6-10.1 Microstrip Patch Antenna Coupling

Previous sections illustrate that a patch may be fed in various ways. A dipole has a clear feed that leads to an impedance feed point with coupling in terms of an impedance matrix. This section uses model of section 6-1 using radiation of magnetic currents of the patch perimeter. The resonant cavity shape and excitation determine the edge distribution. The peak magnitude is computed by integrating the pattern over a half sphere to determine directivity so that pattern matches when computed by using the dyadic Greens function with the current distribution on an infinite ground plane. Physical optics calculations determine coupling between two sets of magnetic currents on the two patches using (Eq. 1-55); see also Section 2-4.4. Coupling S_{21} is converted to a normalized admittance independent of the feeding method used to excite the resonant cavity. This method was described in Diaz and Milligan, *Antenna Engineering using Physical* Optics, Artech 1996 but contains a scale error. These values do not include the conductor and dielectric loss tangent losses of both patches on thin substrates or surface wave losses.

Square Patch

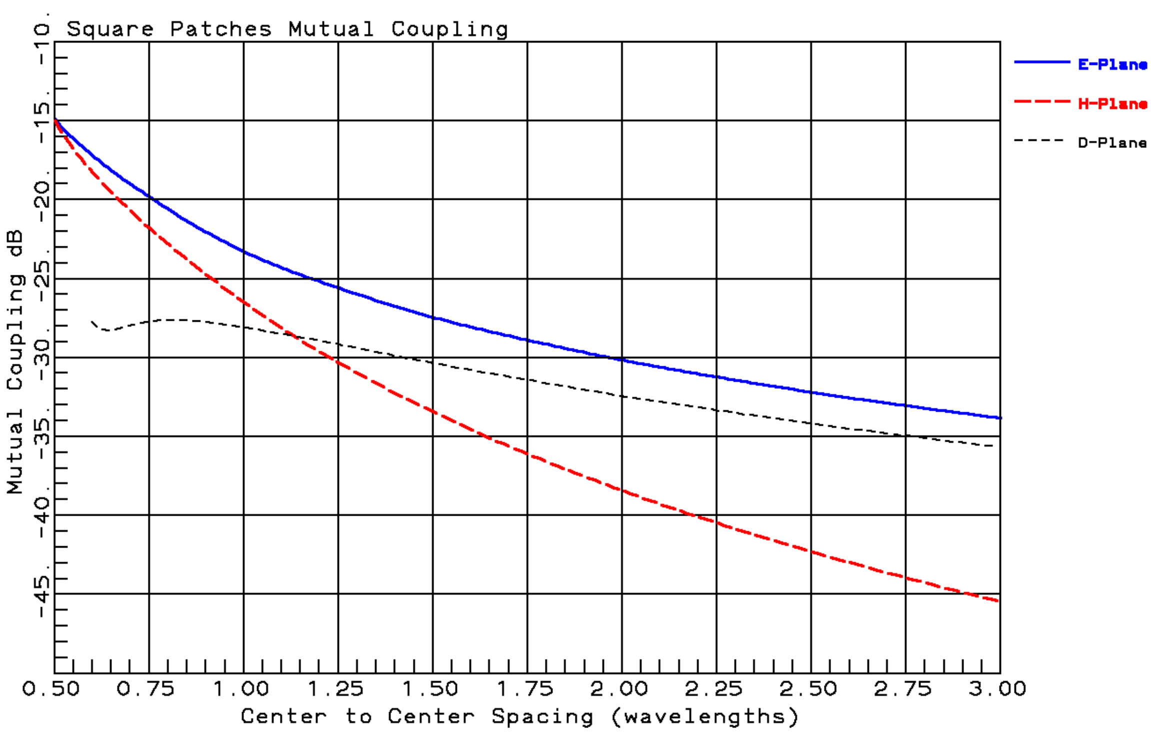

Figure 6-10.1.1 Square Patch Mutual Coupling, ε_r = 2.35 substrate

Associated with Figure 6-10.1.1 is the normalized admittance in the *E*-, *H*-, and diagonal planes.

