

Technical Guide

Microwave Ovens with Inverters



Panasonic Services Company
National Training

Inverter Technology

Panasonic uses proprietary Inverter technology in most of its microwave ovens.

Difference Between Traditional and Inverter Microwave Ovens

Traditional microwave ovens

Conventional microwaves ovens use power transformers to increase the household line voltage (120 VAC at 60 Hz) to a level high enough to operate the magnetron. The magnetron generates the microwaves that cook the food. This technique has its drawbacks.

Operating at a low frequency of 60 Hz, the transformer is relatively inefficient:

- Power is lost (through heat dissipation) in converting the line voltage to the higher magnetron level.
- The transformer operates at a constant power (cooking level) that can only be changed by switching the power on or off repeatedly.

Inverter Technology

In inverter-equipped microwave ovens, the power transformer is replaced by a circuit board, which converts the 60Hz incoming line frequency to a variable rate of 20 KHz to 45 KHz. A relatively small transformer is then required to increase the voltage to the level required by a magnetron.

By varying the pulse width, the output power can be linearly controlled for more precise cooking and defrosting levels. The bulky power transformer is replaced by a small, lightweight circuit board; and, because less heat is dissipated, power efficiency is increased.

Conventional technology uses just a single power level, which is regulated by switching pulses. In contrast, inverter technology directly controls the power output. This constant soft penetration of microwave energy prevents the common problems of shrinkage, overcooking, and loss of nutrients. The result is even food temperature and textures throughout.

Power Level Comparison

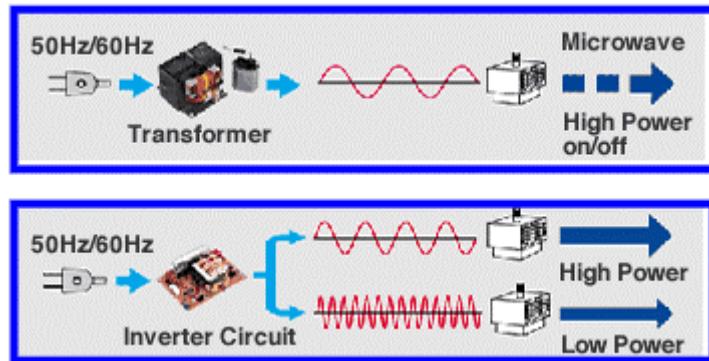


Figure 1

Traditional microwaves send out a single level of power in small bursts to cook food at different speeds. For example, when set at 60% power, the microwave energy would be on 60% of the time and idle 40% of the time.

Inverter microwaves, however, give accurate, true multiple power levels. When you ask for 60% power, the oven delivers 60% power (e.g. they don't just operate 60% of the time). This applies no matter what power level is selected. True power levels give you better cooking results and your food would have an even texture and temperature after cooking. The constant soft penetration of microwave energy into the center of the food helps prevent overcooking on edges and surfaces.

Difference Between Pulsing and Linear Power Control

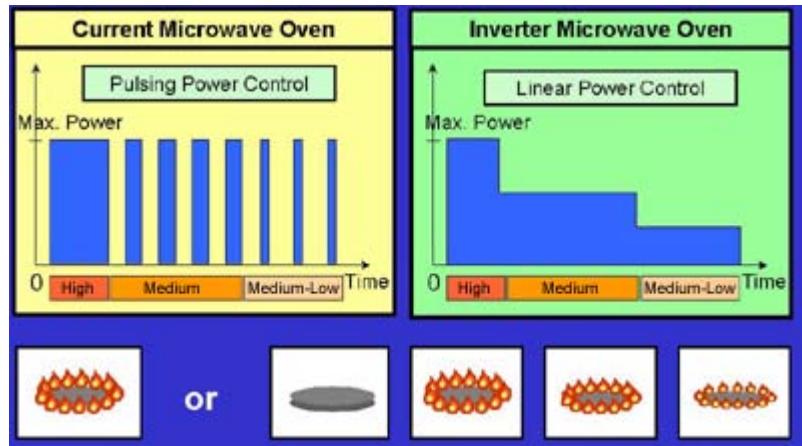


Figure 2

Steam Sensor

This sensor detects the presence of steam emitted by the food being heated and then, based on how long it took to reach the steam stage, it gauges how much longer it should cook, before shutting off.

The steam sensor works just like the effect called piezoelectricity. The piezoelectricity effect generates electricity when mechanical shock is applied to the general dielectrics material.

In the case of the steam sensor, this effect is called pyroelectricity, where electricity is generated when heat shock (hot steam) is applied to the general dielectrics material. See the figure below.

