Electric Pressure Cooker

Repair Manual

UKaid from the British people

MECS Modern Energy Cooking Services

PEEDA

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Preface

Welcome to the repair manual for Electric Pressure Cookers. This comprehensive guide is designed to assist technicians and enthusiasts in understanding, troubleshooting, and fixing common issues with these essential kitchen appliances.

Electric Pressure Cookers have become crucial tools in kitchens, offering efficiency, convenience, and precise cooking capabilities. However, like any complex machinery, they may encounter problems over time, ranging from minor malfunctions to more serious issues.

The manual was developed by drawing on the findings of the PEEDA-MECS study into the repair of eCooking appliances. This training manual and the larger repair study were funded by and received technical support from the UK Aid Modern Energy Cooking Services (MECS) Programme and were developed in close coordination with the Alternative Energy Promotion Centre (AEPC) and Renewable Energy for Rural Livelihood (RERL) programme.

The study surveyed institutions, service centers, trainers, technicians, suppliers, and households to assess the most common faults for Electric Pressure Cookers. Existing Council for Technical Education and Vocational Training (CTEVT) modules for electrical appliances were also reviewed to understand best how this module could most effectively be integrated into training courses. Inputs were also incorporated form the workshop with fruitful discussion gathering invaluable feedback from experts representing AEPC, CTEVT, and its technical institutions in Kathmandu, Banepa, Butwal, as well as major e-cooking technology suppliers, and other INGOs/NGOs and private institution working in similar fields.

In this manual, we aim to provide detailed explanations, diagrams, and step-by-step instructions to aid in diagnosing and repairing various issues that may arise with Electric Pressure Cookers. If you are a professional technician, this manual will equip you with the knowledge and skills needed to keep these appliances running smoothly.

We encourage users to read through this manual thoroughly before attempting any repairs, ensuring safety precautions are always followed. Additionally, referring to the manufacturer's guidelines and specifications specific to your appliance model is essential.

PEEDA is committed to working alongside organizations dedicated to leveraging technology for noble purposes and advancing knowledge. We are willing to work with any organization passionate about utilizing this resource for a generous cause to embark on a collaborative journey with us.

We hope this manual serves as a valuable resource in maintaining and extending the lifespan of your Electric Pressure Cooker.

Biraj Gautam
Chief Executive Officer
PEEDA

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1. Introduction

The electric pressure cooker, also known as an EPC, is a modern electric stove. Although its external appearance is similar to a regular rice cooker, it can prepare all kinds of dishes, such as lentils, rice, vegetables, meat, soups, and more. When power is supplied to the EPC, the heating plate inside it heats up, and this heat is used to cook foods. Different buttons on the control panel can be used to change settings and cooking times according to the type of food to be cooked. It also has a pressure release valve which regulates the pressure inside the cooker by releasing excess steam when the internal pressure exceeds the desired level. EPCs generally consume less energy than regular rice cookers when cooking the same amount of food, and there are several reasons for this. Firstly, EPCs are highly insulated, meaning that most of the heat generated during cooking is retained within the cooker, reducing energy loss. Secondly, EPCs do not continuously draw power. Once the desired level of pressure is reached inside the cooker, it cycles power on and off as necessary to maintain that pressure, resulting in overall lower energy consumption compared to continuous power consumption.

Figure 1: EPC and its parts

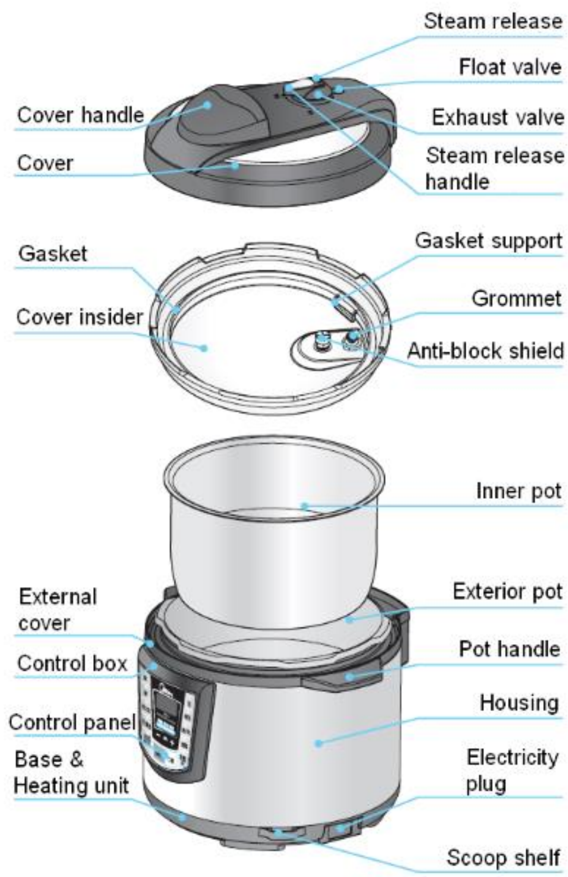


Figure 3: Detailed Diagram of EPC
Image source: Instantpot.com

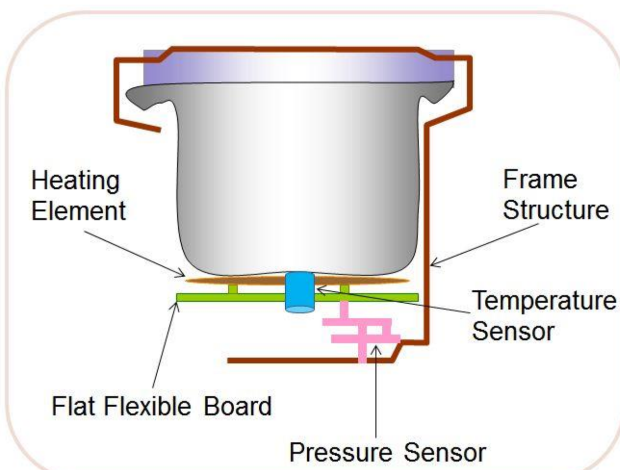


Figure 2: Parts of inner pot
Image source: Instantpot.com

2. Parts of EPC

Control Board

The control board enables users to control the functionalities of the EPC. It is found inside the control box and includes components such as switches, LEDs, displays, microprocessors, and other electronic devices. This board allows users to change modes, set timers, adjust pressure levels, and perform various functions related to EPC using the different buttons on the board. The microprocessor in this board changes modes based on information received from switches, temperature sensors, and pressure sensors. It also provides instructions for various tasks such as powering the heating coil on or off, adjusting timers, and more, based on the information it receives.

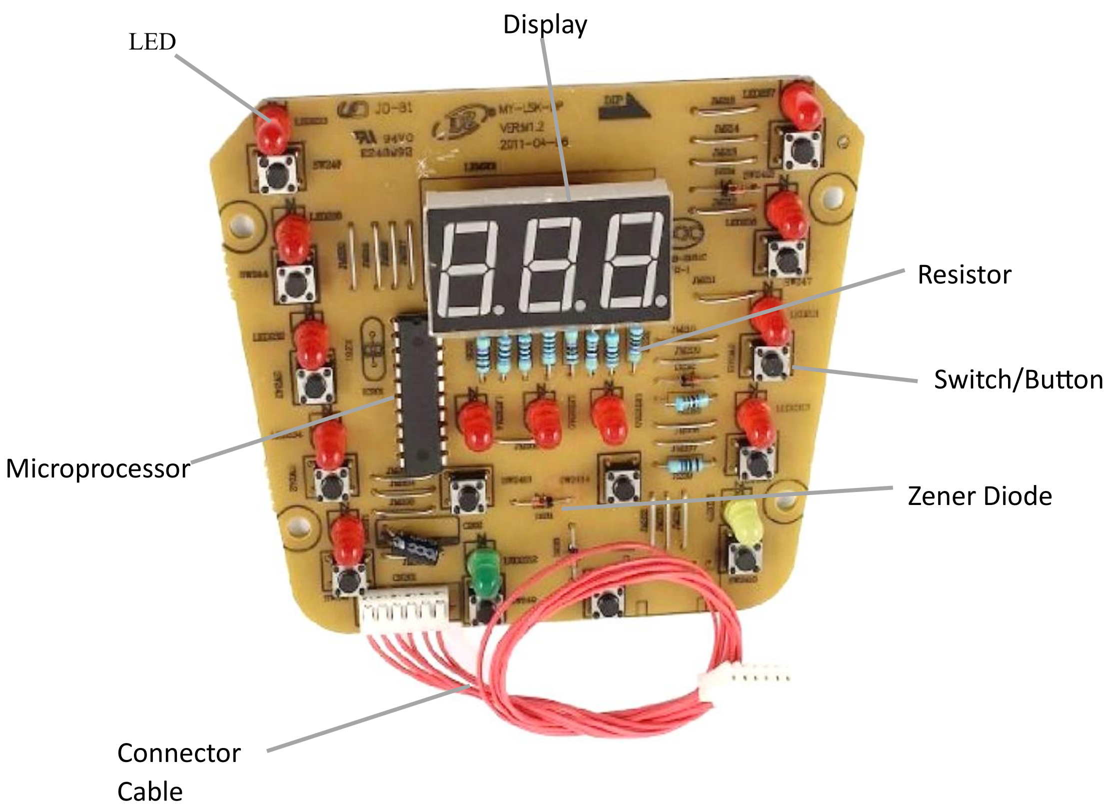


Figure 4: EPC Control Board

Power Board

The main function of the power board is to control the current flowing through the heating coil and provide necessary power to various components in the control board and power board itself. The power board consists of various components such as capacitors, relays, diodes, fuses, transistors, etc. These components help the board perform tasks like converting AC current to DC, voltage/current regulation, and other related functions. With the help of fuses and temperature sensors, the power board also ensures the safety of electronic parts and EPC from short circuits, excessive heat, high voltage, and other potential risks.

