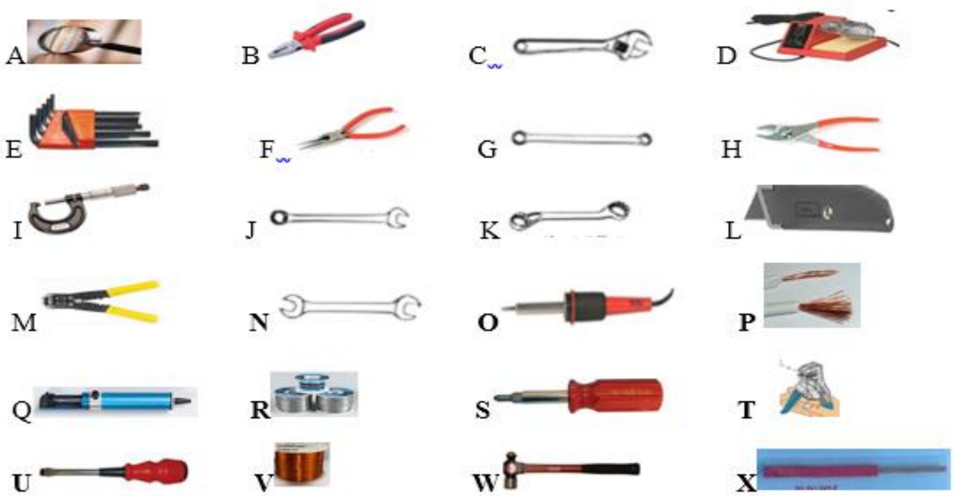
4. Which type of DC Power supply has better voltage regulation.
   A. Ac power supply
   B. Regulated linear dc power supply
   C. Switch Mode Power Supply
   D. Un-regulated linear dc power supply
   E. None

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



I. **Give Short and Clear answer**

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

   A. ______________________________

   B. ______________________________

   C. _______________________________

   D. __________________________________

   E. ________________________________

Unit Three: Maintain/repair the power supply unit
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: • Replace defective parts/components • Mount and Solder Repaired or replaced parts/components • Perform Control settings/adjustments in accordance with service-manual • Perform repair activity within the required timeframe • Perform Cleaning of unit This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Replace defective parts/components • Mount and Solder Repaired or replaced parts/components • Perform Control settings/adjustments in accordance with service-manual • Perform repair activity within the required timeframe • Perform Cleaning of unit

3.1 Replace defective parts/components

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, 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 refers 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.

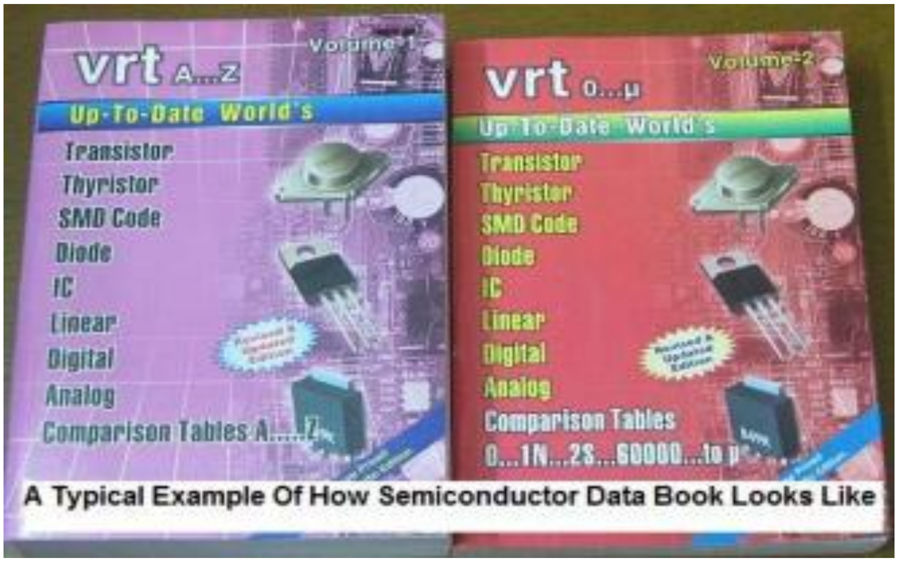


Figure3.1 Semiconductor Replacement data book

Note: Always use original part numbers for replacement purposes!

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.