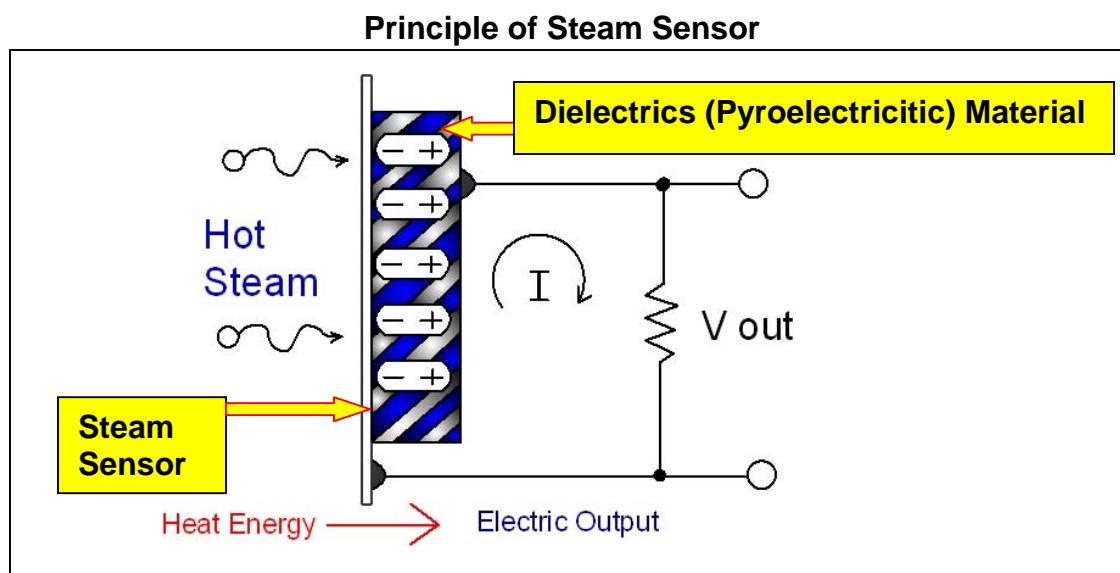


Figure 9

When the food is heated by the microwave oven, the food temperature gradually increases and steam is generated from the food. The steam sensor, which is located near the cooling fan, detects the steam from the food.

The fan keeps one side of the sensor cool and the other side, which has the element, receives and feels the hot steam from the oven cavity.

Steam Sensor Location



Figure 10

Side view of the microwave oven illustrating the steam operation

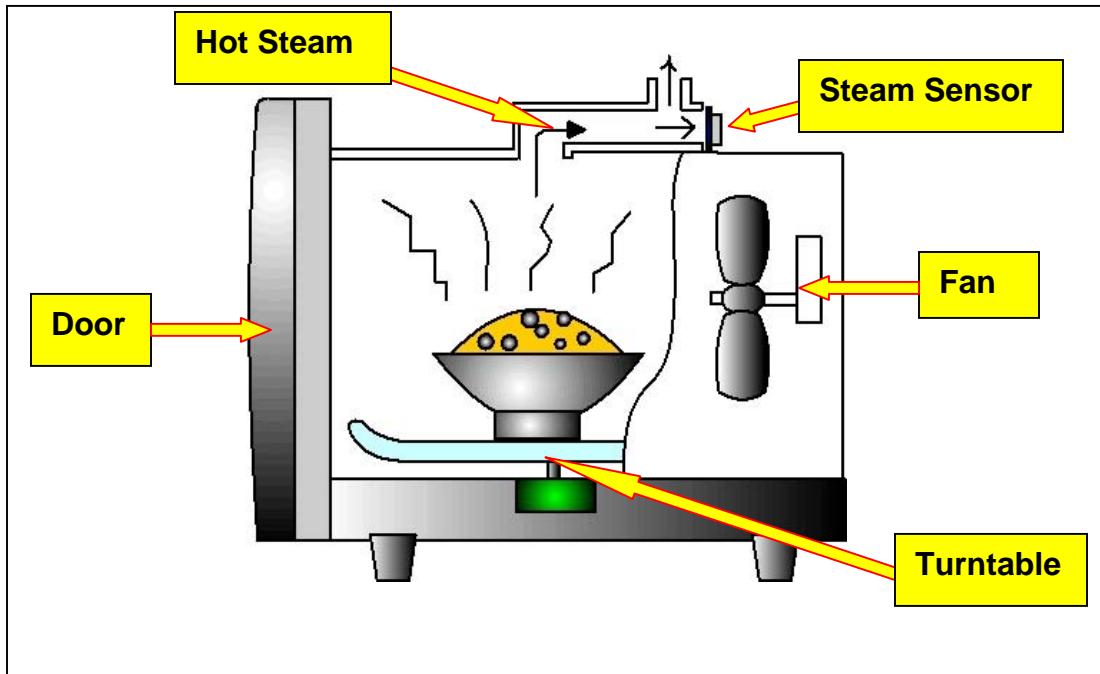


Figure 11

How to check the steam-sensor function.