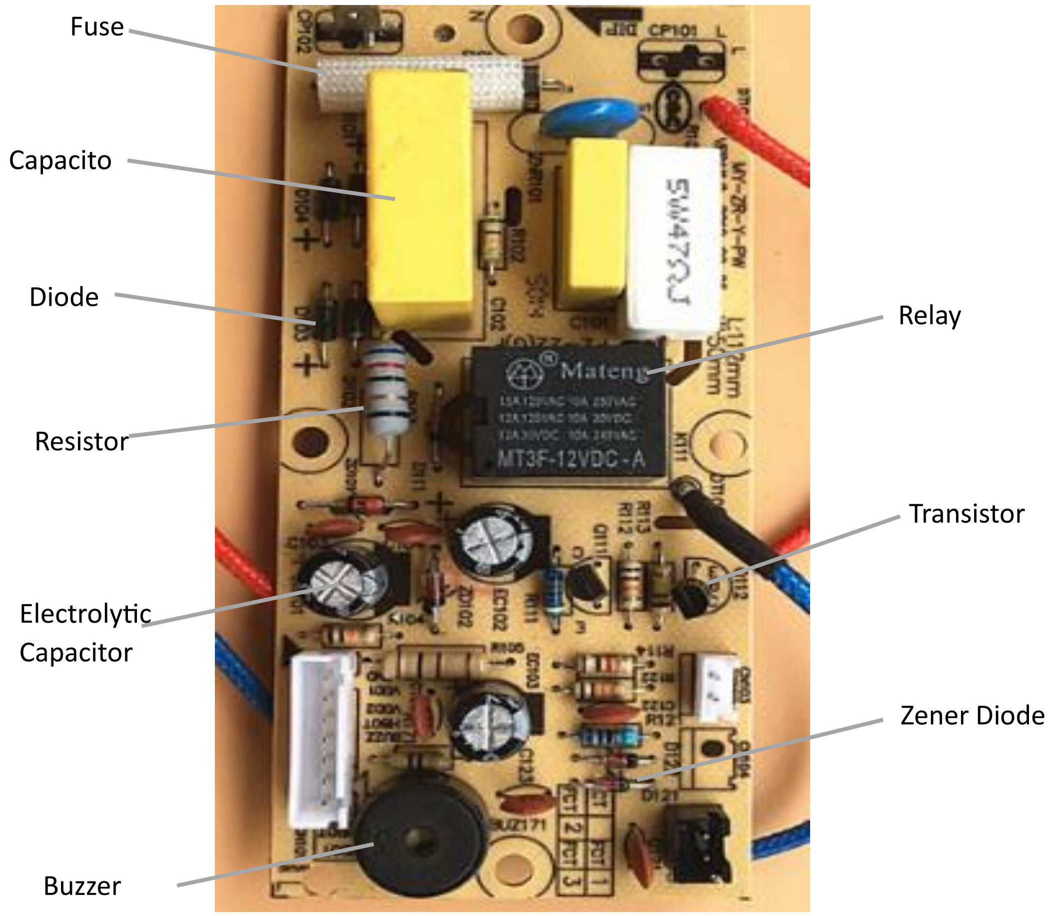


Figure 5: EPC Power Board

<u>Heating Plate</u>

The heating plate is a crucial component of the EPC as it generates the heat necessary to cook foods. A heating coil is placed beneath the surface of the heating plate. When current flows through the coil, it generates heat, and this heat is used for cooking food. The surface of the plate is typically made of aluminium metal.

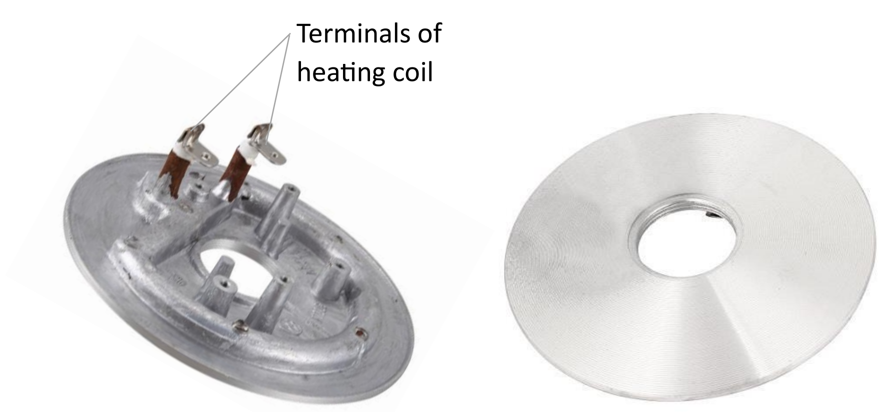


Figure 6: Heating Plate

Temperature Sensor

The temperature sensor is placed in the middle of the heating plate. It measures the temperature of the vessel and provides this information to the microprocessor. Based on this information, the processor can control the power supplied to the heating coil. Excessive temperature can also result in the automatic shutdown of the EPC. Inside the temperature sensor, there is a thermistor. It is a kind of resistor whose resistance changes according to the temperature. The processor can determine the vessel's temperature based on the changes in the resistance of this resistor. Usually, EPCs use a negative temperature coefficient thermistor meaning the resistance decreases with an increase in temperature.

Temperature Sensor used in EPC

Thermistor

Figure 7: Temperature sensor and Thermistor

Pressure Sensor

The pressure sensor is connected to the bottom of the external container. When a high pressure develops inside the EPC, the pressure sensor sends this signal to the microprocessor. The processor then turns off the power to the heating coil, which allows the pressure to return to normal state after some time.

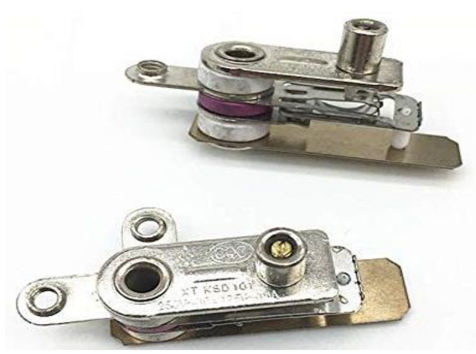
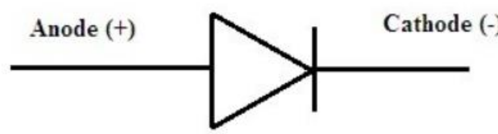


Figure 8: Pressure Sensor used in EPC

Diode

A diode is an electronic component in which current can flow in only one direction. Diodes have two pins or terminals. The terminal with a silver-colored band is called the cathode, while the other terminal is called the anode. When a higher voltage is applied to the anode terminal compared to the cathode, the diode allows current to flow from the anode to the cathode. In other conditions, it does not allow the flow of current. Diodes are used for various purposes, such as converting AC voltage to DC, maintaining current and voltage stability, and allowing current flow in only one direction for different applications.

Diode



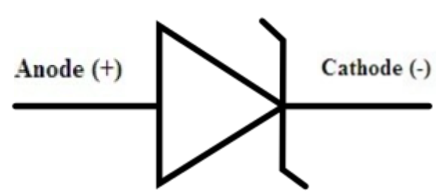
Symbol of Diode

Figure 9: Diode

Zener Diode

A Zener diode is also an electronic component like a regular diode. However, it is specially designed to work in the reverse direction. When the voltage across a regular diode's cathode is higher than the voltage across the anode, the diode does not conduct current. But when the voltage is significantly higher, the diode can allow a substantial current to flow in the reverse direction (from cathode to anode). But Zener diodes can also conduct current in the reverse direction when the reverse voltage is low(2.4 volt, 5.1 volt, 12 volt). Zener diodes find applications in various tasks such as voltage regulation, protecting other components from high voltage, and more.

Zener Diode



Symbol of Zener Diode

Figure 10: Zener Diode and it Symbol

Transistor

A transistor is an electronic component that can be used as a switch or an amplifier. It can be turned on and off thousands of times in a second. Transistors come in two types: NPN and PNP. Both types of transistors have three terminals: emitter (E), base (B), and collector (B). However, the positions of these pins may differ depending on the type of transistor. For example, in Model S8550, a PNP transistor shown in Figure 9, you can see that when the flat side is facing up, the pins are arranged in the following order from left to right: emitter (E), base (B), and collector (C). The best way to identify the pins accurately is to Google search the transistor's model number. For the transistor shown in Figure 9, you can search for 'S8550D pinout' to easily identify its pins.

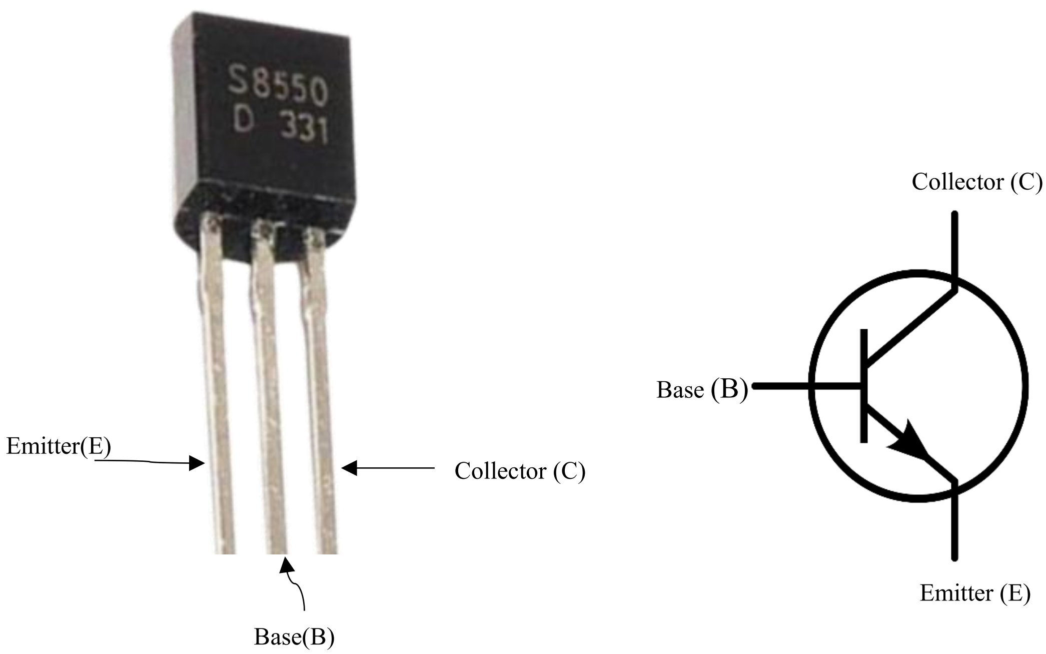


Figure 11: Transistor(left) and its symbol(right)

Relay

A relay is a type of electronic switch which helps to control the power supplied to the heating coil. A relay has two pins on one side and three pins on the other side. When the two-pin end is connected to a voltage equal to or greater than the voltage rating of the relay, current can be passed in the desired direction through another end. For example, if there is excessive pressure inside an EPC, the pressure sensor provides this information to a microprocessor, and the microprocessor cuts off the current flow to the relay, which, in turn, stops the power supply to the heating coil. Similarly, to control the temperature of the heating plate, the microprocessor can make decisions about providing or cutting power to the relay.

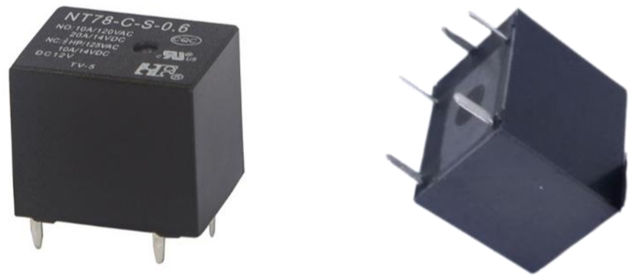


Figure 12: Relay

Fuse

The fuse prevents the stove from operating in case of a short circuit or overload. If the current exceeds a certain limit, the fuse wire may melt and cannot carry current between the plug and the power board. In such cases, it is necessary to identify the cause of the short circuit, remove it, and replace the fuse with a new one. The capacity of the fuse used may also vary according to the capacity of the induction stove.

Figure 13: Fuse

Thermal Fuse

The primary function of a thermal fuse is to cut off the power supply to the EPC if the cooker heats above a certain predefined limit. It is present between the power receiver and the power board, usually in the phase line, attached to the inner casing of the EPC. The threshold temperature above which it melts is written on its surface as shown in figure 14. The thermal fuse also has a current rating. If the current flowing through the fuse exceeds this rating, it may potentially lead to overheating and melting of a fuse. Thus, when selecting a thermal fuse, it is necessary to choose an appropriate value of both temperature and current rating.

Figure 14: Thermal Fuse

Capacitor

Both the power board and the UI board use various types of capacitors for different purposes. Capacitors help the rectifier stabilize the DC voltage produced, perform various tasks such as protecting electronic devices from momentary high voltages, and more. The value of a capacitor is measured in terms of capacitance and its unit is Farad.