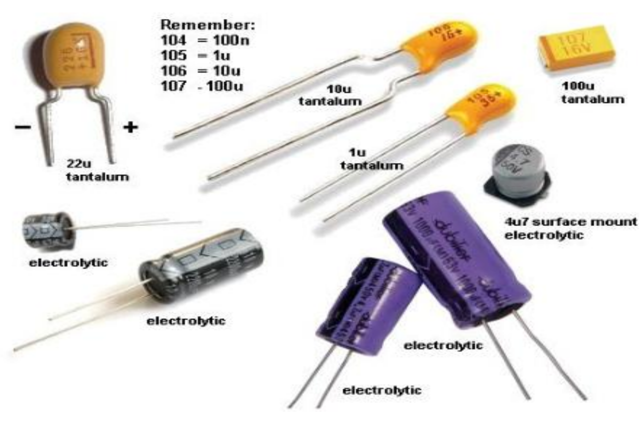


Figure3.2. Different types Capacitors

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.

3.2 Mounting and Soldering 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.

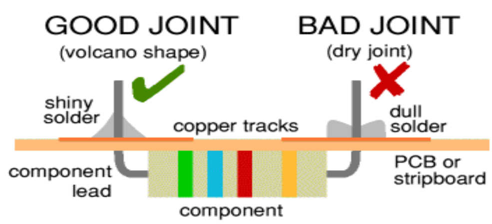


Figure3.3 joint

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.

Figure3.4. 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.

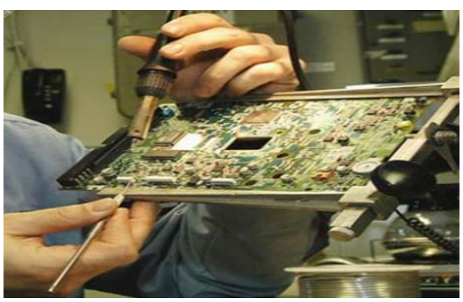


Figure3.5. Soldering a component

3.3 Control settings/adjustments in accordance with service-manual

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.

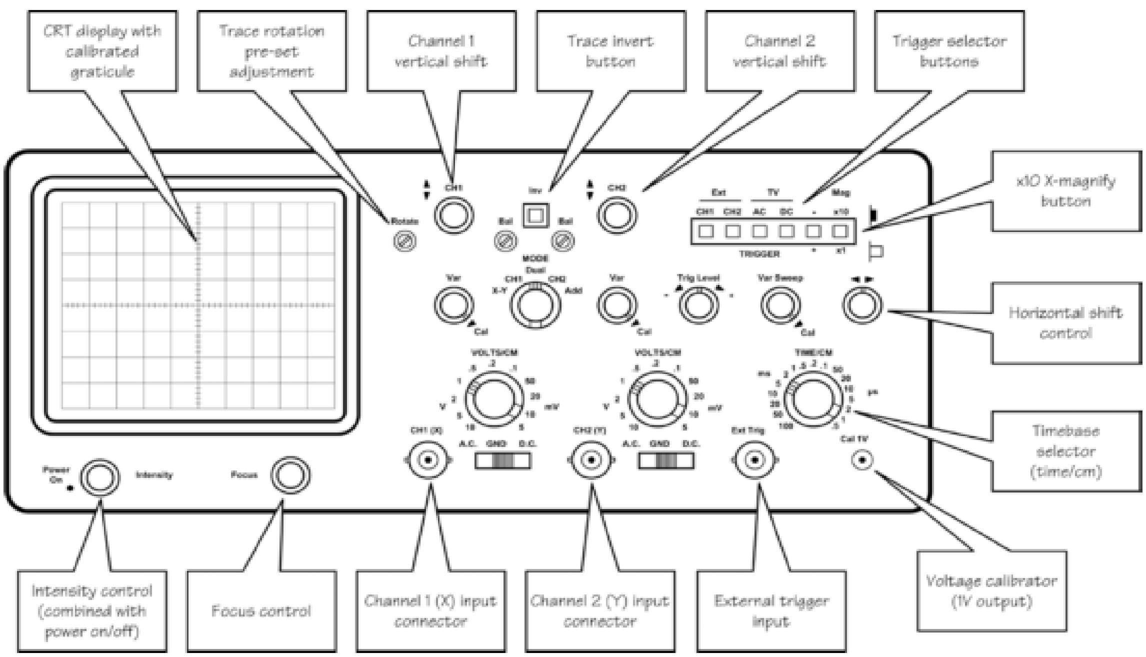


Figure3.5.Front panel controls and displays on a typical dual-channel oscilloscope

Adjust 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.

