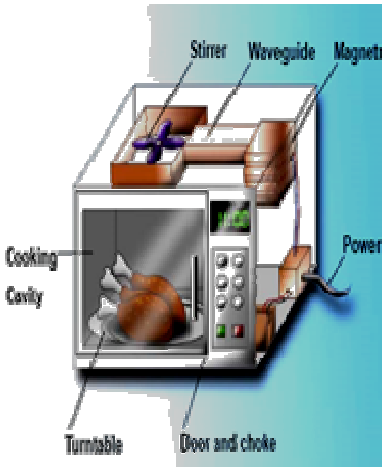
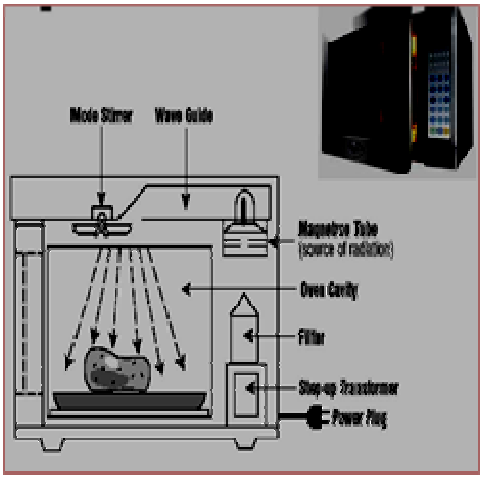
ELECTRICAL/ELECTRONICS EQUIPMENT SERVICING

LEVEL – II

Based on April, 2022 curriculum Version 1





Module Title: Maintaining and Repairing Micro Wave oven

Module Code: EISE EES2 M09 0822

Nominal duration: 60Hours

Prepared by: Ministry of Labour and Skill

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Addis Ababa, Ethiopia

Table of Contents

Acknowledgement

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Acronym

RFI ---------- Radio Frequency Interference

SPC ---------- Statistical Process Control

OSH ---------- Occupational safety and health

WHO ---------- World Health Organization

AC –---------- Alternative current

DC –---------- Direct current

HVC ----------– High Voltage Capacitor

DMM –---------- Digital Multi-meter

Introduction to the Module

In electrical/electronics equipment servicing filed; the **Maintaining and Repairing Micro Wave oven** project helps to know the microwave is to heat food or drinks we want in seconds or minutes apparatus, but many times the system may fail or function incorrectly. To avoid complications and have to resort to buying a new appliance, we are going to teach to detect and remedy the most common faults.

This is a Guide on how to refurbish microwave oven. For that we need to know a microwave oven works, what usually goes wrong or how can we identify a microwave oven problem, and what segment or portion you need to fix it. So here are some of the simple step-by-step instructions for how to service a microwave oven door, how to dismantle a microwave oven, and how to test a temperature probe. This Fix-It Guide also refers to appliance controls repair, fan repair, electrical cord repair and fuse repair.

It refers to a microwave oven is a gadget for heating and cooking food more quickly than a conventional oven. A magnetron inmost the oven fabricates a beam of electromagnetic waves, known as microwaves. Which is suitable for Maintaining and Repairing Micro Wave Oven?

This module covers the units:

- Prepare tools and workstation
- Diagnose faults of the unit.
- Maintain/repair the unit.
- Test repaired unit

Learning Objective of the Module

- Prepare unit, tools, equipment and workstation
- Diagnose faults of the unit.
- Maintain/repair the unit.
- Test repaired unit

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 exercise

Unit one: Prepare tools and workstation

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

- workplace and equipment for maintenance
- Repair/maintenance history.
- Service manuals and service information.
- Set / arrange workplace for repair.
- Necessary tools, test instruments and PPE.

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:

- ready workplace and equipment for maintenance
- Verify repair/maintenance history.
- Obtain service manuals and service information.
- Set / arrange workplace for repair.
- Prepare necessary test instruments and PPE.

1.1. Ready workplace and equipment for maintenance

Understand your responsibilities for keeping work equipment in good working order, how often you need to maintain it and where you can keep a record. You need to carry out maintenance to ensure the workplace structure, equipment, machinery, fixtures and fittings and facilities are in good working order. Inadequate maintenance can lead to dangerous situations, accidents and health problems.

1.1.1 What is the preparation before maintenance work.

Safe maintenance work requires proper planning, a safe work area, appropriate equipment, careful work execution and diligent final checks.

- Importance.
- Planning.
- Providing a safe work area.
- Allocating appropriate equipment.
- Work execution.
- Final checks.
- Legislation

1.1.2 Why is maintenance of the workplace and equipment important

Regular maintenance is essential to keep equipment, machines and the work environment safe and reliable. Lack of maintenance or inadequate maintenance can lead to dangerous situations, accidents and health problems. Maintenance is a high-risk activity with some of the hazards resulting from the nature of the work.

1.2. Verify Repair/Maintenance History.

Micro-tech maintains a web site with a large amount of information on microwave oven repair including an on-line Tech Tips Database with hundreds of solutions to common problem for many models of microwave ovens. There is also an extensive list of microwave oven related links to other interesting sites (including this document!). The comprehensive Safety Info is a must read as well. Not entirely coincidentally, I assume, some of its wording appears remarkably familiar! Micro-tech also offers instructional videos and books on microwave oven and VCR repair.

It is quite possible your problem is already covered at the Micro-tech site. In that case, you can greatly simplify your troubleshooting or at least confirm a diagnosis before ordering parts. My only reservation with respect to tech tips databases in general - this has nothing to do with Micro-tech in particular - is that symptoms can sometimes be deceiving and a solution that works in one instance may not apply to your specific problem. Therefore, an understanding of the hows and whys of the equipment along with some good old fashioned testing is highly desirable to minimize the risk of replacing parts that turn out not to be bad.

1.2.1. Method Collect the evidence Approach with an open mind

Before disturbing or changing anything- Stop, Look, Listen and Learn Collect only relevant information, if in doubt about its validity include it and discard later if unrelated Question the user Check the system running if possible

- Use sources of information, manuals, maintenance records etc .
- Use test equipment to verify calibration and settings
- Analyses the evidence separate the various symptoms and work out the importance of each one
- Check if the evidence leads to a previously recorded fault
- Locate the Fault Use all resources available- test equipment etc.
- If possible locate fault to component level Never assume- always remove and check suspect components.

1.2.2. Technique Used On Complex Faults with A History Of Data

Observe machine running (if safe to do so)
Use test equipment (built in or otherwise) Refer to manufacturers manual (look for fault finding aids). A. A. **Use sensory techniques**

1. Collect the Evidence.
2. Consider machine history records.
3. Question the operator (use good social skills)
4. Consider Packaging materials Raw materials Services (air water etc)

2. Analyses the evidence (diagnosis)

1.2.3. The simplest problems

- Bad interlocks switches or door misalignment causing fuses to blow or no operation when the start button is pressed.
- Locate and replace defective switches and/or realign door.
- Arcing in oven chamber: clean oven chamber and waveguide thoroughly.
- Replace carbonized or damaged waveguide cover. Smooth rough metal edges. Touch up the interior paint.

- Blown fuse due to power surge or old age: Replace fuse. On rare occasions, the main fuse may even be intermittent causing very strange symptoms.
- An MOV, probably on the controller, may have shorted due to a power surge blowing the controller fuse. Remove remains of MOV, replace fuse and test, replace MOV for future surge protection.
- Erratic touchpad operations due to spill - let touchpad dry out for a week.
- Bugs in the works - the controller circuit board are a nice warm safe cozy place to raise a family.....

1.2.4. Repair or replace?

With small to medium size microwave ovens going for $X-Y it hardly makes sense to spend $X to have one repaired. Even full size microwave ovens with full featured touch panel can be had for under $Y. Thus, replacement should be considered seriously before sinking a large investment into an older oven.

However, if you can do the repair yourself, the equation changes dramatically as your parts costs will be 1/2 to 1/4 of what a professional will charge and of course your time is free. The educational aspects may also be appealing. You will learn a lot in the process. Many problems can be solved quickly and inexpensively. Fixing an old microwave for the dorm room may just make sense after all.

1.2.5. Identify a Microwave Oven Problem

If your microwave isn't working at all, make sure power is on at the outlet and test the electrical cord immediately. Inspect the fuse and replace it if it isn't working or defective. Also, make sure that the door closes properly.

If the oven doesn't cook at all or cooks only intermittently but the display is on, make sure that scrutinize the door interlock switch, the thermal cutout, and all the major and minor parts that don't pass the test.

If the oven keeps dissipating fuses, make sure that you check if the door is faulty, Interlock or monitor.

If the carousel won't turn on then please go through the plastic coupling underneath the tray. Check the roller assembly and make sure the tray is sitting level on the turning mechanism.

Just in case you encounter some problem again with the microwave, take it to a service center that works on microwave ovens.

B. What Do I Need for Microwave Oven Repair?

You can buy substitute parts from the manufacturer. Tools you'll need to dismantle and test a microwave oven include these:

- Screwdrivers
- Wrenches
- Multi-meter

A. **Service a microwave oven door:**

1. Check the door, such as broken components.
2. Examine the door seal along the inside front edge of the oven use a little soap or detergent, rinse it and dry it. Inspect the door hinge to ensure that it isn't damaged.
3. Check the door latch on the outside and inside of the door to make sure it works smoothly and not get stuck.

B. Disassemble a microwave oven:

1. Open the microwave oven and withdraw all trays or carousels inside the oven cavity. If the unit is built-in, unfasten all holding the unit in place and remove the microwave oven.
2. Switch on the unit on its back and clear all the screws or bolts that hold the housing to the frame.
3. Be cautious while removing the housing and identify the capacitor and make sure you don't touch it. In Capacitors electricity continues to flow even when they are unplugged.

C. DON'T TOUCH the capacitor!

Inspect and, if needed, clean switches and other simple components. Don't disturb the magnetron (probably encased in a secondary housing).

Test the electrical cord, fan, fuse, interlock, and other appliance components.

Reassemble and test the microwave oven.

1.3. Obtain service manuals and service information.

1.3.1. Circuits Of This Unit Repairs Should Be Carried Out With Great Care.

The filament leads of magnetron carry High Voltage with respect to ground. Extreme caution must be exercised. Never plug the unit into a power source to determine which component is defective in high voltage section.

A. The Following Precautions Must Be Taken Before Servicing.

1. **Before the power is applied**:

I. Make sure the primary interlock switch, the secondary interlock switch and the interlock monitor switches operate properly by opening and closing the door several by opening and closing the door several times.

II. Make sure the perforated screen and the dielectric choke of the door are correctly and firmly mounted.

2. **After power is applied:**

I. Make sure the interlock switch mechanism is operating properly by opening and closing the door.

II. Check microwave energy leakage must be below the limit of 5 mW/cm^2. (All service adjustments should be made minimum microwave energy leakage readings).

1. **Do not operate the unit until it is completely repaired**, if any of the following conditions exist.

A. The unit must not be operated.

- The door does not close firmly.
- The hinge is broken.
- The door seal is damaged.
- The door is bent or warped, or there is any other visible damage on the unit that may cause microwave energy leakage.

NOTE: Always keep the seal clean.

- Make sure that there are no defective parts in the interlock mechanism.
- Make sure that there are no detective parts in the microwave generating and transmission assembly (especially waveguide).

4, **The following items should be checked after the unit is repaired:**

- The interlock monitor switch is connected correctly and firmly.
- The magnetron gasket is properly positioned and mounted.
- The waveguide and the oven cavity are intact. (no microwave energy leakage)
- The door can be properly closed and the safety switches work properly.
- The unit must stop when the door is opened or the time is up.
- The unit must not be operated with any of the above components removed or by-passed.

1.3.2. Warning Service Information for Microwave.

Microwave ovens contain circuitry capable of producing very high voltage and current, contact with following parts may result in a severe, possibly fatal, electrical shock. (Example) High Voltage Capacitor, High Voltage Power Transformer, Magnetron, High Voltage Rectifier Assembly, High Voltage Harness etc. Read the Service Manual carefully and follow all instructions.

F.G. Danger high voltage.

A. Before Servicing

1. Disconnect the power supply cord , and then remove outer case.
2. Open the door and block it open.
3. Discharge high voltage capacitor

1.3.3. Discharge The High-Voltage Capacitor Before Servicing.

The high-voltage capacitor remains charged about 60 seconds after the oven has been switched off. Wait for 60 seconds and then short-circuit the connection of the high voltage capacitor (that is the connecting lead of the high voltage rectifier) against the chassis with the use of an insulated screwdriver

Whenever troubleshooting is performed the power supply must be disconnected. It may, in some cases, be necessary to connect the power supply after the outer case has been removed, in this event.

1. Disconnect the power supply cord, and then remove outer case.
2. Open the door and block it open.
3. Discharge high voltage capacitor.
4. Disconnect the leads to the primary of the power transformer.
5. Ensure that these leads remain isolated from other components and oven chassis by using insulation tape.
6. After that procedure, reconnect the power supply cord.

B. When the testing is completed,

1. Disconnect the power supply cord, and then remove outer case.
2. Open the door and block it open.
3. Discharge high voltage capacitor.
4. Reconnect the leads to the primary of the power transformer.
5. Reinstall the outer case (cabinet).
6. Reconnect the power supply cord after the outer case is installed.
7. Run the oven and check all functions.

C. After repairing

1. Reconnect all leads removed from components during testing.
2. Reinstall the outer case (cabinet).
3. Reconnect the power supply cord after the outer case is installed.
4. Run the oven and check all functions.

Microwave ovens should not be run empty. To test for the presence of microwave energy within a cavity, place a cup of cold water on the oven turntable, close the door and set the power to HIGH and set the microwave timer for two (2) minutes. When the two minutes has elapsed (timer at zero) carefully check that the water is now hot. If the water remains cold carry out **Before Servicing procedure** and reexamine the connections to the component being tested. When all service work is completed and the oven is fully assembled, the microwave power output should be checked and microwave leakage test should be carried

1.4. Set / arrange workplace for repair.

1.4.1. Scope/range work area preparations:

A. Responsible for ensuring the preparations carried out safely by following company defined procedures.

- You will be accountable for the integrity of the work and ensuring the work is recorded in a formal manner.
- Authorization for proceeding with the work will be given by authorized signatories within the Permit to Work system

B. The type of work area to be prepared would include:

- Chemicals manufacturing and petroleum sites
- Controlled operational areas

- Offshore installations

C. The type of work area preparations could involve ensuring that the location and condition of work environments are appropriate in terms of:

- Layout
- Security
- Safety
- Isolations (where relevant)
- Accessibility

D. The type of work area protection and safety requirements will take into account any hazards due to the particular working conditions that could also include:

- Working on access structures (scaffold)
- At height
- Inside systems and plant
- Adverse weather conditions
- Confined spaces
- In shafts

1.5. Necessary tools, test instruments and PPE

1.5.1. Necessary tools and test instruments

- #1 and #2 Phillips screwdriver
- Pencil
- Ruler or tape measure and straight edge
- Carpenter square (optional)
- Tin snips (for cutting damper, if required)
- Scissors (to cut template, if necessary)
- Electric drill with 3 /16″, ½″ and ⅝″ drill bits
- Filler blocks or scrap wood pieces, if needed for top cabinet spacing (used on recessed bottom cabinet installations only) - DMM
- Gloves
- Saw (saber, hole or keyhole)
- Stud finder or Hammer (optional)
- Safety goggles
- Level
- Duct and masking tap
- MOUNTING SPACE 30^0

1.5.2. Personal Protective Equipment (PPE) ·

Chemicals in hazard group S can damage the skin or eyes, or enter the body through the skin and harm you. Sheets Sk100 and Sk101 give good advice on how to keep the materials off your skin. · Check the material safety data sheet or ask your supplier to find out what personal protective equipment is needed. · Look after your protective equipment. When not in use, keep it clean and store it in a clean, safe place. · Keep your protective equipment clean and change it at recommended intervals or when it is damaged.

Self-Check -1.1.

Test I: short Answer writing

Instruction: write short answer for the given question. You are provided 4 minute for each question and each point has 5 Points.

1. Necessary tools and test instruments
2. What is Personal Protective Equipment?
3. write six point technique used on complex faults with a history of data

Test II: Say True or False

1. After repairing reconnect all leads removed from components during testing.
2. Before repairing reinstall the outer case (cabinet).
3. Microwave ovens should not be run empty.

Test III: Choose the best answer from the give alternative given below.