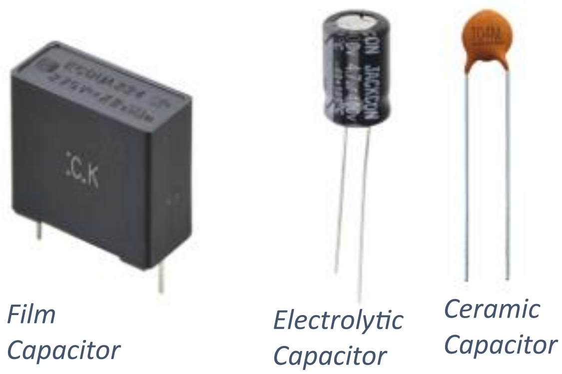


Figure 15: Different Types of Capacitors

Resistor

Both in the control board and power board, resistors are used in large numbers to control the current and change the voltage levels. Depending on applications, they can be used in different places. The value of a resistor is measured in terms of resistance and its unit is ohm(Ω).

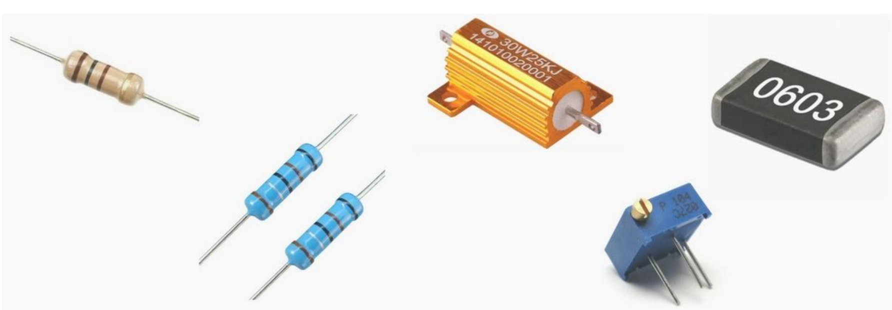


Figure 16: Different types of Resistors

3. Precautions to be Taken Before EPC Repair

3.1 Safety Precautions

As with any electrical work, you must consider your safety as the first priority while repairing the EPC. If you are not careful enough, there is a risk of electrocution which can cause injuries and sometimes be lethal. Therefore, it is strongly advised that you follow the safety measures provided in this section before you begin any repair work.

- To avoid possible electrical accidents during repair work, disconnect power from the EPC first.
- Work only in well-ventilated areas with adequate lighting and airflow.
- Wear gloves, safety glasses, and appropriate footwear.
- Depending on the brand and model of the EPC, there may be some variations in its design and components, so it is advisable to read the EPC's manual before starting the repair work.
- When in contact with liquid substances such as water, there is an increased risk of electric shock, so it is necessary to stay away from contact with such substances.
- To prevent potential fire hazards, install a separate MCB of the appropriate rating for the repair workshop so that it trips in case of short circuits.

3.2 Proper Storage of Components

When disassembling EPC for repair, small components like screws and buttons can easily get lost or misplaced if not properly stored. Further, accidental mechanical damage to the PCB or control panel can make the situation worse. This can lead to frustrations and unnecessary delays. The following is a list of some instructions which can help you avoid this hassle.

- Begin by gathering all parts and components required for the repair task.
- Keep the storage area clean and clutter-free for easy access to parts.
- Use designated containers or compartments for different types of parts.
- You can even label each container or compartment, indicating the contents and their respective locations.
- Handle small parts such as screws with care, to prevent loss or spillage.
- Store larger parts such as panels or circuit boards in protective cases or boxes to shield them from damage.

4. Tools Needed for Repairing EPC

1. Screwdriver

Screwdrivers are used to tighten and loosen the screws. Depending on the size of the screws, you may require different types of screwdrivers.

Figure 17: Screwdriver

2. Pliers

Pliers are used to cut or bend wires. They can also be used to handle objects.

Figure 18: Pliers

3. Wire Cutter/Wire Stripper

This instrument is used to cut or stripe wires of different sizes.

Figure 19: Wire cutter/Stripper

4. Soldering Iron

The soldering iron is required to connect various components to a PCB board. When the iron is supplied with electricity, its tip heats up. This heat is used to melt solder wire and attach the pins of components to the board.

Figure 20: Soldering Iron

5. Soldering Wire and Soldering Paste

The soldering wire is used to connect the pins of components to the board by melting it. After some time of use, the soldering iron tip may become oxidized. The soldering paste is used to remove this oxidation from the tip.

Soldering Wire *Soldering Paste*

Figure 21: Soldering wire and Soldering Paste

6. Desoldering Pump

To remove electronic components from a PCB board, a desoldering pump is used. The solder connection between the pins and the board is first melted using a soldering iron. Then, the molten solder is removed by using the desoldering pump.

Figure 22: Desoldering Pump

7. Multimeter

A multimeter is a versatile device. With its help, you can measure the voltage and current of DC and AC circuits. Additionally, it can be used to test various electronic components such as resistors, capacitors, diodes, transistors, and more. A control knob is used to adjust settings as per the requirement. For example, to measure the resistance of a resistor, the pointed head of the control knob is placed on the resistance measurement section. A detailed explanation of using a multimeter for testing various electronic devices is provided in chapter 6.

Figure 23: Digital Multimeter

5. Troubleshooting

5.1 Common faults found in EPCs

EPCs can encounter various technical issues. Some issues render the device no longer usuable while others pose operational difficulties without halting the functionality. It is essential for any repairer to have an understanding of frequently found faults and the underlying causes behind them. Table 1 lists commonly found electrical and mechanical faults in EPCs. In this manual, we will deal specifically with the electrical faults.

Table 1: Most commonly found faults in EPCs

Electrical Faults	Mechanical Faults
1. EPC doesn’t turn on	1. Pressure valve malfunction
2. Inner pot doesn’t heat up	2. Sealing ring leaking steam
3. Pressure doesn't build up	3. Loss of coating on the inner pot
4. Display doesn’t turn on or is unreadable	4. Lid jams
	5. Broken lead hinge
5. Overheating	6. Leakage from lid gasket
6. Electric shock	7. Inner pot loses shape/lid no longer closes
7. Broken power cord	

5.2 Error Codes

EPCs display error codes to indicate various problems or malfunctions. Typically, error codes are used to indicate the following technical problems:

- Issues with the internal circuitry.
- Overheating of the cooker
- Issues with the temperature sensor or the heating coil. The EPC may not reach the required temperature, or the control board may not provide proper instructions to the heating coil.
- Issues with the pressure sensor or the steam release valve. The EPC may not have the necessary pressure built up.
- EPC lid not properly closed. When the lid is not sealed properly, the EPC cannot begin the cooking process. If there are any issues with the lid, open/close it properly or conduct a check.
- Issues with the internal circuit or the control board.
- Issues with the power supply. This indicates that the power is unstable or the voltage is not steady.

Error codes used to indicate a particular problem vary from one brand to another. Thus, it is essential to go through a particular EPC's user manual before conducting any repair work. Table 2 shows the error codes and problems indicated by them in some of the EPC brands found in Nepal.

Table 2: Error codes of some EPC brands found in Nepal

Error Codes	EPC Brands			
	Urban	**Electron**	**Geepas**	**Baltra**
E1	Temperature sensor is open-circuited	Pressure switch malfunctions	Temperature sensor open-circuited	Temperature sensor is off
E2	Temperature sensor short-circuited	Temperature sensor short-circuited	Temperature sensor short-circuited	Temperature sensor is short-circuited
E3	Overheating of the cooker	Temperature Sensor open circuited	Overheating of the cooker	Overheating of the cooker
E4	Misoperation of low pressure switch	Overheating of the cooker	Pressure controller is out of work	Problem with pressure switch
E6	Misoperation of high-pressure switch	-	-	-

In most cases, the faulty parts of the power board or control board of the EPC can be easily identified with the help of error codes. For example, if the EPC shows a high-temperature error even when the surface temperature is normal, there might be a short circuit in the temperature sensor. Knowing the relationship between the error codes and associated parts can significantly reduce the repair time.

5.3 Troubleshooting of issues

There is a specific set of steps that need to be followed to reach the underlying causes of each fault. This section lists the troubleshooting methods for some of the most commonly found faults in EPCs. While the methods are not exhaustive and do not guarantee success every time, they should help you identify the problematic areas most of the time.

1. EPC doesn't turn on

Troubleshooting method

- Ensure that there is no power outage and that the outlet to which the EPC is connected is getting a power supply.
- **Check the voltage level**: Some EPCs may not turn on if the supply voltage is too low. This is due to the safety mechanism embedded in the device. Ensure that the voltage level at the outlet is within the operating range of EPC. In the case of Nepal, the nominal voltage is 230 volts and the voltage range of 220 to 240 volts is considered normal.
- **Check the power cord**: EPC won't turn on if there is a problem with the power cord. If you have another similar power cord, you can try connecting this cord to the outlet. If the EPC turns on, then you know that the problem is with the power cord. If you don't have an alternative, you can test the cord by following the method given in section 6.6.

It can also be tested by checking the voltage level at the power receiver. It consists of three flat pins and is attached to the round cover located at the bottom side of the EPC(see point 5 of section 5.4). The pin on the top is for earthing and the lower two pins are for phase and neutral of the power supply. Turn on the power supply to the EPC and measure the voltage between the lower two pins with the help of a multimeter. If the multimeter doesn't show any value, then there is a problem with the power cord.

- **Ensure that there is a power supply on the power board**: Usually, there are two flat pins protruding from the surface of the power board to which the supply from the power cord is directly connected. Turn on the power supply to the EPC and measure the voltage between these two pins with the help of a multimeter. If the multimeter doesn't show any value, then there is a problem with the connection between the power board and the power receiver.
- **Check the fuse**: A very high value of current or a short circuit can melt the fuse in the power board. Test the continuity of the fuse with the help of a multimeter. Detailed procedure for testing and replacing a fuse is given in section 6.1.
- **Check the thermal fuse**: When the cooker overheats, the thermal fuse gets blown away disrupting the power supply to the power board. Test the continuity of the thermal fuse fuse with the help of a multimeter. Detailed procedure for testing and replacing the thermal fuse is given in section 6.2.

2. Inner Pot doesn't heat up

It often happens that EPC powers up, touch buttons on the control panel work, and the display works as expected but the inner pot does not heat up.

Troubleshooting method

- **Check for error messages**: When there is a problem with the temperature sensor, it can report a high temperature to the processor even when the temperature is normal or when the cooker hasn't even started heating. When this happens, the power boards can cut off the power supply to the heating element. Depending on the brand of EPC, the display might indicate an error. If it shows a high-temperature error even when the pot hasn't developed sufficient heat, you know that there is an issue with the temperature sensor. Testing and replacement of a temperature sensor is given in section 6.3.
- **Check for failed solder connections**: If the solder connection of components in the power board breaks or has microfractures, the heating element might not get an electricity supply, preventing it from heating up. Sometimes, the breakage on the board is visible while at other times you might have to inspect the connection of individual components. Some of the components to test are: heating element relay, resistors, capacitors, transistors, and microprocessor.
- **Check for loose connections**: Shake the components on both the power board and control board to find if they have loose connections. If the components jiggle on shaking, solder its pin until it is stiff and doesn't move.