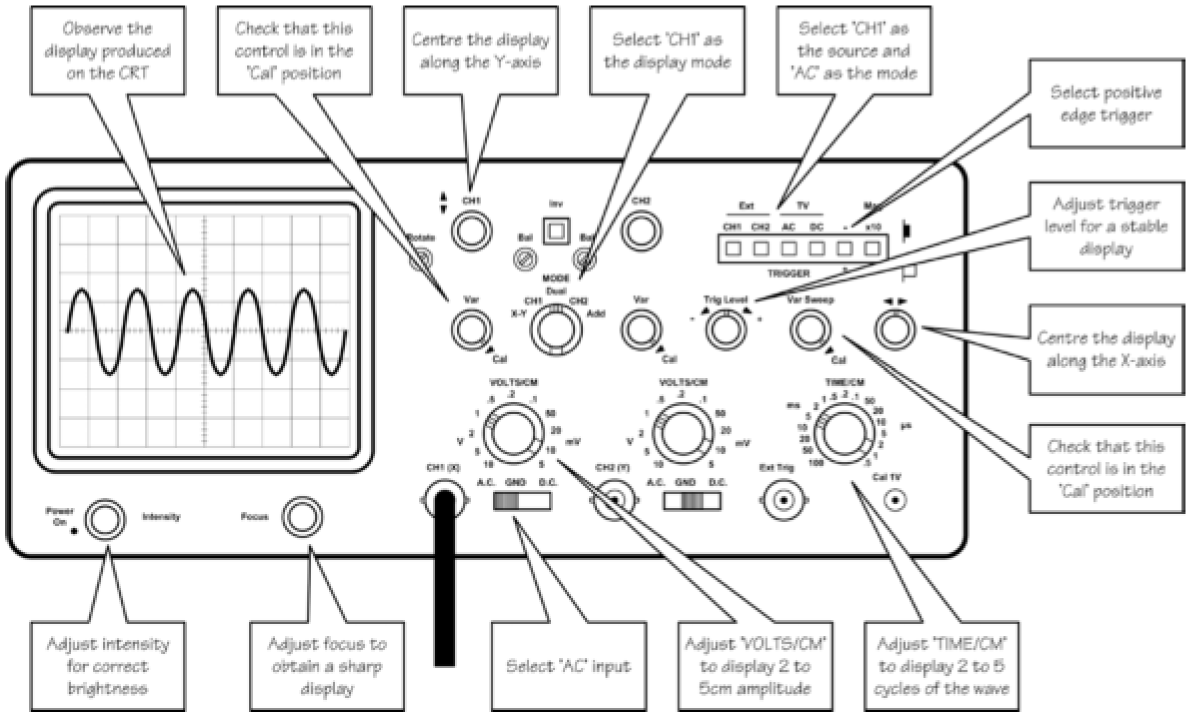


Figure3.6 Procedure for adjusting the controls to display a sinusoidal waveform (single-channel mode)