To determine if this function is working ok, do the following:

1. Place a water load of 150 cc in the oven.
2. Press the sensor re-heat pad.
3. Press start.
Note: Steam is normally detected approximately 1.5 to 4 minutes after pressing power. This period is named "The detection period T1".
After going through this period, the unit automatically jumps to another period called "The remaining cooking time period T2". The T2 time ranges from 8 seconds to 23 seconds.
4. "The steam sensor function" is normal, if after jumping to the T2 period, the "remaining cooking time" (8sec. ~ 23 sec.) appears in the display window.

Inverter Circuit

For information about the inverter power supply turn to pages 2 and 3.....

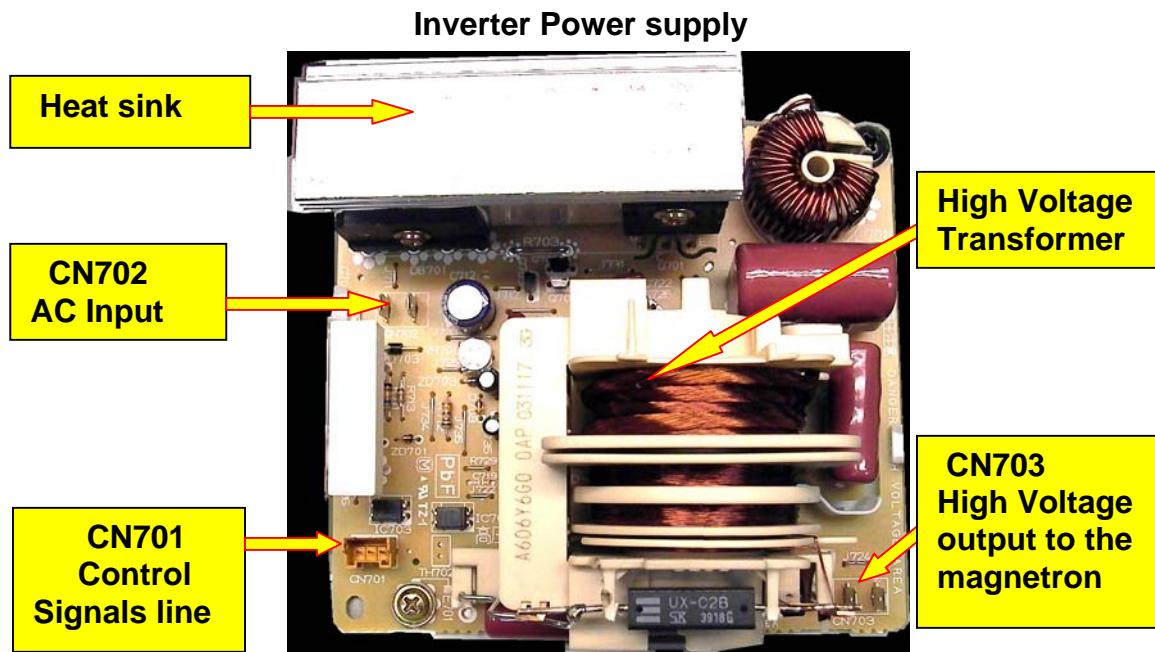


Figure 12

Inverter Power Supply Circuit Explanation

The inverter power supply circuit uses the AC line 120V, 60Hz to supply 4,000V DC to the magnetron tube.

The AC input voltage is rectified by the bridge rectifier DB701
DC voltage is applied to the Switching IGBT (Insulated Gate Bipolar Transistor) circuit.

Note: The **IGBT** is a cross between the bipolar and MOSFET transistors.

The high voltage transformer is driven by a PWM (Pulse Width Modulated) signal generated by the microprocessor in the DPC (Digital Programmer Circuit). The transformer is a component in the resonance circuit of the oscillator. Therefore, a change in load or the power level affects the frequency of the drive signal. Typically, the frequency ranges between 20KHz to 40KHz.

The high voltage transformer generates approximately 2,000V DC or more in the secondary winding and approximately 3V AC in the filament winding.