1. Which one is not correct to repair Microwave oven Before Servicing

A. Disconnect the power supply cord B. Open the door and block it open

C. Discharge high voltage capacitor D. Remove outer case E. None

2. Which of the following items should be checked after the unit is repaired: Except,
   A. The interlock monitor switch is connected
   B. The magnetron gasket is properly positioned and mounted.
   C. No microwave energy leakage
   D. The door can be properly closed E. None

Operation Sheet 1. 1 :

verify the Interlock System on a Microwave Oven for Safe Performance Using Service Manuals and Service Information

Operation title: procedures of test the interlock system on a microwave oven for safe performance using service manuals and service information

Purpose: To practice and demonstrate the knowledge and skill required verify the interlock system on a microwave oven for safe performance using service manuals and service information

Instruction: Use the given select tools and equipment so that microwave oven is usually done sure the primary interlock switch, the secondary interlock switch and the interlock monitor switches operate properly by opening and closing the door. For this operation you have given 4 Hour and you are expected to provide the answer on the given steps.

Procedure It follow to Do

STEP 1: Put on safety glasses
STEP 2: Unplug the microwave oven from its power source
STEP 3: Position the oven so that the metal tag on the rear panel can easily be read
STEP 4: Complete the following information concerning the oven specifications:
STEP 5: Check the door, door gasket, and oven surfaces
STEP 6. Check as best you can the major electronic components located between the cabinet and the cavity walls:

Tools and requirement:

- Microwave oven as selected by instructor
- Operating manual for selected microwave
- sixteen-ounce measuring beaker
- Cool water supply
- Paper and pencil
- Ruler or tape measure and straight edge
- Carpenter square (optional)
- Tin snips (for cutting damper, if required)
- Saw (saber, hole or keyhole)
- Stud finder or Hammer (optional
- Safety glasses

LAP Test – 1.1.

Test the Interlock System on a Microwave Oven for Safe Performance

Instructions: Given necessary templates, tools, materials and equipment you are required to perform test the Interlock System on a Microwave Oven for safe performance for the following tasks within 5 hour.

Task -1: Fill the measuring beaker with nine ounces of cool water and place the beaker in the center of the oven cavity.

Task -2: Close the oven door and plug the power cord in
Task -3: Set the power control at the highest available level
Task -4: Set the timer for three to five minutes
Task - 5: Press the start button
Task - 6: Permit the water to come to a boil and quickly open the oven door Just a bit less than one inch

Precautions: select necessary templates, tools, materials and equipment before test the Interlock System on a Microwave Oven for Safe Performance on the given format

Quality Criteria: the given test the Interlock System on a Microwave Oven for Safe Performance is with correct specification

Unit Two: Diagnose Faults Of The Unit

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

- systematic pre-testing procedure
- Conduct complete check-up of Micro Wave oven
- Identify system defect/fault symptoms.
- test instruments with user manuals
- Proper troubleshooting procedures.
- Check isolated Circuits using specified testing procedures.
- Explain identify defects and faults.
- Checking control settings/adjustments.
- Documenting results of diagnosis and testing.
- Advising/informing Customers.

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:

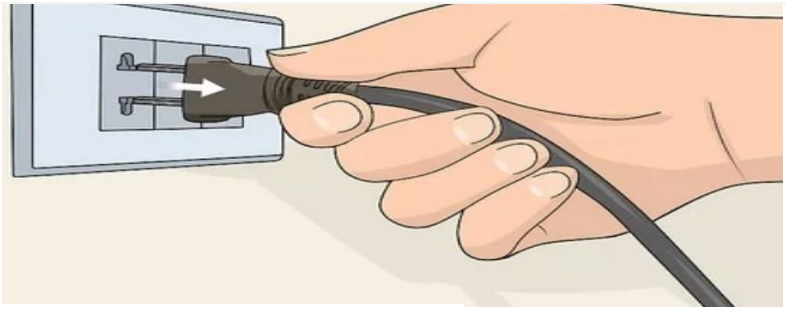
- Observe systematic pre-testing procedure
- Conduct complete check-up of Micro Wave oven
- Identify system defect/fault symptoms.
- apply test instruments with user manuals
- Implement proper troubleshooting procedures.
- Check isolated Circuits using specified testing procedures.
- Identify defects and faults.
- Check control settings/adjustments.
- Documenting results of diagnosis and testing.
- Advising/informing Customers.

2.1. Observing systematic pre-testing procedure

2.1.1. How to Test an Oven Element

Oven elements, also known as heating elements, are the coils on the top and bottom of your electric oven that heat up and glow red when you turn your oven on. If your oven isn't turning on or there's something wrong with the temperature in the oven when you cook, the problem may be a faulty heating element. Perform a continuity test on your heating elements with a multi-meter to determine if the elements are working correctly. This assesses whether the element is properly receiving electrical signals from your oven. Other basic tests include physically inspecting the coils and cross-checking the temperature with an oven thermometer.

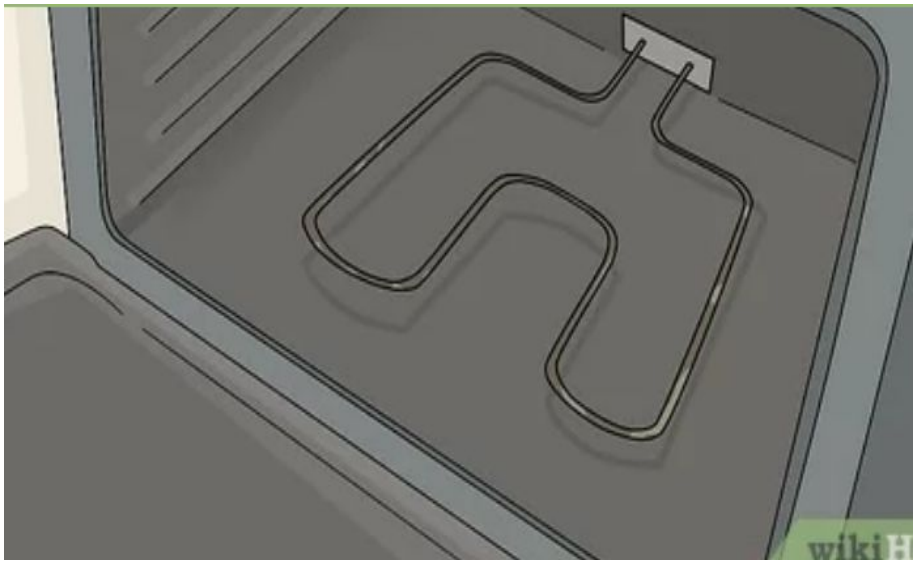
1. Testing an Element with a Multi-meter



2. **Unplug the oven and let it cool if necessary.**

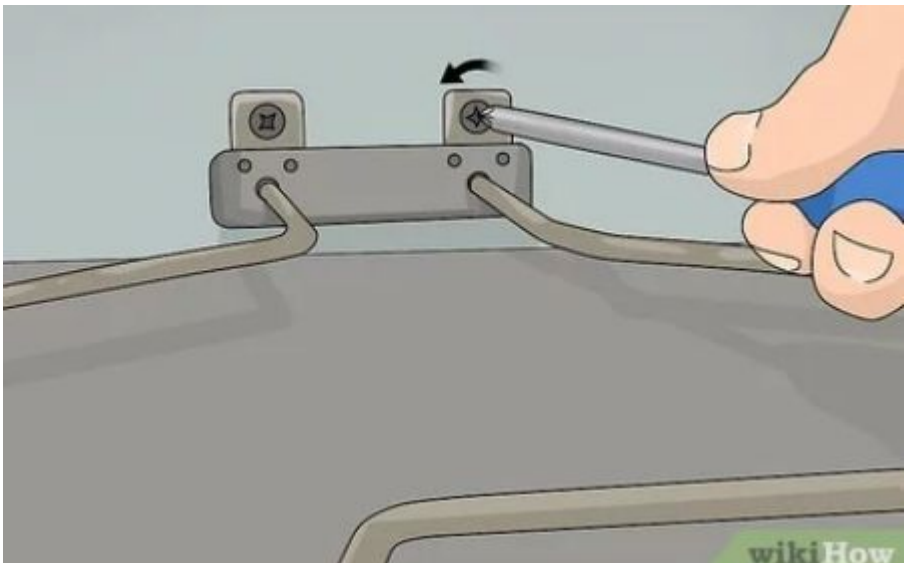
A multi-meter test assesses continuity in an element and will tell you whether your heating element is working or not. You cannot test a heating element safely without removing it, and you cannot remove it when the oven is hot or on. If you were just using the oven, turn the oven off and wait 30-60 minutes for the oven to cool. Then, pull it out from the wall and unplug it.[1]

- You may seriously injure yourself if you test an oven element while the oven is on.
- If your oven is fixed into the wall, flip the appropriate fuse on your fuse box to turn the breakers for the room off.
- While oven elements look different, they are almost always a single loop of metal. A continuity test sends an electrical signal down one end of the coil and assesses how accurately and successfully the signal reaches the other end of the coil.



3. **Identify the heating elements in your oven at the top and bottom.** The heating elements are the big coils at the top and bottom of your oven. Open your oven door and remove the metal racks. Then, look at the very bottom of the oven and look for a 0.5–1 in (1.3–2.5 cm) thick metal coil that loops around the bottom of the oven. This is your main heating element. Next, look at the roof of your oven's interior. If you have a broiler, there will be a second coil attached to the top of the oven.[2]

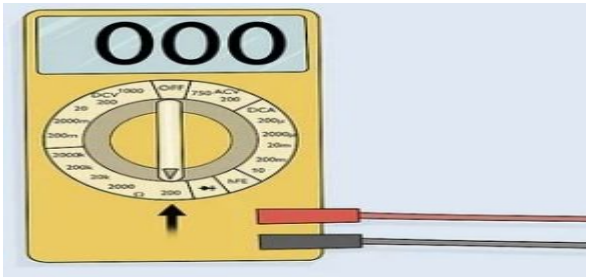
- Heating elements come in different shapes and sizes, but the overall steps are the same regardless of your make or model.
- The heating element is black or gray when the oven is off. When the oven is on, these elements glow orange



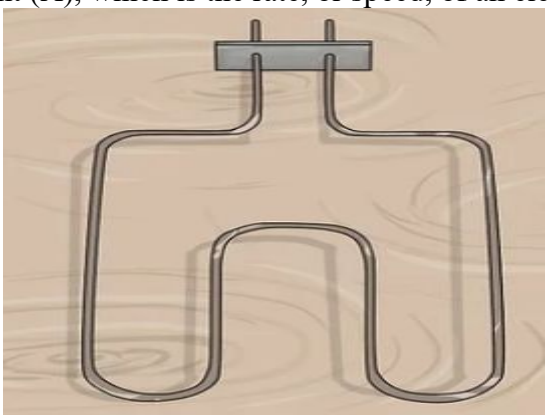
4. **Remove the heating element that you want to test.** Then, look for a panel connecting the element to the back of the oven. Use a screwdriver to remove the screw on this panel. Next, gently pull the element out 2–4 inches (5.1–10.2 cm) to expose the element's

terminals, which are the 2 pieces of metal that are connected to 2 wires. Use a pair of needle-nose pliers to gently slide the metal brackets at the end of each wire out of the element's terminals. Lift your element out of the oven.[3]

- Most ovens have 2 heating elements—one on top for the broiler and one on the bottom for the oven. You can test either element, but you must remove it from the appliance.
- Elements may be shaped differently from model to model, but the overall process is the same for every element. Some elements have more than 1 screw on the plate holding the terminals in place.

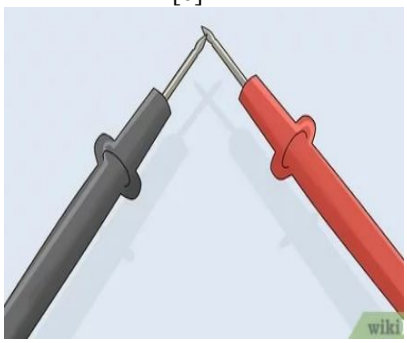


5. **Turn the dial on your multi-meter to the lowest ohms (Ω) setting.**
   Plug the red cord into the red slot and your black cord into the black slot on the face of your multi-meter. Turn the device on. Then, turn the dial on your multi-meter so that it is set to ohms, which is the unit of measurement used to measure electrical resistance. Use the lowest number available in your ohm range, which is usually 200 ohms, to test your heating elements.
   - Every multi-meter is different. Some have digital menus, while others us a rotating dial. Consult your multi-meter's instruction manual if you can't figure out how to set it to test ohms.
   - The other multi-meter settings include voltage (V), which basically measures the power of a current, resistance (mAVΩ), which measures how a current is throttled by a material, and current (A), which is the rate, or speed, of an electrical signal.



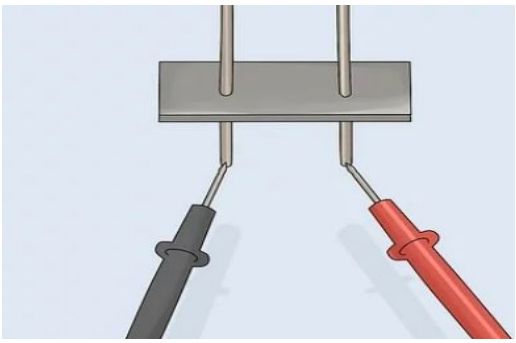
6. **Place your heating element on the floor or a wooden table.**
   You may electrocute yourself if you perform a continuity test with the item on a metal or ungrounded surface, which is why you removed the heating element in the first place. Put

the heating element on the ground to make things easy. Alternatively, a concrete or wood surface that is grounded will work as well.[6]



7. **Calibrate the multi-meter by touching the metal probes together.** Before you test your heating element, make sure that your multi-meter is registering electrical signals correctly. To do this, simply touch the metal probe on the end of your red wire to the metal probe on the end of your black wire. The probes are the little metal prongs sticking out the end of each wire. If the number on your screen is lower than 1.0, your wires are functioning correctly. If the number is higher than 1.0, try cleaning the terminals on your wires and testing again.[7]

- The higher the number on the multi-meter screen, the greater the difference between the input signal and the output signal. If it helps, imagine the multi-meter's probes like 2 ends of a pipe. The number on the screen is how much water leaks out of the pipe when the water is running.
- If the number on your screen is higher than 1.0 and you've already cleaned your terminals, replace the wires for your multi-meter—they aren't picking up signals correctly.
- If the number on the screen is 0 or 0.1, your terminals are in really good shape and you'll get a very accurate reading. Digital multi-meters will usually beep when an electrical signal has continuity.



8. **Touch the probes to the terminals on your element.** Without touching the oven element with your hands, put the metal probe on your red wire against one of the metal terminals on your heating element. If you can't tell where the terminals are, they're always the little metal pieces that the wires in your oven connect to. Put the black wire's

probe against the other terminal. Hold the wires still and wait 3-5 seconds for your multi-meter to pick up a reading.

- It doesn't matter which terminal you put the red and black wires against, so long as they aren't touching one another.

9. **Interpret the results on the screen to see if the continuity is 0-50 ohms.** Once your multi-meter beeps or the number stops moving up and down, read the number on your screen. If it 0 or less than 1.0, your element has perfect continuity. However, some signal is often lost from one end to the other, and this is nothing to worry about so long as the loss is less than 50 ohms. If the number is higher than 50 ohms, or you see a single 1 with no decimal on the left side of your screen, your element is broken and needs to be replaced.[8]

- Standard continuity readings come in the form of a double-digit number with a decimal point. A reading of 1 with no decimal point on the left side of your screen means that there is no signal whatsoever. On some multi-meters, it means that the reading is so high; it can't be displayed on your screen.
- If the continuity is under 50 ohms and your oven still isn't heating properly, the problem is not the heating element itself.

2.2. Conducting complete check-up of Micro Wave oven

2.3. Identifying system defect/fault symptoms.

"Fault location and Diagnosis

2.3.1. Preparation for fault diagnosis

Signs barriers are in place Visibility: has dust, grease and dirt been cleaned to reveal as much as possible of the job in hand?

Symptoms: do you understand the nature of the problem?

What is that the equipment has failed to do?

How is the performance abnormal?

2.3.2. Determine and Remove the Root cause

The root cause of the fault must be located and removed otherwise the fault will eventually reoccur **Rectify the Fault**

Any adjustment, repair or replacement should only be carried after identifying and removing the root cause of the problem.

2.3.3. Identify the cause Symptom Fault

Symptom - signs or indications that there is a deviation from the normal operating mode.

Fault – the particular defect or combination of defects that cause the symptom to occur.

Cause – the reason why a fault has occurred.

Symptom (overheating)

Fault (worn bearing)

Cause (poor lubrication)

Sensory (visual) fractures, surface cracks, corrosion, leaks, damage, contaminated oils, loose fastenings, excessive wear, metallic particles, broken chains and belts, missing parts.

Sensory (smell) Smell- hot oil, burnt out motor, burnt out belts, overheating.