- **Check for the connection between the power board and the control board**: A connector cable connects the power board and the control board. If this connection becomes loose or has other problems, the microprocessor in the control board might not be able to send the proper signals to supply power to the heating element. Tighten the cable if you find a loose connection. If the cable has a breakage somewhere, you might need to replace it.

3. Display doesn't turn on or is unreadable

   <u>Troubleshooting method</u>

- **Check for physical damages**: If there are visible damages to the display or the components connected to it, it might prevent the display from turning on or cause it to show unreadable garbage characters. If you see such defects, replace the display or other components with a new one.
- **Try resoldering**: Sometimes, it is the dry soldering of the connection of the display pins or other components that leads to display issues. Try resoldering the display pins and components connected to it and see if it works.
- **Try a replacement part**: If you cannot identify the exact reason behind the issue, try replacing the old display with a newer one. If the new display works, you know that the old display is damaged.

4. Pressure doesn't build up

   While several operational events prevent EPC from building up pressure, we are interested in finding the electrical and mechanical causes of this problem.

   <u>Troubleshooting method</u>

- **Check for damages**: If the sealing ring or float valves are damaged, EPC fails to build up the required pressure. See if there are any visible damages to these parts. Replace the parts if you detect any defects.
- **Check for error codes**: Refer to the manual of the EPC and see if there are any error codes associated with this issue. If there is an error code, there might also be an explanation of the reason behind the problem. For example, it might indicate that there is a problem with the high-pressure switch or low-pressure switch etc.
- **Check the pressure sensor**: Incorrect operation of the pressure sensor can also prevent EPC from building up the pressure. Check whether the pressure sensor is working properly or not. Also, the breakage or defect in the connection between the pressure sensor and the power board can lead to this problem.

5. EPC gives Electric Shock

Incidents of electric shock with EPCs are very rare. However, if the EPCs have undergone repairs before and wires have not been connected properly, it increases the likelihood of electric shocks.

Precautionary safety measures to take

- **Check the earthing wire**: There is an earthing wire connected to the external cover of the EPC (see point 8 of section 5.4). If the current somehow leaks to the cover, the earthing wire brings it to the ground, preventing a person from getting shocked. If this wire is broken or disconnected from the cover, the leaking current passes through the human body resulting in a potentially fatal electric shock. Reconnect the loose earthing wire to the cover or replace the wire in case it is broken.

Troubleshooting method

- **Check for disconnected wires**: Any disconnected wire touching the external cover of the EPC can lead to electric shock. Remove such wires and connect them properly to their original places.

To avoid the chances of shock, it is important that when you have finished repairing other issues, you connect all the wires, cables and connectors properly to their original places.

6. EPC overheats

Troubleshooting method:

- **Check the temperature sensor**: If the EPC overheats even when an appropriate amount of food is added, there is likely a problem with the temperature sensor. Testing and troubleshooting of a temperature sensor is given in section 6.3.
- **Check for damages in the heating element**: Defects in the heating element can potentially lead to overheating of the inner pot. If you detect any damages or defects to the heating element replace it with a new one.

Table 3 summarizes the faults, troubleshooting methods and references to testing the relevant components.

Table 3: Summary of troubleshooting

Fault	Troubleshooting	Relevant component testing references
EPC doesn’t turn on	• Check for Power Outage • Check voltage level • Check the power cord • Check the voltage at the power board • Check the fuse • Check the thermal fuse	• Power Cord • Fuse • Thermal Fuse
EPC doesn't heat up	• Check for error codes • Check for failed solder connections	• Temperature sensor • Resistor • Capacitor • Diode

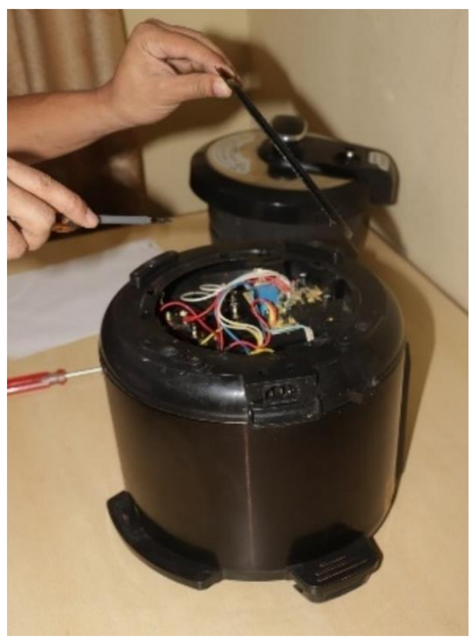
	• Check for loose or broken connections	• Zener Diode • Transistor • Microprocessor
EPC doesn't build up pressure	• Check for the sealing ring or float valve damages • Check for error codes • Check the pressure sensor	• Pressure sensor
Display doesn't turn on or is unreadable	• Check for physical damages • Try resoldering • Try a replacement part	
EPC gives electric shock	• Check the earthing wire • Check for disconnected wires and connectors	
EPC overheats	• Check for temperature sensor • Check for damages to the heating element	• Temperature sensor

5.4 Dismantling the EPC

When there is a problem in the EPC, it may be necessary to open and repair its parts. The process of dismantling the EPC can be quite complicated for those who have no experience. Therefore, we will first learn the process of opening the various parts of the EPC step by step, and then only go on to inspect individual components as needed.

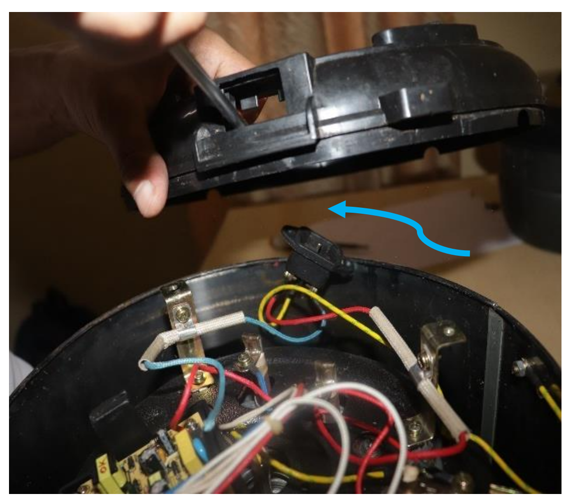
1. Separate the lid of the EPC from its body part.

2. Tilt the EPC upside down and separate the thin cover with the help of a screwdriver.



3. Separate the power board from the circular cover located at the back of the EPC. Remove the thin cover.

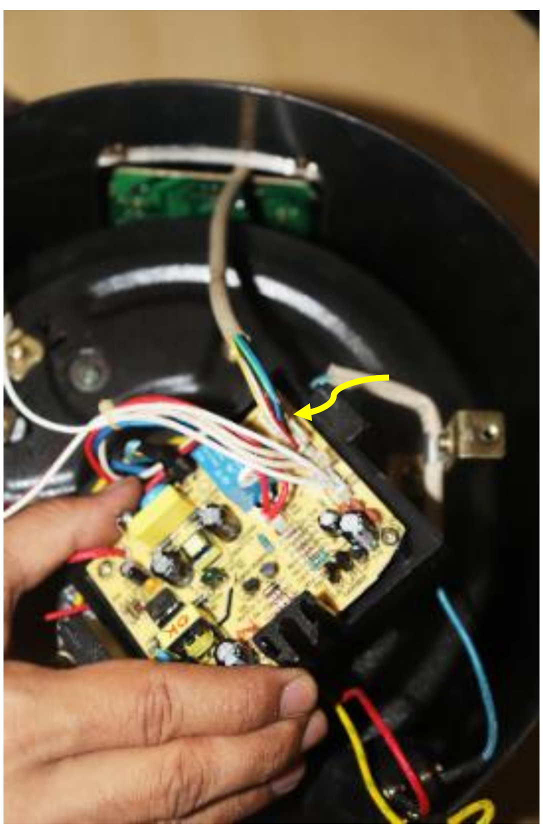
If there is a problem with the power board, you can still repair it without disconnecting the remaining parts. However, if there is a problem in other parts, you may need to open all the covers.

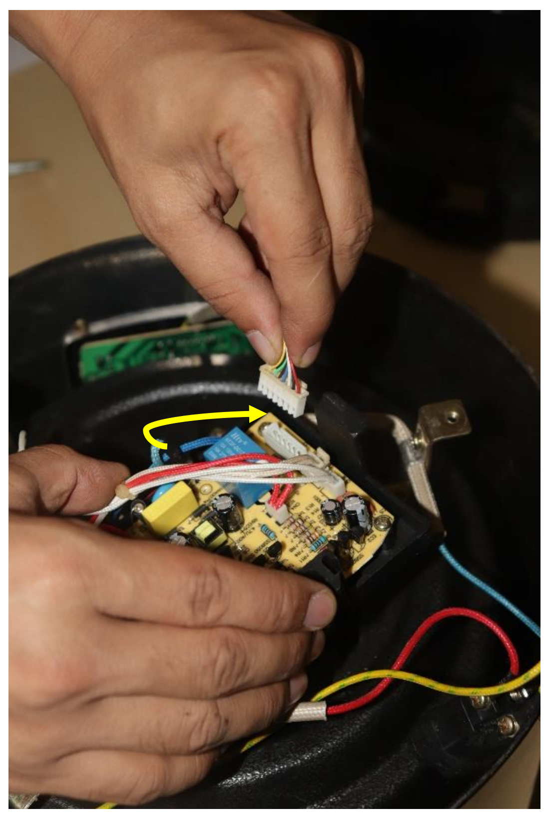


4. Remove screws of the round cover with the help of a screwdriver and separate the cover from the body part of the EPC.

5. Separate the power receiver located in the round cover with the help of a screwdriver.

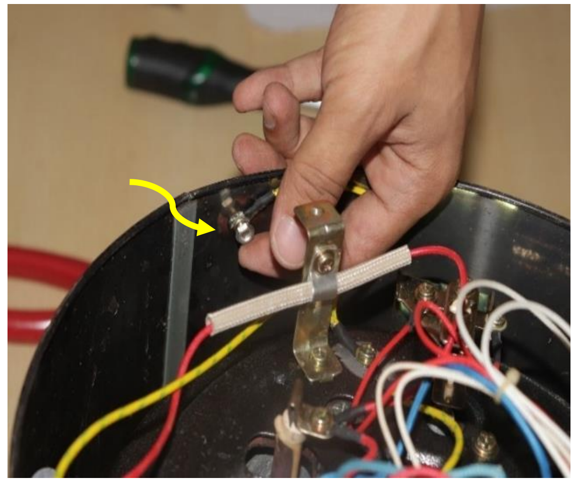
6. Disconnect the cable connecting the power board to the control/display board.