The half wave rectifier circuit, (D701, D702) generates the necessary 4,000V DC needed to drive the magnetron.

A signal from the current-sensing transformer CT701 in the inverter circuit is used to monitor the power output from the magnetron. This signal is applied to the microprocessor in the DPC to determine the working condition and the output necessary to control the PWM signal supplied to the inverter to control the power output.

Warning:

It's neither necessary nor advisable to attempt measurement of the high voltage.

Inverter Power Supply Circuit

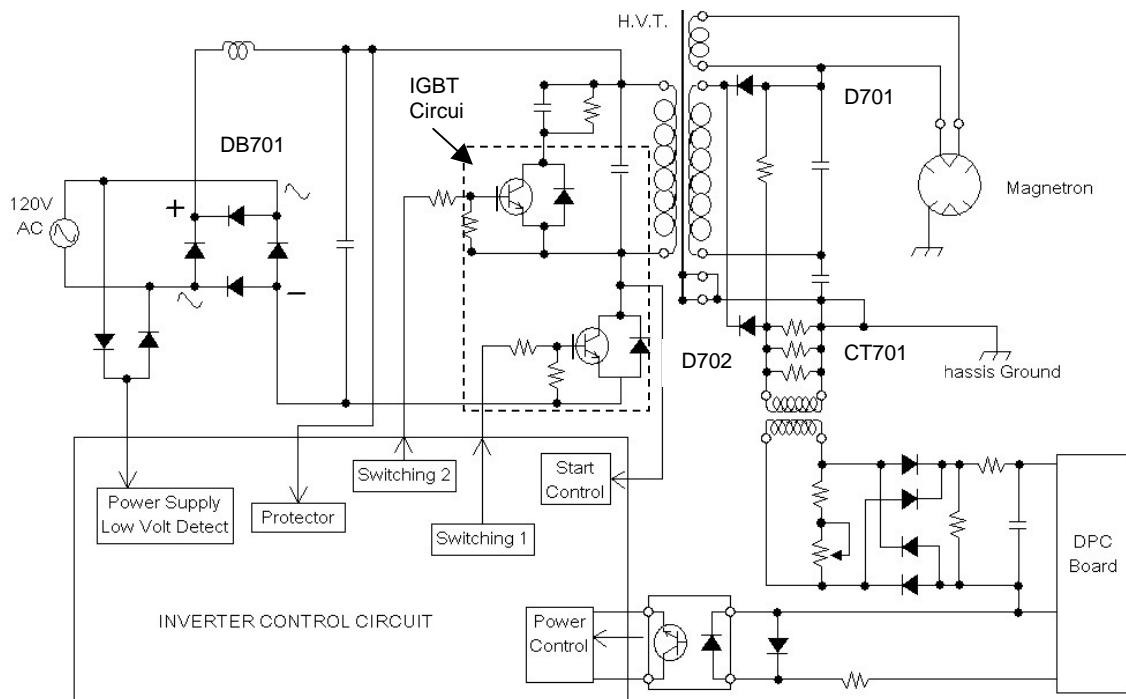


Figure 13

Warning

1. Always unplug the microwave oven from the electricity supply, before removing the outer panel.
2. Never touch the inverter PCB with the microwave oven plugged into the electricity supply. The inverter circuit board handles voltages up to 5000 volts and is very dangerous.
3. Do not touch the heat sink during operation of the microwave oven. The heat sink handles high voltage and becomes very hot.
4. Always discharge the high voltage capacitors located on the inverter circuit board before beginning any troubleshooting.
5. Only test the inverter circuit board by installing it completely into the oven and refitting the outer panel.
6. Always connect the inverter circuit to earth via the earth plate. It is very dangerous to operate the inverter circuit when it is not connected to earth.

