HOME ECONOMICS GUIDE

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Selecting a Microwave Appliance

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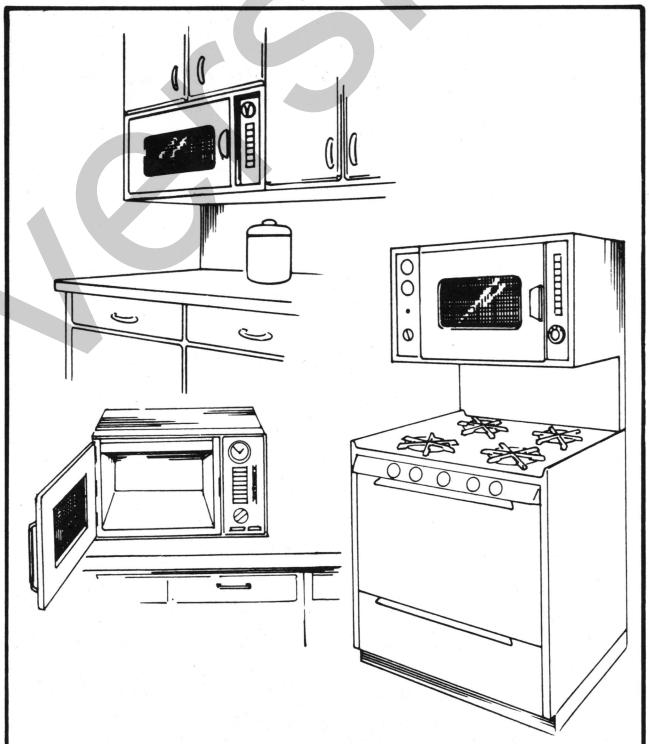
Microwave cooking appliances are special electrical appliances for thawing, heating or cooking foods. Electrical energy is generated into high-frequency energy, which is transmitted by short (micro) waves that heat food. The two frequencies approved by the Federal Communications Commission (FCC) for use in microwave cooking appliances are 2450 and 915 megahertz (MHz).[1]

For information on cooking in microwave ovens, see UMC guides GH 4496, "Cooking Foods in Microwave Ovens" and GH 4497, "Heating Prepared Foods in Microwave Ovens."

Microwave cooking appliances are available as microwave ovens (a few models have heating elements designed for top browning of foods) and microwave-conventional ovens. In this case conventional refers to standard electric bake and broil units located within the same oven cavity, which may be used separately or at the same time as the microwaves. The microwave-conventional oven is not available with gas bake and broil units.

The magnetron tube generates the high-frequency energy and sends it into the oven cavity. Devices used to distribute the microwaves evenly are a stirrer, a fan-like device or a turntable which rotates the food within the oven cavity. Microwaves are contained in the oven cavity by the materials used in the cavity walls and door and by the door seal.

Microwaves travel in straight lines and are reflected by the metals used in cooking and baking utensils and the interior surfaces of the oven; they pass through glass, paper, air, and some plastics and are absorbed by liquids and the moisture and fat in food. Whenever microwaves are absorbed[2], there is an increase in the temperature of the material. This occurs because microwave energy causes rapid movement of moisture and fat molecules in the substance, resulting in heat. Since microwaves penetrate,



The microwave oven can be a counter top, built-in (alone or paired with a conventional oven), or be the upper oven in a double oven range (electric or gas).

*This guide has been approved by the Family Economics and Management Department of the College of Home Economics, University of Missouri-Columbia.

[1]MHz means millions of cycles per second. The 2450 MHz wavelength is about 5 inches, and the 915 MHz wavelength is about 12½ inches. The 2450 MHz wavelength is faster for thawing, heating and cooking of thin, flat shapes of food than the 915 MHz wavelength. Because of its deeper penetration, the 915 MHz wavelength is more suitable for cooking chunky shapes of food. Microwave oven manufacturers are no longer using the 915 MHz wavelength for consumer ovens.

[2]Food, being a poor electrical conductor, absorbs the energy.