Sensory (Touch) Touch - vibration, wear, play, belt or chain tension, out of balance, excessive clearance.

2.3.4. Fault detection and fault diagnosis is a work in progress.

It will evolve over time, especially based on input from the LinkedIn group Fault Detection and Diagnosis.

Fault detection and diagnosis is a key component of many operations management automation systems.

A "fault" is another word for a problem**. A "root cause"** fault is a fundamental, underlying problem that may lead to other problems and observable symptoms. (It might not be directly observable).

A root cause is also generally associated with procedures for repair.

A "fault" or "problem does not have to be the result of a complete failure of a piece of equipment, or even involve specific hardware. For instance, a problem might be defined as non-optimal operation or off-spec product. In a process plant, root causes of non-optimal operation might be hardware failures, but problems might also be caused by poor choice of operating targets, poor feedstock quality, poor controller tuning, and partial loss of catalyst activity, buildup of coke, low steam system pressure, sensor calibration errors, or human error. A fault

may be considered a binary variable (”OK” vs. “failed”), or there may be a numerical “extent”, such as the amount of a leak or a measure of inefficiency.

A symptom is an observed event or variable value, needed to detect and isolate faults. If a symptom is the response to a question or an on-demand data request (when actively testing a system instead of just passively monitoring it), it is referred to as a test or test result.

Fault detection is recognizing that a problem has occurred, even if you don't yet know the root cause. Faults may be detected by a variety of quantitative or qualitative means. This includes many of the multivariable, model-based approaches discussed later. It also includes simple, traditional techniques for single variables, such as alarms based on high, low, or deviation limits for process variables or rates of change; Statistical Process Control (SPC) measures; and summary alarms generated by packaged subsystems.

Fault diagnosis is pinpointing one or more root causes of problems, to the point where corrective action can be taken. This is also referred to as “fault isolation”, especially when emphasizing the distinction from fault detection. In common, casual usage, "fault diagnosis" often includes fault detection, so “fault isolation” emphasizes the distinction.

2.4. Requiring test instruments with user manuals

2.4.1. Microwave safety measures that you must follow!

Microwave has become a must have kitchen appliance today. It is being used very often for cooking, baking and heating purpose. It has made cooking a joyful experience. But it is very important to follow some microwave safety measures while using and handling this appliance:

10 safety measures that must be followed while using a microwave:

Avoid Metals and papers: Do not use any metal container /metal utensil or any cookware that has metal handle or trims to avoid fire inside microwave. Always remove the aluminum foil from the food item before heating them in microwave. Also do not use paper cups or paper disposable utensils for cooking and heating.

2. No flammable food or beverage: Do not heat or cook any food and beverage item that is flammable in nature (i.e. items that catch fire). Heating such items can cause fire or explosion inside microwave

3. No sealed food and beverage items: Do not heat food items that are packed and sealed. Heating such items can lead to explosion inside the microwave. First take out the food from sealed packet and then heat it in a microwavable dish or utensil.

4. Place microwave away from heating sources in the kitchen: Do not keep it near or beneath any cooking or heating appliance. This can lead to overheating of the microwave.

5. Do not cover the vent of microwave at the top when it is in use: Also do not cover any part of the microwave with metal foil. This can lead to overheating of the appliance and sometimes even risk of fire.

6. Never ever attempt to use microwave with door open as this act can lead to exposure to microwave energy.

7. If food items or materials inside the oven catch fire, immediately turn off the power, unplug the device and keep oven door closed

8. After cooking or heating, allow the utensil or dish to stand in the microwave oven for a short time before taking it out. This will bring down the temperature of the hot container and will protect the user from risk of any injury or burn.

9. Over-sized food containers should not be heated inside microwave to avoid fire or electric shock.

10. Never use microwave as a storage unit: Do not store any item other than manufacturer recommended accessories inside it.

The microwave oven should be serviced only by service personnel. Therefore call for only professional help for your microwave examination, repair, or adjustment.

2.4.2. Testing Instruments Safety Guidelines.

8) Safety Guidelines

Figure 8.1- A Danger Sign

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

2.4.3. Using Multimeter

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

Figure6.3 Digital and Analogue Multimeter

Analogue and digital Multi-meters have either a rotary selector switch or push buttons to select the appropriate function and range. Some Digital Multi-meters (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.

A. Precaution

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

A. 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.

B. Measuring Voltage

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

- If the meter is Digital, select the highest range or use the auto-ranging feature, by selecting "V." The meter will automatically produce a result, even if the voltage is AC or DC.
- If the meter is not auto-ranging, you will have to select if the voltage is from a DC source or if the voltage is from an AC source. DC means Direct Current and the voltage is coming from a battery or supply where the voltage is steady and not changing and AC means Alternating Current where the voltage is coming from a voltage that is rising and falling.
- You can measure the voltage at different points in a circuit by connecting the black probe to chassis. This is the 0v reference and is commonly called "Chassis" or "Earth" or "Ground" or "0v."
- The red lead is called the "measuring lead" or "measuring probe" and it can measure voltages at any point in a circuit. Sometimes there are "test points" on a circuit and these are wires or

loops designed to hold the tip of the red probe (or a red probe fitted with a mini clip or mini alligator clip).

- You can also measure voltages across a component. In other words, the reading is taken in parallel with the component. It may be the voltage across a transistor, resistor, capacitor, diode or coil. In most cases this voltage will be less than the supply voltage.

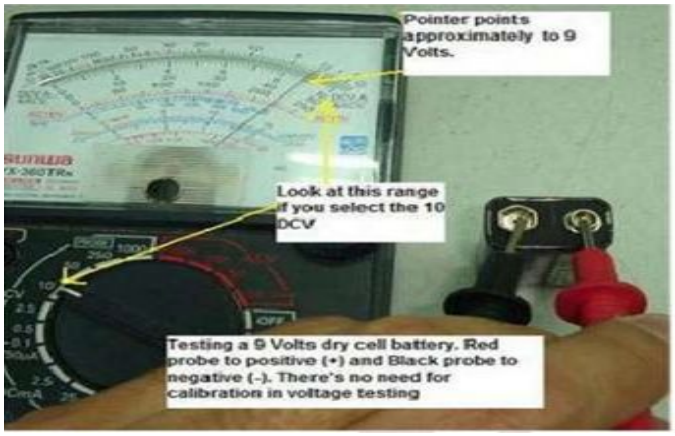


Figure6.4 Measuring the voltage using analog meter

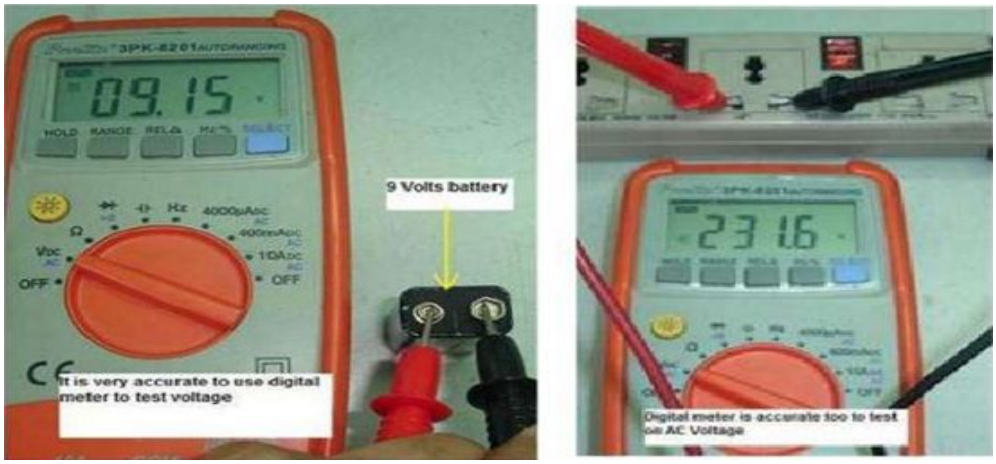


Figure 6.5Measuring the voltage using digital meter.

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.

C. 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.

2.5. Impelemation of proper troubleshoot defects/faulty parts

2.5.1. Troubleshooting Procedures

Trouble shooting procedure is important to reduce the time required for maintenance and troubleshooting is done easily if we have a theoretical knowledge about the equipment.

A. 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.

Many times equipment failure is caused by troubles in the power supply. If an electrical device ceases to operate, the most probable fault is power supply. Diagnosis it systematically mentioned below.

2.5.2. Verify that the power supply is faulted or not.

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.

Given that the system power is available and the power supply is connected to it, check the output of the power supply. If the output voltage is zero, or highly deviated value from its rated value the device is faulted.

2.5.3. Identify and locate the cause of the trouble

First check the fuse. If the fuse blows investigate the root cause of it before replacing. If the fuse is normal perform voltage test starting from the input side to the output side stage by stage until you get abnormal reading which is also the symptom of fault. Recall the transformer stages bellow, and apply voltage measurement at each stage using the following steps:

2.5.4. Correct the problem.

Once the root cause of a given fault is found, 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 rated components. This is actually one type of maintenance task.

A. Verify that the device reverts to its normal condition.

This is simply done by measuring the output voltage. If the fault still exist, repeat step 2 and 3 for the other fault.

B. **Follow up to prevent further trouble.**

If the fault is expected to be created by misuse of the power supply, for example if it were overloaded, consults the user how to use it in order to prevent the same fault in the future.

2.5.5. Most Common Problems And Possible Causes microwave oven

The following chart lists a variety of common problems and nearly all possible causes. Diagnostic procedures will then be needed to determine which actually apply. The 'possible causes' are listed in *approximate* order of likelihood.

Most of these problems are covered in more detail elsewhere in this document.

While this chart lists many problems, it is does not cover everything that can go wrong. However, it can be a starting point for guiding your thinking in the proper direction. Even if not listed here, your particular problem may still be dealt with elsewhere in this document.

- **Problem:** Totally dead oven.

  Possible causes:

  1. No power to outlet (blown fuse or tripped breaker or GFCI).
  2. Blown main fuse - likely due to other problems.
  3. Open thermal protector or thermal fuse.
  4. Defective controller or its power supply.
  5. Clock needs to be set before other functions will operate (some models).

- **Problem:** Totally dead oven after repair.

  Possible causes:

  1. Cabinet screws replaced in incorrect location (safety interlock not engaged).
  2. Any number of screw-ups. :)

- **Problem:** No response to any buttons on touchpad.

  Possible causes:

  1. Door is not closed (some models).
  2. You waited too long (open and close door to wake it up).
  3. Controller is confused (pull plug for a minute or two to reset).
  4. Defective interlock switches.
  5. Faulty controller or its power supply.
  6. Touchpad or controller board contaminated by overenthusiastic cleaning.
  7. Defective/damaged touchpad.

- **Problem:** Oven runs when door is still open.

  Possible causes:

  1. Damaged interlock assembly.
  2. Cooling fans (only) running due to bad sensor or still warm.

- **Problem:** Oven starts on its own as soon as door is closed.

  Possible causes:

  1. Defective TRIAC or relay.
  2. Controller is confused (pull plug for a minute or two to reset).
  3. Defective controller or its power supply.
  4. Touchpad or controller board contaminated by overenthusiastic cleaning.
  5. Defective/damaged touchpad.

- **Problem:** Oven works but display is blank.

  Possible causes:

  1. Defective controller or its power supply.
  2. Broken display panel.
  3. Oven needs to be reset (pull plug for a minute or two to reset).

- **Problem:** Whacked out controller or incorrect operation.

  Possible causes:

  1. Previous or multipart cook cycle not complete.
  2. Controller is confused (pull plug for a minute or two to reset).
  3. Defective controller or its power supply.
  4. Touchpad or controller board contaminated by overenthusiastic cleaning.
  5. Defective/damaged touchpad.
  6. Defective sensor (particularly convection/microwave combos).

- **Problem:** Erratic behavior.

  Possible causes:

  1. Previous or multipart cook cycle not complete.
  2. Bad connections in controller or microwave generator.
  3. Faulty relay - primary (or HV side, much less commonly used).
  4. Defective controller or its power supply.
  5. Bad contacts/connections on mechanical timers. Intermittent fuse.
  6. Power surge at start of cook cycle confusing controller.
  7. Microwave (RF) leakage into electronics bay.

- **Problem:** Some keys on the touchpad do not function or perform the wrong action.

  Possible causes:

  1. Touchpad or controller board contaminated by overenthusiastic cleaning.

2. Defective/damaged touchpad.
3. Controller is confused (pull plug for a minute or two to reset).
4. Faulty controller.

- **Problem:** Microwave oven does not respond to START button.

  Possible causes:

  1. Defective START button.
  2. Faulty interlock switches.
  3. Door is not securely closed.
  4. Faulty controller.
  5. You waited too long - open and close door to wake it up!

- **Problem:** No heat but otherwise normal operation.

  Possible causes:

  1. Blown fuse in HV transformer primary circuit or HV fuse (if used).
  2. Bad connections (particularly to magnetron filament).
  3. Open thermal protector or thermal fuse.
  4. Open HV capacitor, HV diode, HV transformer, or magnetron filament.
  5. Shorted HV diode, HV capacitor (will blow a fuse), or magnetron.
  6. Damaged protective VDR from filament to chassis (not commonly used).
  7. Defective HV relay (not commonly used).

- **Problem:** Timer and light work but no heat, cooling fan, or turntable rotation.

  Possible causes:

  1. Defective (lower) door interlock switch or door not closing fully.
  2. Faulty relay or triac.

- **Problem:** Fuse blows when closing or opening door:

  Possible causes:

  1. Defective door interlock switch(s).
  2. Interlock switch knocked out of position.
  3. Misaligned door.

- **Problem:** Loud hum and/or burning smell when attempting to cook.

  Possible causes:

  1. Shorted HV diode, magnetron.
  2. Burnt carbonized food in or above oven chamber.

3. Shorted winding in HV transformer.
4. Frayed insulation on HV wiring.

- **Problem:** Arcing in or above oven chamber.

  Possible causes:

  1. Burnt carbonized food deposits.
  2. Exposed sharp metal edges.

- **Problem:** Fuse blows when initiating cook cycle.

  Possible causes:

  1. Defective interlock switches or misaligned door.
  2. Shorted HV capacitor.
  3. Shorted HV diode.
  4. Shorted magnetron (probably won't blow main fuse but HV fuse if used).
  5. Defective triac.
  6. Old age or power surges.
  7. Defective HV transformer.
  8. Short in wiring due to vibration or poor manufacturing.

- **Problem:** Fuse blows when microwave shuts off (during or at end of cook cycle).

  Possible causes:

  1. Defective TRIAC (doesn't turn off properly).
  2. Defective relay.
  3. Shorting wires.

- **Problem:** Oven heats on high setting regardless of power setting.

  Possible causes:

  1. Faulty primary relay or TRIAC or HV relay (not commonly used).
  2. Faulty controller.

- **Problem:** Oven immediately starts to cook when door is closed.

  Possible causes:

  1. Shorted relay or TRIAC.
  2. Faulty controller.

- **Problem:** Oven heats but power seems low or erratic.

  Possible causes:

  1. Low line voltage.

2. Magnetron with low emission.
3. Faulty controller or set for wrong mode.
4. Stirrer (or turntable) not working.
5. Intermittent connections to magnetron filament or elsewhere.
6. Faulty primary relay or triac or HV relay (not commonly used).
7. Damaged protective VDR from filament to chassis (not commonly used).

- **Problem:** Oven heats but shuts off randomly.

  Possible causes:

  1. Overheating due to blocked air vents or inoperative cooling fan.
  2. Overheating due to bad magnetron.
  3. Bad connections in controller or microwave generator.
  4. Faulty interlock switch or marginal door alignment.
  5. Faulty controller.
  6. Overheating due to extremely high line voltage.
  7. Stuck stirrer fan resulting hot spots detected by sensors.

- **Problem:** Oven makes (possibly erratic) buzzing noise when heating.

  Possible causes:

  1. Fan blades hitting support or shroud.
  2. Vibrating sheet metal.
  3. Vibrating transformer laminations.
  4. Turntable or stirrer hitting some debris.

- **Problem:** Oven light does not work.

  Possible causes:

  1. Burnt out bulb :-).
  2. Bad connections.

- **Problem:** Fans or turntables that do not work.

  Possible causes:

  1. Gummed up lubrication or bad motor bearing(s).
  2. Loose or broken belt.
  3. Bad motor.
  4. Bad thermostat.

2.6. Checking isolated Circuits using specified testing procedures.

2.6.1. Isolating transformers.

Isolating transformers connected in the test supply will prevent the risk of electric shock
If a person touches a single live conductor of the isolated supply while in contact with an earthed conductor.
It should be clearly understood, however, that an isolating transformer cannot prevent an electric shock if someone makes contact simultaneously with both conductors of the supply on the secondary side of the transformer, unless the output voltage is below 50 V ac (120 V dc) in dry conditions and 16 V ac (35 V dc) in wet conditions.13v
The integrity of the isolation from earth should be tested regularly, or earth fault monitoring devices should be installed, to ensure that dangerous earth faults are detected.