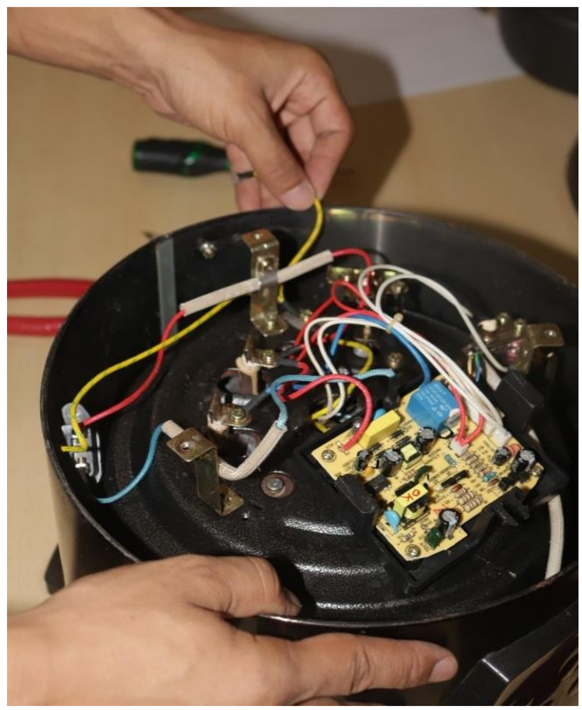




7. Separate the cover connected to the handle of EPC with the help of a screwdriver

8. Disconnect the earthing wire attached to the external cover by loosen the nut.

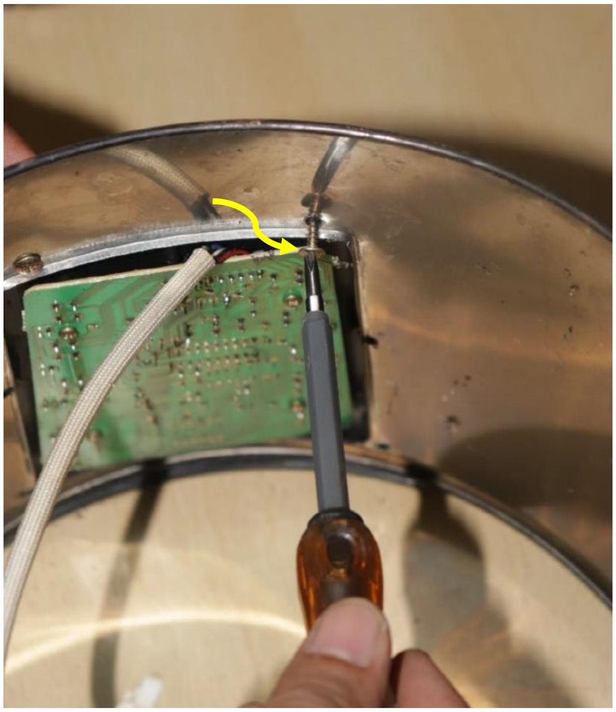


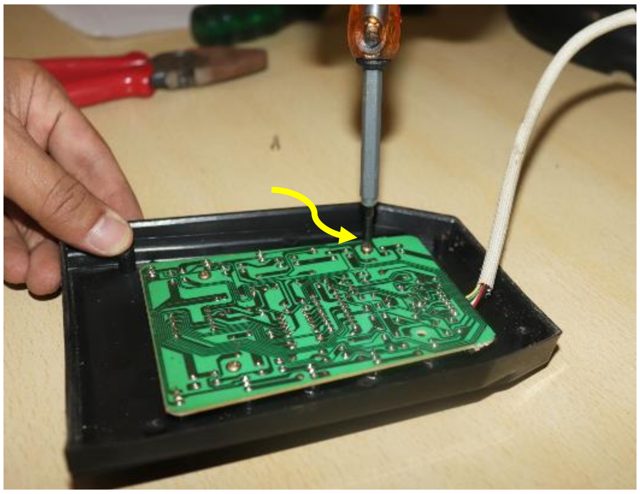
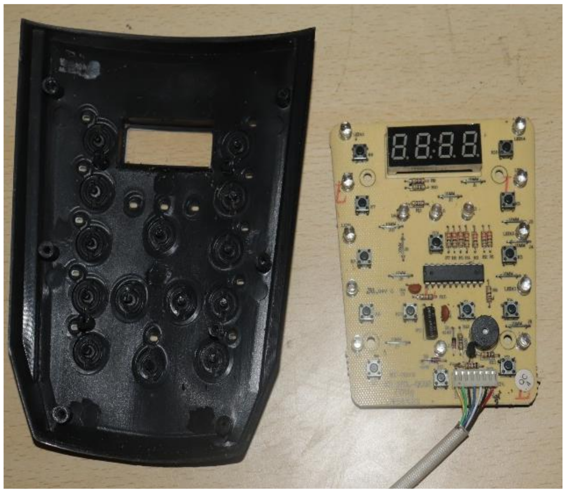


9. Separate the external cover from the internal part of the EPC




10. If there is a problem with the control/display board, you can separate it from the external cover.



6. Component Testing

In this chapter, we will discuss in detail the procedures for testing components and points to consider before their replacement. It is to be noted that the components to be tested should be detached from the PCB while testing. The results or values obtained when the component is connected to the PCB may differ from those obtained during testing conducted under detached conditions. Considering that a normal repair shop may not have access to sophisticated testing devices, the methods provided deal with the use of a multimeter in testing and troubleshooting. While a multimeter is good enough for testing components like fuses and resistors, it is not ideal for testing other components like capacitors. In such scenarios, the theoretical knowledge of these components could help a great deal.

6.1 Fuse

When an overload or short circuit occurs, fuses can potentially blow. Often, a damaged fuse can be identified from external inspection. In a blown fuse, the fuse wire inside may have melted or disconnected, and there could also be a black mark inside the fuse holder glass.

Figure 24: Blown Fuse

Testing of fuse using a multimeter

1) Connect the black probe of the multimeter to the voltage port (VΩ) and the red probe to the common port (COM) of the multimeter. Set the multimeter to continuity mode.

2) Now, as shown in Figure 26, place the black and red probes of the multimeter on the two terminals of the fuse. If the fuse is intact, the multimeter will indicate continuity. If the multimeter detects an open circuit or displays any significant reading, it means the fuse has melted.

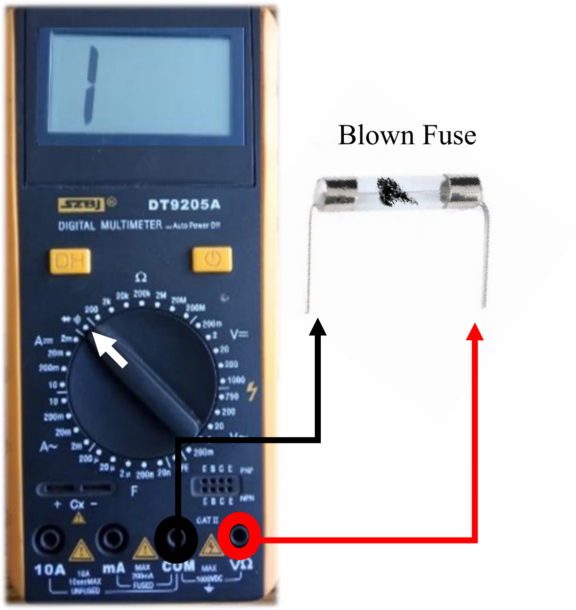


Figure 26: Dmaaged fuse indicating an open circuit

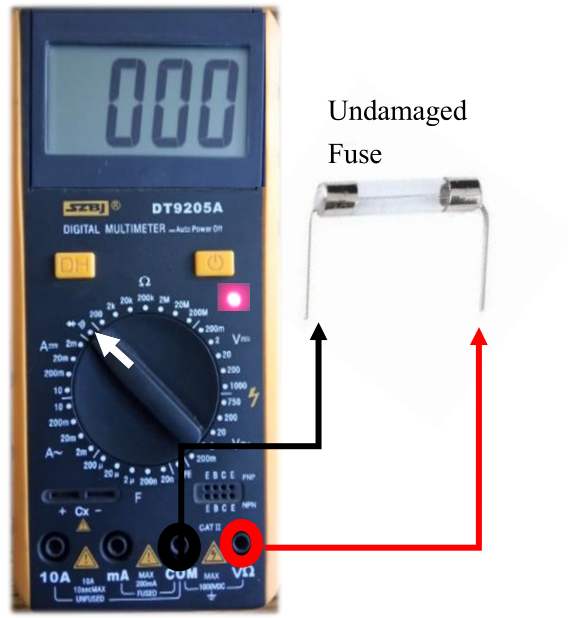


Figure 25: Undamaged fuse indicating a short circuit

Points to be considered when replacing a fuse

The current rating of the new fuse should be equal to that of the old fuse. If the rating is lower than the old one, unnecessary fuse-blowing problems may occur. On the other hand, if the rating is higher than the old one, the fuse may not blow even when an excessive current flows through. For example, if the old fuse has a rating of 10 Amp, the new fuse should also have a rating of 10 Amp.

6.2 Thermal Fuse

When the internal temperature of the cooker exceeds a certain threshold, it can potentially melt the thermal fuse and disrupt the power supply to the power board. A damaged thermal fuse might not always be identifiable from observation. Thus it is best to test with the help of a multimeter.

Testing thermal fuse using a multimeter

1) Connect the black probe of the multimeter to the voltage port (VΩ) and the red probe to the common port (COM) of the multimeter. Set the multimeter to continuity mode.
2) Now, as shown in Figure 28, place the black and red probes of the multimeter on the two terminals of the thermal fuse. If the fuse is intact, the multimeter will indicate continuity (Figure 29). If the multimeter detects an open circuit (Figure 28) or displays any significant reading, it means the thermal fuse has melted.

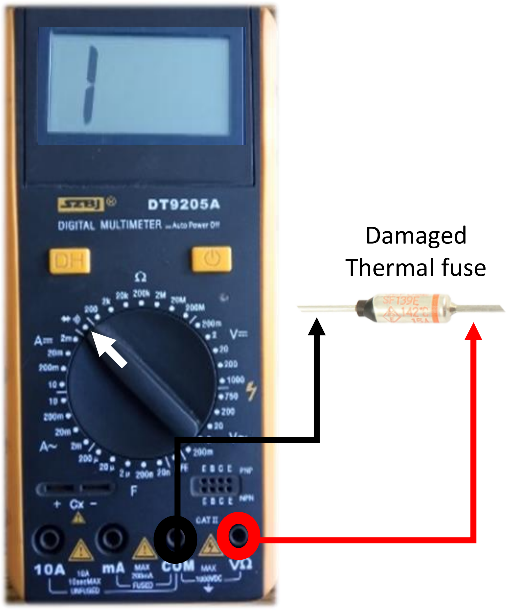


Figure 28: Damaged thermal fuse indicating an open circuit

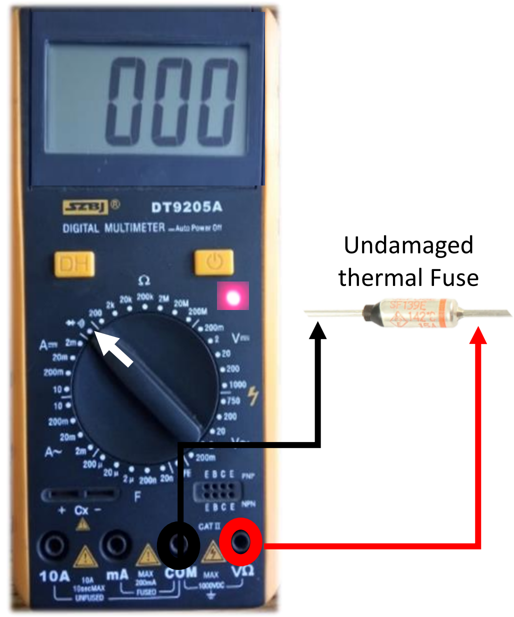


Figure 27: Undamaged thermal fuse indicating continuity

<u>Points to be considered when replacing a thermal fuse</u>

The thermal rating and current rating of the new fuse should be equal to that of the old fuse. If the rating is lower than the old one, unnecessary fuse-blowing problems may occur. On the other hand, if the rating is higher than the old one, the fuse may not blow even when the cooker heats above the safety limit or an excessive current flows in the circuit.

