Basic EMC Examples

Electromagnetic (EM) environment is an integral part of the modern world. The EM environment created intentionally and unintentionally by various sources. If the EM filed becomes strong enough, it can influence the operation of many electrical and electronics devices.

The EM environment usually encompasses a receptor (a receiver of EM interference). The ability of a receptor (device/equipment/system) to operate satisfactory in EM environment without introducing intolerable EM disturbances to other devices/equipment/systems in the same environment is called electromagnetic compatibility (EMC).

EMC is usually investigated by applying EM measurements. In the other words, functionality of a product in EM field is verified using measurement equipment. This means that software gives initial computational solution, only. However, good software can help a lot in EM experiments and production. WIPL-D Software suite offers a remarkable variety of tools and features for efficient simulation of electromagnetic compatibility (EMC) problems. Extremely **efficient Method-of-Moments (MoM) based simulation kernel** allows solving electrically large and complex scenarios quickly, with minimum amount of computer resources required. Both **GPU and CPU** numerical analysis can be efficiently performed on inexpensive computer platforms Enabled short simulation time means that EMC simulations can be run in large number of frequency points.

EMC simulation capabilities of WIPL-D software suite will be demonstrated by presenting several demonstrational examples.

EM Field in the Vicinity of Transmission Line

Transmission lines are used in high-power voltage transmission as well as in low-power – high-frequency devices. Transmission lines represent sources of electric and magnetic fields in their vicinity. Some power transmission lines usually carry voltages higher than 100 kV and currents higher than 100 A. High electric field, occurred in that case, is specially considered when influence on human is investigated.

A transmission line shown in Figure 1. It is modeled and simulated using WIPL-D. The model was created using WIPL-D entities (*Wires*). The line is fed by ideal voltage generator and it's terminated with 50 Ohms resistor. Output results are electric and magnetic field in the vicinity of transmission line. These are shown in Figure 2.
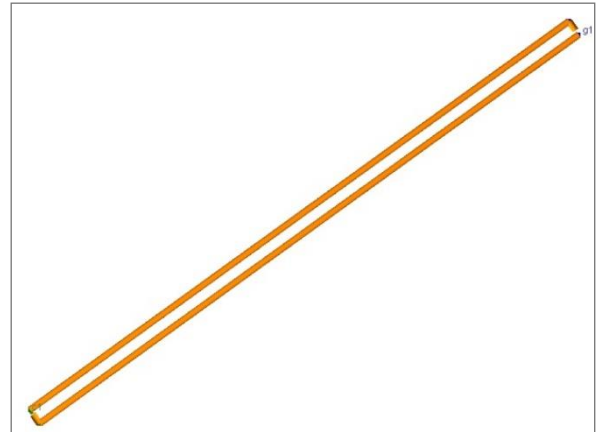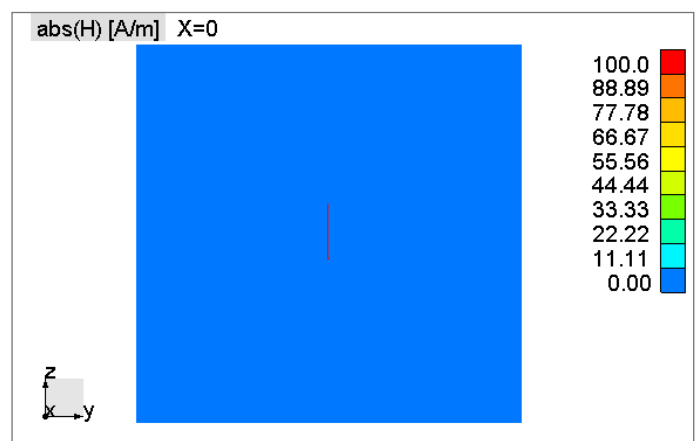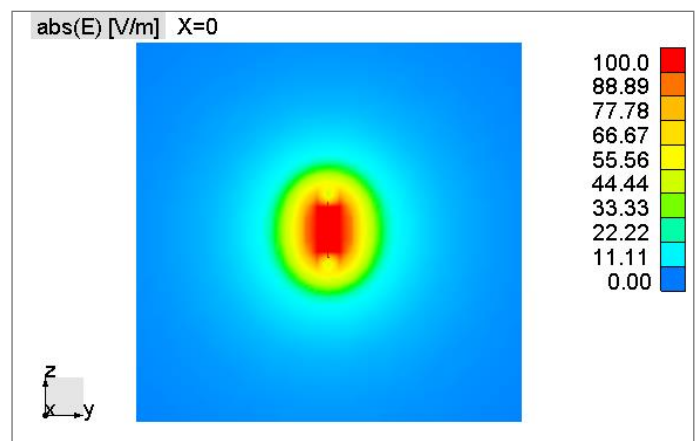