This project is designed to replace the **defective control board with a new Control Board in Microwave Oven irrespective** of brand and capacity. Microwave ovens are dumped as e-waste due to unserviceable control boards. Spare parts such as magnetron, HV transformer, HV diode and drive mechanism, except control board, are readily available in the market. Block diagram of the microwave oven is shown in Fig. 1

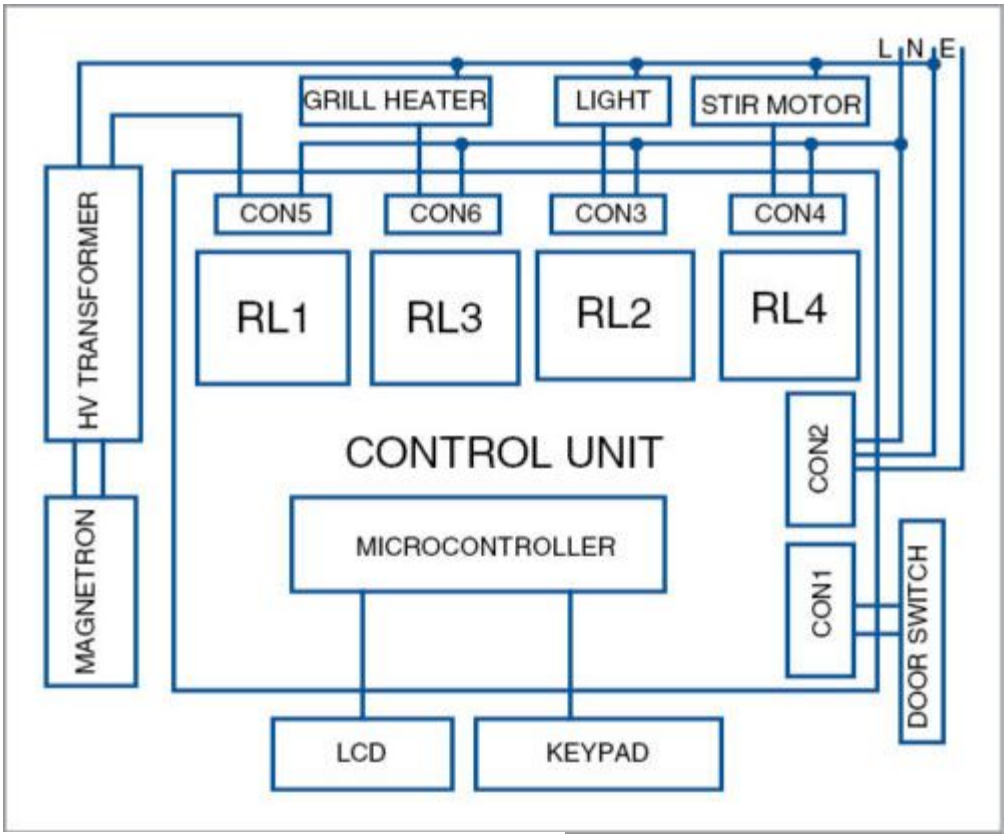


Fig. 1: Block diagram of microwave oven

2.6.2. Circuit and working

The circuit diagram of the microwave oven is shown in Fig. 2. It is built around 5V voltage regulator 7805 (IC1), microcontroller (MCU) AT89C52 (IC2), four 12V relays (RL1 through RL4), five PNP transistors (BC557), 14 tactile switches, one 16×2 line LCD (LCD1) and a few discrete components.

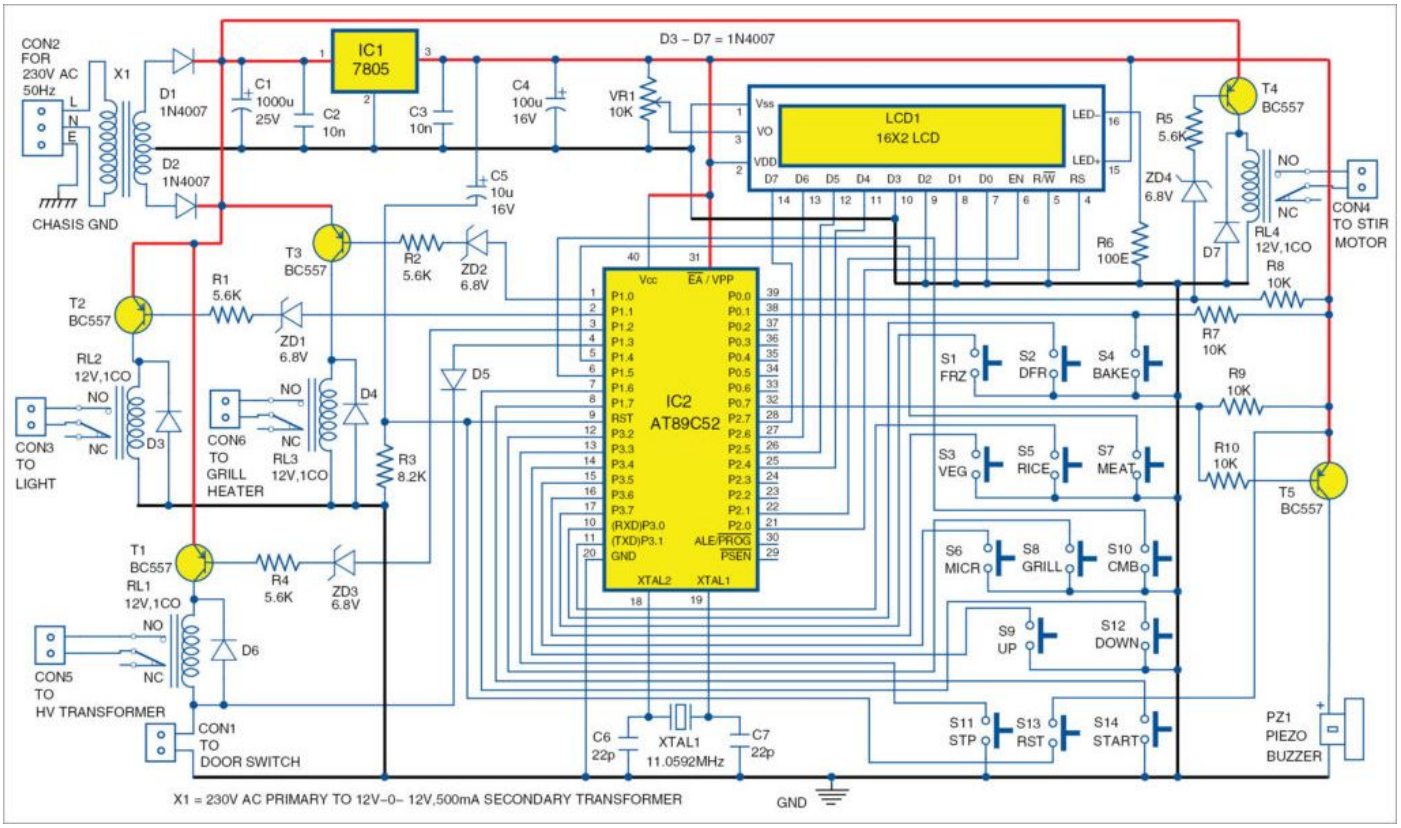


Fig. 2.6.2. : Circuit diagram of microwave oven

The circuit is powered with 230V AC. Transformer X1 reduces voltage to 12 volts. Diodes D1 and D2 act as rectifier diodes. Capacitor C1 is connected as a filter. The rectified, filtered and regulated DC voltage is fed to the power section of the circuit, and 5V is fed to the control circuit via 7805.

AT89C52 MCU, running at a clock frequency of 11.0592MHz, is interfaced with 14 controlling switches, 16×2 LCD and four relays. Use Zener diodes ZD1 through ZD4 to connect 12V relay through a PNP transistor to 5V MCU. Diode D5 prevents the 12V supply to the MCU when the door switch is opened.

TOTAL DELAY FOR DIFFERENT COOKING STYLES

Mode	Veg		Meat			Rice		Bake	Defrost
Style	Micro	Combi	Micro	Grill	Combi	Micro	Combi	Combi	Micro
Micro On (Sec)	12	12	15	Off	15	12	12	10	Min-Max
Micro Off (Sec)	8	8	5	Off	5	8	8	10	Max-Min
Grill On (Sec)	Off	8	Off	22	5	Off	8	10	Off
Grill Off (Sec)	Off	12	Off	8	15	Off	12	10	Off
Total (Min)	5	3	15	15	10	10	6	20	0.5
Cycles	15	9	45	45	30	30	18	60	-

Relays RL1, RL2, RL3 and RL4 are connected to the MCU through four relay driver transistors T1, T2, T3 and T4, respectively. Transistor T5 is used to drive the piezo buzzer. PNP transistors are used as active low output from the controller. The LCD is connected at port P2. Potmeter VR1 can be used to adjust the contrast of LCD1. D4 through D7 are protection diodes for relay driver transistors. AT89C52 runs with a crystal frequency of 11.0592MHz.

PARTS LIST

Semiconductors:
IC1 - 7805, 5V voltage regulator
IC2 - AT89C52 MICU
T1-T5 - BC557 pnp transistor
D1-D7 - 1N4007 rectifier diode
ZD1-ZD4 - 6.8V, Zener diode
Resistors- (all 1/4-watt, ±5% carbon):
R1, R2, R4, R5 - 5.6-kilo-ohm
R3 - 8.2-kilo-ohm
R6 - 100-ohm
R7-R10 - 10-kilo-ohm
VR1 - 10-kilo-ohm potmeter
Capacitors:
C1 - 1000µF, 25V electrolytic
C2, C3 - 10nF ceramic disk
C4 - 100µF, 16V electrolytic
C5 - 10µF, 16V electrolytic
C6, C7 - 22pF ceramic disk
Miscellaneous:
PZ1 - Piezo buzzer
S1-S14 - Tactile switch
LCD1 - 16X2 LCD
RL1-RL3 - 12V, 1CO, 30A relay
RL4 - 12V, 1CO, 1A relay
XTAL1 - 11.0592MHz crystal
CON1 - 2-pin connector
CON3-CON6 - 3-pin connector
CON2 - 3-pin connector
X1 - 230V AC primary to 12V-0-12V, 500mA secondary transformer

2.6.3. Software

The software is written in C language and compiled with Kiel µvision 4 software. Logic behind the software is described briefly for easy understanding and editing. In the main part of the software, the MCU scans continuously the condition of the seven input switches, comprising vegetable (VEG), meat, rice, frozen (FRZ), bake, up and defrost (DFR). If any these switches are found de-pressed by the program, the software jumps to the corresponding sub-routine. On auto sub-routine, each branch sets the total time of cooking and on/off delay timing for magnetron and grill heater. Total delay and on/off delay against each cooking styles are shown in the table.

On de-pressing Defrost, the program executes defrost sub-routine. Defrosting technique provided in the microwave oven is for cooking or heating refrigerated food. Normal cooking of refrigerated food in an oven results in rapid burning of outer parts, resulting in damaged food.

For compensating this at defrost mode, the system initially switches on the magnetron just for a few seconds. It slowly increases on time and decreases off time. This technique helps penetrate the heat throughout the food evenly.

Grill option is provided for meat only. Combi option is provided for rice, meat and cake only. On de-pressing Up, the software executes manual mode sub-routine. At manual mode, total cooking time can be selected by pressing Up or Down. With each press, time increments or decrements by one second.

By holding Up or Down, time increments or decrement by 10 seconds. After setting the time, any cook mode can be selected (Micro Veg or Combi). On/off delay is according to the preset

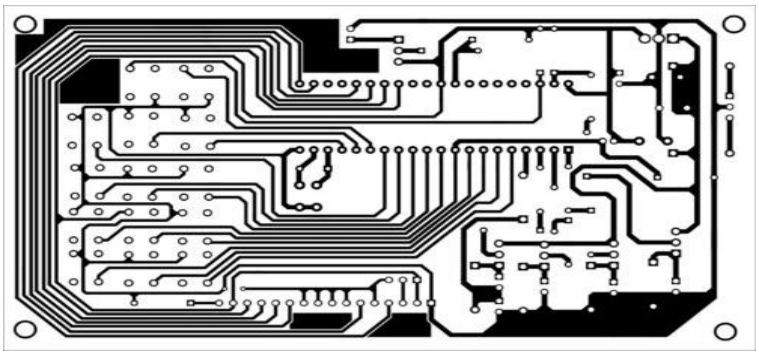
sequence, according to the type of cooking selected. Accurate delay time is achieved by enabling Timer0 of the MCU (IC2).

Unlike in conventional ovens, double protection is provided for door opening while cooking, both in software and hardware. When the door is opened, coil ground connection to magnetron relay disconnects. At the same time, software detects this condition and switches off the magnetron.

LCD1 shows all parameters. It is connected in four-wire method or 4-bit mode of operation. Corresponding software is simple and self-explanatory.

At EFY Lab, Top view programmer was used for programming the IC.

2.6.4. Construction and testing



F.G. 2.6.4. PCB Layout digram

ut of the microwave oven is shown in Fig. 3 . 3: PCB layout of microwave

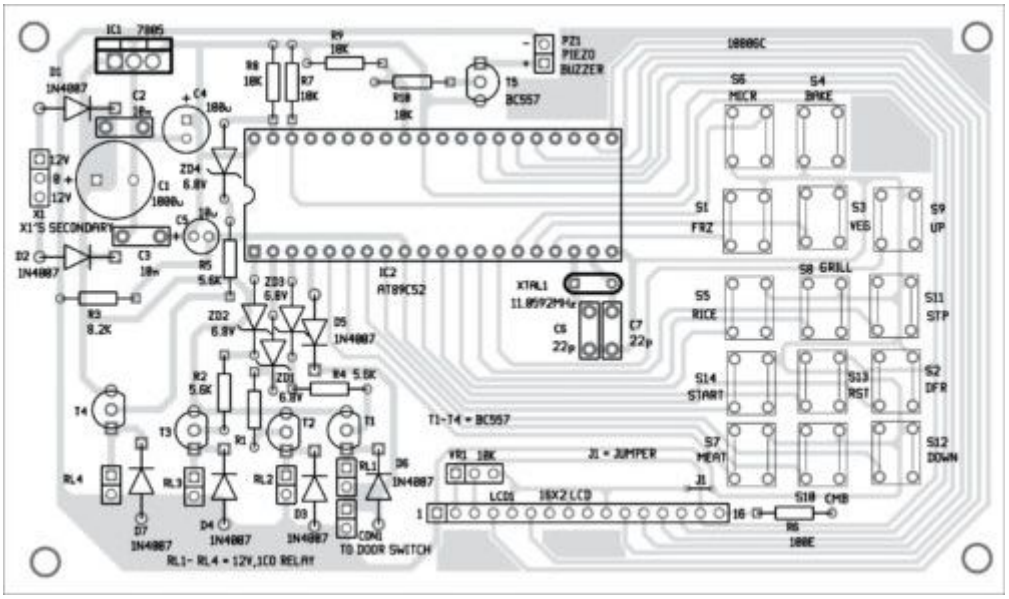


Fig. 2.6.2: Components layout for the PCB

Place all components on the PCB and solder carefully. Load the program (hex file) of the software to the MCU IC. Use IC base on the PCB. Solder the tactile switches on a separate PCB and connect the same to the main PCB, as per the circuit diagram.

After assembling the circuit, enclose it in a suitable box. Fix the switches and relays on the front and back sides of the cabinet. Connect relay coils on the PCB using 2-wire cables. Connect grill heater, HV transformer, stir motor and light using external high current-carrying wires via relay contacts.

Connect the wires to CON1, CON2, relays, CON3 an CON4 as shown in Fig. 2, except HV transformer and heater connections. Connect two 100W lamps instead of HV transformer and grill heater. Switch on the oven, and ensure all controls are working properly.

Check for minimum time durations, and ensure that the lamp is on/ off as the per sequence shown in the table. If the working and time duration is found satisfactory for all cook styles, switch off the unit and connect the HV transformer and heater. Close the covers and prepare any food item as per your choice.