6.3 Temperature sensor

Temperature sensors can get damaged due to ageing, physical erosion, or electrical surges. If you detect physical defects, replace it with a new one. If not, you can test with the help of a multimeter.

<u>Testing thermistor with the help of a multimeter</u>

1) Connect the black probe of the multimeter to the voltage port (VΩ) and the red probe to the common port (COM) of the multimeter. Set the multimeter to continuity mode.
2) Now, as shown in Figure 31, place the black and red probes of the multimeter on the two terminals of the thermal fuse. If the multimeter indicates continuity, the thermistor is short-circuited from the inside and needs replacement.

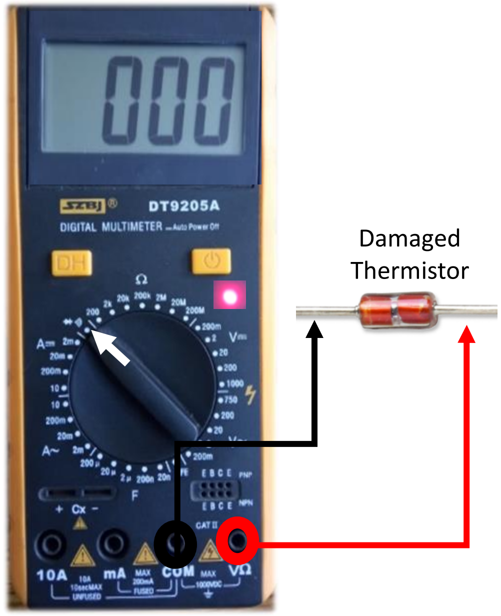


Figure 30: A damaged thermistor indicating a short circuit

3) Now, set the multimeter in resistance mode (typically above 100K) and place the black and red probes of the multimeter on the two terminals of the thermistor. If the thermistor is not damaged, the multimeter should display a certain resistance. While keeping the probes of the multimeter at its two terminals, gently heat the surface of the thermistor with a lighter (however, avoid the flames touching its surface). In doing so, its resistance should start falling sharply. If the resistance value doesn't change or changes very slowly, the thermistor is probably damaged and needs replacement.

<u>Points to be considered when replacing a temperature sensor</u>

1) The type of a new thermistor should be the same as that of the old thermistor. For example, if the old thermistor is of negative temperature coefficient type(NTC), the thermistor must also be of NTC type.
2) The resistance value of a new thermistor should be equal to that of the old thermistor at normal temperature and both of them should have the same operating range.

6.4 Capacitor

In a broken capacitor, it can be seen whether it is bulging or leaking from the outside.

The process of determining the value of a capacitor from external inspection

Electrolytic capacitors have their value written on the surface. For example, in the capacitor shown in Figure 32, the value is marked as 1800 microfarads (µF).

Figure 31: Electrolytic Capacitor

Figure 32: Ceramic Capacitor

Similarly, for ceramic capacitors, you need to calculate the value based on the number written on the surface. For example, in Figure 33, the ceramic capacitor is marked as 103. In this case, if you place a number of zeros indicated by the third digit behind the numbers indicated by the first two digits, you will determine the value of the capacitor in picofarads (pF). Therefore, the value of this capacitor is 10,000 picofarads (pF) or 10 microfarads (µF).

Testing Capacitors using a Multimeter

Some multimeters have a special feature that allows you to test capacitors directly. As shown in Figure 34, if there are ports for testing capacitors in the multimeter, you can insert the two pins of the capacitor into these two ports (matching the polarity in the case of electrolytic capacitors). By doing this, the multimeter measures and displays the capacitance of the capacitor, and if the measurement approximately matches the value written on the capacitor, it means the capacitor is working correctly. However, if there is a significant difference between the two measurements, it indicates that the capacitor is faulty.

Figure 33: Multimeter with a feature for testing Capacitors

If the multimeter does not have the capability to directly test capacitors, you can still troubleshoot using the resistance test method. However, this method may not accurately determine whether the capacitor has undergone a change in value or not. Therefore, even if it appears that the capacitor is intact using this method when it is actually faulty, it may cause the power board or the UI electronics board to deviate from their normal operation and also cause the stove to malfunction.

<u>Testing a capacitor from the resistance testing method</u>

1) Connect the red probe of the multimeter to the voltage port (VΩ) and the black probe to the common port (COM) of the multimeter. Set the multimeter to the resistance mode so that it can measure a high resistance (typically above 1 MΩ).
2) Place the red and black probes of the multimeter on the two pins of the capacitor. When you do this, if the capacitor is functioning correctly, the multimeter will initially display a number that increases over time. After some time, the rate of change of the displayed number decreases, and eventually, it will settle on a single value.

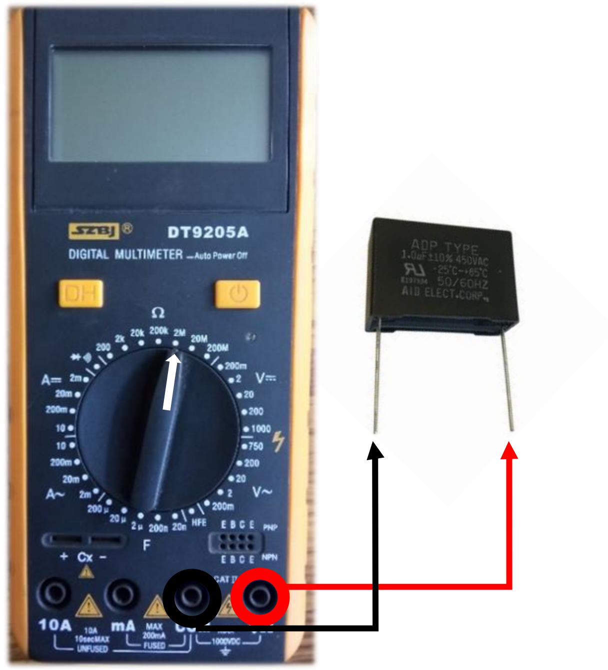


Figure 34: Testing of capacitor using resistance method

<u>Points to be considered when replacing a capacitor</u>

1) The capacitance value of the new capacitor should be equal to or very close to the value of the old capacitor. Capacitance is measured in microfarads (μF), nanofarads (nF), or picofarads (pF).
2) The voltage rating of the new capacitor should be equal to or higher than the old one. Using a capacitor with a lower voltage rating can lead to failure or safety hazards.
3) If the old capacitor has + and - pins marked, make sure to replace the new capacitor that also has the polarity mentioned. Ensure that the new capacitor's pins are in the correct positions.

6.5 Resistor

Resistors that are burned or broken can be checked from external inspection.

<u>Testing resistors using a multimeter</u>

If you already know the resistance value of the resistor you are testing, you can easily test it using the multimeter. However, if you do not know the resistance value, you need to determine it by examining the color bands on the resistor.

Determination of resistance from color bands

Resistors have four or five color bands. Each color corresponds to a specific numerical value, as shown in Figure 36.

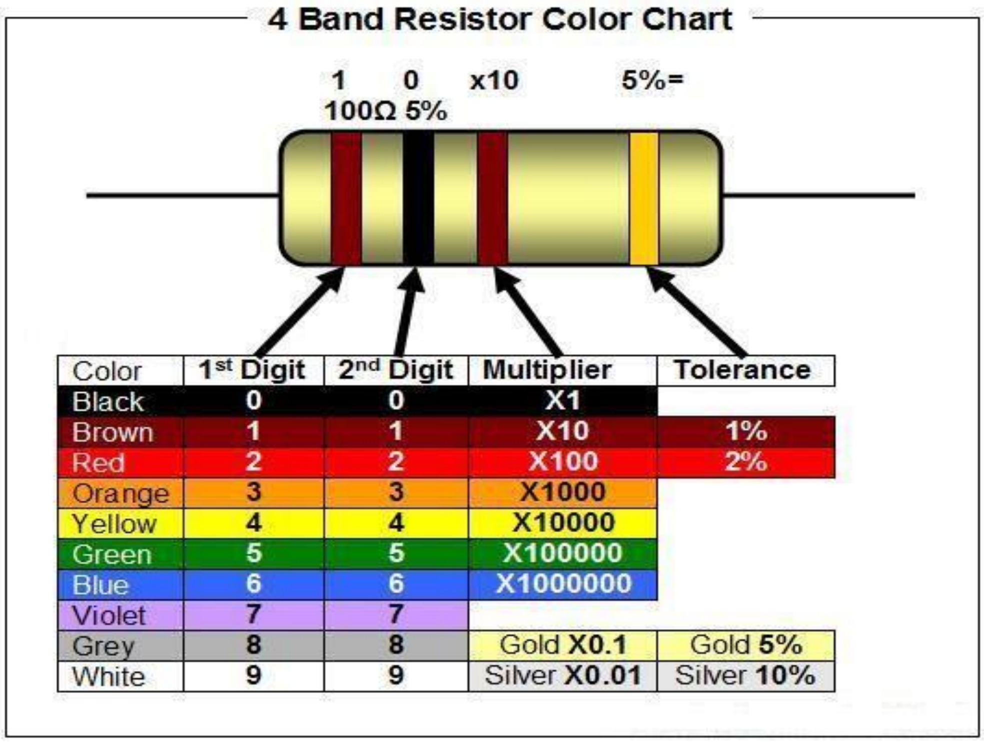


Figure 35: Resistor Color codes

Image Source: https://in.pinterest.com/pin/414401603183261574/

Now you can calculate the resistance value using the following procedure:

1) Handle the resistor with a silver or gold color band on the right. If the resistor doesn't have these bands, you need to measure the distance between the extreme color bands to their nearest pins. As seen in Figure 46, the gap between the last band and its nearest pin is greater than the gap between the first pin and its nearest pin.
2) Now, starting from the left, write down the digit represented by the first color band. In Figure 36, the first band is brown, so write down the digit '1'. Then, for the second band, which is black in this case, write down '0' because black represents '0'. Next, multiply this number by the value represented by the third band. In the example shown, since the third band is brown, multiply the number by '10'. In the example shown, multiplying '10' by '10' gives you a value of '100Ω', which is the actual value of the resistor.
3) The fourth band indicates how much the actual value of the resistor may vary from the calculated value using the above method. In the example shown, the last band is gold, indicating that the actual value of the resistor can vary by 5% (from 95Ω to 105Ω if the calculated value is 100Ω).

Once you have determined the actual value of the resistor, the process for checking its value using a multimeter is as follows:

1) Connect the red probe of the multimeter to the voltage port (VΩ) and the black probe to the common port (COM) on the multimeter. Set the multimeter to the resistance mode (ohms or Ω). When in the resistance mode, set the meter to measure a value just above the actual resistance of the resistor.
2) Place the red and black probes of the multimeter on the two pins of the resistor. When you do this, if the resistor is not damaged, the multimeter will display a value close to the actual resistance value. If the resistor is damaged, the multimeter will indicate a short circuit, an open circuit, or a resistance value that is too different from the actual value of the resistor.

Figure 36: Measurement of resistance using a multimeter

Points to be considered when replacing a multimeter

1) The value of the new resistor should match the value of the old resistor.
2) The power rating of the new resistor should be equal to or greater than the power rating of the old resistor.

