Shielding windows against microwaves with aluminum shutters

We measured a commercially available metal window shutter to see how well it shielded against microwaves. The result was respectable.

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Shielding microwaves

Shielding a house against microwave radiation from wireless networks, mobile communication, wireless utility meters and much else involves shielding the walls, roof, doors and windows.

Here we test aluminum window shutters of the brand Roll-A-Shield, which is commercially available in the United States. They can be completely closed so no light enters, or they can be fully opened. They can also be partially opened so narrow slits between each slat lets in a tiny amount of light.

They are sold as "sun shutters" to protect a home against the heat of the sun, especially in the desert Southwest USA. In hurricane-prone areas, such as Florida, similar products are used to protect the windows against flying debris.

The shutters

The shutters consist of horizontal aluminum slats that roll down in front of the window from a spool housed above the window. The slats are insulated and held in place by aluminum tracks on both sides and a track at the bottom.

The spool is also encased in aluminum plates.

When the shutters are partially closed, with the slits open, the slits are as wide as the window and 1 millimeter (about 1/16 inch) high.

Morning sun coming in through the shutters with the slits open.

The installation we tested was on a metal house. Since the steel siding was not totally flat, small wood spacers were used behind the tracks.

Summary of results

We tested the shutters using a small 1.9 GHz microwave transmitter, which was placed outside the window. On the inside we placed an RF meter on a tripod and did measurements at varying elevations with the shutters open, fully closed, or with the narrow slits.

We found the average shielding effect was 24 dB (99.6% of power density), and no real difference whether the shutters were fully closed or they had the narrow slits open.

However, we found a great variance of shielding depending on the angles we used. We found a low of just 9 dB (86%) and a high of 31 dB (99.9%).

The steeper angles from the transmitter to the RF meter gave the lesser shielding effects. In most real-life situations the incoming microwaves would arrive at a flat angle and thus be better shielded. For a distant transmitter, we expect the shielding effect to be about 26 dB (99.8%).

We have previously measured windows with aluminum frames and low-E metallic coating. We found them to provide a shielding effect around 20 dB (99.0%). We have not tested windows with plastic or wood frames, but expect them to be much poorer.

The windows in our test did not have a low-E metallic coating and were fully transparent to the microwaves.

How the measurements were done

We used a cordless phone base as our microwave source. It transmits continuously on 1.9 GHz and uses 110 volt power so we could turn it on and off remotely with a long cord and power strip. We placed it outside and 1 meter (3 feet) from the window.

The RF meter was a TENMARS TM-195. It samples 3 times per second, so to be sure we got comparable readings we measured the peak (max) value over 30 seconds for each data point.

The tripod was placed 1 meter (3 feet) from the window and was not repositioned during the series of measurements. We varied the height of the instrument using the tripod. All measurements at a given height were done together, without altering the height in between. This is important as the measurements varied dramatically with the height.

Transmitter located outside with the RF meter inside. Shutters closed.

Fourteen measurements were taken for each shutter position (open, slits, fully closed) for a total of 42 data points. The height of the sensor varied from 107 cm (43 inches) to 145 cm (58 inches) above the floor.

The room was shielded against outside microwaves, except for the window being tested. The door was of steel, the other windows were closed with their own shutters and/or covered with aluminum foil. The walls and roof were built of steel plates and the inside of the walls covered with aluminum foil.

The glass on the test window was ordinary glass without any coating, such as low-E (low-E provides some microwave shielding).

The measurements for the shutters fully closed and closed with slits were so similar that we combined the data for our overall numbers.