Inverter Power Supply

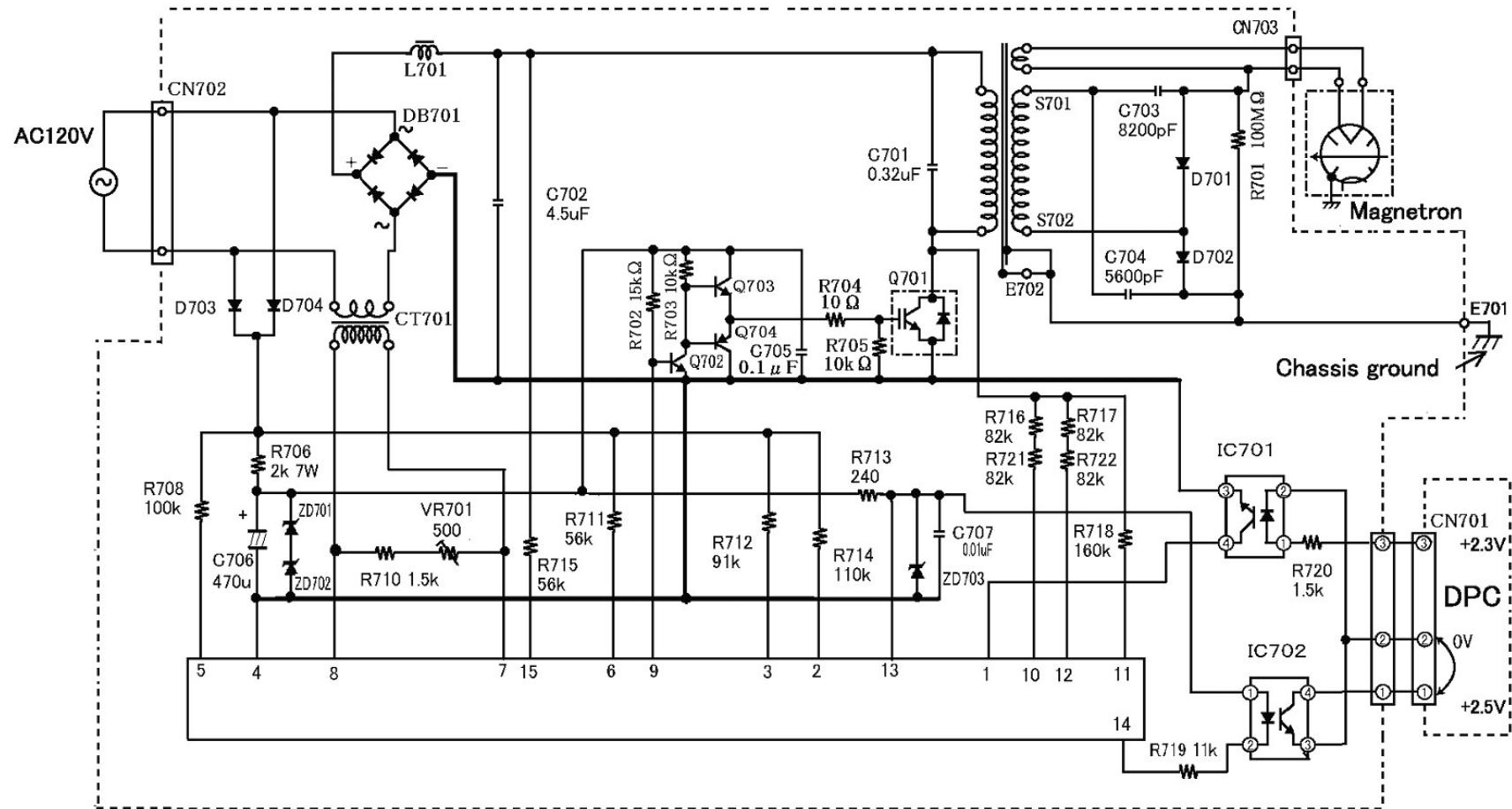


Figure 14

Test and Measuring Procedures

Procedure to check the Inverter using an Ammeter

Equipment needed:

1-liter beaker

An AC Ammeter.

1. Place the beaker with one liter of water into the oven cavity.
2. Unplug the 2 pins high voltage connector from the plug CN703 on the Inverter power supply.
3. Set the oven at high power for 1 minute and press start. The Oven operates for approximately 15 seconds and then it stops showing the error code **H98**.
During operation, the AC line current should be between 1A and 1.7A.
4. Unplug the 3 pins connector from CN701 on the inverter power supply.
5. Set the oven at high power for 1 minute and press start. The Oven operates for approximately 27seconds and then it stops showing the error code **H97**.
During operation, the AC line current should be between 0.4A and 0.8A.

Safety Tips

Safety tips for operation of microwave ovens

- Do not operate the oven when it is empty.
- Exercise extreme caution if you have a pacemaker implant. Microwave radiation may cause pacemaker interference.
- Persons with pacemaker implants should not be near a microwave oven unless they are sure that it is in good operating condition and there is no leakage of microwave radiation.
- Check to see that the door seal and inside surfaces of the door and oven cavity are clean after each use.
- Keep out of the reach of children. Do not permit young children to operate the oven.
- Do not put your face close to door window when oven is operating.