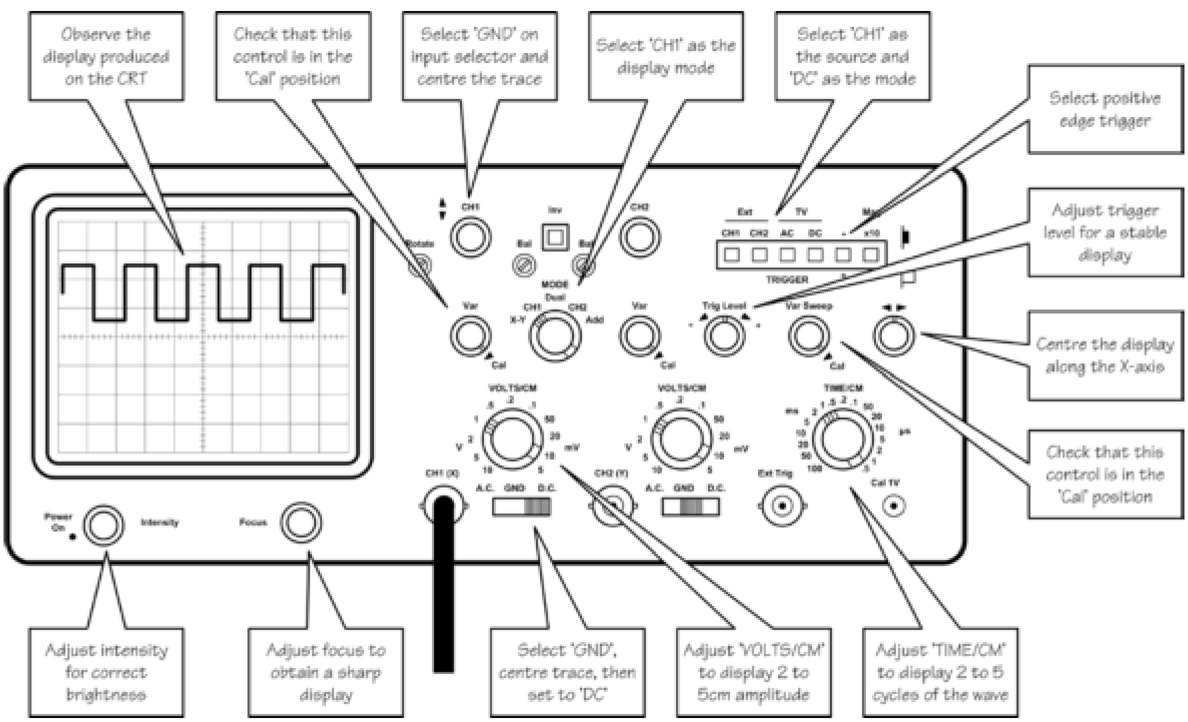


Figure3.7. Procedure for adjusting the controls to display a square waveform (single-channel mode)

Adjust 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 . 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.

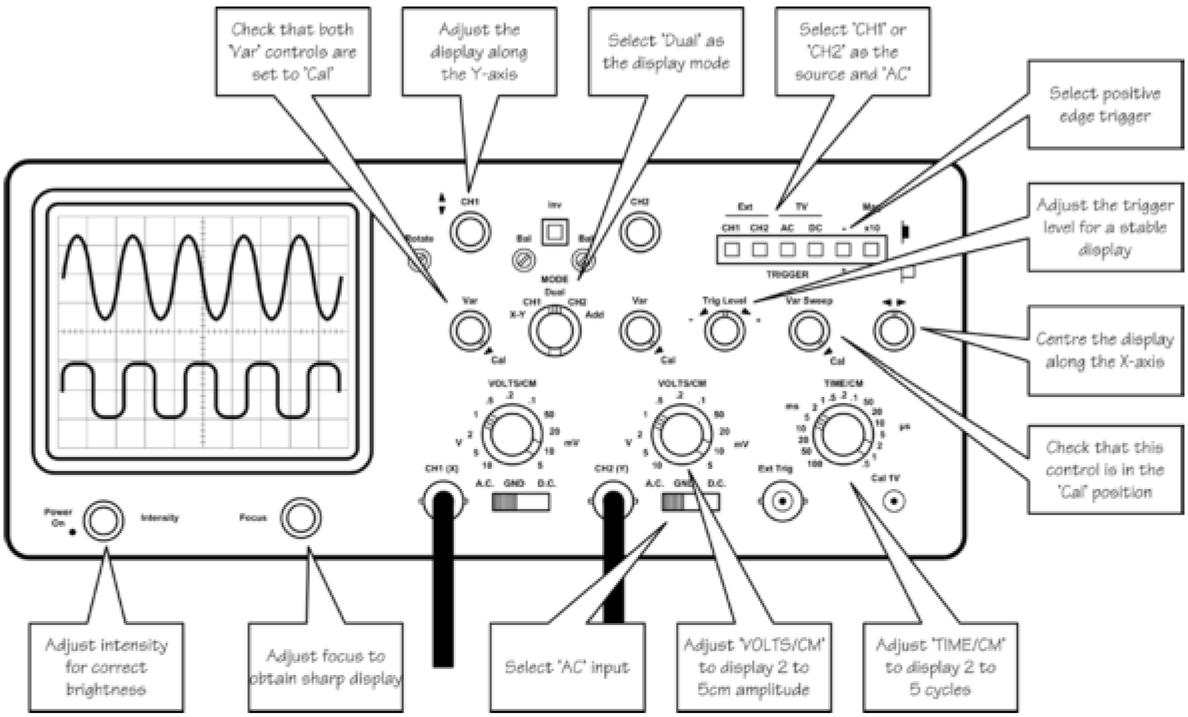


Figure3.8. Procedure for adjusting the controls to display two waveforms (dual-channel mode)

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.