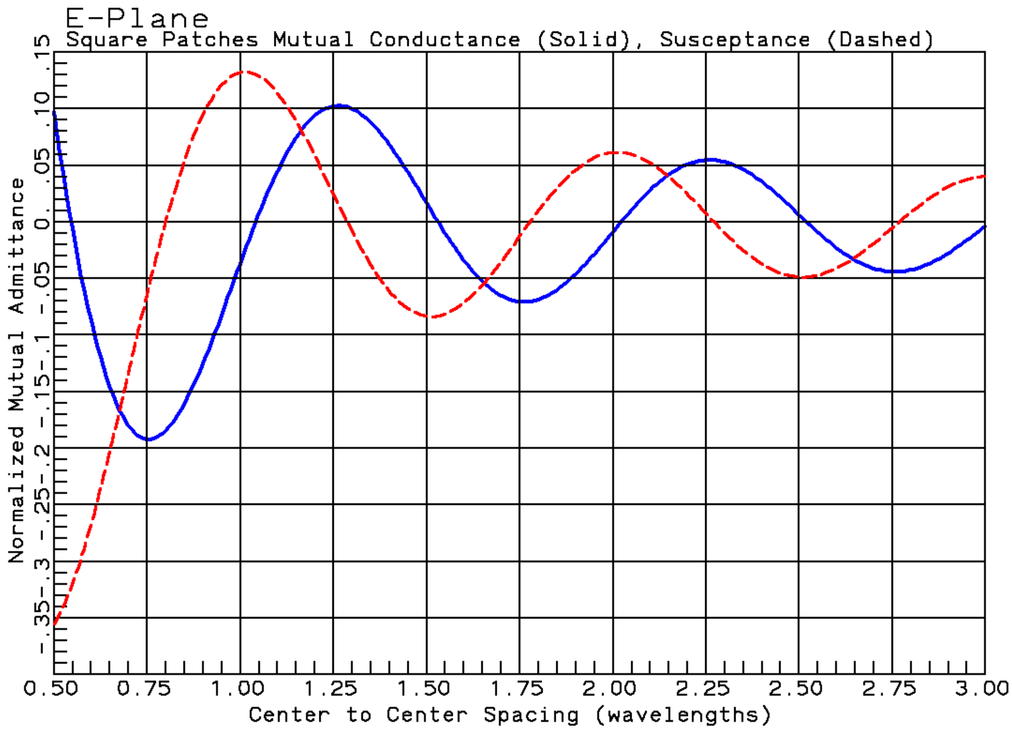

Figure 6-10.1.2 Square Patch Mutual *E*-Plane Normalized Admittance, ε_r = 2.35 substrate

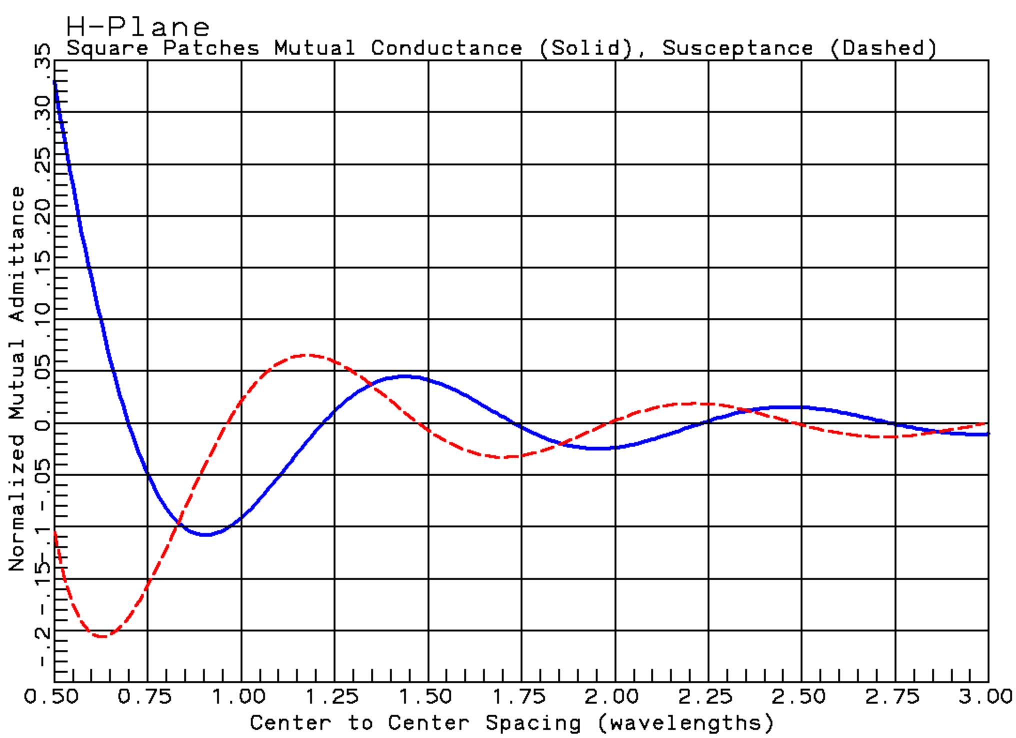

Figure 6-10.1.3 Square Patch Mutual *H*-Plane Normalized Admittance, ε_r = 2.35 substrate