Safety tips for installation and maintenance of microwave ovens

- Take special care to ensure that no damage occurs to the part of the oven making contact with the door or door seals.
- Ensure that the microwave is unplugged or disconnected from electrical power before reaching into any accessible openings or attempting any repairs.
- Ensure that the adjustment of applied voltages, replacement of the microwave power generating component, dismantling of the oven components, and refitting of wave-guides are undertaken only by persons who have been specially trained for such tasks. The services of a qualified repairman should be sought when any malfunction is suspected.
- Do not bypass the door interlocks.
- Do not test the microwave power-generating component without an appropriate load connected to its output. The power generated must never be allowed to radiate freely into occupied areas.

Models line-up

Mid and Family-Size

NNS504W/M / NNS614W / NNH664B/W / NNH764B/W / NNT694S / NNP794B/W / NNP794S

Full-Size

NNH964B/W / NNP994B/W / NNP994S / NNS254W / NNH264B/W/Q / NNP294B/W / NNP294S

Convection

NNC980W/B / NNC994S

Understanding Ionizing & Non-Ionizing Radiation

There is a distinction made between IONIZING radiation, which has enough energy to physically break chemical bonds at the molecular level, and NON-IONIZING radiation, which does not.

Radiation falls within a wide range of energies from the electromagnetic spectrum. The spectrum has two major divisions: non-ionizing and ionizing radiation.

Radiation that has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to change them chemically, is referred to as "**non-ionizing radiation.**" Examples of this kind of radiation are sound waves, visible light, and microwaves.

Radiation that falls within the "**ionizing radiation**" range has enough energy to actually break chemical bonds. This is the type of radiation that people usually think of as "radiation." We take advantage of its properties to generate electric power, to kill cancer cells, and in many manufacturing processes.

The energy of the radiation shown on the spectrum below increases from left to right as the frequency rises.

Types of Radiation in the Electromagnetic Spectrum

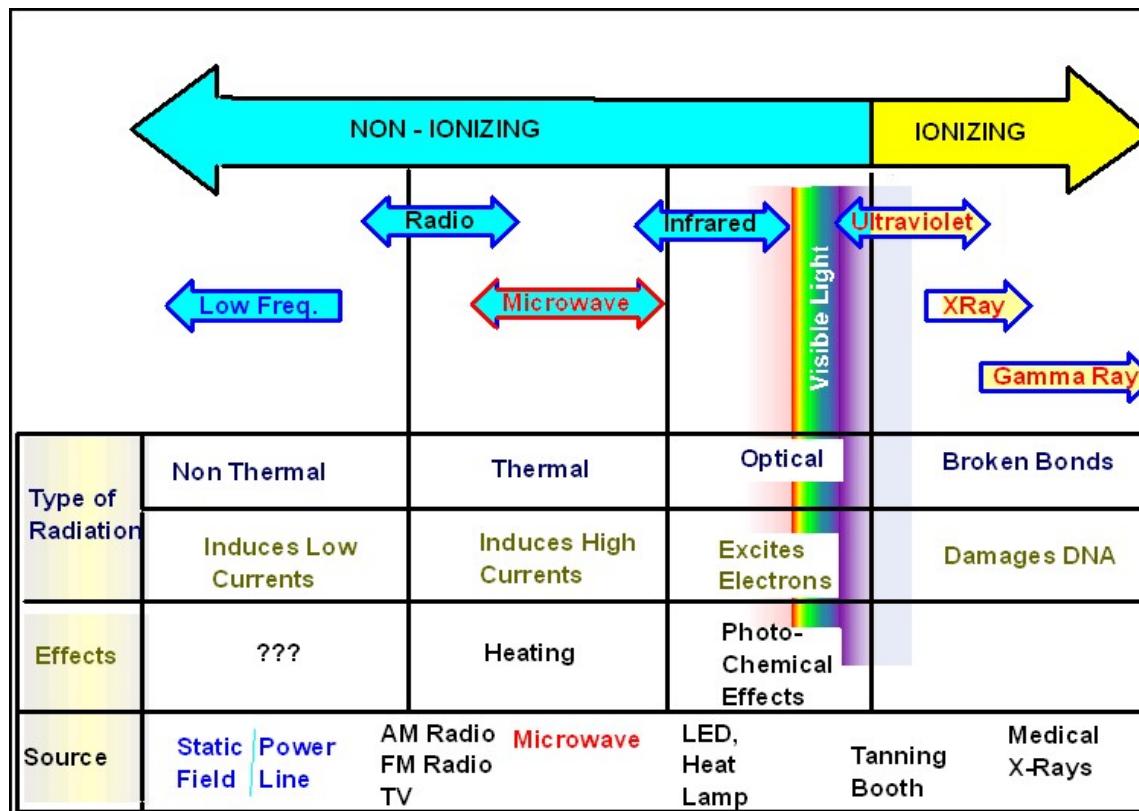


Figure 22

Non-ionizing Radiation

We take advantage of the properties of non-ionizing radiation for common tasks:

- microwave radiation: telecommunications and heating food
- infrared radiation: infrared lamps to keep food warm in restaurants
- radio waves: broadcasting

Non-ionizing radiation ranges from extremely low frequency radiation, shown on the far left through the audible, microwave, and visible portions of the spectrum into the ultraviolet range.