Figure 1. Transmission line

Figure 2. Electric and magnetic field in the vicinity of transmission line

Waveguide Resonator

Waveguide resonators represent waveguide structures usually short circuited at both ends, forming a closed box cavity. A rectangular waveguide is modeled and simulated in WIPL-D (Figure 3). Observed results are current distribution on waveguide perfectly conducting walls (Figure 4) and electric and magnetic field in the waveguide (Figure 5).
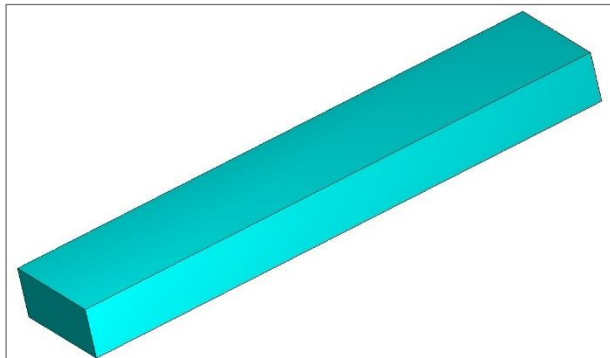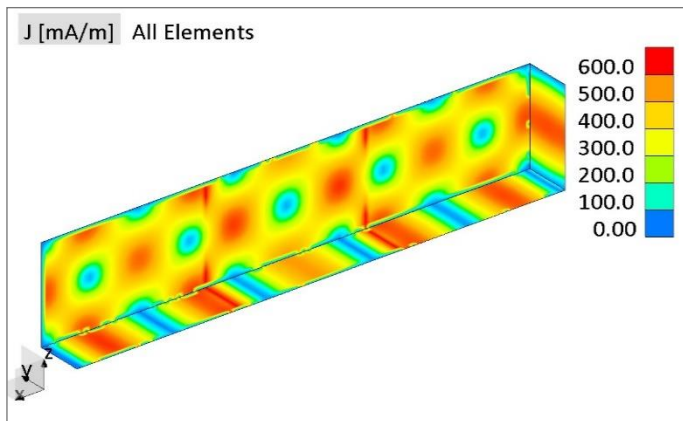
Figure 3. Waveguide resonator

Figure 4. Current distribution on walls of the waveguide resonator
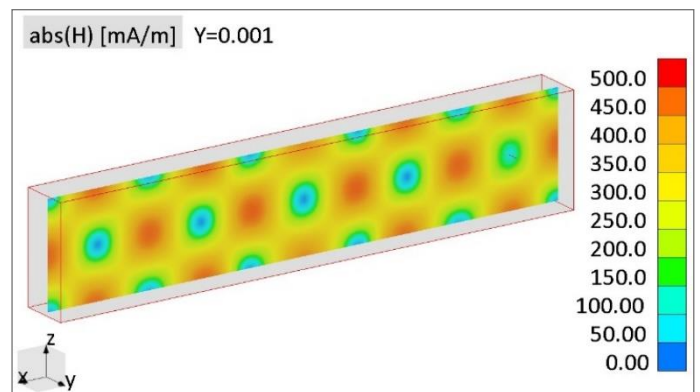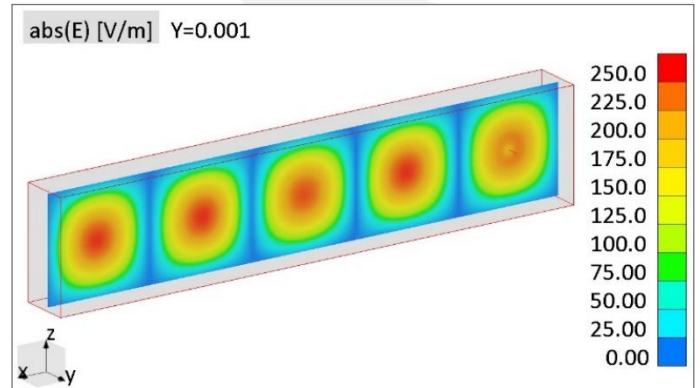
Figure 5. Electric and magnetic field in waveguide resonator

Wire in Cavity

Undesired coupling of EM energy from one system (emitter) to another (receptor) is the EM interference.