3.4 Performing repair activity within the required timeframe

Simple method to Repair any Types of SMPS

1. **Checking The secondary side first**

Step 1 Discharge The Big Capacitor

Figure3.9 Discharging the Big Capacitor

Figure3.10 Discharging the Big Capacitor with a 2.2Kohm 10watt resistor

Step 2 Remove SMPS

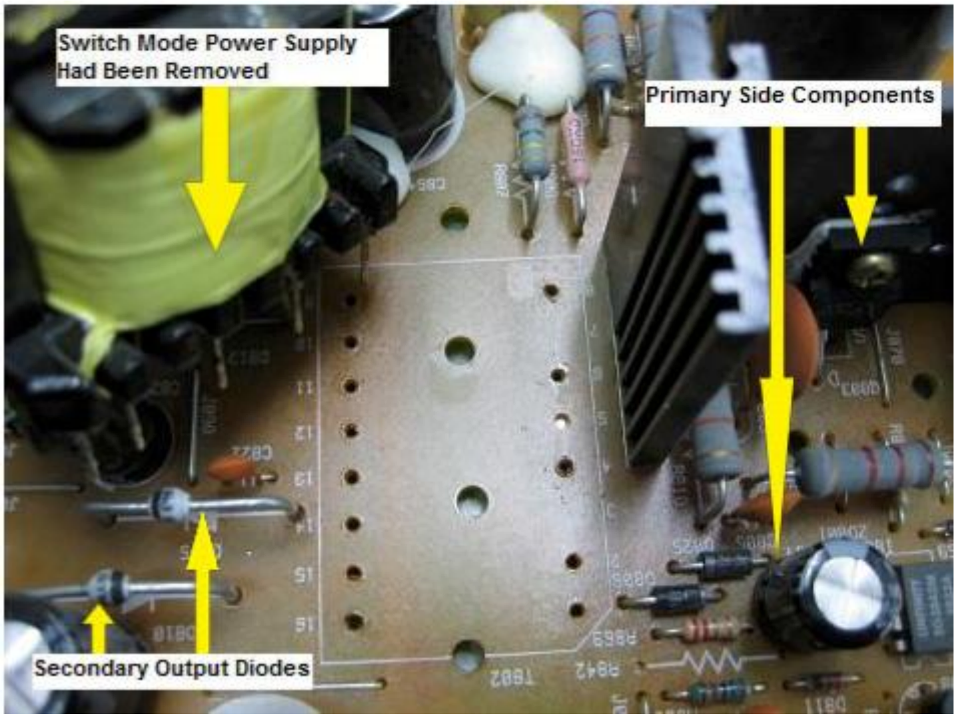


Figure3.11. Removal of SMPS

Step 3 Test The Secondary diode or Schottky Diode of SMPS

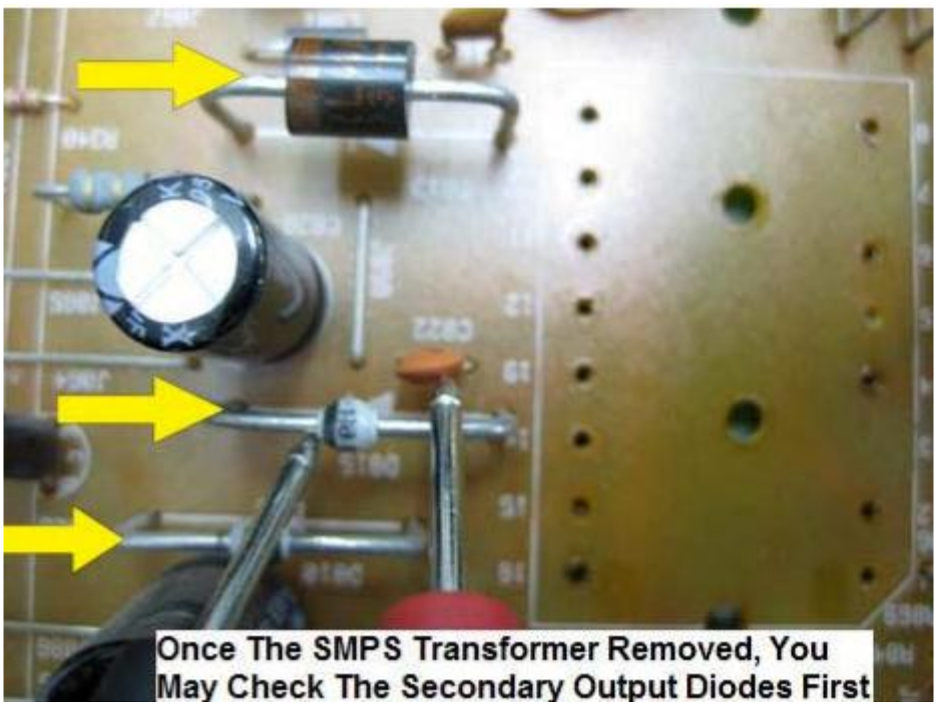


Figure3.12 Testing The Secondary diode of SMPS

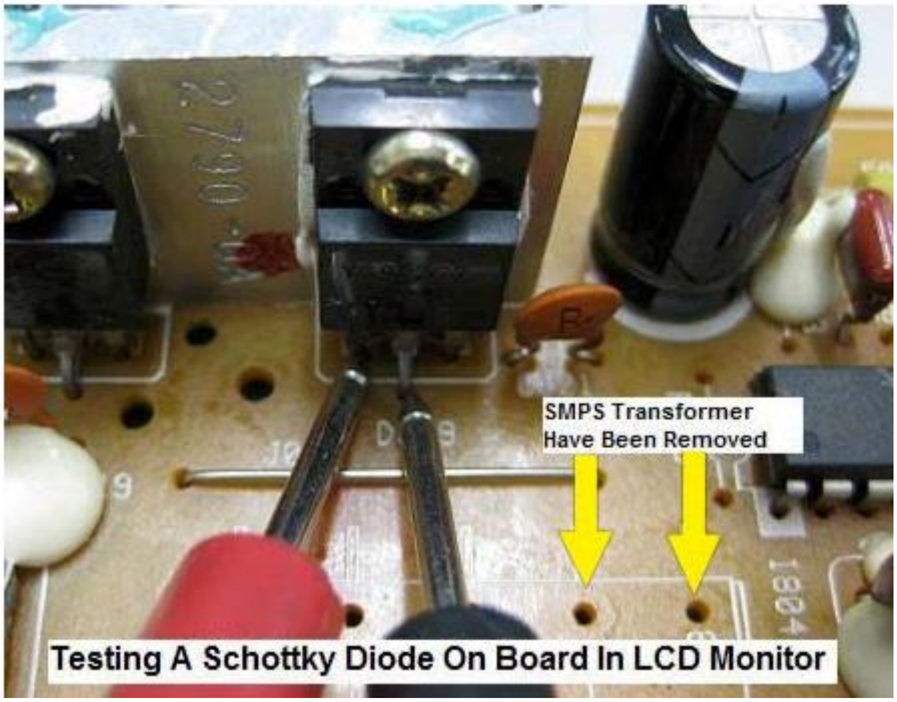


Figure3.13. Testing The Secondary Schottky Diode of SMPS

Step 4 Checking the electrolytic capacitor using Blue ESR meter

Figure3.14. Checking the electrolytic capacitor using Blue ESR meter

Step 5 Checking the Feedback circuit