2.6.5. Operational instructions

1. Switch on the power. Display will show Standby.
2. 2. Select one option (frozen, defrost, bake, veg, rice or meat).
3. (a) Press Meat. Buzzer will beep.
   (b) Press Micro. (You can select Micro, Grill or Combi).
   (c) Press Start. Display will show Meat/Auto/Micro. Time will start decreasing from 15:00 minutes. On completion of time, the buzzer will beep. After the beep, display w
4. Show Cooking Complete.
5. 3. **You can select any one of the options:** Frozen, Defrost, Bake, Veg or Rice, and repeat the above steps (a, b and c).

Manual mode

1. 1. Switch on the power. Display will show Standby.
   2. Press Up key. Display will show Set Time
2. 4. Hold Up/Down to increase the speed of count.
3. For example, to select Veg for 3.00 minutes,

(a) Press Veg. Buzzer will beep.

(b) Press Micro. (You can select Micro, Grill or Combi)

(c) Press Start. Display will show Manual/Veg/Micro. Time will start decreasing from 3:00 minutes. On completion of time, buzzer will beep. After the beep, display wills s Cooking Complete.

5. **You can select any option:** Frozen, Defrost, Bake, Rice or Meat, and repeat the above steps (a, b and **Caution**

Microwave ovens operate at high frequency and voltage waves (microwaves), which is highly dangerous. Take extreme care while working with microwave ovens.

2.7. Explaining Identified defects and faults

2.7.1. 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.

2.7.2. 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 AC. mains supply.

Whereas many electronic circuits operate from low voltage supplies and can thus be handled quite safely, the high AC. 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 AC. and DC.** 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.

2.7.3. 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.

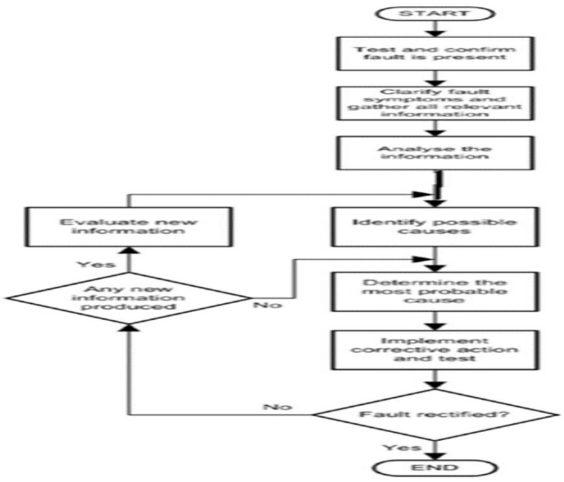


Fig.2.7. the flowchart

2.8. Checking control settings/adjustments.

2.8.1. Alignment and Adjustments

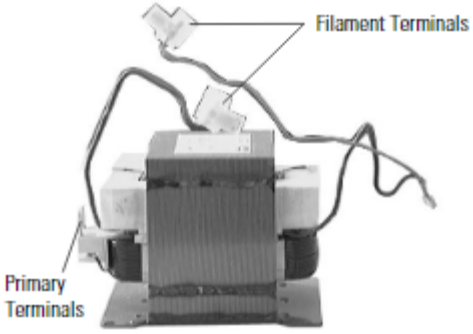
A. High Voltage Transformer

Remove connectors from the transformer terminals and check continuity.

1. Normal resistance readings are as follows:

H.V.T SPEC.	SHV-945EGI-AC-2
Secondary	86Ω ± 10%
Filament	Shows Continuity
Primary	1.5Ω ± 10%

(Room temperature = 20℃)



B. Low Voltage Transformer

1. The low voltage transformer is located on the control circuit board.
2. Remove the low voltage transformer from the PCB Ass'y and check continuity.
3. Normal resistor reading is shown in the table

C. Magnetron continuity

- Checks can indicate only an open filament or a shorted magnetron.

To diagnose an open filament or shorted magnetron:

1. Isolate the magnetron from the circuit by disconnecting its leads.
2. A continuity check across the magnetron filament terminals should indicate one ohm or less.

3. A continuity check between each filament terminal and magnetron case should read open.

2.8.2. Operation Instructions

When the oven first plugged in, beep will sound and the display will show ” ” and “1:01” In the process of cooking set, broke about 30 seconds the oven will return to standby mode.

During cooking, if press STOP/CANCEL pad once, the program will be paused, then press START/QUICK START pad to resume, but if press STOP/CANCEL pad twice, the program will be canceled. After ending cooking, the screen will display End with sound every two minutes until user press STOP/CANCEL pad or open the door. In the process of operation, press a valid button, the buzzer rings once, but if press a invalid button, the buzzer rings twice Setting clock time

This is a 12 or 24 hour clock.

You can choose to set the clock time in 12 or 24 hour cycle by pressing the CLOCK pad in standby mode.

1. In standby mode, press CLOCK pad once or twice to choose 12 or 24 hour clock.
2. Turn TIME/MENU to indicate the hour digit.
3. Press CLOCK pad.
4. Turn TIME/MENU dial to indicate the minute digit.
5. Press CLOCK to confirm the setting. NOTE: During cooking, you can check the current time of the clock by pressing CLOCK pad. Express cooking this feature allows you to start the oven quickly. In standby mode, press the START/QUICK STA

2.9. Documenting results of diagnosis and testing.

2.9.1. Identified the objectives of technical documentation

Proper documentation would list every stage in the process from start to end. As we discussed troubleshooting is a logical and step by step process that must be followed every time. If problems and customers are not the same, then how can even the best troubleshooting staff survive without proper documentation? It is the life support for troubleshooting

The lack of equipment documentation is a major problem faced by maintenance services in production plants. Equipment documentation is necessary to ensure maintenance management, repair work, manufacture of spare parts, rapid troubleshooting, work safety, the correct selection

and management of spare parts and efficient staff training. Unfortunately, when purchasing production equipment, technical documentation is frequently neglected by both supplier and customer.

Complete documentation is expensive. For a new factory it can vary between 8 and 22 per cent of the value of the equipment. In order to lighten expenses for existing plants, full documentation should only be prepared for priority equipment. In any case, investment in setting up or improving technical documentation will only be justified if the documentation is used efficiently. For this, the documents must be updated regularly and dispatched judiciously.

2.9.2. Content of equipment documentation

Technical documentation can be divided into three types:

- Study and engineering;
- construction and start-up;
- Exploitation.

We have paid most attention to the third type, which is vital for the efficient running of the factory, because most of the documents concerning engineering, construction and start-up are little used once the factory is in production.

Equipment documentation is classified in four different types of file, established by zone, department or production line: these are the general file, the machine files, the utilities file, and the standard files. All the documents should be presented in hard-cover A4 binders. The different headings are separated by numbered insertions so that each heading is easily accessible.

A. **General file**

This file consists of:

- technical specifications for the installation;

- flow sheets showing the machines and apparatus, and information concerning raw materials, consumption of fluids, etc.; the plant layout and section drawings of installations showing clearly the connections between the different machines;

- operation and service instructions.

In order to obtain an overall view of the equipment belonging to the installation, an ‘inventory of machines’ will be set up including the machines, apparatus and important accessories.

B. **Machine files**

In the machine files a distinction is made between the important/complex machines and the simple ones. The file of an important or complex machine is composed of eight headings under

which the equipment documentation is classified. The same sort of classification is used for simpler machines and equipment but the content will be reduced.

The different headings comprise the following documents, separated by numbered insertions:

1. Technical documentation: machine record card/layout drawings/description of functioning
2. Installation and start-up: foundations and installation/transport and handling/instructions for assembling/commissioning
3. Instructions for operation: safety instructions/operation/instructions for tuning/troubleshooting
4. Service instructions: maintenance/lubrication

2.10. Advising/informing Customers

Advice is a noun that means **guidance about what someone should do**. Advise is a verb that means to give someone advice about something. Despite their very similar spelling, advice and advice are pronounced differently.

2.10.1. How Microwaves Cooks foods.

First, know that microwaves—the actual waves produced by these ovens—are a type of electromagnetic radiation. These waves cause water molecules in food to vibrate. These vibrations, in turn, produce the heat that cooks food.

The waves are produced by a vacuum tube within the oven called a magnetron. They are reflected within the oven's metal interior; can pass through glass, paper, plastic, and similar materials; and are absorbed by food.

Microwaves are a kind of non-ionizing radiation. They do not have the same risks as x-rays or other types of ionizing radiation. (Ionizing radiation is a more energetic type of radiation that can cause changes to human cells.)

2.10.2. Injury Risks and Background on Microwaves

Most injuries related to microwave ovens are the result of heat-related burns from hot containers, overheated foods, or exploding liquids.

Most injuries do *not* relate to radiation. That said, there have been very rare instances of radiation injury due to unusual circumstances or improper servicing.

In general, these radiation injuries are caused by exposure to large amounts of microwave radiation leaking through openings such as gaps in the microwave oven seals. However, FDA regulations require that microwave ovens are designed to prevent these high-level radiation leaks. In fact, manufacturers must certify that their microwave ovens comply with specific FDA

safety standards. These standards require any radiation given off by ovens to be well below the level known to cause injury.

Although some people have been concerned that microwave ovens could cause interference with certain electronic cardiac pacemakers, today's pacemakers are designed to shield against this interference. You can consult with your health care provider if you still have concerns.

2.10.3. Safety Tips for customer health care provider

A. **Follow the manufacturer's instructions for use.** Directions in the user manual provide recommended operating procedures and safety precautions. For instance, you should not use some microwave ovens when they are empty. In addition, you should not heat water or liquids longer than the manufacturer's instructions and recommendations.

B. **Use microwave-safe containers.** Use cookware specially manufactured for use in the microwave oven. Generally, you should not use metal pans or aluminum foil because microwaves reflect off them, causing food to cook unevenly and possibly damaging the oven. And you should not use some plastic containers because heated food can cause them to melt. The FDA recommends using glass, ceramic, and plastic containers labeled for microwave oven use.

C. **Avoid super-heated water.** "Super-heated" means water is heated beyond its boiling temperature, without signs of boiling. If you use a microwave oven to heat water in a clean cup beyond the boiling temperature, a slight disturbance or movement may cause the water to violently explode out of the cup. There have been reports of serious skin burns or scalding injuries around people's hands and faces as a result of this phenomenon.

Adding ingredients such as instant coffee or sugar to water *before* heating greatly reduces the risk of hot-water eruption. Also remember to follow the manufacturer's heating instructions.

D. **Check for leakage.** There should be little cause for concern about excess microwave radiation leaking from these ovens unless the door hinges, latch, or seals are damaged. The FDA recommends looking at your oven carefully to see if any of these issues exist. The agency also recommends that you do not use an oven if the door doesn't close firmly or is bent, warped, or otherwise damaged.

E. **Don't use ovens that seem to operate when the door is open.** The FDA monitors these appliances for radiation safety issues and has received increasing reports about microwave ovens that appear to stay on—and operate—when the door is open. The FDA recommends that you immediately stop using a microwave oven if this happens.

Self-check 2.1.

Test I: short Answer writing

Instruction: write short answer for the given question. You are provided 4 minute for each question and each point has 5 Points.

1. Write Operational instructions to find fault parts of microwave oven.
2. Write the step you follow to diagnose an open filament or shorted magnetron

Test II: Say True or False

1. Should not use metal pans or aluminum foil because microwaves reflect off them.
2. You should not use some microwave ovens when they are empty.
3. In the process of cooking set, broke about 30 seconds the oven will return to standby mode.
4. Regular maintenance is essential to keep equipment
5. Safe maintenance work requires proper planning

Test III: Choose the best answer from the give alternative given below.

1. If you were just using the oven, turn the oven off and wait -------- minutes for the oven to cool.

   A. 30-60 minutes B. 40-70 minutes C. 20-50 minutes D. 10-40 minutes

2. Which one is not the probable cause of microwave oven, if the Problem is some keys on the touchpad do not function or perform the wrong action?

   A. Controller board contaminated by overenthusiastic cleaning.
   B. Defective/damaged touchpad.
   C. Controller is confused (pull plug for a minute or two to reset).
   D. Defective START button.

3. Which one is the probable cause of microwave oven, if the Problem is microwave oven does not respond to START button.

   A. Faulty interlock switches.
   B. Defective/damaged touchpad.
   C. Controller is confused (pull plug for a minute or two to reset).
   D. Door is not securely closed.

Operation Sheet 2.1:

Troubleshoot Microwave Oven Problems with Circuit Diagnosis

Operation title: procedures of troubleshoot microwave oven problems with circuit diagnosis.
Purpose: To practice and demonstrate the knowledge and skill to troubleshoot microwave oven problems with circuit diagnosis
Instruction: Use the given select tools and equipment so that microwave oven is usually done sure the skill to troubleshoot microwave oven problems with circuit diagnosis to the microwave oven circuit diagram operate properly. For this operation you have given 4 Hour and you are expected to provide the answer on the given steps.

Tools and equipment needed

- Microwave oven: Litton model 1304, 1305, 1420, or 1422
- Service manual for selected oven
- Microwave safe container with two-cup capacity
- Pencil and paper
- Safety glasses

Procedure it follows to Do

STEP 1: Put on safety glasses
STEP 2: Conduct a preliminary inspection of the oven to assure that it is safe to service
STEP 3: Place a little less than two cups of water in a container, place it in the oven, and set the oven for full power (cook condition) as shown in the schematic in Figure 1
STEP 4: Close the oven door, set the timer for two minutes, and start the oven
STEP 5: Check to see if the blower motor is operating and if it is, move on to Step 7
STEP 6 : Establish that the blower motor is not working and complete the following procedures in order:
STEP 7: Check to see if the stirrer blades rotate, and if they do, move on to Step 8
STEP 8: Establish that the stirrer blades are not rotating and correct the defective stirrer system with the procedures.
STEP 9: Check to make sure timer is advancing properly, and if it is, move on to Step 11
STEP 10: Establish that the timer is not advancing properly and troubleshoot for a defective or binding timer assembly
STEP 11: Open the oven door
STEP 12: Check to see if the water you placed in the cavity has heated, and if it has, the cook operation is normal and you should move on to Step 15
STEP 13 : Establish whether or not the water is heating slowly by performing the power tests outlined in Job Sheet #6 that covers:

LAP Test – 2.1.

Troubleshoot microwave oven problems with circuit diagnosis

Instructions: Given necessary templates, tools, materials and equipment you are required to perform troubleshoot microwave oven problems with circuit diagnosis for safe performance for the following tasks within 5 hour.

Task -1: Check for a bad fuse; see Job Sheet #3 for fuse location
Task -2: Check for an open thermal protector for the magnetron or the cavity
Task - 3: Check for a defective timer assembly as outlined in Job Sheet #12
Task - 4: Check for a defective or out of adjustment Interlock Switch Module
Task - 5: Check for a defective or binding motor with standard troubleshooting procedures.
Task - 6: Problems with line voltage less than 120V AC
Task - 7: Problems with a defective power transformer, a defective capacitor, or a defective magnetron

Precautions: select necessary templates, tools, materials and equipment before test the to perform troubleshoot microwave oven problems with circuit diagnosis for safe performance on the given format

Quality Criteria: the given to perform troubleshoot microwave oven problems with circuit diagnosis for safe performance for Safe Performance is with correct specification

Unit Three : Maintain/repair the unit

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

- Using Personal protective equipment's.
- Following electro-static discharge (ESD) protection procedure.
- Replacing defective parts/components.
- Soldering, mounting and repairing parts/components.
- Performing control settings/adjustments.
- Performing repair activity
- Observing care and extreme precaution the unit/product
- Performed Cleaning of units.

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:

- Using Personal protective equipment's.
- Following electro-static discharge (ESD) protection procedure.
- Replacing defective parts/components.
- Soldering, mounting and repairing parts/components.
- Performing control settings/adjustments.
- Performing repair activity
- Observing care and extreme precaution the unit/product
- Performed Cleaning of units.

3.1. Personal Protective Equipment or PPE

It is commonly known has been design specifically to protect employees in the work environment. Not only is it important to protect employees but also to protect the employer from unwanted legal claims. Furthermore, PPE is often a legal requirement and it is the responsibility of the employer to ensure employees wear protective clothing and observe safety and health regulations. It is also a responsibility, which employees must take seriously.

3.1.1. Common Personal Protective Equipment (PPE)

During diagnose and troubleshoot Mechatronics system, the following Personal Protective Equipment or PPE are most commonly used.

- Safety hat
- Safety shoes
- Ear muffs
- Goggles
- Mask
- Gloves
- Safety belt/Harness

Fig . PPE

3.1.2. If technicians not use appropriate PPE

The followings are some of the main risks of not using appropriate personal protective equipment:

- The lungs will be affected, example, from breathing in contaminated air
- The head and feet will be affected, example from falling materials
- The eyes, example from flying particles or splashes of corrosive liquids

- The skin will affected, example from contact with corrosive materials
- The body will affected, example from extremes of heat or cold.