6.6 Power Cable

Using a multimeter, you can easily test whether the power cable is functioning correctly or not. In instances where the cable is burnt, disconnected from the power board, or damaged in any way, such issues can be identified through external inspection.

Procedure for Testing the Power Cable Using a Multimeter

In most power cables the live pin is marked as 'L' and the neutral pin is marked as 'N'. Similarly, on the other end of the cable, the live wire is indicated by a red wire, while the neutral wire is indicated by a black wire. Test continuity between the two ends of the live wire and the neutral wire. If the multimeter shows an open circuit, it indicates that the cable is broken somewhere in between.

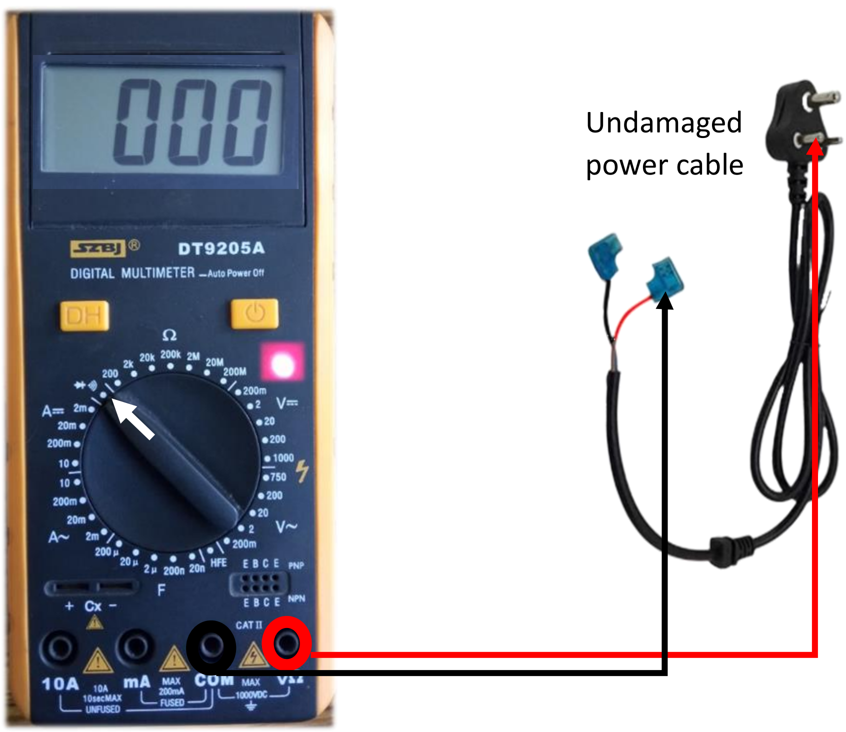


Figure 37: Multimeter indicating continuity when testing an undamaged power cable

6.7 Diode

A diode can break down due to various reasons like excessive current flow, connecting a high voltage in the opposite direction, operating at high temperature, etc. A burnt or broken diode can be identified from external inspection.

Testing of Diode using Multimeter

A diode has two terminals. The terminal with a silver-colored band is called the cathode, and the other terminal is called the anode. The procedure to test the diode using a multimeter is given below:

1) Connect the red probe of the multimeter to the voltage port (VΩ) and the black probe to the common port (COM) of the multimeter. Set the multimeter to the diode mode.
2) Place the red probe of the multimeter on the anode pin of the diode and the black probe on the cathode pin. On doing this, the real diode should display a number between 300 and 800 on the multimeter. If the multimeter shows an open circuit or a short circuit, it means the diode is faulty and needs to be replaced.
3) Now, connect the black probe to the anode pin and the red probe to the cathode pin. Doing this, a good diode should indicate an open circuit.

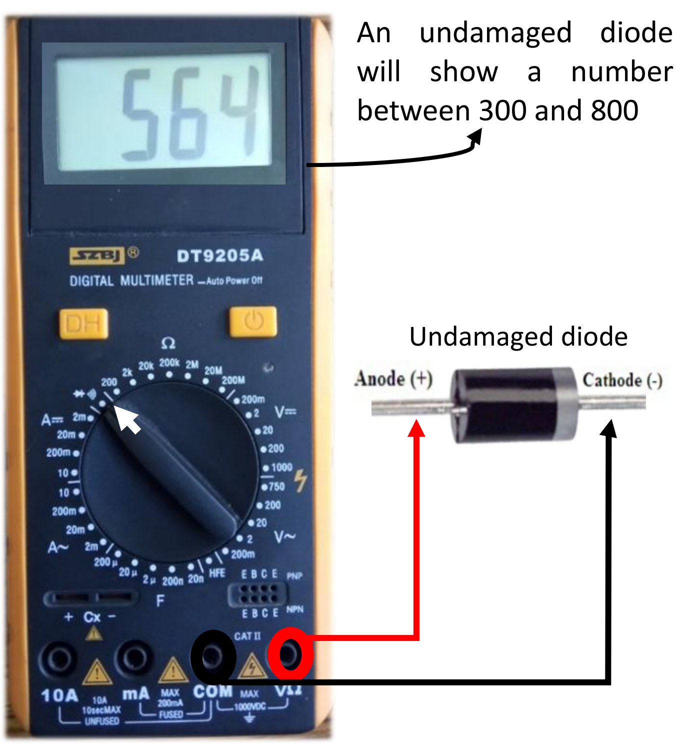


Figure 38: Test of an undamaged diode showing a specific number

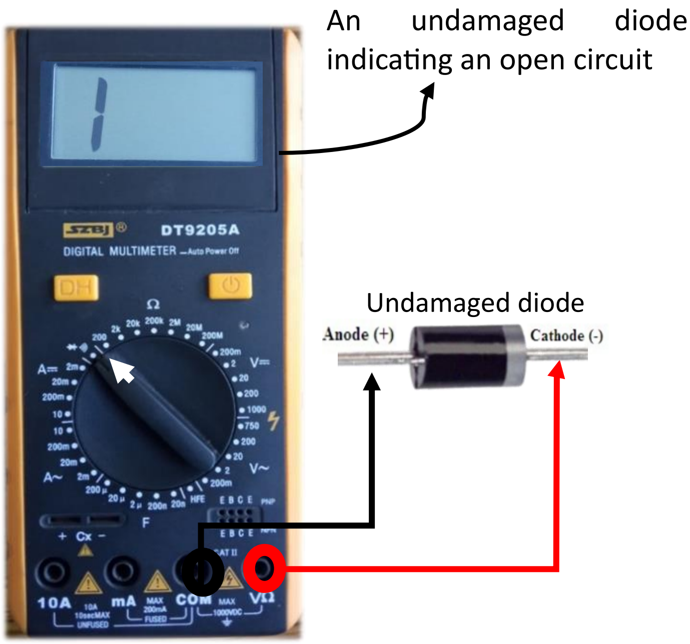


Figure 39: Undamaged diode indicating an open circuit

<u>Points to be considered when replacing a diode</u>

1) When possible, the model number of the new diode should match that of the old diode. If the model numbers do not match, the ratings of the new diode should be similar to or better than the old one. Diode specifications, such as voltage, current, and power ratings, should be checked.
2) Pay attention to the orientation of the diode pins. The anode and cathode pins of the new diode should be connected to the same locations as the old diode wherever they were originally connected.

6.8 Zener Diode

The Zener diode, like the normal diode, breaks down when subjected to excessive current flow, connected in the reverse direction to a very high voltage, or operated at high temperatures. A burnt or damaged Zener diode can be identified from external inspection alone.

<u>Testing of Zener diode using a multimeter</u>

A Zener diode has two pins or terminals. The terminal near the black ring is called the cathode, while the other terminal is called the anode. The process of testing a Zener diode using a multimeter is given below:

1) Connect the red probe of the multimeter to the voltage port (VΩ) and the black probe to the common port (COM) of the multimeter. Set the multimeter to the diode mode.

2) Place the red probe of the multimeter on the anode pin of the diode and the black probe on the cathode pin. By doing this, the real diode should display a number between 300 and 800 on the multimeter. If the multimeter shows an open circuit or a short circuit, it means the diode is faulty and needs to be replaced.

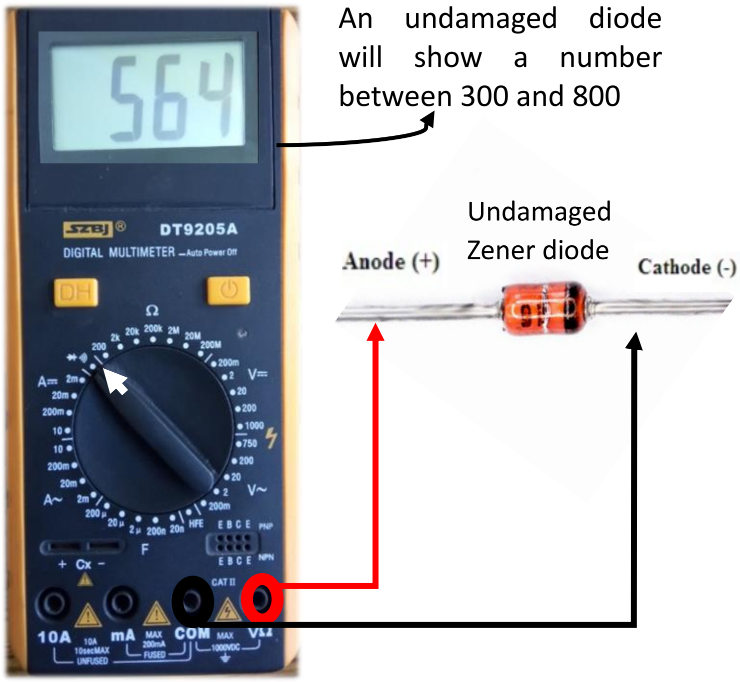


Figure 40: Test of an undamaged diode showing a specific number

3) Now, connect the black probe to the anode pin and the red probe to the cathode pin. Doing this, a good diode should indicate an open circuit.

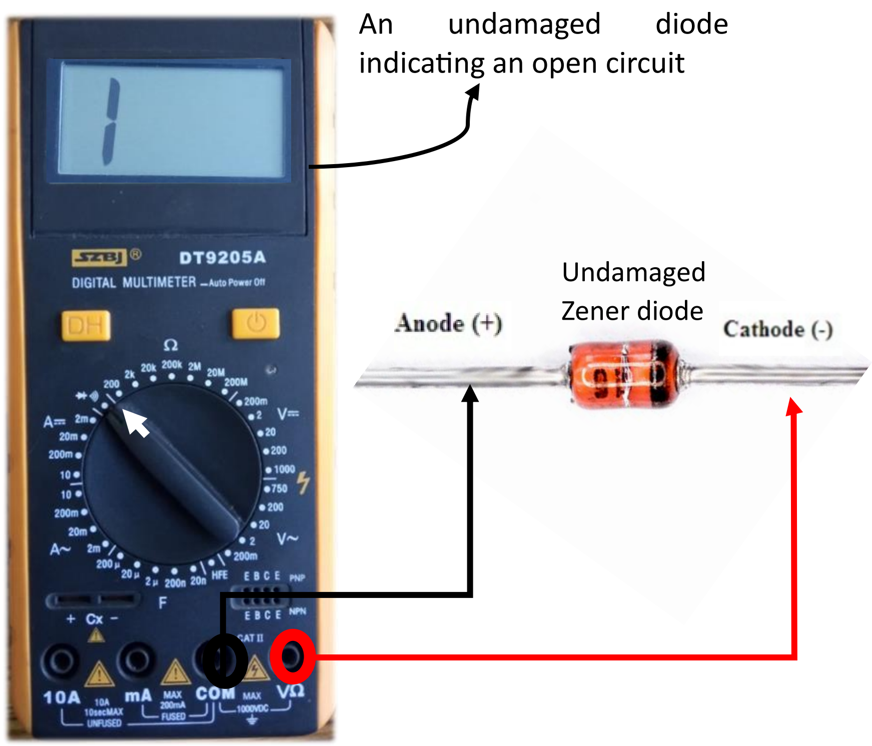


Figure 41: Undamaged zener diode indicating an open circuit

<u>Points to be considered when replacing a diode</u>

1) When possible, the model number of the new diode should match the old diode. If the exact model number is not available, the ratings of the new diode should be similar to or better than the old diode. Parameters like reverse voltage, current, and power ratings of the Zener diode should be checked.
2) Pay attention to the orientation of the diode pins when replacing it. Where the anode and cathode pins of the old diode were connected, the pins of the new diode should also be connected in the same positions.