- ✓ It consists resistor capacitor optoisolator IC and TL431IC

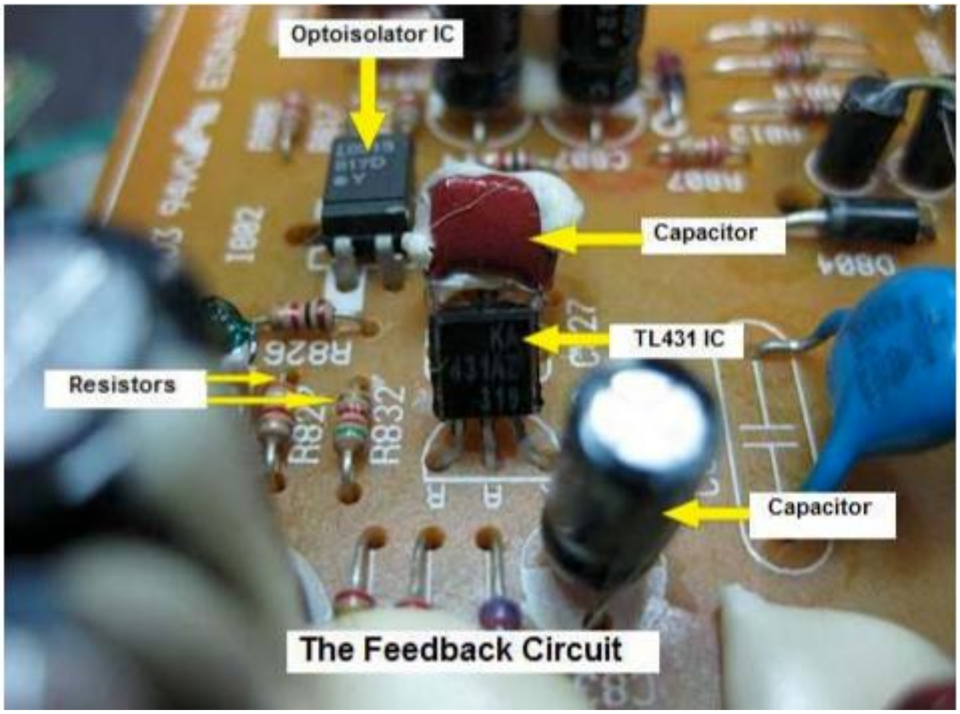


Figure3.15 Checking the Feedback circuit

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

Figure3.16 De-soldering all the components of the primary side

Step 8 Looking dry joints in a circuit

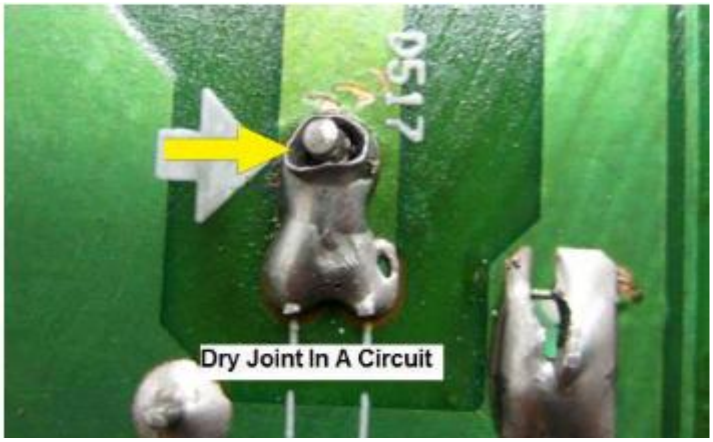


Figure3.17 looking dry joints in a circuit

Step 9 checking the board

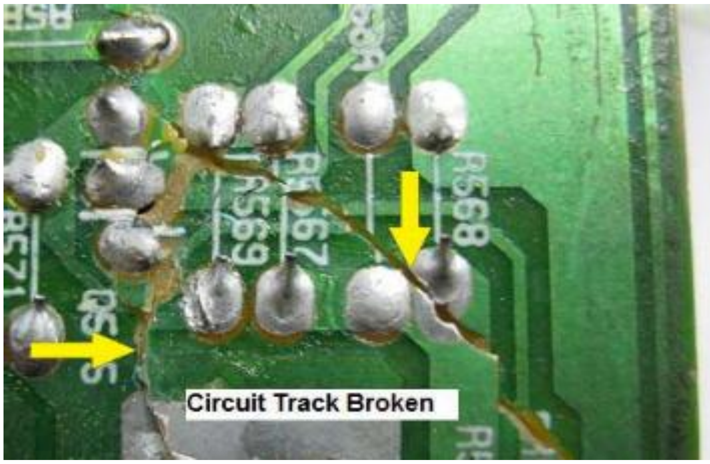


Figure3.18 checking the board

Figure3.19 damaged board

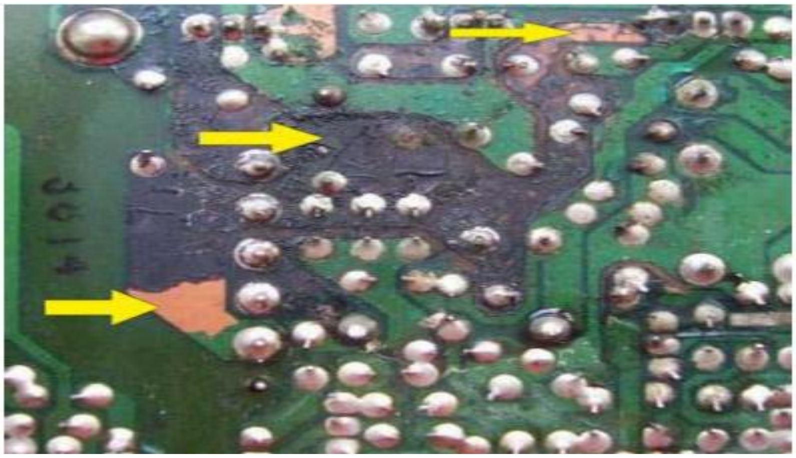


Figure3.20 Rusted board

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

3.5 Perform cleaning of unit

3.5.1 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

Operation Sheet 3.1	**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 3.2	**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.

