Introduction to shielding a home against microwave radiation

This article describes how shielding works to protect a home against mobile phone base stations, smart meters, wireless networks, etc. It includes a discussion of how much shielding is needed and other essential information for a successful shielding project.

Keywords: *shield, microwaves, EMF, radio frequency, wireless, Wi-Fi, WLAN, cell tower, base station, smart meter, Faraday, EMC, radiation, electrical sensitivity*

The rising need for shielding

The ambient levels of microwave radiation from wireless networks, cellular towers, smart meters and many other sources have risen dramatically for the past two decades. In many cities and towns the radiation levels are now above what is considered safe for healthy people according to many independent scientists (Belyaev, 2016).

The demand for wireless services does not seem to be anywhere near a saturation point. The ambient radiation levels will therefore continue to rise for the foreseeable future.

Office building with several cellular base stations on the roof.

Most homes do not provide any shielding against microwaves at all. The waves go right through windows, plywood, lumber, insulation and drywall. Even bricks and concrete are not much of a hindrance. That is why cell phones and Wi-Fi work inside houses. The problems they sometimes have inside are often due to reflections, not lack of signal strength.

The traditional remedy for people with electrical sensitivities has been to move to the country, but wireless services continue to be extended into even rather remote areas. There are now few havens left, and very few will continue to be free of development.

Shielding the bedroom, or an entire house, is an alternative to moving away, but there are practical limits to how much shielding can be installed.

It is only recently that people have started shielding their homes to protect their health, though shielding has already been used for decades for other reasons. Research institutions and medical facilities use shielding to protect sensitive equipment, such as MRI scanners. Government agencies, military installations and large corporations use shielding to protect against surveillance and electronic weapons. Shielding is also used to reduce radiation from electronic equipment, to limit interference with radio reception.

The people who design and install shielded spaces commercially are usually referred to as EMC engineers. EMC stands for Electromagnetic Compatibility. Sometimes they use the term EMI instead, which stands for Electromagnetic Interference.

What are microwaves?

Microwaves are a type of radio waves with a very short wavelength. They are used for many types of telecommunication, such as cellular telephones, smart phones, cordless phones, broadcast television, smart meters, wireless networks (Wi-Fi, WLAN), baby monitors, GPS, police radio, military communication and much else. They are also used for radar and microwave ovens.

The unit hertz is used to specify how fast a radio wave oscillates, which is called its frequency. When listening to an FM radio station at "98.6," the radio is tuned to the frequency 98.6 megahertz (98.6 million hertz).

Microwaves are defined as having a frequency between 300 megahertz and 3000 gigahertz (3,000,000 megahertz) though presently the frequencies above 10 gigahertz are mainly used for radar and satellites. Mobile phones typically use frequencies between 900 megahertz and 3000 megahertz, depending on the country. The 5G systems are expected to eventually also use frequencies from 24 gigahertz to 60 gigahertz, and some day even higher.

Some types of communication use frequencies that are lower than microwaves, such as FM, AM and shortwave radio, marine navigation and power line communication (PLC).

There are also other types of radiation that are not microwaves, such as from power lines, electrical wires and the new wireless power systems.

Shielding basics

A room or a house is shielded by wrapping it in shielding materials. This is called a Faraday cage. Many houses already have a small Faraday cage in the form of a microwave oven. A microwave oven heats the food by radiating it with intense microwave radiation which is similar to Wi-Fi signals, but much stronger. They are so strong that they are a direct threat to human life. The designers of the microwave oven have to build a Faraday cage around the oven to prevent the radiation from escaping and harming nearby people.

A microwave oven is shielded to keep the microwave radiation inside. The same shielding will also keep microwaves from cell towers out of the oven so a cell phone will not work inside.

The Faraday cage in the oven is used to keep the radiation inside, but the same cage will also keep radiation out. To demonstrate, try to put a cell phone inside a microwave oven and then call from another phone. The shielded phone will not ring, unless there is a cell tower nearby powerful enough to penetrate the shield.

Notice how the microwave oven is made of metal and has a special shielded window on the front. Also note how the door closes firmly with a large overlap to limit leakage of the microwaves. Looking even closer, one can see that the air vents are designed so the air does not move directly out through the shield. These are all features of a good Faraday cage — shielding on all sides and no direct holes or slits to leak radiation.

The shielding of a microwave oven is not perfect, it is just designed to reduce the radiation leaking through to a level deemed acceptable. The leakage can be measured with a radio-frequency meter that covers the frequency used by the oven (2.5 gigahertz).

A shielded room or house is similar to a microwave oven, but can be much more complicated — especially when a high level of shielding is needed. Advanced shielding methods may involve multiple layers of shielding and much attention to the weak areas, such as doors, windows, ventilation holes, water pipes, electrical wires and other features that can bring microwaves through the shield.

Alternatives to shielding

Reducing the radiation at the source is more effective than trying to shield. In some cases it may be possible to get the neighbor to use network cables rather than a wireless computer network, but it is difficult and touchy to rely on a neighbor's cooperation. A mobile phone company is very unlikely to agree to moving a tower or reducing the radiation from it. If reducing the source is not possible, then shielding is probably the most effective option other than moving away.

There are various pendants and devices marketed with claims that they reduce EMF radiation or modify it to make it harmless. The explanations of how they work are nebulous and do not seem to stand up to independent scrutiny. Both the United States Federal Trade Commission and *Microwave News* have called such devices "scams" (MWN, 2010; FTC, 2011). The main danger of these things is that they can give a false sense of security if they are used instead of prudent measures.