3.2. Electrostatically Sensitive Devices (ESD)

3.2.1. What is ESD?

Static charge is an unbalanced electrical charge at rest. Typically, it is created by insulator surfaces rubbing together or pulling apart. One surface gains electrons, while the other surface loses electrons. This results in an unbalanced electrical condition known as static charge. When a static charge moves from one surface to another, it becomes ESD. ESD is a miniature lightning bolt of charge that moves between two surfaces that have different potentials. It can occur only when the voltage differential between the two surfaces is sufficiently high to break down the dielectric strength of the medium separating the two surfaces. When a static charge moves, it becomes a current that damages or destroys gate oxide, metallization, and junctions. ESD can occur in any one of four different ways: a charged body can touch an IC, a charged IC can touch a grounded surface, a charged machine can touch an IC, or an electrostatic field can induce a voltage across a dielectric sufficient to break it down.

3.2.2. Electrostatically Sensitive Devices Stress Models

ESD can have serious detrimental effects on all semiconductor ICs and the system that contains them. Standards are developed to enhance the quality and reliability of ICs by ensuring all devices employed have undergone proper ESD design and testing, thereby, minimizing the detrimental effects of ESD. Three major stress methods are widely used in the industry today to describe uniform methods for establishing ESD withstand thresholds (highest passing level).

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

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

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

- **Fire**

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

- **Lifting**

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

- **Ventilation**

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

3.3. Replacing defective parts/components.

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

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

In data books there would be suggestions as to which part numbers are suitable for replacement. This kind of data book is a must for anyone who works in electronic repair line. Apart from that, you could also find your own replacement by comparing the specification between the original

and the replacement transistor. Always look for the replacement that has the same or higher specification in terms of voltage and Ampere and Wattage.

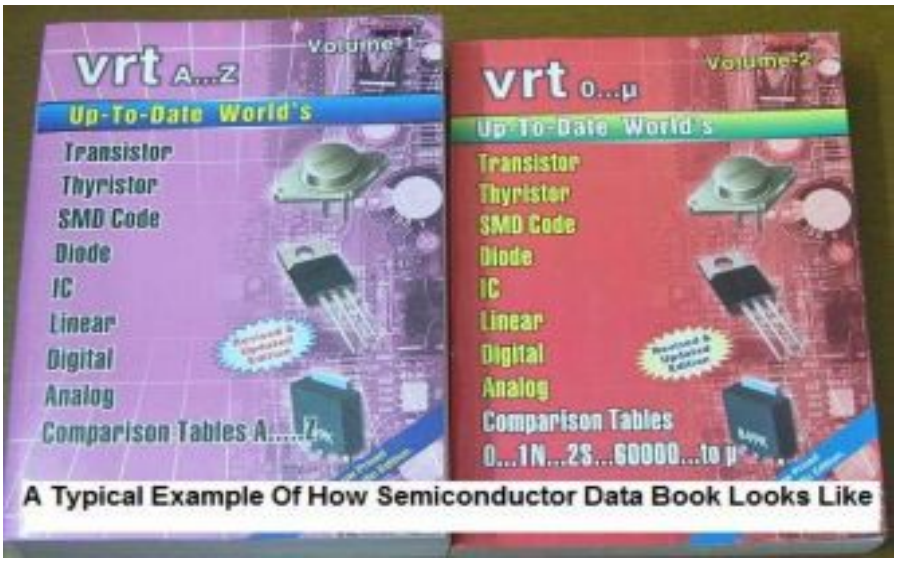


Figure2.1 Semiconductor Replacement data book

Note: Always use original part numbers for replacement purposes!

3.3.1. Location and the type of faulty component

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.

C. 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

D. 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.

3.4. Soldering, mounting and repairing parts/components.

There are two basic forms of electronic component construction, those with leads for through-hole mounting and those for surface mounting. Through-hole mounting gives a very rugged construction and uses well established soldering methods. Surface mounting has the advantages of high packing density plus high-speed automated assembly. With all components, excessive forces or heat can cause serious damage and should always be avoided.

3.4.1. Soldering

- Avoid any force on the body or leads during or immediately after soldering
- Do not correct the position of an already soldered device by pushing, pulling or twisting the body
- Avoid fast cooling after soldering
- The maximum allowable soldering time is determined by:
- Package type
- Mounting environment
- Soldering method
- Soldering temperature
- Distance between the point of soldering and the seal of the component body

The maximum permissible temperature of the solder is 260 °C; this temperature must not be in contact with the joint for more than 5s. The total contact time of successive solder waves must not exceed 5s.

The component may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified storage maximum. If the PCB has been preheated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

3.4.2. Mounting

If the rules for handling and soldering are observed, the following mounting or process methods are allowed:

• Preheating of the printed-wiring board before soldering up to a maximum of 100 °C

• Flat mounting with the diode body in direct contact with the printed-wiring board with or without metal tracks on both sides and/or plated-through holes

• Flat mounting with the diode body in direct contact with hot spots or hot tracks during soldering

• Upright mounting with the diode body in direct contact with the printed-wiring board if the body is not in contact with metal tracks or plated-through holes

3.4.3. Repairing soldered joints

Apply the soldering iron to the component pin(s) below the seating plane, or not more than 2 mm above it. If the temperature of the soldering iron bit is below 300 °C, it may remain in contact for up to 10s. If it is over 300 °C but below 400 °C, it may only remain in contact for up to 5s.

3.4.4. Surface mount devices (SMDs)

Since the introduction of surface mount devices (SMDs), component design and manufacturing techniques have changed almost beyond recognition. Smaller pitch, minimum footprint area and reduced component volume all contribute to a more compact circuit assembly. Consequently, when designing PCBs, the dimensions of the footprints are perhaps more crucial than ever before.

One of the first steps in this design process is to consider which soldering method, either wave or reflow, will be used during production. This determines not only the solder footprint dimensions, but also the minimum spacing between components, the available area underneath the component where tracks may be laid, and possibly the required component orientation during soldering.

Although reflow soldering is recommended for SMDs, many manufacturers use, and will continue to use for some time to come, a mixture of surface-mount and through-hole components on one substrate (a mixed print).

The mix of components affects the soldering methods that can be applied. A substrate having SMDs mounted on one or both sides, but no through-hole components is likely to be suitable for reflow or wave soldering. A double-sided mixed print that has through-hole components and some SMDs on one side and densely packed SMDs on the other normally undergoes a sequential

combination of reflow and wave soldering. When the mixed print has only through-hole components on one side and all SMDs on the other, wave soldering is usually applied.

To help with your circuit board design, this guideline gives an overview of both reflow and wave soldering methods and is followed by some useful hints on hand soldering for repair purposes, and the recommended footprints for SMD discrete semiconductor packages.

3.4.5. Reflow soldering process

There are three basic process steps for single-sided PCB reflow soldering, these are:

• Applying solder paste to the PCB

• Component placement

• Reflow soldering.

3.5. Performing control settings/adjustments.

3.5.1. Switching On the Appliance for the First Time

A. **Setting the Clock:** after connecting your appliance or after an extended power outage, 12:00 will flash on the display. Set the time of day.

Confirm each setting by pressing the KNOB. The oven will also work if the clock is not set. However, timer functions are not available in this case (see chapter

B. Setting the Timer Functions.

After a few minutes of idling, the appliance will switch to standby mode.

E. **Changing The Clock Setting :** Clock settings may be changed when no timer function is activated

F. Selecting The Language: If you are not happy with the language in which the messages on the display are presented, select another one. English is the preset language. Rotate the KNOB and select your language from the list. CONFIRM the selection. The main menu will appeal

I. Automatic mode

In this mode, first select the type of food. This is followed by automatic setting of the quantity, level of doneness, and cooking end time. The program offers a large choice of preset recipes reviewed by professional chefs and nutrition experts.

II. **Microwaves**

This mode is suitable for cooking, roasting, and defrosting of food.

III. Professional mode

Use this mode when you wish to prepare any type and amount of food. All settings are selected by the user.

3.5.2. Cooking By Selecting The Type Of Food (Auto Mode)

- Confirm each setting by pressing the KNOB.
- Rotate the KNOB and select the Auto mode. C
- Confirm the setting by pressing on the KNOB.
- Select the type of food and the dish.
- Confirm the selection.
- Preset values will appear.
- Rotate the KNOB and confirm by pressing the KNOB to change these settings

3.6. Performing repair activity

3.6.1. Routine Repairing Activity

The maintenance required by a drying oven is simple and no complex routine maintenance is necessary. General maintenance routines to carry as necessary are described next. The procedures vary depending on the type of oven and designs from diff erent manufacturers. Warning: Before carrying out any maintenance routine on the oven, verify that it is at room temperature and disconnected from the electrical feed outlet.

A. **Access to electronic components Frequency:** Whenever necessary The oven's electronic components are usually located in its lower part.

In order to be able to check them, proceed as follows:

1. Disconnect the oven from the electrical feed outlet.

2. Move the oven forward until the front part of the base is aligned with the edge of the working space.

3. Place two wedges of approximately 3 cm in thickness below each front support. This will elevate the front part of the oven and facilitate the inspection of electronic elements once the lower cover is removed.

3. Remove the screws securing the lower cover and lift it. Next, check the electronic control components.

In general, the following elements are located in this compartment.

- The programmable control panel
- A safety release

- The main switch and circuit breaker (combined)

5. Replace the cover once checking has been completed.

1. Changing of the heating resistors Frequency:

Whenever necessary The procedure explained next must be performed by personnel with a good knowledge of electricity.

1. Disconnect the oven from the electrical feed outlet.
2. Remove the thermometer from the upper part of the chamber.
3. Open the door and remove the shelves.
4. Disconnect the thermometer's probe.
5. Remove the screws that secure the lower panel.
6. Remove the lower panel.
7. Remove the screws that secure the resistor's electrical feed cables and disconnect the terminals fastening these to the resistors.
8. Remove the screws that secure the resistors as well as the external resistors.
9. Install new resistors with the same characteristics as the originals.
10. Reinstall the parts and reconnect the electrical components.

B. Changing the cooling ventilator Frequency:

Whenever necessary To change the cooling ventilator (generally located in the lower part), these procedures must be followed:

1. Proceed as explained for opening the electronic compartment.
2. Disconnect the ventilator's electrical feed terminals.
3. Undo the screws that secure the ventilator.
4. Install a ventilator with the same specifi cations as the original; connect the wires feeding the ventilator to the terminals.
5. Replace the protective cover.

C. Changing of the door gasket Frequency:

Whenever necessary The door's gasket is usually made of silicone.

1. Turn off the oven and open the door.
2. Loosen the safety devices that keep the gasket in place.
3. Remove the gasket using a screwdriver for disengaging it from the retention guide. Avoid using excessive force which can distort the housing.

4. Install the replacement gasket starting from the upper part. Next, move the rest of the gasket towards the sides, securing it with the assembly elements which fasten it to the door. Finish the procedures on the lower part of the door in the same fashion.

D. Changing of the thermocouple Frequency:

Whenever necessary

1. Open the electronic control compartment.

2. Remove the thermocouple's connecting cables from their connection points on the control card.

3. Loosen the thermocouple assembly from the upper part of the oven. Move it towards the front part until a free length of at least 15 cm of connector cable is left exposed.

4. Cut the cable from the thermocouple to remove its wrapping. 5. Secure the cut ends of the defective thermocouple with the cables from the replace

3.7. Observing care and extreme precaution the product

3.7.1. Precautions to Be Observed Before and During Servicing

(*a*) Do not operate or allow the oven to be operated with the door open.

(*b*) Make the following safety checks on all ovens to be serviced before activating the magnetron or other microwave source, and make repairs as necessary: (*1*) Interlock operation, (*2*) proper door closing, (*3*) seal and sealing surfaces (arcing, wear, and other damage), (*4*) damage to or loosening of hinges and latches, (*5*) evidence of dropping or abuse.

(*c*) Before turning on microwave power for any service test or inspection within the microwave generating compartments, check the magnetron, wave guide or transmission line, and cavity for proper alignment, integrity, and connections.

(*d*) Any defective or misadjusted components in the interlock, monitor, door seal, and microwave generation and transmission systems shall be repaired, replaced, or adjusted by procedures described in this manual before the oven is released to the owner.

(*e*) A Microwave leakage check to verify compliance with the Federal performance standard should be performed on each oven prior to release to the owner.

(iv) Include additional radiation safety precautions or instructions which may be necessary for particular oven designs or models, as determined by the Director, Center for Devices and Radiological Health or the manufacturer.

(6) ***Warning labels.*** Except as provided in paragraph (c)(6)(iv) of this section, microwave ovens shall have the following warning labels:

(i) A label, permanently attached to or inscribed on the oven, which shall be legible and readily viewable during normal oven use, and which shall have the title emphasized and be so located as to elicit the attention of the user. The label shall bear the following warning statement:

3.7.2. Precautions for Safe Use to Excessive Microwave Energy

A. DO NOT Attempt to Operate This Oven With:

I. Object Caught in Door.

II. Door That Does Not Close Properly.

III. Damaged Door, Hinge, Latch, or Sealing Surface.

B. A label, permanently attached to or inscribed on the external surface of the oven, which shall be legible and readily viewable during servicing, and which shall have the word "CAUTION" emphasized and be so located as to elicit the attention of service personnel. The label shall bear the following warning statement:

Caution: This Device is to be Serviced Only by Properly Qualified Service Personnel.

Consult the Service Manual for Proper Service Procedures to Assure Continued Compliance with the Federal Performance Standard for Microwave Ovens and for Precautions to be taken to Avoid Possible Exposure to Excessive Microwave Energy.

(iii) The labels provided in accordance with paragraphs (II)(6)(i) and (ii) of this section shall bear only the statements specified in that paragraph, except for additional radiation safety warnings or instructions which may be necessary for particular oven designs or models, as determined by the Director, Center for Devices and Radiological Health or the manufacturer.

(iv) Upon application by a manufacturer, the Director, Center for Devices and Radiological Health, Food and Drug Administration, may grant an exemption from one or more of the statements (radiation safety warnings) specified in paragraph (c)(6)(i) of this section. Such exemption shall be based upon a determination by the Director that the microwave oven model for which the exemption is sought should continue to comply with paragraphs (c) (1), (2), and (3) of this section under the adverse condition of use addressed by such precautionary statement(s). An original and two copies of applications shall be submitted to the Division of Dockets Management (HFA-305), Food and Drug Administration, 5630 Fishers Lane, rm. 1061, Rockville, MD 20852. Copies of the written portion of the application, including supporting data and information, and the Director's action on the application will be maintained by the

A. **Branch for public review. The application shall include:**

- The specific microwave oven model(s) for which the exemption is sought.
- The specific radiation safety warning(s) from which exemption is sought.
- Data and information which clearly establish that one or more of the radiation safety warnings in paragraph (c)(6)(i) of this section is not necessary for the specified microwave oven model(s).
- Such other information and a sample of the applicable product if required by regulation or by the Director, Center for Devices and Radiological Health, to evaluate and act on the application.

3.8. Performing Cleaning of units.

3.8.1. Procedure of Cleaning and Care

1. Turn off the oven and unplug the power cord from the wall when cleaning.
2. Keep the inside of the oven clean. When food splatters or spilled liquids adhere to oven walls, wipe with a damp cloth. Mild detergents may be used if the oven gets very dirty. Avoid using spray or other harsh cleaners. They may stain, streak or dull the door surface.
3. The outside of the oven should be cleaned with a damp cloth. To prevent damage to the operating parts inside the oven, water should not be allowed to seep into the ventilation openings.
4. Wipe the door and window on both sides, the door seals and adjacent parts frequently with a damp cloth to remove any spills or spatters. Do not use abrasive cleaner.
5. A steam cleaner is not be used.
6. Do not allow the control panel to become wet. Clean with a soft, damp cloth. When cleaning the control panel, leave oven door open to prevent oven from accidentally turning on.
7. If steam accumulates inside or around the outside of the oven door, wipe with a soft cloth. This may occur when the microwave oven is operated under high humidity condition. And it is normal.
8. It is occasionally necessary to remove the glass tray for cleaning. Wash the tray in warm sudsy water or in a dishwasher.
9. The roller ring and oven floor should be cleaned regularly to avoid excessive noise. Simply wipe the bottom surface of the oven with mild detergent. The roller ring may be washed in

mild, soapy water or in a dishwasher. When removing the roller ring, be sure to replace it in the proper position.