Self-Check 3.1	**Written Test**

Short Answer

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

I. Shor Answer

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

3. List and explain the control systems of an oscilloscopes.*4pts*

4. List the horizontal deflection systems of an oscilloscopes.3*pts*

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 ___________________**

Unit Four: Test and inspect repaired products
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: • Iinspect and test repaired products • Observe Housekeeping procedures • Dispose Waste materials • Document Work completion This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Perform Iinspect and test repaired products • Observe Housekeeping procedures • Dispose Waste materials • Document Work completion

4.1 Perform Iinspect and test 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.

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.

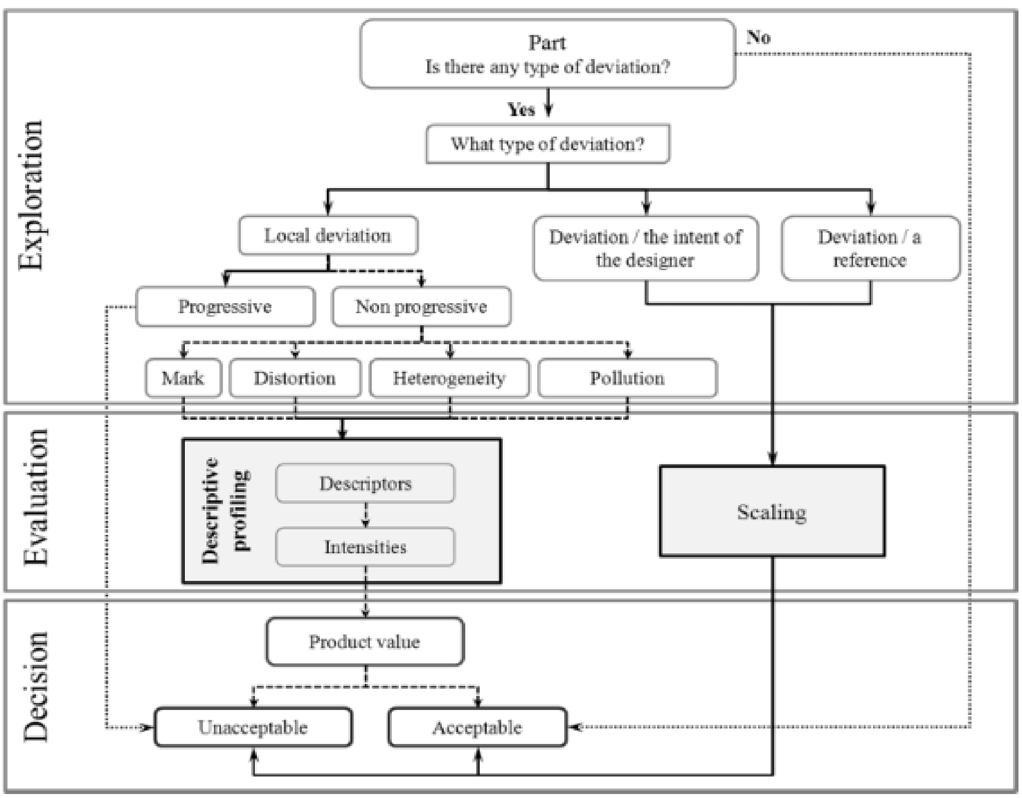


Figure 4.1.Visual inspection process

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.

4.2 Observing Housekeeping procedures

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).

4.3 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

4.4. Documenting Work completion

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 Check 4.1	Written Test

Short Answer

1. Define Inspection
2. Inspection records Includes
3. Repair equipment documentation includes:
4. What is E-Waste?
5. 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** ____________________

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