6.9 Transistor

High voltage, high current, high temperature, and various other factors can cause the transistor to be damaged. A burnt, melted, or broken transistor can be identified from external inspection alone. In case of internal short circuits and other issues, identification may not be possible from external inspection.

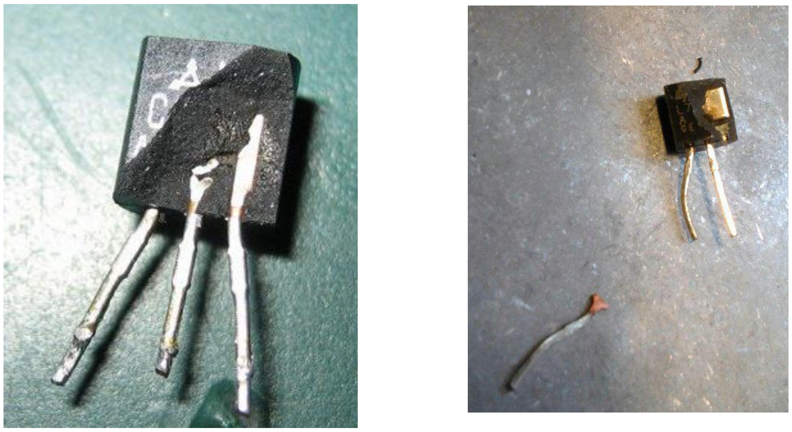
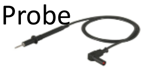


Figure 42: Damaged Transistors

Testing transistor using a multimeter

1) Before testing a transistor, its type and pins should be identified. Use the method provided in the introduction of the components to determine whether the transistor is NPN or PNP and also identify its base, collector, and emitter pins.
2) Connect the red probe of the multimeter to the voltage port (VΩ) and the black probe to the common port (COM) of the multimeter, and set the multimeter to diode mode.
3) If the transistor to be tested is NPN, then the result of placing the red and black probes of the multimeter on different pins of the transistor should be as given in the following table:

Red Probe 	Black Probe 	Expected Result
Base	Emitter	The multimeter should show a particular number (Fig. 44). If the transistor is damaged, the multimeter will indicate a short circuit or an open circuit.
Base	Collector	The multimeter should show a particular number (Fig. 45). If the transistor is damaged, the multimeter will indicate a short circuit or an open circuit.
Emitter	Base	The multimeter should indicate an open circuit (Fig. 46)
Emitter	Collector	The multimeter should indicate an open circuit (Fig. 47)
Collector	Base	The multimeter should indicate an open circuit
Collector	Emitter	The multimeter should indicate an open circuit

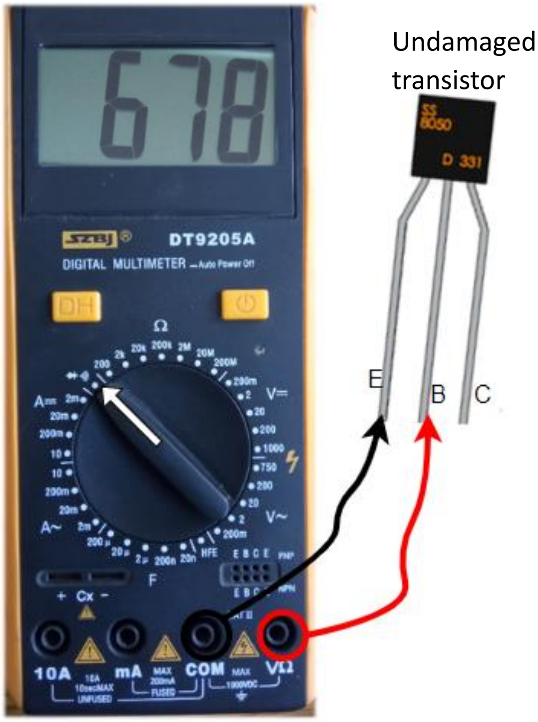


Figure 44

Figure 45

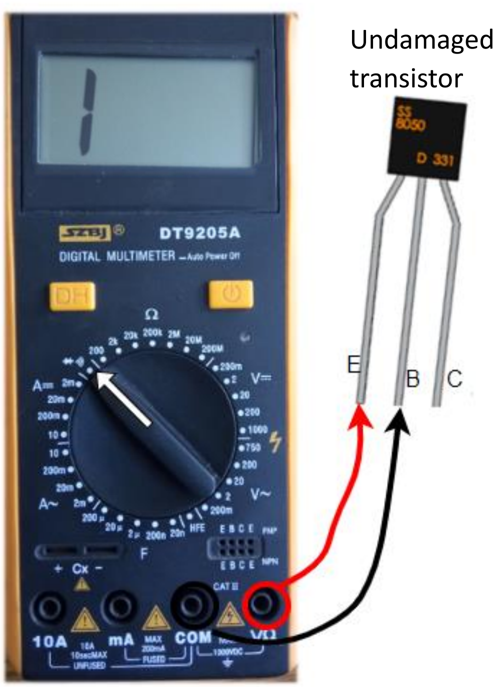


Figure 46

Figure 47

4) If the transistor to be tested is PNP, then the result of placing the red and black probes of the multimeter on different pins of the transistor should be as given in the following table:

Red Probe 	Black Probe 	Expected Result
Emitter	Base	The multimeter should show a particular number (Fig. 48). If the transistor is damaged, the multimeter will indicate a short circuit or an open circuit.
Collector	Base	The multimeter should show a particular number (Fig. 49). If the transistor is damaged, the multimeter will indicate a short circuit or an open circuit.
Base	Collector	The multimeter should indicate an open circuit (Fig. 50)
Emitter	Collector	The multimeter should indicate an open circuit (Fig. 51)
Base	Emitter	The multimeter should indicate an open circuit
Collector	Emitter	The multimeter should indicate an open circuit

Figure 48

Figure 49

Figure 50

Figure 51

Points to be considered when replacing a transistor

1) If possible, use a transistor with the same model number as the old diode. If you can't find the same model number, use a new transistor with similar or better ratings than the old one. Check for specific parameters such as voltage, current, and power ratings. You can search for the alternative transistor on the website https://alltransistors.com/
2) If the old transistor is NPN, the new one should also be NPN, and if the old one is PNP, the new one should be PNP as well.
3) When placing the transistor on a PCB, ensure that the emitter, base, and collector pins are connected to their respective positions.

7. End of Life

Electronic waste (or E-Waste) is a growing problem around the world, with more and more everyday items containing circuit boards and micro-processors. In Nepal alone, an estimated 28 kilotonnes tonnes of e-waste was generated in 2019, and this total will only increase, with the shift to e-cooking potentially adding to this burden. Any E-waste can contain materials and substances that are hazardous to both humans and the environment, but they also contain valuable resources that have the potential to be reused or sold.

Ideally, any electrical appliances (not just eCookstoves) that have malfunctioned should follow the following hierarchy:

- Repair,
- Refurbish (when several aspects of the device need attention),
- Dismantle and collect useful components for reuse in other devices,
- Separate different materials (metals, plastics, circuit board, batteries),
- Sell to material recyclers.

The next few sections explain what can be done to minimize the negative impact of e-waste and support repair and recycling in Nepal.

1. Identify and create a recommended inventory of spare parts to keep.

When undertaking repairs of e-cooking devices, keep accurate records of what the fault was, how it was repaired, and any components that needed replacing. Identifying the correct size of resistor, or capacitor and replacing like with like will reduce the likelihood of a cascade of faults that may ultimately leave the device unrepairable. For example, replacing a resistor with one of a smaller capacity may enable higher current to flow though the circuit, causing further damage or potential danger to users. A larger resistor may generate too much heat, leading to further faults in the electronic system, or potentially cause a fire.

Recording faults and knowing which are most common also helps to identify the spare parts worth keeping from broken devices to support future repairs in other devices (see table below). This requires developing the skills necessary to remove useful items from broken devices so that they can be used again, e.g. use soldering iron to melt solder to remove items from circuit boards rather than cutting them off. Circuit boards can be kept intact until spare parts are required and removed as necessary.

Useful spare parts to keep for common repairs and sales
Electric Pressure Cookers
- Inner pots - Gaskets - Display - Fuse - Universal board - Push button switch - Heating coil

2. Extraction of valuable components and raw materials.

Single materials can be sold on to material recyclers at a higher price, so it is good practice to separate materials where possible. For example, different metals (copper, aluminium, steel) have different market values. Stripping off the plastic covering for wire using wire strippers (not burning) can also help reduce toxic air pollution.

- Magnets can be useful for identifying most steel items (they are magnetic),
- Aluminium can be identified through its lighter weight, and it is non-magnetic,
- Magnesium can be identified by putting a small drop of a mild acid (like vinegar) on the surface, it will bubble and fizz. Aluminium will not fizz.
- Copper, by its colour

3. Good practices for the environment.

There are a few activities that can reduce impact on the environment.

- Create a community database of common part failures to inform the wider local repair network of best practise in repair. Overtime, it will become clear which components most usually need repair/replacement and suitable stockpiles can be created.
- Combine local repair network resources to purchase more expensive repair items, such a wire stripping tools, small plastic shredders and multi-meters.
- Consider combining waste materials within the repair network, to get a better bulk price from material suppliers.
- Be careful when dismantling cooking devices and minimise breakages to external components when accessing inner workings/parts. This will increase the number of devices that can be returned to useful service.
- Make sure all the screws and components are replaced correctly in re-assembly, as this will reduce the opportunity for other failures to occur.
- If a device cannot be repaired, strip all useful components and separate materials. Do not throw a device away or attempt to burn it. Inappropriate disposal of e-waste can contaminate Nepal's environment and drinking water and cause health issues.

4. Contact points for advice.

There are a number of places where further information regarding end of life disposal can be found.

- Local government waste operators
- Device Manufacturers
- Doko Recyclers:
  - E-waste Research and Project Team: 9801104497
  - E-waste Management Team:
  - 9802330381, 9802330382

ABOUT PEEDA

People, Energy & Environment Development Association (PEEDA) is an NGO established in 1997 for the enhancement of the renewable energy sector in Nepal. PEEDA aims to mobilize local as well as external resources to harness the indigenous resources of the country and promote rural economic development. PEEDA focuses mainly on institutional development, participation with stakeholders at the grass root level in development activities, research, and lobbying for policy change

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