10. Remove odors from your oven by combining a cup of water with the juice and skin of one lemon in a microwaveable bowl. Microwave for 5 minutes. Wipe thoroughly and dry with a soft cloth.
11. If the light bulb burns out, please contact customer service to have it replaced.
12. The oven should be cleaned regularly and any food deposits should be removed. Failure to maintain the oven in a clean condition could lead to deterioration of surface that could adversely affect the life of the unit and could possibly result in a hazardous situation.
13. Please do not dispose of this appliance into the domestic rubbish bin; it should be disposed to the particular disposal center provided by the municipalities.

3.8.2. Microwave oven preventive maintenance.

A. Regular cleaning at least will avoid potentially expensive repairs in the future. Most of this involves things that don't require going inside and anyone can do. A shop that wants to add on preventive maintenance while doing some other repair is just trying to pad their wallet - anything that was required to ensure the health of the oven should have been included. :)

- Clean the interior of the oven chamber after use with a damp cloth and some detergent if necessary. Built up food deposits can eventually carbonize resulting in sparks, arcs, heating, and damage to the mica waveguide cover and interior paint - as well as potentially more serious damage to the magnetron. If there is any chance of food deposits having made their way above the waveguide cover in the roof of the chamber, remove the waveguide cover and thoroughly clean inside the waveguide as well.
- Clean the exterior of the cabinet and touchpad in a similar manner. DO NOT use a spray where any can find its way inside through the door latch or ventilation holes, or a dripping wet cloth. Be especially careful around the area of the touchpad since liquid can seep underneath resulting in unresponsive or stuck buttons or erratic operation. Do not use strong solvents (though a bit of isopropyl alcohol is fine if needed to remove sticky residue from unwanted labels, for example).
- Inspect the cord and plug for physical damage and to make sure the plug is secure and tight in the outlet - particularly if the unit is installed inside a cabinet. (Yes, I know it is difficult to

get at but I warned you about that!.) Heat, especially from a combination microwave/convection oven or from other heat producing appliances can damage the plug and/or cord. If there is evidence of overheating at the outlet itself, the outlet (and possibly the plug as well) should be replaced.

- Periodically check for built up dust and dirt around the ventilation holes or grills. Clean them up and use a vacuum cleaner to suck up loose dust. Keeping the ventilation free will minimize the chance of overheating.
- Listen for any unusual sounds coming from inside the oven. While these appliances are not exactly quiet, grinding, squealing, scraping, or other noises - especially if they were not there when the oven was new - may indicate the need for some more extensive maintenance like belt replacement or motor lubrication. Attending to these minor problems now may prevent major repairs in the future.
- Keep your kitchen clean. Yes, I know, this isn't exactly microwave specific but cockroaches and other uninvited guests might just like to take up residence inside the electronics bay of the oven on the nice warm controller circuit board or its neighborhood and they aren't generally the tidiest folks in the world. If it is too late and you have a recurring problem of cockroaches getting inside the electronics bay, tell them to get lost and then put window screen over the vents (or wherever they are entering). Such an open mesh should not affect the cooling of the electronic components significantly. However, the mesh will likely clog up more quickly than the original louvers so make sure it is cleaned regularly. If possible, clean up whatever is attracting the unwanted tenants (and anything they may have left behind including their eggs!!). WARNING: See the section: SAFETY before going inside.

CAUTION: Do not spray anything into the holes where the door latch is inserted or anywhere around the touchpad as this can result in internal short circuits and costly damage - or anywhere else inside, for that matter. If you do this by accident, immediately unplug the oven and let it dry out for a day or two.

Self-check 3.1.

Test I: short Answer writing

Instruction: write short answer for the given question. You are provided 4 minute for each question and each point has 5 Points.

1. Write Procedure of Cleaning and Care for microwave oven maintenance.
2. Precautions for Safe Use to Excessive Microwave Energy.

Test II: Say True or False

1. The oven's electronic components are usually not located in its lower part.
2. Clock settings may be changed when timer function is activated
3. Avoid fast cooling after soldering
4. Avoid any force on the body or leads during or immediately after soldering
5. Do not correct the position of an already soldered device by pushing, and pulling

Test III: Fill the blank space for the question provided given below.

1. _____ is an unbalanced electrical charge at rest
2. _____is commonly known has been design specifically to protect employees in the work environment
3. _____ is serious detrimental effects on all semiconductor ICs and the system that contains them

Operation Sheet: 3.1.

Replaces a Door Hook on a Microwave Oven

Operation Title: 3.1. To Replaces a Door Hook on a Microwave Oven

Purpose: To practice and demonstrate the knowledge and skill to replaces a door hook on a microwave oven.

Instruction: Use the given select tools and equipment so that microwave oven is usually done sure the skill to replaces a door hook microwave oven problems with the microwave oven circuit cabinet diagram operates properly. For this operation you have given 4 Hour and you are expected to provide the answer on the given steps.

Tools and materials

- Microwave oven: Litton model 1320, 1325, 1440, or 1450
- Service manual for selected oven
- Screwdriver with insulated handle
- Standard tools
- RF leakage test meter and materials
- Safety glasses

Procedure you follow to do it

Step: 1. put on safety glasses

Step: 2. unplug the power cord and remove the access panel

Step: 3. DISCHARGE THE CAPACITOR

Step: 4. Remove the door from the oven as outlined in Job Sheet #4

Step: 1 Disassemble the door as outlined in Job Sheet #4

Step: 1 Remove door hook according to the following:

LAP Test – 3.1.

To Replacing a Door Hook on a Microwave Oven

Instructions: Given necessary templates, tools, materials and equipment you are required to perform replacing a door hook on a microwave oven problems with replacement steps for safe performance for the following tasks within 5 hour.

Task -1: Remove the snap ring, pivot pin, and torsion bar;
Task -2: Remove the door hook and door handle;
Task -3: Push out the guide pin to remove the hook from the handle
Task -4: Remove the compression spring, push out the guide pin
Task -5: Remove the door handle
Task -6: Remove snap ring and pivot pin to remove hook
Task -7: Unplug the power cord
Task -8: Record your findings
Task -9: Clean up area and return tools and materials to proper storage

Precautions: select necessary templates, tools, materials and equipment before replacing a door hook on a microwave oven for Safe Performance on the given format.

Quality Criteria: the given replacing a door hook on a microwave oven for Safe Performance is with correct specification

Unit Four: Test repaired unit

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

- Reassembling repaired units.
- Testing and cleaning reassembled units.
- Compiling documentations.
- Disposing waste materials.

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:

- Reassemble repaired units.
- Test and clean reassembled units.
- Compile documentations.
- Dispose waste materials.

4.1. Reassembling repaired units

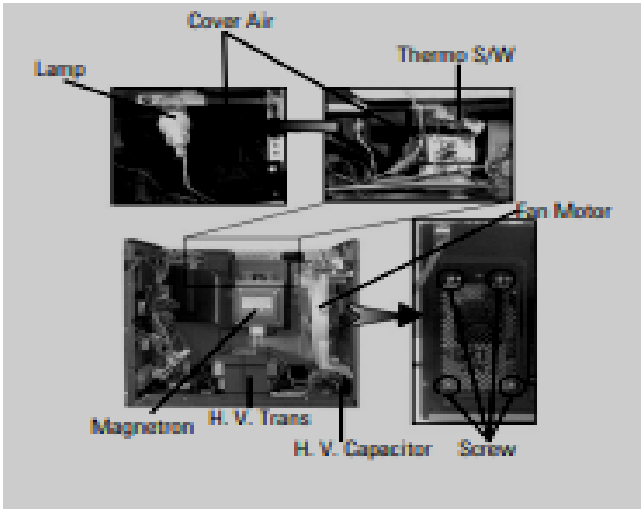
4.1.1. Replacement of Magnetron, Motor Assembly and Lamp

Remove the magnetron including the shield case, permanent magnet, choke coils and capacitors (all of which are contained in one assembly).

1. Disconnect all lead wires from the magnetron and lamp.
2. Remove the bracket mounting.
3. Remove the magnetron supporter
4. Remove the air cover.
5. Remove screws securing the magnetron to the wave guide.
6. Take out the magnetron very carefully.
7. Remove screws from the back panel.
8. Remove the essay noise filter.

9. Take out the fan motor.

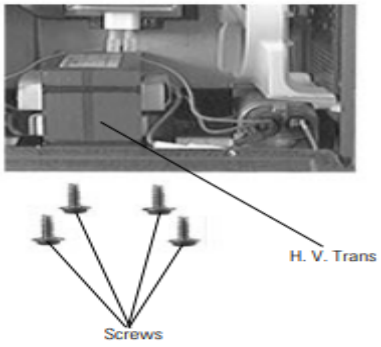
10. Remove the oven lamp by pulling out from hole of air cover carefully. NOTE1: When removing the magnetron, make sure that its antenna does not hit any adjacent parts, or it may be damaged. NOTE2: When replacing the magnetron, be sure to remount the magnetron gasket in the correct position and make sure the gasket is in good condition.



4.1.2. Replacement of High Voltage Transformer

1. Discharge the high voltage capacitor.

2. Disconnect all the leads.



3. Remove the mounting bolts.

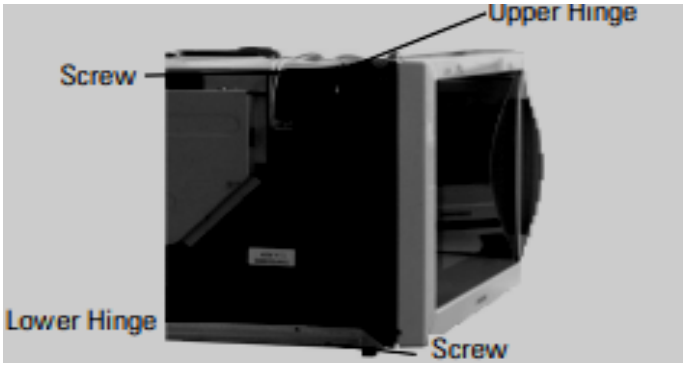
4. Reconnect the leads correctly and firmly.

4.1.3. Replacement of Door Assembly of microwave oven

1 Removal of Door Assembly

Remove screws securing the upper hinge and lower hinge.

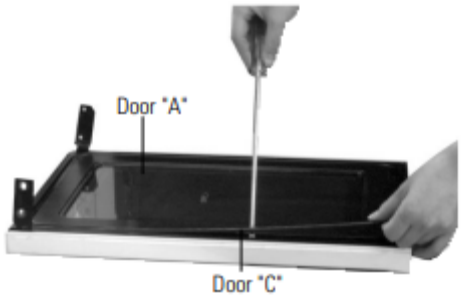
Then remove the door assembly.



Removal of Door "C

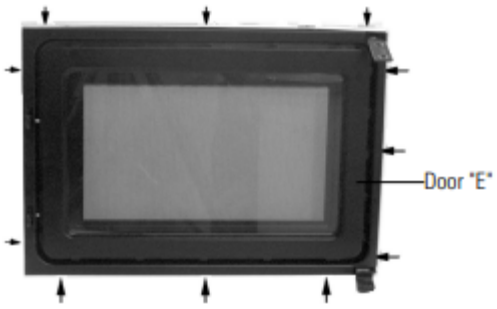
Insert flat screwdriver into the gap between Door "A" and Door "C" to remove Door "C". Be careful when handling Door "C" because it is fragile. Following the procedure as shown in the figure, insert and bend a thin metal plate between Door "E" and Door "A" until you hear the 'tick' sound. 1. Insertion depth of the thin metal plate should be 0.5mm or less. 4-3-2 Removal of Door "C" 4-3-3 Removal of Door "E" Upper Hinge

Insert flat screwdriver into the gap between Door "A" and Door "C" to remove Door "C". Be careful when handling Door "C" because it is fragile



Removal of Door "E"

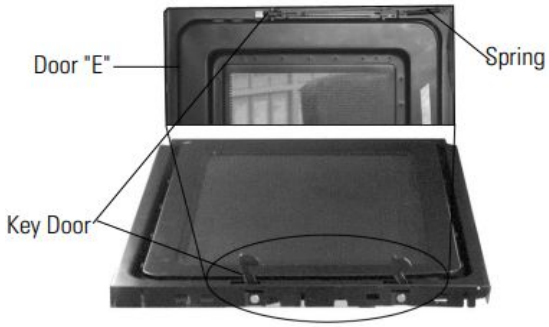
Following the procedure as shown in the figure, insert and bend a thin metal plate between Door "E" and Door "A" until you hear the 'tick' sound.



2. Insertion depth of the thin metal plate should be 0.5mm or less.

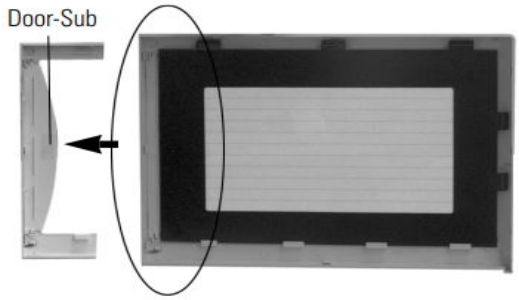
Removal of Key Door & Spring

Remove pin hinge from Door "E" Detach spring from Door "E" and key door.



Removal of Screen-Door & Sub-Door

1. Remove Door"E" from Door"A".
2. Remove Door-Screen"B" and Sub Door.



4.1.4. Reassembly Test

1. When mounting the door to the oven, be sure to adjust the door parallel to the bottom line of the oven face plate by moving the upper hinge and lower hinge in the direction necessary for proper alignment.
2. Adjust so that the door has no play between the inner door surface and oven front surface. If the door assembly is not mounted properly, microwave energy may leak from the space between the door and oven.
3. Do the microwave leakage test

A. Replacement of Fuse

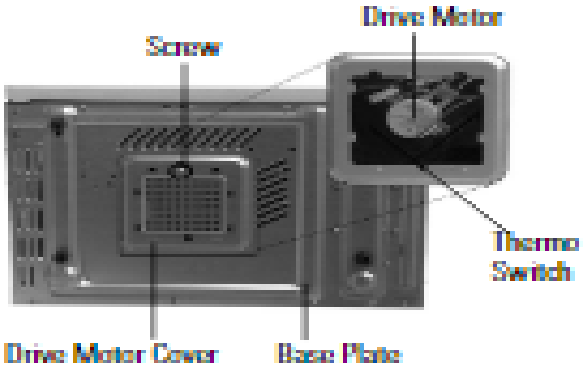
1. Disconnect the oven from the power source.

2. When 15A fuse blows out by the operation of interlock monitor switch failure, replace the primary interlock switch, door sensing switch, monitor switch and power relay.

3. When the above three switches operate properly, check if any other part such as the control circuit board, blower motor or high voltage transformer is defective.

B. Replacement of Drive Motor

1. Take out the glass tray and guide roller from the cavity.
2. Turn the oven upside down to replace the drive motor.
3. Remove a screw securing the drive motor cover.
4. Disconnect all the lead wires from the drive motor.
5. Remove screws securing the drive motor to the cavity.
6. Remove the drive motor and coupler.
7. When replacing the drive motor, be sure to remount it in the correct position with the coupler.
8. Connect all the leads to the drive motor.
9. Screw the drive motor cover to the base plate with a screw driver.



4.2. Testing and cleaning reassembled units.

4.2.1. Cleaning and Care

1. **Turn off the oven and unplug the power cord from the wall when cleaning.**

2. Keep the inside of the oven clean. When food splatters or spilled liquids adhere to oven walls, wipe with a damp cloth. Mild detergents may be used if the oven gets very dirty. Avoid using spray or other harsh cleaners. They may stain, streak or dull the door surface.

3. **The outside of the oven should be cleaned with a damp cloth.** To prevent damage to the operating parts inside the oven, water should not be allowed to seep into the ventilation openings.

4. **Wipe the door and window on sides,** the door seals and adjacent parts frequently with a damp cloth to remove any spills or spatters. Do not use abrasive cleaner.

5. **A steam cleaner is not be used.**

6. **Do not allow the control panel to become wet.** Clean with a soft, damp cloth. When cleaning the control panel, leave oven door open to prevent oven from accidentally turning on.

7. **If steam accumulates inside or around the outside of the oven door, wipe with a soft cloth**. This may occur when the microwave oven is operated under high humidity condition. And it is normal.

8. **It is occasionally necessary to remove the glass tray for cleaning**. Wash the tray in warm sudsy

4.2.2. Making measurements/Testing inside microwave ovens

WARNING: In general, I DO NOT recommends making any sorts of measurements on the high voltage components of a live microwave oven. I only include this section for those who really want to know the details.

You may be temped to break out your Radio Shack DMM and start poking away inside a live microwave oven. DON'T! This isn't like a CD player! Most of the time, no measurements of any kind on the oven while it is operating will be needed to identify and correct the problem. However, where this is not the case, here are some guidelines to a long life:

WARNING: ALWAYS pull the plug and discharge the HV capacitor BEFORE doing anything inside! Never be tempted to make any changes of any kind while the oven is on - not even if your meter is being consumed by 5 foot flames! First, pull the plug and discharge the HV capacitor!