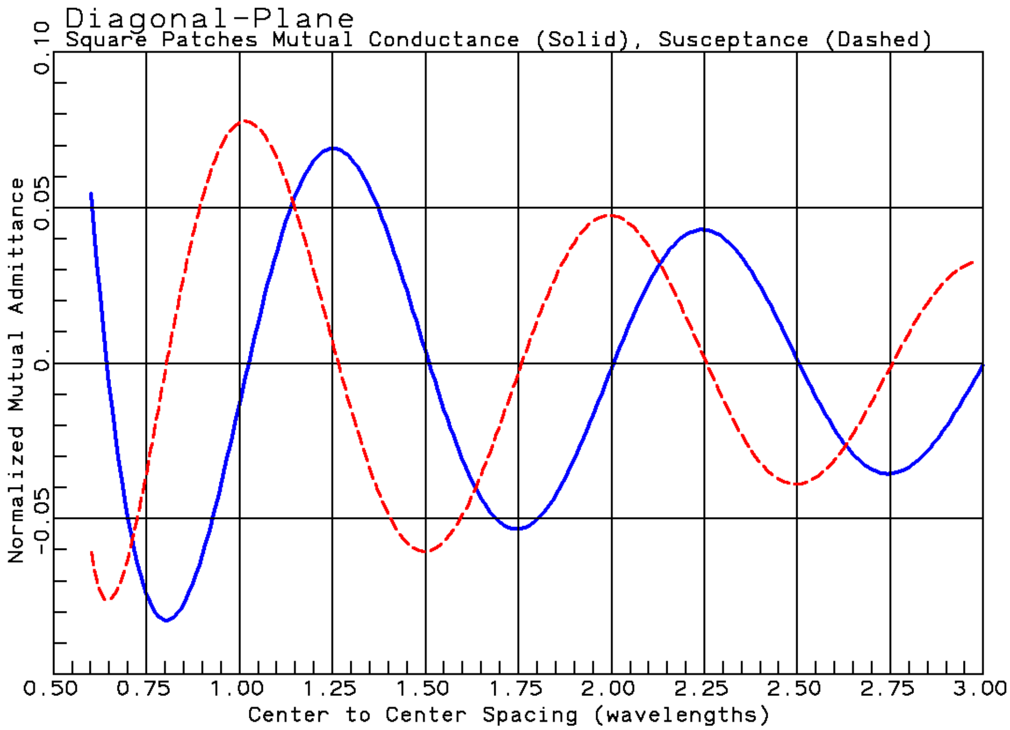

Figure 6-10.1.4 Square Patch Mutual *D*-Plane Normalized Admittance, ε_r = 2.35 substrate

Another dielectric substrate will alter the size of the effective patch and the coupling. The attached executable **COPSPC** computes coupling once effective size is determined for a new dielectric constant. The program can be run using an input text file **COPSPC1.TXT** that can be edited for the new case. Output plots are written in the HP plotter language HPGL which can be converted to other plot format by available routines. The physical optics method does not include surface wave effect which should be avoided in design, see Section 6-2 for a discussion of these problems.

A similar executable **COPCPC** with an associated input text file is supplied for circular patches. The executable **COPRPC** computes coupling for rectangular patches. The figures below give results for these patches.