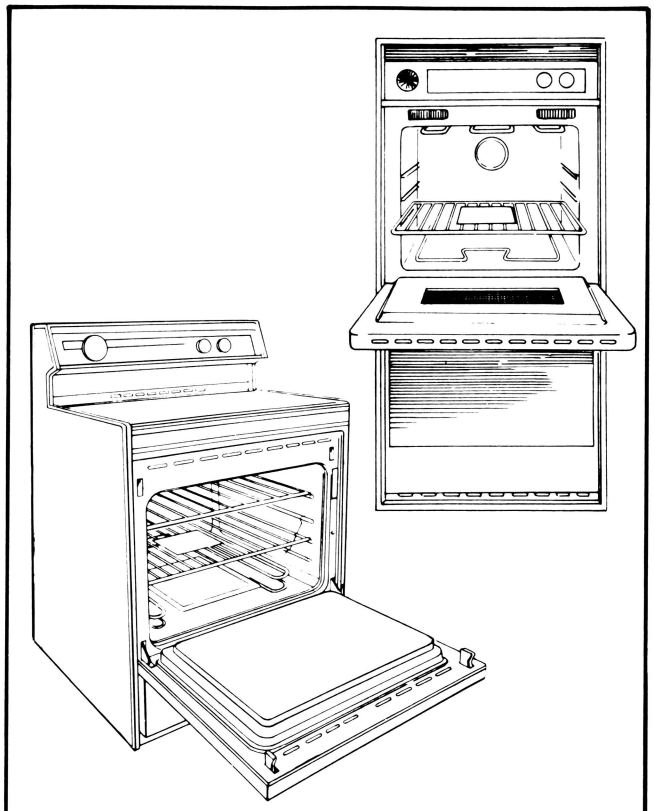
heat can be produced within the food; however, more heat is produced near the surface of food. Since this heat will continue to move to the center of the food during heating as well as after the power is off, some "standing time" heating will occur.

Time, temperature and humidity-sensing controls determine whether or not microwaves enter the cavity. The timer control, found on all microwave appliances, allows the power to be on for a preselected time period. The timer will indicate the remaining heating time. The temperature control allows the power to be on until the temperature sensed by a probe inserted into the food reaches a preselected temperature or one necessary to maintain a preselected temperature. A dial or panel will indicate the changing temperature. In a few models, time is determined by sensors affected either by the temperature or relative humidity of the exhaust.

Most appliances are available with a full power setting and one or more lower power settings. The lower power settings are most useful in thawing foods and in cooking protein foods. In thawing, the ice crystals in the center of the food must be melted without the outsides of the food being cooked. In protein cookery, a slow rate of heat penetration is needed when it is desirable to minimize toughening and to break down the connective tissue in less tender cuts of meat.

A lower power setting may be achieved by using a lower wattage output. Most manufacturers achieve lower power settings by cycling full power on and off. The time base used in any complete off/on cycle is from 1 to 60 seconds, depending upon the manufacturer. However, at a defrost setting all are on one-third to one-half of the base time cycle. At some settings, the power may be on as little as one-tenth of the base time cycle. Changing power settings is done manually at the end of each time period or automatically if this feature is available.

Automatic programming is available on ovens with electronic features. This includes memory capabilities. Automatic programming allows the user to sequence several combinations of power, time and temperature settings. Program options may include heating by preselected elapsed time(s) and heating to preselected temperature(s). This option may be followed by "hold" at a lower temperature. Some "hold" settings are a lower power setting that is not temperature-controlled. Other program options may include start heating and time of day to finish heating.



The microwave-conventional oven can be built in or be a part of a free standing range with conventional surface units.

Food Considerations

Speed is the main advantage of microwave heating and cooking. The cooking speed depends on the power output and the food. The microwave power output of most ovens is between 600 and 700 watts; the microwave power output in microwave-conventional ovens is about 400 watts.

The food-related factors affecting cooking times are:

—Amount of food to be cooked. Doubling the amount of food nearly doubles the cooking time.

—The size and shape of the food. The outside edges of food have more surface area exposed to the microwaves and heat faster. Food in flat, thin shapes will heat faster than food in a chunky shape.