Most of these things are off the market within a few years again, but new ones keep appearing.

An inventor of a very elaborate and costly system that he claimed could pull microwaves out of the air was taken to court in Sweden in 2015. He could not explain how his system worked or demonstrate objectively that it worked, so he lost the case and was barred from selling anything like it ever again (EI Wellspring, 2016).

Shielding effectiveness

The perfect shield does not exist. It is not possible to build a shield that blocks microwaves 100%. In praxis, shielding is rated by how much it reduces the radiation. Specialists use a decibel scale (dB). The table below shows how much a certain decibel shield will reduce the radiation for two different scales.

Reduction in decibel dB	**Reduction of power density uW/m^2**	**Reduction of field strength V/m**
	10x	3x
10	100x	10x
20	1,000x	32x
30	10,000x	100x
40	100,000x	316x
50	1,000,000x	1,000x
60		

If you measure the radiation as field strength (in volts-per-meter) then a 30 dB shield will reduce 0.3 V/m to 0.009 V/m.

If you measure the power density (uW/m^2), the same 30 dB shield will reduce 200 uW/m^2 to 0.2 uW/m^2.

It doesn't matter whether you use V/m or uW/m^2 to measure the microwaves. They are equally suitable, though it can be confusing that there are multiple scales. Most RF instruments can show both scales, and some can also show other scales, such as dBm and A/m.

The human effects are not linear

The effects of microwaves on the human body do not appear to be linear. This means that a doubling of the radiation strength does not double the effect. This is similar to how we detect sound and light, which are also not linear. Sound, light and microwaves are all forms of waves, they just have different frequencies.

What this means is that it does not make sense to spend money on shielding that reduces the radiation by 50% (i.e. a twofold reduction). Just as we will barely notice a 50% change in the light or sound level of a room, so will such a puny reduction of the radiation not really mean anything.

How much shielding is needed?

The level of shielding needed depends on what level of radiation is wanted inside the shielded area and what the level of radiation is outside.

Let's say you live in an area that has an ambient microwave level of 100 uW/m^2 (0.01 uW/cm^2). If you want the inside of your house to have the same radiation level as a lightly populated rural area that has wireless services from distant towers, perhaps with a radiation level around 1 uW/m^2 (0.0001 uW/cm^2), then a hundredfold (20 dB) shielding level is needed.

If you want a house or room to be so heavily shielded that a cell phone barely works, then you'll need the inside level to be below 0.01 uW/m^2. That would require shielding that reduces microwaves at least ten thousandfold (40 dB) in this example. That can still be done, but it is more complicated. For an existing house it may only be realistic to shield individual rooms that much. It may be simpler to move to a rural area where the radiation level is lower and then just install basic shielding.

These figures are just examples. The ambient levels in a town can be both higher and lower than 100 uW/m^2. We have seen levels of nearly 10,000 uW/m^2 in an affluent and densely populated city — and the levels are still rising.

What level of chronic radiation is safe is unknown. Current government standards are in most countries based solely on the outdated assumption that the heating of the body is the only health effect. Literally thousands of studies have shown this assumption to be false.

The BioInitiative report is a compilation of these studies. In the 2007 edition, the report concluded that the radiation limits should be 1000 uW/m^2 for healthy people. The 2012 edition said the limit must be lower yet, suggesting something in the 30–60 uW/m^2 range (Sage, 2007, 2012).

The BioInitiative reports state that the limit should be lower yet for people who are electrically sensitive, but are unable to provide specific guidance.

The EUROPAEM 2016 guidelines suggest daytime limits of 10–1000 uW/m^2 and nighttime limits of 1–10 uW/m^2 for microwaves. For sensitive populations they suggest 0.1–1 uW/m^2 (Belyaev, 2016).

This author's personal observation is that the level of sensitivity can vary greatly. Some extremely sensitive people get symptoms at radiation levels well below 0.1 uW/m^2.

Consider that a heavily shielded room or house can become a prison if trips outside are unbearable.

Hiring a professional

You may want to consider hiring professional help for your shielding project, especially if shielding above 20–30 dB is needed.

Be aware that there are people who offer such services who are not really professionals. Their price will (should) be a lot lower, but the quality of their advice will vary dramatically. Beware of claims that seem inflated. Anybody can buy a couple of low-cost instruments and call themselves an expert.

A true professional, will typically have a degree in engineering or similar technical field and may also have other credentials, such as P.E. (professional engineer) or be a member of a professional society, such as IEEE. They may advertise themselves as specialists in EMC or EMI. Such a professional will be costly, but so are all professionals, such as architects and physicians.

If you hire a professional, expect a thorough evaluation of the house with detailed measurements and analysis of the strongest signals. Also expect a detailed shielding plan with estimates of how much the shielding will dampen the various frequencies found in the area. Few of us can afford that level of competence, which won't be available in small towns and rural areas unless you're willing to pay travel costs that may include airfare and overnight stay in a hotel. Do also keep in mind that such experts tend to work with corporations, not individuals, and may be very skeptical about the existence of electrical and chemical sensitivities.

This series of articles is designed to help a homeowner or renter install their own shielding without hiring a professional, but without professional help you may not achieve more than a 20–30 dB reduction of the microwaves.

More information on shielding

This website has additional articles about shielding electromagnetic fields, including the other parts of this article series, case stories, etc. The shielding section is available on: www.eiwellspring.org/shielding.html.

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