- **High voltages - DON'T** even think about this unless you have a proper high voltage probe or meter, or a proper microwave oven tester - AND KNOW HOW TO USE IT SAFELY. Even professionals have been killed performing measurements of this type using proper equipment! Luckily, current measurements can provide enough information to help make a diagnosis.

WARNING: The high voltage components inside a microwave oven are at a NEGATIVE potential with respect to the chassis. DO NOT be tempted to interchange the probe and ground wire if you are using a high voltage probe on a meter with a POSITIVE input (e.g., for testing CRT HV) and no polarity switch! The ground cable doesn't have anywhere near the required insulation. Get the proper equipment!

One thing you can do relatively safely is to connect a Variac directly to the primary of the HV transformer. With this set at a MAXIMUM of 10 percent, the voltage on the filament terminals of the magnetron should read from -150 to -250 V with respect to the chassis. A scope can also be used if it has a proper 10:1 probe as long as you aren't tempted to turn up the Variac any higher! The scope waveform should be close to a sinusoid with its positive tips at 0 V. Such reduced voltage tests won't identify problems that only occur at full voltage, however.

- **Magnetron current** - Place a 10 ohm 10 watt resistor in series with the HV diode cathode and ground. Measure the voltage drop across this resistor. Sensitivity will be 10 V/A. Normal anode current is around 300 to 400 mA for a typical oven. This will be -3 to -4 VDC across the 10 ohm resistor with respect to chassis ground. SET EVERYTHING UP AND THEN STAND BACK and don't forget to DISCHARGE the HV capacitor after making the measurement:
- If it is around this range, the magnetron is probably fine.
- If it is very low or 0, magnetron is bad or HV is not working. Note that a shorted as well as open magnetron also results in no current. If the magnetron is shorted, it bypasses all current to ground. If the magnetron is open, the HV capacitor charges up and then there is no more current through the HV diode (but there will be an initial transient).
- If it is much too high (whether fuse blows or not), capacitor is shorted.

(A properly conducting magnetron will load down the HV power supply. If the magnetron is non-conducting, the voltage remains high.

The power supply will produce 3,500 to 4,000 volts DC, or more, open circuit (as when the oven is first turned on and the magnetron filament/cathode is not fully heated). With full conduction by the magnetron, the HV drops to between 1,800 and 2,100 V. Weak magnetrons conduct somewhat, but the HV remains well above the 2,100 V. (The voltages vary with design and model, but the magnitude of the change is the key.)

I check the HV using my 30 kV HV probe with a DMM, measuring between the magnetron filament connectors (either one) or at another equivalent point, and case ground. (Again, depends

on the circuit, but I think this is a common configuration.) The HV at the magnetron filament is negative to ground.

4.2.3. Testing the high voltage components

WARNING: First, with power disconnected, discharge the high voltage capacitor. See the section Safe discharging of the high voltage capacitor.

Assuming the oven passes the above test for interlocks and door alignment, the triac (if used) may be defective. There could also be a wire shorting to the chassis. However, the most likely problems are in the microwave generator.

An ohmmeter can be safely used to quickly determine if the capacitor, HV diode, or magnetron are a dead short (as well as for an open magnetron filament).

Use an ohmmeter to test the diode and capacitor. While connected in circuit, the resistance in at least one direction should be several M ohms. (Try it in both directions, use the higher reading).

Test the magnetron from the filament to chassis - it should be high in at least one direction. Test the filament for continuity - the resistance of a good filament is close to 0 (less than 1 ohm).

Where the capacitor and diode are combined into one unit, it should be possible to test each component individually. In some cases, it may also be possible to replace only the one that is found to be defective or make up a substitute HV cap/diode assembly from individual components if the combined unit is excessively expensive or no longer available.

These may be considered to fail/no conclusion tests - they can definitively identify parts that are bad but will not guarantee that they are good. Parts may test ok with no voltage applied but then fail once operated in-circuit. Connections may open up when they heat up. The magnetron may short out when full voltage is applied.

Don't overlook the wiring as no heat or erratic operation can result from simple bad connections!

An alternative way of determining if the problem is in the control circuits (triac, relay, wiring) or microwave generator (HV transformer, HV capacitor, HV diode, magnetron, wiring, etc.) is to connect the HV transformer primary directly to a line cord and plug. Tape the removed wire lugs to prevent shorts.

Plug the transformer cord into a switched outlet strip which includes a fuse or circuit breaker.

Put a cup of water into the oven cavity to act as a load.

- Power the oven via its line cord. Initiate a cook cycle. It should go through the normal cycle (of course no heat) without blowing the fuse or any unusual sounds. If there is a problem in this case, something in the controller or its wiring is shorted.

- Now, initiate a 1 minute cook cycle on HIGH and with the oven running, switch on the HV transformer.
  - If the transformer or other HV components are faulty, the outlet strip fuse will blow or circuit breaker will trip. Or, if a lamp is plugged into the outlet strip at the same time, it will likely dim significantly due to the heavy load before the fuse or breaker cuts out.
  - If the problem is with the triac or its drive, the oven will now heat normally. When the cook cycle is near its end, switch off the outlet strip. Check the water's temperature.

More complete information on testing and replacing the individual components is provided in the next few sections.

4.2.4. Testing the high voltage diode

WARNING: First, with power disconnected, discharge the high voltage capacitor. See the section safe discharging of the high voltage capacitor

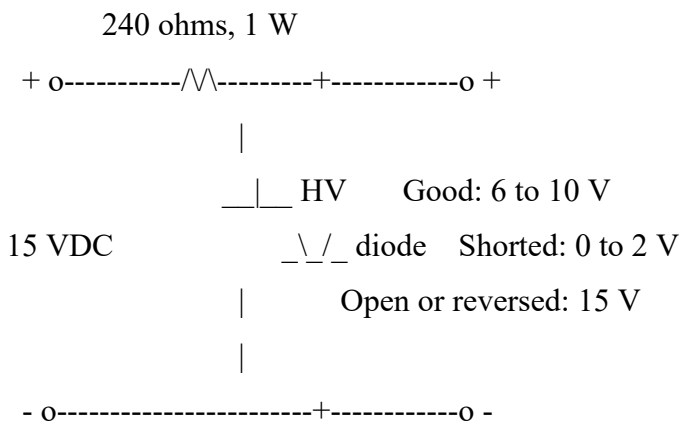
The HV diode can fail shorted (most likely) or open. It is not likely for there to be anything in between as so much heat would result that the diode would not remain that way for long.

- A shorted HV diode will likely result in a loud hum from the HV transformer when a cook cycle is initiated. The main fuse will probably not blow. However, note that the actual wattage drawn from the power line will probably be *much lower* than under normal conditions. Although there will be a high current flowing in the HV transformer secondary through the HV capacitor (likely causing a loud hum or buzz), the real power consumed will be reduced since the current and voltage will be out of phase (due to the series capacitor) and the power factor will be low. A reading on an AC line wattmeter of 300 W compared to the normal 1,200 to 1,500 W would be reasonable.
- An open HV diode will result in AC instead of DC across the magnetron with a peak negative value (the only one that matters) about 1/2 of what it should be. The result will likely be little or no detectable heat but no other symptoms.

The resistance measured across the leads of the HV diode should be greater than 10 M ohm in at least one direction when disconnected from the circuit. However, the HV diode is composed of multiple silicon diodes in series to get the voltage rating. Its forward voltage drop will therefore be too great (6 V or more) for a DMM to produce a definitive answer as to whether it actually works as a rectifier.

The HV diode can be tested with a DC power supply (even a wall adapter of at least 12 or 15 V output), series resistor (to limit current), and your multimeter. This will determine proper behavior, at least at low voltages.

The following is the schematic of a simple HV diode tester:



The voltage drop in the forward direction should be at least 6 V with a few mA of current but may be somewhat higher (8 V or more) with a few hundred mA. If your DMM or VOM has a resistance scale operated off a battery of at least 6 V, you may get a reading in one direction (but only one) without the need for an external power supply.

Or, assume for now that the diode is good if it is not shorted - which is likely.

Although a shorted HV diode is usually an isolated event, it is possible for failures elsewhere to have caused the diode to blow. Possible causes include a shorted HV cap, arcing between windings in the HV transformer, and possibly even a defective magnetron or damaged waveguide. These may only occur with full voltage so unless there is obvious physical damage (e.g., charring between the HV transformer windings or hole burned in the waveguide), it may be necessary to eliminate the other components one by one.

4.2.5. Microwave Measurement Procedure.

A. **Requirements:**

1) **Microwave leakage limit (Power density limit):** The power density of microwave radiation emitted by a microwave oven should not exceed 1mW/cm2 at any point 5cm or more from the external surface of the oven, measured prior to acquisition by a purchaser, and thereafter (through the useful life of the oven), 5 mW/cm2 at any point 5cm or more from the external surface of the oven. 2) Safety interlock switches: Primary interlock switch shall prevent

microwave radiation emission in excess of the requirement as above mentioned, secondary interlock relay and door sensing switch shall prevent microwave radiation emission in excess of 5 mW/cm2 at any point 5cm or more from the external surface of the oven.

B. **Preparation for testing:** Before beginning the actual measurement of leakage, proceed as follows:

1) Make sure that the actual instrument is operating normally as specified in its instruction booklet.

Important: Survey instruments that comply with the requirement for instrumentation as prescribed by the performance standard for microwave ovens, 21 CFR 1030.10(c)(3)(i), must be used for testing.

2) Place the oven tray in the oven cavity.

3) Place the load of 275 15 ml (9.8 oz) of tap water initially at 20 5 C (68 F) in the center of the oven cavity. The water container shall be a low form of 600 ml (20 oz) beaker with an inside diameter of approx. 8.5 cm (3-1/2 in.) and made of an electrically nonconductive material such as glass or plastic. The placing of this standard load in the oven is important not only to protect the oven, but also to insure that any leakage is measured accurately.

4) Set the cooking control on Full Power Cooking Mode

5) Close the door and select a cook cycle of several minutes. If the water begins to boil before the survey is completed, replace it with 275 ml of cool water.

C. **Leakage test:**

4.2.6. Closed-door leakage test (microwave measurement)

1) Grasp the probe of the survey instrument and hold it perpendicular to the gap between the door and the body of the oven.

2) Move the probe slowly, not faster than 1 in./sec. (2.5 cm/sec.) along the gap, watching for the maximum indication on the meter.

3) Check for leakage at the door screen, sheet metal seams and other accessible positions where the continuity of the metal has been breached (eg., around the switches, indicator, and vents). While testing for leakage around the door pull the door away from the front of the oven as far as is permitted by the closed latch assembly.

4) Measure carefully at the point of highest leakage and make sure that the highest leakage is no greater than 4mW/cm2, and that the primary interlock switch and the secondary interlock relay do turn the oven OFF before any door movement.

NOTE: After servicing, record data on service invoice and microwave leakage report.

4.3. Compiling documentations.

4.3.1. Introduction Maintenance documentation

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

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.

4.3.2. Repair equipment is documented.

A. 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).

B. 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!!!

4.4. Disposing waste materials.

4.4.1. Introduction discarding of waste

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

4.4.2. Disposal of E-waste is electronic waste.

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

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

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

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

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

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

Self-Check – 4.1

Test I: short Answer writing

Instruction: write short answer for the given question. You are provided 4 minute for each question and each point has 5 Points.

4. Necessary tools and test instruments
5. What is Personal Protective Equipment?
6. write six point technique used on complex faults testing system

Test II: Say True or False

1. During measuring Magnetron current Place a 10 ohm 10 watt resistor in series with the HV diode cathode and ground.
2. If it is around 10 ohm 10 watt resistor this range, the magnetron is probably fine.
3. If it is very low or 0, magnetron is bad or HV is not working.

Test III: Choose the best answer from the give alternative given below.

1. Which one is not correct to repair Microwave oven Before Servicing

A. Disconnect the power supply cord B. Open the door and block it open

C. Discharge high voltage capacitor D. Remove outer case E. None

2. Which of the following items should be checked after the unit is repaired: Except,
   A. The interlock monitor switch is connected
   B. The magnetron gasket is properly positioned and mounted.
   C. No microwave energy leakage
   D. The door can be properly closed E. None

Operation sheet 4.1.

Conduct an RF Leakage Test On Microwave Oven

Operation Title: perform different Leakage Test On Microwave Oven.

Purpose: To practice and demonstrate the knowledge and skill required perform different Leakage Test On Microwave Oven for safe performance using service manuals and service information

Instruction: Given necessary, workshop, tools and materials and equipment's you are required to perform Door Seals, Door Class, Cabinet Vents, And Power Cord to Assure the Oven Is In Compliance With the Performance Standard for Microwave Ovens.

Tools and materials

- Microwave oven as selected by instructor
- Microwave radiation detection meter as selected by instructor
- Microwave radiation detection probe for selected radiation detection meter
- Nine volt battery
- Operator's manual for selected meter and probe
- sixteen-ounce measuring beaker
- Pencil and paper
- Safety glasses

Procedure you follow to do it

STEP- 1: Put on: safety glasses
STEP- 2: Fill a beaker with 9 ounces of water that is about room temperature
STEP- 3: Place the load (the water) into the oven cavity and close the oven door
STEP- 4: Prepare your RF meter as outlined in a previous job sheet
STEP- 5: Turn the fangs selector switch on the RF meter to the correct position
STEP- 6: Turn ths microwave oven ON
STEP- 7: Pick up the meter in one hand and the test probe with the spacer cone in the other
STEP- 8: Start at the upper left hand corner of the door seal %/ith the tip of the spacer cone slightly touching the door edge (Figure 1).
STEP- 9: Move the tip of the probe slowly across the top edge of the door until you reach a point where you get a reading

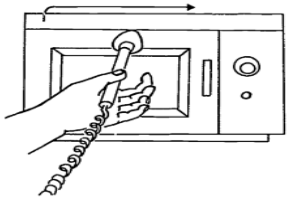


Figure 1

STEP- 10: Stop at any point where you get a reading and turn the shaft of the probe to obtain the highest reading possible

STEP- 11: Continue slowly left to right across the top edge, down the right edge, right to left across the bottom edge, and up the left edge until all edges have been completely checked

STEP- 12: Record your readings as you go and enter them in the appropriate at the end of the job sheet

STEP- 13: Turn the range multiplier switch to position X1 if you cannot get readings from the X10 position

STEP- 14 : Repeat the door edge measurements at the X1 position and enter your readings in the appropriate chart

STEP- 15: Hold the tip of the probe to the upper top edge of the door glass

STEP- 17: Move the probe slowly back and forth on the oven window until you reach the bottom of the door

17. Stop at any point where you get a reading and turn the shaft of the probe to obtain the highest reading possible.

LAP Test 4.1.

Perform different Leakage Test On Microwave Oven.

Instructions: Given necessary templates, tools, materials and equipment you are required to perform test the Interlock System on a Microwave Oven for safe performance for the following tasks within 5 hour

Task -1: Set the multiplier range at X10 and check the power cord at the point where it enters the oven cabinet

Task -2: Check all vents, air ducts, or any other openings in the oven cabinet at the X10 range, and if you don't get a reading, switch to the X1 range

Task -3: Record all readings in the appropriate chart in Figure 2 that accompanies this job sheet

Task -4: Turn the RF meter OFF

Task -5: Turn the microwave oven OFF and unplug the power cord to the oven 0 Have your instructor check your charts in Figure 2

Task -6: Remove the spacer cone from the probe and the probe from the meter and replace everything in the meter carrying case

Task -7: Turn the RF meter to proper storage and double-check the work area to make certain everything is in order.

Precautions: select necessary templates, tools, materials and equipment before performing different leakage test On Microwave Oven. for Safe Performance on the given format.

Quality Criteria: the given performing different leakage test On Microwave Oven. for Safe Performance is with correct specification

List of Reference

1. BLODGETT OVEN COMPANY www.blodgettcorp.com 50 Lakeside Avenue, Box 586, Burlington, Vermont 05402 USA Telephone (800) 331-5842, (802) 860-3700 Fax: (802)864-0183 PN T0582 Rev F (3/01) E 2000 --- G.S. Blodgett Corporation.
2. Pillsbury Classic #114: Simple Summer Recipes: Pillsbury Classic Cookbooks Series by Monn, William (Editor)
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6. RF and Microwave Coupled-Line Circuits by R.K. Mongia, I.J. Bahl, P Bharta and J. Hong
7. BETTER HOMES AND GARDENS MICROWAVE COOK BOOK **by Morton, Nancy (Editor) / Trollope, Joyce (Editor**

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