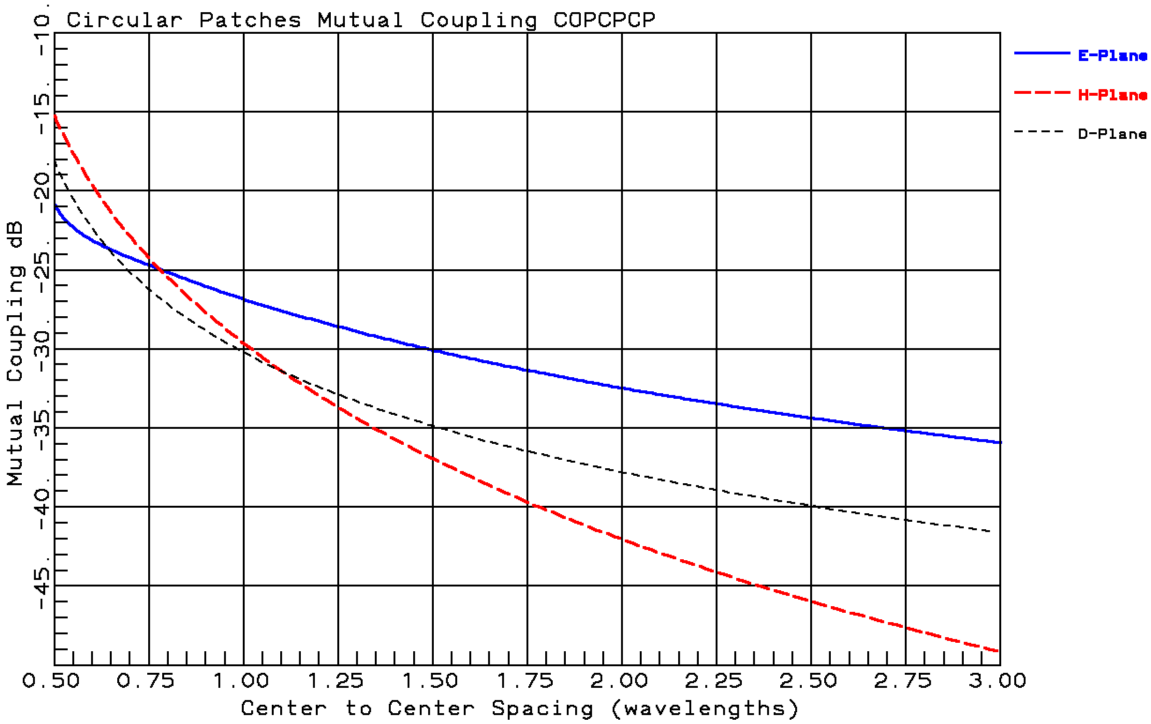

Figure 6-10.1.5 Circular Patch Mutual Coupling, ε_r = 2.35 substrate

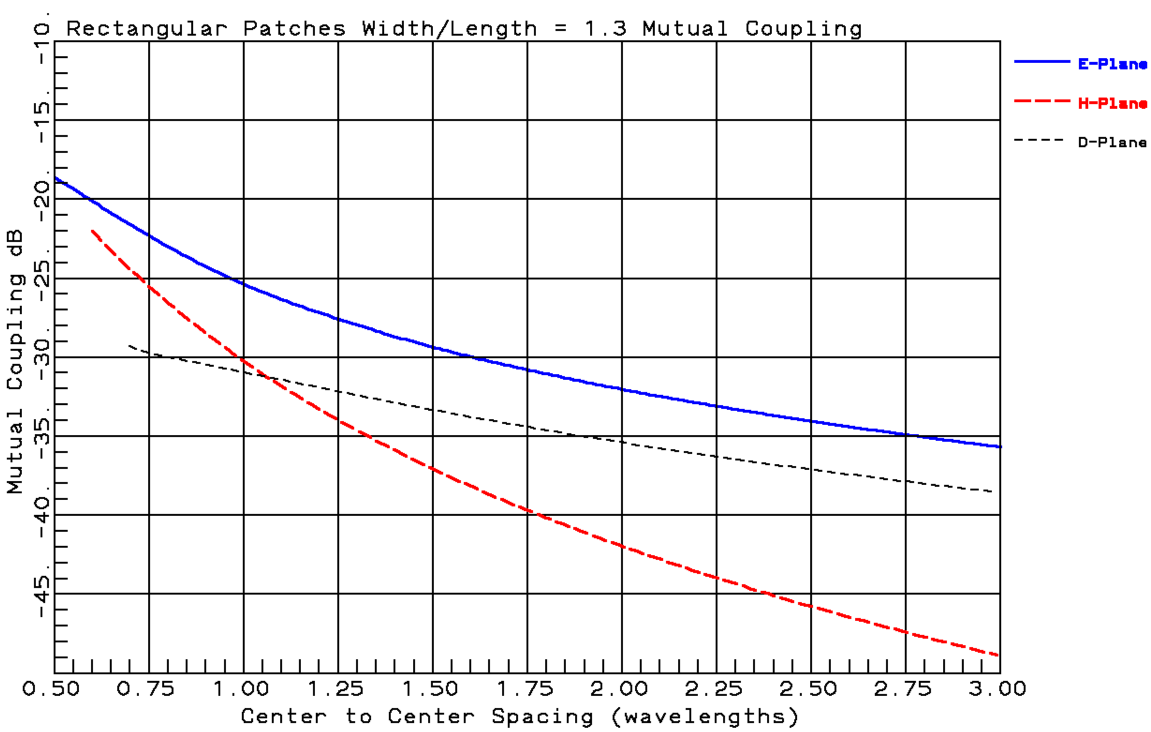