—Temperature of the food. The colder the food, the longer it takes to heat to a given temperature; frozen

food takes about twice as long as refrigerated food.[3]

—Specific composition of the food. The amount of heat needed to raise the temperature of the food depends on the composition of that food. Very moist foods take longer to heat than foods with little moisture.[4] Foods low in fat or sugar take longer than foods high in fat or sugar.[5]

Microwave heating is convenient to use and often will reduce time for:

a. Thawing of frozen foods.

b. Heating of thawed and refrigerated foods, canned and bottled cooked foods, and fully baked products to a serving temperature.

c. Complete cooking of most foods. Features which allow reducing of microwave power are needed for some protein cookery.

Microwave heating will not:

a. Shorten the time needed for meats such as those used in stews or pot roasts or other foods to become tender. (Total cooking time may be less because the meat may be brought to the simmering temperatures faster than is possible in conventional cooking.)

b. Produce food with a crispy crust. (This requires dry-hot conditions found in a conventional oven or provided by the conventional heat source in microwave-conventional ovens.)

c. Produce a browned appearance in some baked products and meats which require a high surface temperature of the food for the browning reaction to take place. However, food containing a high amount of fat, such as bacon, or large quantities of food with fatty surfaces, such as roasts, will reach temperatures at which browning will occur. Special microwave browning grills are designed to absorb microwave energy and become very hot. Food placed on and in full contact with the heated surface becomes browned.

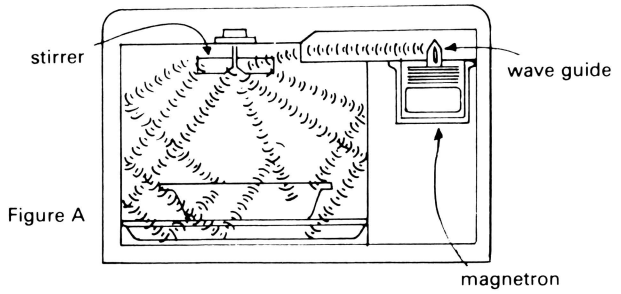


Figure A

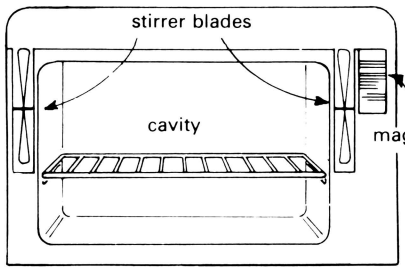
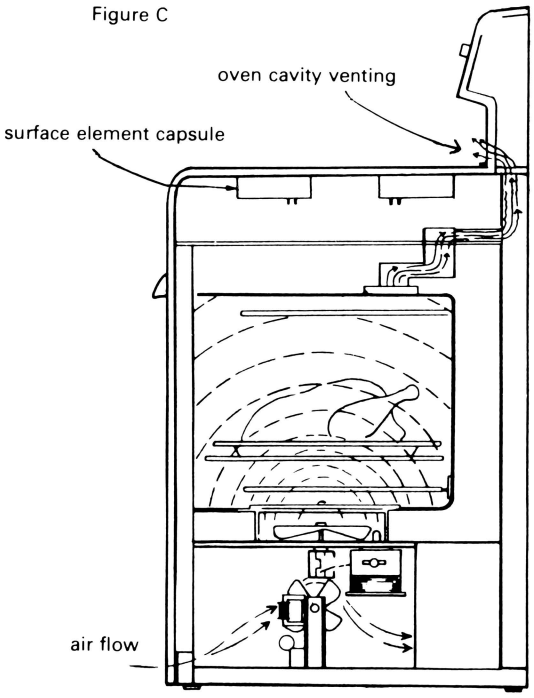


Figure B

Figure C



Microwaves usually enter the oven cavity from the top (Figure A). They may enter from the sides as in this microwave oven which allows double loading (Figure B), or from the bottom as in the microwave-conventional oven in a range (Figure C). Some shelf/racks are used in the single top-feed type system as pictured in Figure A.

[3]Thawing food requires a lot of heat. The amount of heat required to raise the temperature of 1 pound of water to 1°F is called a British Thermal Unit (BTU). It requires 144 BTU's to melt 1 pound of 32°F (0°C) ice.