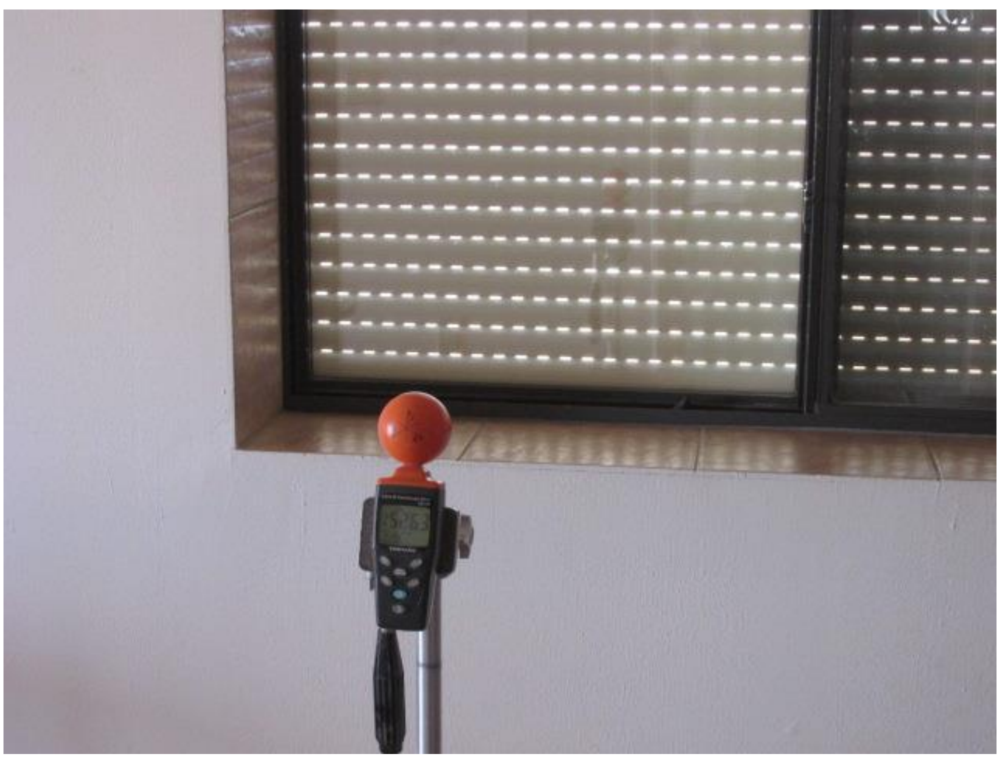
The weather the day of the measurements was cold and partly cloudy, with no thunderstorms in the area.

The house was located in a sparsely populated rural area with low ambient radiation levels.

The ambient microwave levels inside the house were well below any of the active measurements.

Discussion

Most transmitters are vertically polarized, such as cellular base stations and household wi-fi hubs. The slits in the shutters are horizontal, i.e. perpendicular to the vertical radiowaves coming from the outside, which explains why the slits provide as good shielding as the fully closed shutters. We don't expect such good result at much higher frequencies.



The RF meter inside the house, with the shutters closed to slits.

With the RF meter sensor at 107 cm (43 inches) to 138 cm (55 inches) above the floor we found the shielding effect to be an average of 26 dB (99.8% on power density).

For the 2 x 5 measurements at elevation 140 cm (56 inches) to 145 cm (58 inches), the average shielding was 14 dB (96%). Of the ten measurements, two gave a value of just 8 dB (86%).

We speculate that the poorer shielding effect for the higher elevation of the sensor is due to the steeper angle. This being caused by the slits between the slats becoming more transparent, or reflective, even when fully closed.

We considered the possible effects of reflections (standing waves) inside the metal room. For two elevations (54 and 58 inches) we did see dramatically higher radiation with the shutter fully open, which may be caused by reflections, or possibly the lobes of the transmitter. However, this does not seem to explain the cases where we see poorer shielding, as the measurements were not higher there for the fully open shutter.

The installation of these shutters included a drilled hole through the wall to handle a pull string. The hole is 3/4 inch (19 millimeter) in diameter and goes into the steel spool box above the window. Since it is covered with metal on the outside it appears to be shielded. Though we did not specifically test it.

We conclude that these shutters can be a valuable part of an effort to shield a house. They can especially be helpful where the windows have non-metallic frames or otherwise can't be shielded well.

The shutters suffer from the limitation that they only work when closed. They may thus be best suited for bedrooms or individually shielded rooms, rather than entire houses. Another issue is their cost, which was about $700 per large window (including installation).

Data

Height Inches	Height cm	Fully open uW/m^2	Slits uW/m^2	Fully closed uW/m^2
43	107.5	1526	49	43
45	112.5	2740	2	3
45	112.5	2507	4	2
46	115	2212	17	35
46	115	2228	31	24
47	117.5	1707	3	9

54	135	10758	27	38
54	135	10504	15	32
55	137.5	3706	38	10
56	140	3131	108	430
56	140	3057	274	48
56	140	3131	209	436
57	142.5	4895	251	110
58	145	7067	265	255

	Ambient
Start	0.8 uW/m^2
End	0.2 uW/m^2

Ambient levels at start and end of measurements. Peak value over 60 seconds, with shutter fully open.

More information

Other technical reports can be found at:
http://www.eiwellspring.org/technical.html.

Other articles about EMF shielding at: http://www.eiwellspring.org/shielding.html

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