This demonstrational example will consider specific case of coupling – radiation coupling. Radiation coupling between an emitter and receptor results from a transfer of EM energy through radiation path.

The EM shielding is the technique that reduces coupling of undesired radiated EM energy into equipment to enable it to operate compatibly in its EM environment. Shielding problems are difficult to handle when a perfect shielding integrity is not possible because of presence of intentional discontinuities in shielding walls, such as shielding panel joints, ventilation holes, visual access windows or switches.

The demonstrational example Wire in Cavity contains a wire with 50 Ohms resistor on the finite ground plane. These are placed within the cavity with a hole at one of the walls (Figure 6).
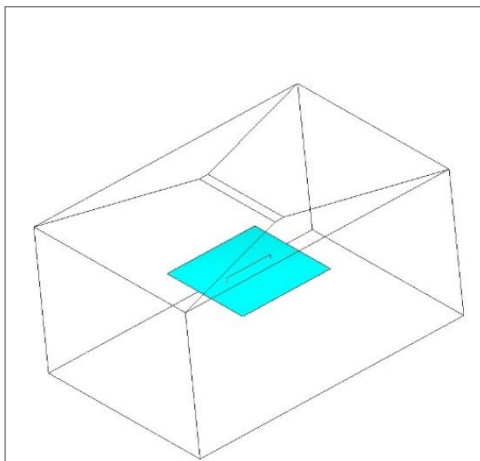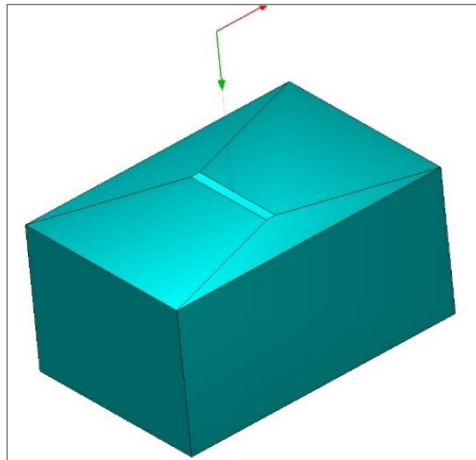
abs(E) [V/m] (x,y,z)=0,0,0.0375

Figure 8. Electric field within the cavity

Figure 6. Wire in cavity

This represents a simple model demonstrating shielding problems. Results of interests are current on the wire (Figure 7) and electric field in the cavity (Figure 8). Peak values appearing at cavity resonant frequencies are clearly recognized at Figures 7-8.
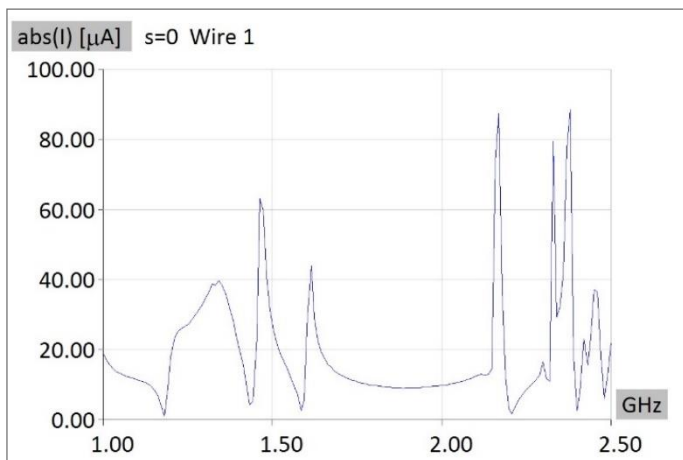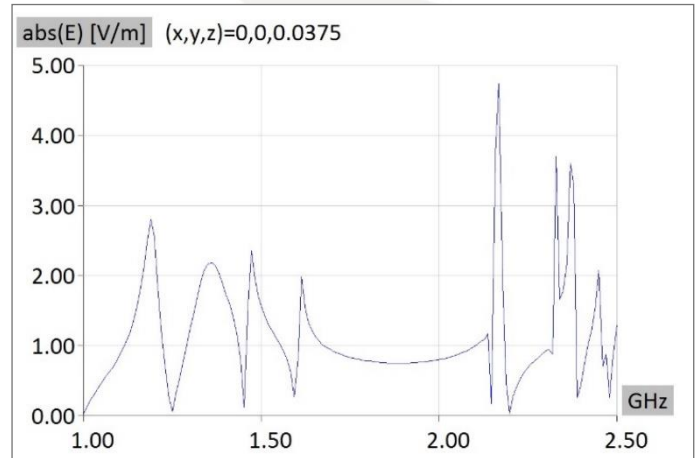
Microstrip Line with Slot

