

The Electromagnetic Surface Patch Code: Version 5.4

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The “Electromagnetic Surface Patch Code” (**ESP5**) is a Fortran 90 user oriented computer code, based upon the method of moments (MM) solution of the Electric Field Integral Equation (EFIE), for the analysis of the radiation and scattering from 3D geometries consisting of an interconnection of thin wires, perfectly conducting (or thin dielectric) polygonal plates, and polygonal dielectric material volumes. The code employs dynamic array dimensions, and thus can treat as large a problem as can fit on the user’s system. It is typically distributed as a Windows PC executable (not Fortran source code), however, executables for other systems may be available. An **ESP5** GUI or Workbench, developed by G. Frank Paynter, is available to aid the user in setting up the **ESP5** input command file, viewing the resulting geometry, and displaying output patterns.

The **ESP5** code can treat geometries consisting of:

- thin wires with finite conductivity, dielectric shells and lumped loads.
- perfectly conducting or thin dielectric polygonal plates (via a sheet impedance approximation).
- polygonal dielectric volumes - each with a different permittivity.
- wire/wire, wire/plate, plate/plate and dielectric volume/dielectric volume junctions.
- arbitrary background medium with a flat earth if desired.
- for radiation problems, excitation can be either by a voltage generator in the wires and plates, or by known impressed electric or magnetic currents.
- for scattering problems excitation by an incident plane wave.

ESP5 can compute most quantities of engineering interest including:

- current distributions, antenna input impedance, array active impedance, radiation efficiency, and mutual coupling.
- near or far zone radiation patterns (all polarizations).
- near or far zone back, bistatic, and forward scattering patterns (full scattering matrix).
- representation of an antenna array in terms of its N port matrices.
- operation either in single frequency or frequency sweep mode.

With **ESP5**, one attempts to model an “arbitrary” geometry as an interconnection of thin wires, polygonal plates, and polygonal dielectric volumes. For example, several polygonal plates could be interconnected to model an airplane, and wires segments

could be arranged to model an antenna on the airplane. As a second example, several polygonal dielectric volumes (each with different permittivity) could be arranged to model a human body. **ESP5** employs internal gridders which segment the input wires, plates and dielectric volumes into the MM expansion and weighting functions, based upon a maximum MM segment size (in wavelengths) specified by the user. Thus, as the frequency is increased, **ESP5** automatically increases the number of MM expansion functions. In this way, the user need only be concerned with the physical geometry being modeled, and not the segmentation of this geometry into MM modes.

The problem geometry, desired data and miscellaneous run control parameters are specified via a command style input file. The command style produces an understandable input file in which the user has flexibility in the order in which the input data is specified. For example, a 1 meter long wire on the z axis is specified by the WRC or Wire Coordinates command

```
WRC: Wire Along z Axis
0.0    0.0    0.0
0.0    0.0    1.0
```

Ten Azimuth radiation patterns from 100 to 1000 MHz with 5 degree step size can be specified by the RAD or Radian Scan command

```
RAD: Azimuth Patterns in the Plane theta = 90 deg.
100.0    1000.0    10
90.0     90.0     0.0
0.0      360.0     5.0
```

Special Command allows **ESP5** to be interfaced with Matlab or other executable files to generate the problem geometry.

The **ESP5** code is not in a final state, and has its limitations. For example, it employs only a direct solver (no iterative or fast MM solvers), and can not treat ferrites or printed circuit antennas. It is anticipated that in the future “bugs” will be corrected and new features will be added to the code. In addition, it may be possible to modify or customize the **ESP5** code for a specific user’s problem. User’s are encouraged to report any problems or suggestions to the author.

ESP5 comes with absolutely no guarantee or warrantee of accuracy or applicability to any problem. Although user’s are encouraged to report any bugs or errors they find while running the code, there is no guarantee that they will be fixed. In essence, the purchaser price for **ESP5** is only to cover our material and handling costs to supply the associated electronic files. U.S. government agencies and U.S. companies with U.S. government contracts can obtain the code plus user’s manual via order forms are available at the ESL home page at <http://esl.eng.ohio-state.edu/>. Follow the link to “Software” under the Research heading.

At this time we will not distribute ESP5 outside the USA.