[4]It takes more heat to increase the temperature of water by 1°F than to increase the temperature of the same amount of food (by weight) by 1°F.

[5]It takes twice as much heat to increase by 1°F the temperature of water than of an equal amount (by weight) of fat and three times as much heat for water as for sugar.

Space Power and Venting Requirements

Counter top model. This may serve as the only cooking appliance; however, it is often used in addition to a range or to other portable cooking appliances. Usually the newest features are introduced in counter top models. These appliances are more convenient to use if there is work space near the entry side of the oven door; a pullout board can be used.

Microwave cabinets are usually 13-15 inches high, 16-18 inches deep, 22-25 inches wide. A few are only 20 inches wide, a few 27 inches wide. Counter top models are equipped with a three-pronged grounding plug and require a 120-volt hook up. A few models use 1200 watts—most use 1600-1750 watts and should be connected to a small appliance circuit. If used on a general purpose circuit, do not use any other heating appliances such as a coffee pot on the circuit at the same time. Space requirements include counter space, clearance between counter and upper cabinets, and circulation space for warm, moist air to escape from the vents located on the back, top or front. Models with electronic features create more heat and may require more clearance space than those with only mechanical controls.

Built-in. In most cases these are counter top models placed in wall cabinets or wall oven cabinets. Special built-in microwave ovens usually fit into 24- or 27-inch width cabinets and may come with unfinished sides. Check the manufacturer's specifications for kitchen cabinet opening; these dimensions will allow proper clearance space for cool air intake (at the bottom) and warm air exhaust at the top and will also accommodate their trim kit. The cabinet size necessary will vary. Some require only 13½ inches in depth and 24 inches in width; others require 24-inch depth and 30 to 33 inches in width.

Double oven range. This may replace an existing 30-inch range. The upper oven is essentially the same as the counter top model. The range top and lower oven are standard gas or electric. The double oven gas range requires 120 volts plus gas lines; the double oven electric range requires 220/240 volt hookup.

Microwave-conventional oven. This may replace an existing conventional oven and requires 120/240 volt hookup. One built-in model requires a kitchen cabinet opening 24¼ inches wide by 31¾ inches high and 24 inches deep; the oven must be vented to the outside. The microwave-conventional unit is usually found in 30-inch, free-standing ranges.

Energy and Time Considerations

Top of the range cooking uses less energy and is usually faster than conventional oven cooking. The microwave oven usually uses less energy and is faster than top of the range cooking when small amounts of food are used (approximately 2 cups or less). The microwave oven uses less energy and is faster than the conventional oven. Two studies in which various appliances were compared for time and energy involved a week's meals (Lovingood and Goss)[6] and meat items (Rhee and Drew).[7] Chart I shows the energy and time savings when the microwave oven is used in conjunction with a conventional range.

The microwave-cnventional oven, whether using the microwaves alone or using the microwaves with bake or broil, is about twice as fast as a conventional oven. The microwave-conventional oven using microwaves alone is slower than the microwave oven except for large amounts such as oven meals; the wattage output of the microwave

Chart I—Energy and time savings when the microwave oven is used in conjunction with the electric range

	Energy savings in percent*	Time savings in percent
	Lovingood Study	Lovingood Study
Microwave and range	24	47
Microwave & conventional oven	42	53
Microwave & surface units	5	21

*The largest energy saving occurred when a microwave oven was used in place of the conventional oven or broiler. This was also the finding in the Rhee and Drew studies in the preparation of beef patties, meat loaf and beef roast.

[6]Rebecca P. Lovingood and Rosemary C. Goss, "Comparisons of Electric Energy Used by Major Cooking Appliances," Virginia Polytechnic Institute and State University, 1978

[7]Flowayne Drew and Ki Soon Rhee, "Fuel Consumption by Cooking Appliances," Journal of the American Dietetic Association, Volume 72, Number 1, 1978

operation is lower in the microwave-conventional oven than in most microwave ovens. This lower wattage successfully combines with the bake or broil unit.

The additional use of bake or broil units in the microwave-conventional oven will reduce heating times but result in the microwave-conventional oven using as much energy as the conventional oven (the microwave-conventional oven uses less time but usually a higher temperature bake setting) and more energy than the microwave oven.