Microstrip line is one of the most popular types of planar transmission lines, primarily because it can be fabricated by popular photolithographic process. It can be easily integrated with other passive and active microwave devices. Presence of different dielectrics in the upper and lower part of space characterizes microstrip lines. The exact fields of a microstrip line constitute hybrid TM-TE wave and require advanced numerical analysis techniques. Usually, in dielectric, effect of dispersion is noticeable. Modeling parts of printed circuits and all of passive electronic components printed on dielectric is connected with modeling of microstrip lines.

Microstrip line with finite ground plane and slot into the ground which is parallel to microstrip transmission modeled in WIPL-D is shown in Figure 9. Observed output results (S-parameters) are shown in Figure 10.

Microstrip line with finite ground plane and slot into the ground which is perpendicular to microstrip transmission line modeled in WIPL-D is shown in Figure 11. Output results (S-parameters) are shown in Figure 12.

abs(I) [μA]   s=0 Wire 1

Figure 7. Current on wire

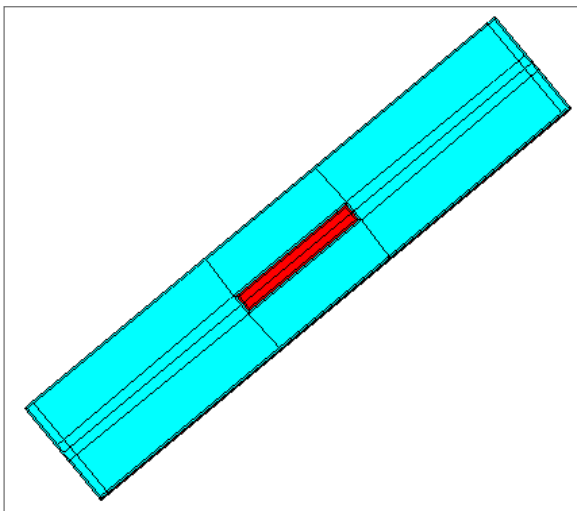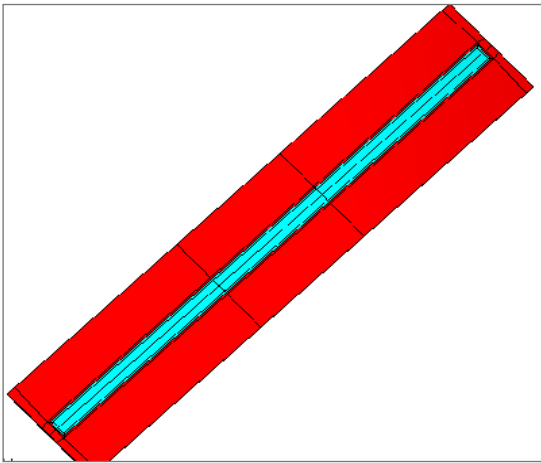**Figure 11. Microstrip line with perpendicular slot; top and bottom view**