Extremely low-frequency radiation has very long wavelengths (on the order of a million meters or more) and frequencies in the range of 100 Hertz or cycles per second or less. Radio frequencies have wavelengths of between 1 and 100 meters and frequencies in the range of 1 million to 100 million Hertz.

Microwaves that we use to heat food have wavelengths that are about 1 hundredth of a meter long and have frequencies of about 2.5 billion Hertz.

Ionizing Radiation

Higher frequency ultraviolet radiation begins to have enough energy to break chemical bonds. X-ray and gamma ray radiation, which are at the upper end of magnetic radiation, have very high frequency --in the range of 100 billion billionth Hertz--and very short wavelengths--1 million millionth of a meter. Radiation in this range has extremely high energy. It has enough energy to strip off electrons or, in the case of very high-energy radiation, break up the nucleus of atoms.

Ionization is the process in which a charged portion of a molecule (usually an electron) is given enough energy to break away from the atom. This process results in the formation of two charged particles or ions: the molecule with a net positive charge, and the free electron with a negative charge.

Each ionization releases approximately 33 electron volts (eV) of energy. Material surrounding the atom absorbs the energy. Compared to other types of radiation that may be absorbed, ionizing radiation deposits a large amount of energy into a small area. In fact, the 33 eV from one ionization is more than enough energy to disrupt the chemical bond between two carbon atoms. All ionizing radiation is capable, directly or indirectly, of removing electrons from most molecules.

There are three main kinds of ionizing radiation:

- alpha particles, which include two protons and two neutrons;
- beta particles, which are essentially electrons; and
- gamma rays and x-rays, which are pure energy (photons).

Troubleshooting

Troubleshooting table

	Symptom	Cause	Corrections
1	Oven is dead. Fuse is ok. No display and no operation at all.	1. Open or loose wire harness 2. Open Thermal cutout. 3. Open low voltage transformer. 4. Defective DPC	Check the fan motor when the cutout is defective.
2	No display and no operation at all. Fuse is blown	1. Shorted harness. 2. Defective primary switch 3. Defective the short switch. 4. Defective Inverter Power supply	Check adjustments of primary switch, secondary switch, and short switch
3	The Oven does not accept key input (Program)	1. Defective DPC 2. Open or loose connection of the membrane keypad. 3. Shorted or open membrane keyboard.	
4	The Oven lamp and the fan motor turn on when oven is plugged in with door closed.	1. Misadjusted secondary switch or loose wiring. 2. Defective secondary switch	Adjust door and latch switches
5	Timer starts to countdown, but there's no microwave oscillation. (No heat while the oven lamp and the fan motor are on)	1. Switches alignment is off 2. Open or loose connection of high voltage circuit, especially the magnetron filament circuit. 3. Defective Inverter 4. Defective magnetron 5. Open or loose wiring of power relay B. 6. Defective primary switch. 7. Defective power relay B or DPC	Adjust door and latch switches. Check the Magnetron and the Inverter.

	Symptom	Cause	Corrections
6	The oven can be programmed, but the timer does not start to countdown.	1. Open or loose wiring of secondary switch. 2. Secondary switch alignment is off. 3. Defective secondary switch	Adjust door and latch switches
7	The microwave output is low. The oven takes too long to cook.	1. Decrease in AC power source voltage. 2. Open or loose wiring of magnetron filament circuit. (Intermittent oscillation) 3. Aging change of magnetron.	Check the outlet voltage. Perform microwave power output test.
8	The fan motor and the oven lamp turn on when the door is opened.	1. Shorted primary switch.	APH (USA) Models only
9	The oven does not operate. It returns to plugged-in mode as soon as the start pad is pressed.	1. Open or loose wiring of temperature sensor. (Thermistor) 2. Defective temperature sensor (Thermistor) 3. Defective DPC.	Check for tight contact of screw on thermistor, and check the connection on the DPC.
10	Loud buzzing noise can be heard.	1. Loose fan. 2. Noisy fan	
11	Turntable motor does not rotate.	1. Open or loose wiring of turntable motor 2. Defective turntable motor	
12	The Oven stops operation during cooking.	1. Open or loose connection of primary and secondary switch 2. Operation of Thermal cutout (Thermistor)	Adjust the door and the switches.
13	The oven returns to plugged-in mode after 10 seconds elapse on the Auto-sensor cooking mode.	1. Open or loose wiring of sensor terminal from DPC 2. Open steam sensor. 3. Defective DPC.	