Figure 6-10.1.6 Rectangular Patch Mutual Coupling, ε_r = 2.35 substrate

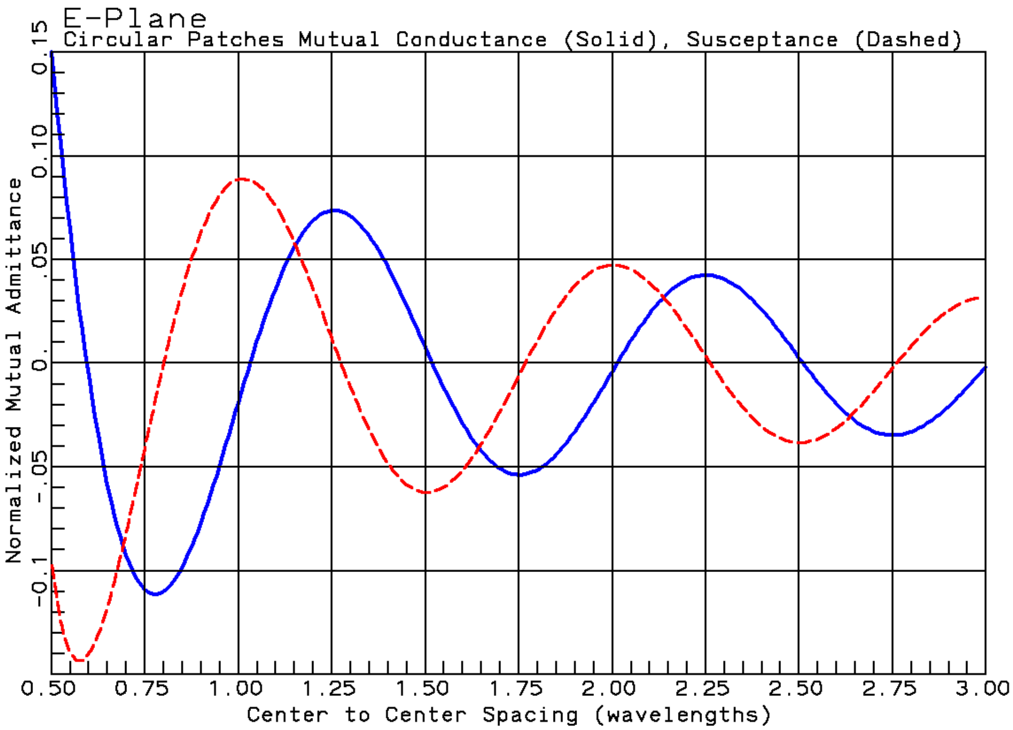

Figure 6-10.1.7 Circular Patch Mutual *E*-Plane Normalized Admittance, ε_r = 2.35 substrate