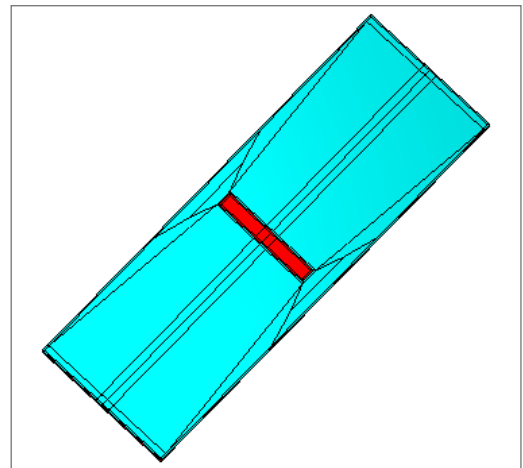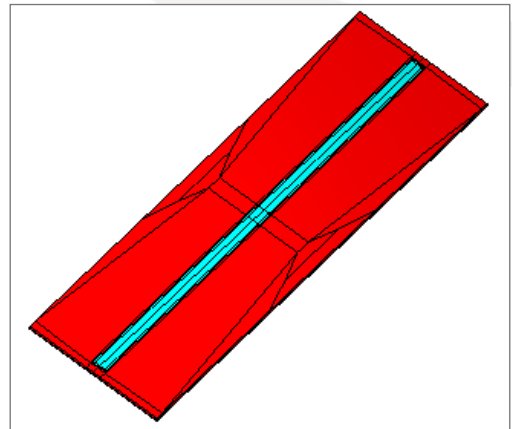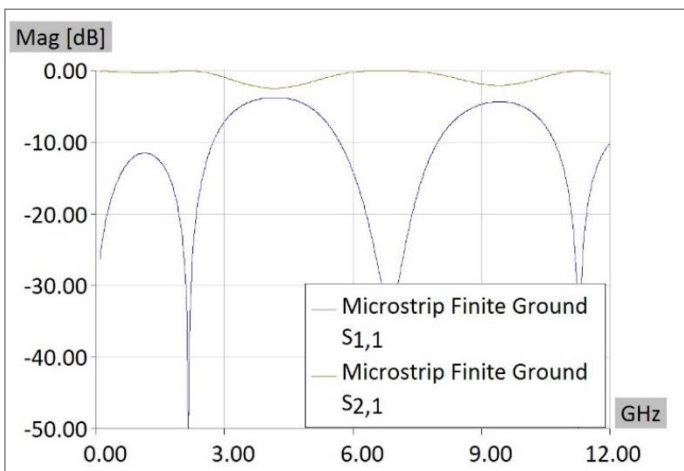**Figure 9. Microstrip line with parallel slot; top and bottom view**

Figure 12. S parameters - microstrip transmission line with perpendicular slot
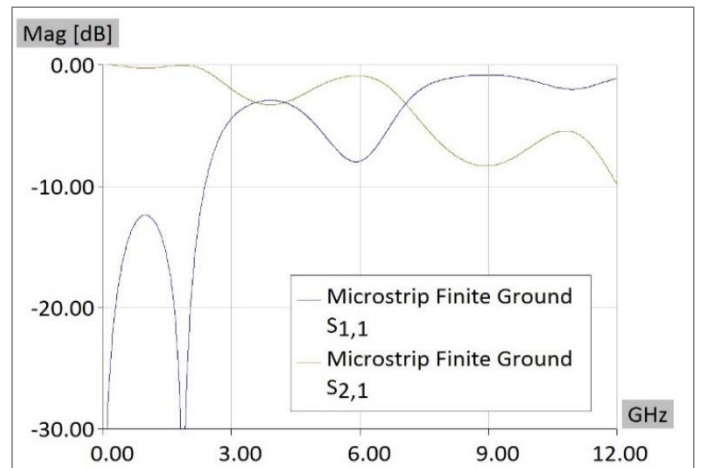

Figure 10. S-parameters - microstrip transmission line with parallel slot

Printed Circuit

Printed circuits are mostly used to electrically connect electronic components. They usually appear as multilayer structures. In the past a few decades, printed circuits became irreplaceable part of almost every electronic system.