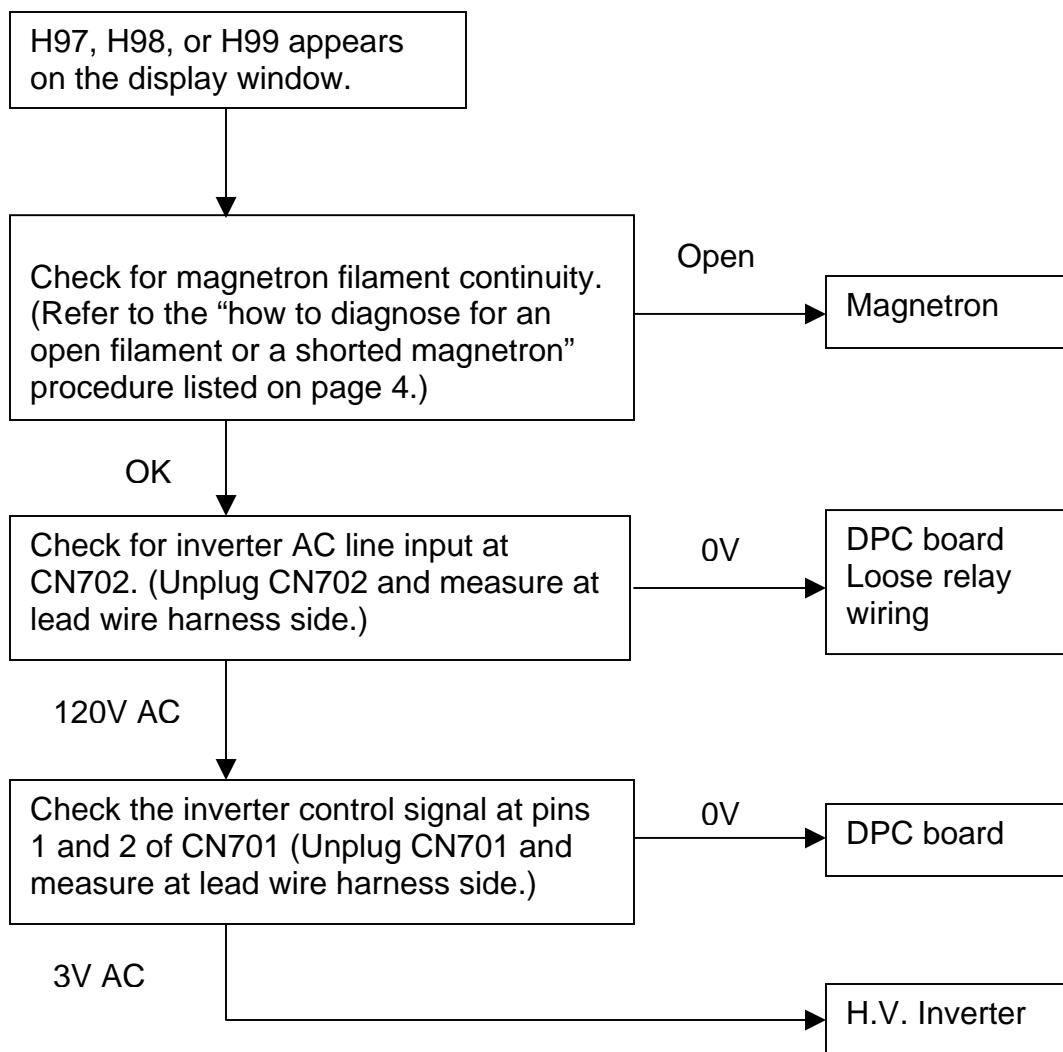
Table 2

Inverter Circuit and Magnetron Troubleshooting

This microwave oven is programmed with a self-diagnostic failure code system used for troubleshooting.

The error codes H97, H98, and H99 are used to indicate problems related to the inverter circuit and the magnetron. These codes appear on the display window after the start key is pressed and there is no microwave oscillation.

Condition



Note: Do not re-adjust preset volume, or try to repair this inverter power supply.