Use of Dishes and Utensils

Glass, glass-ceramic, paper, pottery and many plastics can be used with microwaves.[8,9] Microwaves will cause some containers to get warm; however, most of the heat in the container is absorbed from the food. Glass-ceramic dishes, which are range top or broiler proof, should be used if a browning unit in a microwave oven or the broil unit in a microwave-conventional oven is on.

Metal is usually not used in microwave appliances because the microwaves are reflected by metal. When food is covered with metal such as foil, this reflection does not permit the microwaves to reach the food and be absorbed. Food placed in an open metal pan will cook or heat from the top only. Most manufacturers allow a small amount of metal if a large amount of food is heated (Ratio 1 to 3). If metal pans are used, they should be placed in the oven so they do not touch the sides of the oven cavity (arcing can occur if there is contact during oven use). Pans should have low sides, ¾ inch or less. Dishes with metal trim or designs should not be used.

Certification Seals, Warranties and Care

HEW—indicates that the appliance meets the October 6, 1971, established federal regulations for the power density of the microwave radiation emitted by a microwave appliance.[10] The ovens must be equipped with at least two independently operating safety interlocks, one of which must be concealed and must also have an interlock monitor which would prevent operation in the event of failure of one or both of the interlocks.

FCC—indicates that the appliance is designed to operate on a wavelength and frequency approved by the Federal Communications Commission.

UL—indicates that the appliance meets requirements of the Underwriters Laboratories and should be electrically safe when operated according to directions.

Warranty—Full warranties are usually for one to two years and include both parts and labor. Limited warranties may extend for five or more years and cover specified parts.

Maintenance and Cleaning

—Read the instruction book and care label.

—Keep the interior clean; wash microwave oven with mild detergent and water. This will help prevent bacteria from growing in this warm, moist area. A buildup of food soil on the door will interfere with closure which is essential to prevent the leakage of microwave radiation.[11] Follow special directions for cleaning microwave-conventional ovens.

—Do not shut the door with anything between the door and oven face or use the door of a bottom-hinged oven as a shelf.

—If the oven should operate while the door is open, have the oven checked by service personnel.

—If your oven has been damaged or handled carelessly, it should be checked for microwave radiation leakage. If it has received heavy use, you may wish to have it checked.

—If problems occur, contact dealer; if satisfaction cannot be reached, contact the manufacturer. If satisfaction still cannot be obtained, contact Major Appliance Consumer Action Panel (MACA), 20 N. Wacker Drive, Chicago, Illinois 60606.

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[8]Most of today's dishware is china and can be used in the oven unless it has metal designs on or inside it. Test your dishware for use in the microwave oven. If a dish is cool after the following test, you can use it in the microwave oven. Place a glass of water in the corner of the oven. Place the dish to be tested in the center of the oven; heat for one minute.

[9]Some plastics, even if they pass the dish test, become distorted due to the heat absorbed from food, especially fats.

[10]The regulations set by the Bureau of Radiological Health, Department of Health, Education, and Welfare, indicate that the microwave radiation emitted by a microwave appliance shall not exceed 1 milliwatt per square centimeter at any point 5 centimeters or more from the extreme surface of the appliance at the time of manufacture and no more than 5 milliwatts per square centimeter during its lifetime, if operated according to the directions. The primary interlock shall prevent radiation emission in excess of 5 mw/cm^2. An interlock monitor prevents operation in the event of failure of one or both interlocks; it does not measure emission. Regulations also require permanently attached labels bearing the following warning statements: 1. PRECAUTIONS FOR SAFE USE TO AVOID POSSIBLE EXPOSURE TO EXCESSIVE MICROWAVE ENERGY: Do not attempt to operate this oven with (a) object caught in door, (b) door that does not close properly, or (c) damaged door, hinge, latch, or sealing surface. 2. 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.

[11]There are two types of radiation, non-ionizing and ionizing. Microwaves, infrared rays, and radio and light waves are examples of non-ionizing radiation and can cause temperature change. The effects of non-ionizing radiation are not cumulative. X-rays and Gamma rays are examples of ionizing radiation—these cause chemical changes in cellular structure, and these effects are cumulative.

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