Printed circuit with generator at one and load on the other side is modeled and simulated in WIPL-D (Figure 13). Two ground planes can be found under the printed traces (Figure 14). The traces are very thin as it is shown in Figure 14. Electric field is calculated and shown in Figure 15 at frequency of 8.035 GHz. It was calculated near the printed circuit.
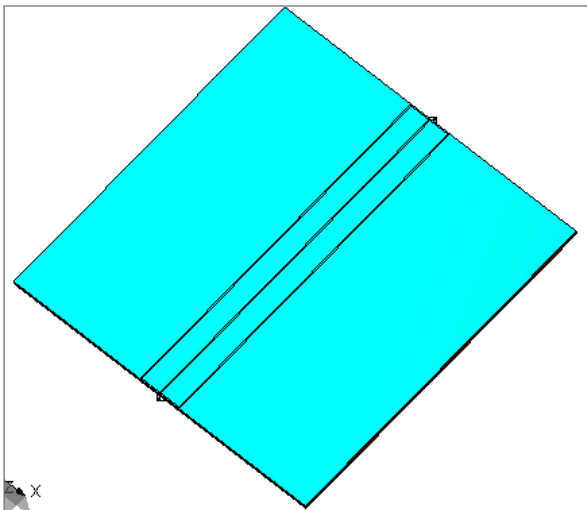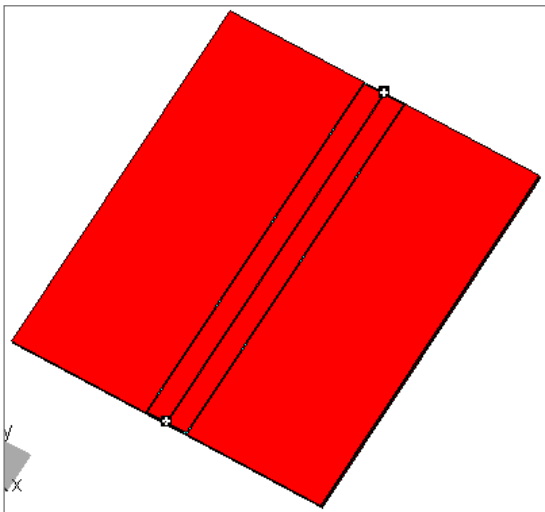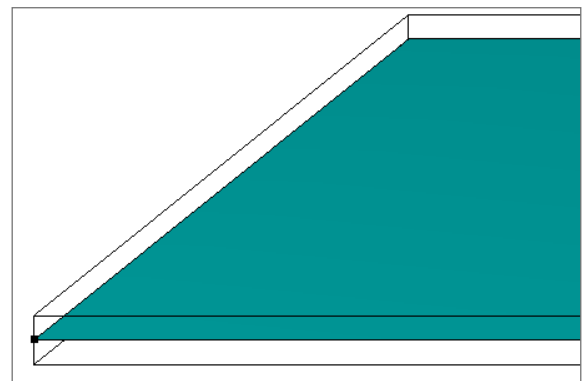
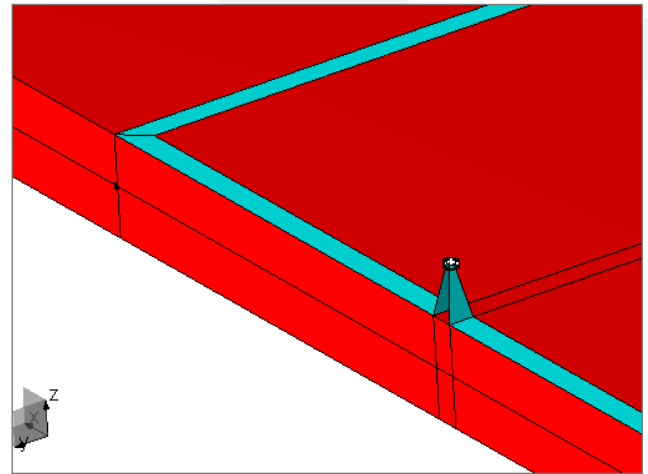**Figure 14. Printed circuit–closer view of the line and the 2nd metallic layer**

Figure 13. Printed circuit; top and bottom view

abs(E) [V/m]   8.035GHz Z=0.00016

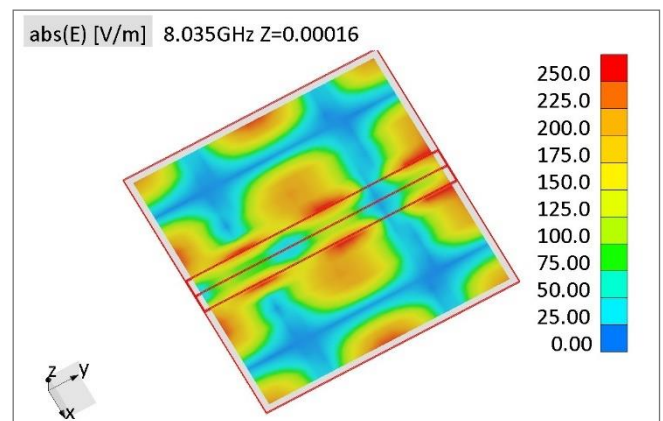| |
|---|
| 250.0 |
| 225.0 |
| 200.0 |
| 175.0 |
| 150.0 |
| 125.0 |
| 100.0 |
| 75.00 |
| 50.00 |
| 25.00 |
| 0.00 |

Figure 15. Electric field near printed circuit