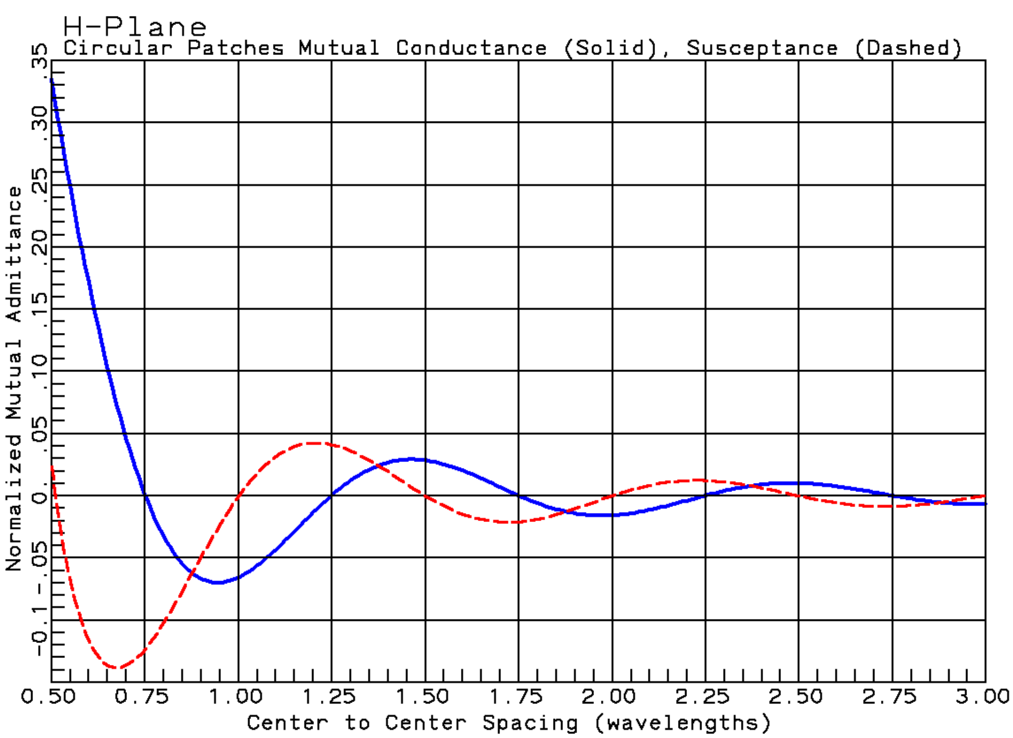

Figure 6-10.1.8 Circular Patch Mutual *H*-Plane Normalized Admittance, ε_r = 2.35 substrate

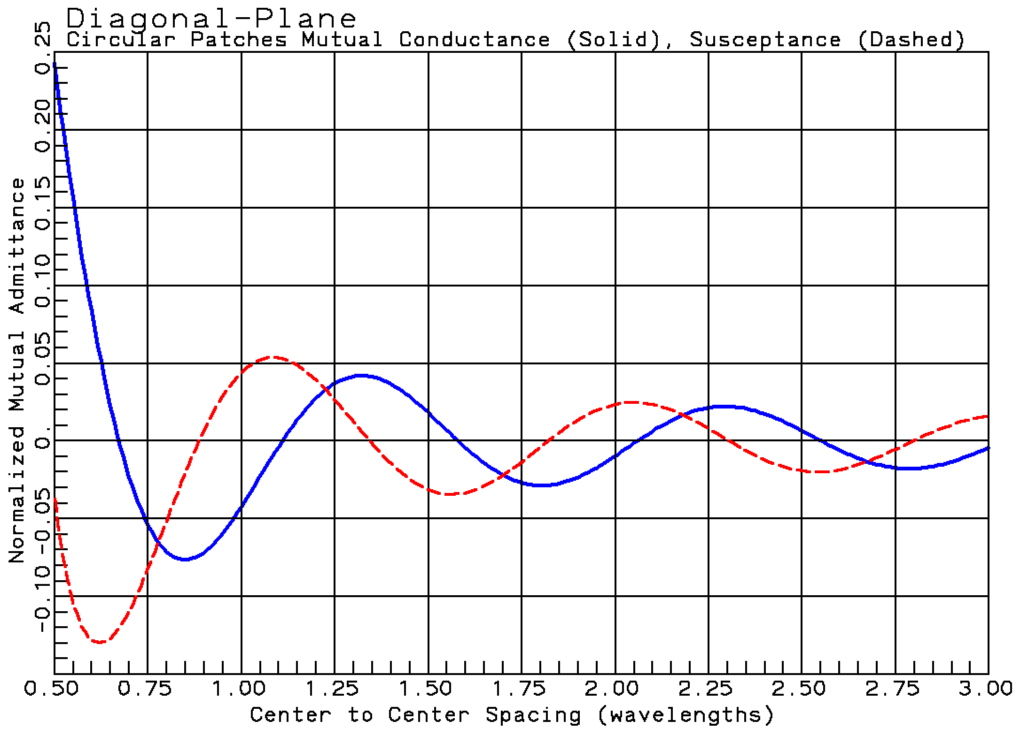

Figure 6-10.1.9 Circular Patch Mutual *D*-Plane Normalized Admittance, ε_r = 2.35 substrate

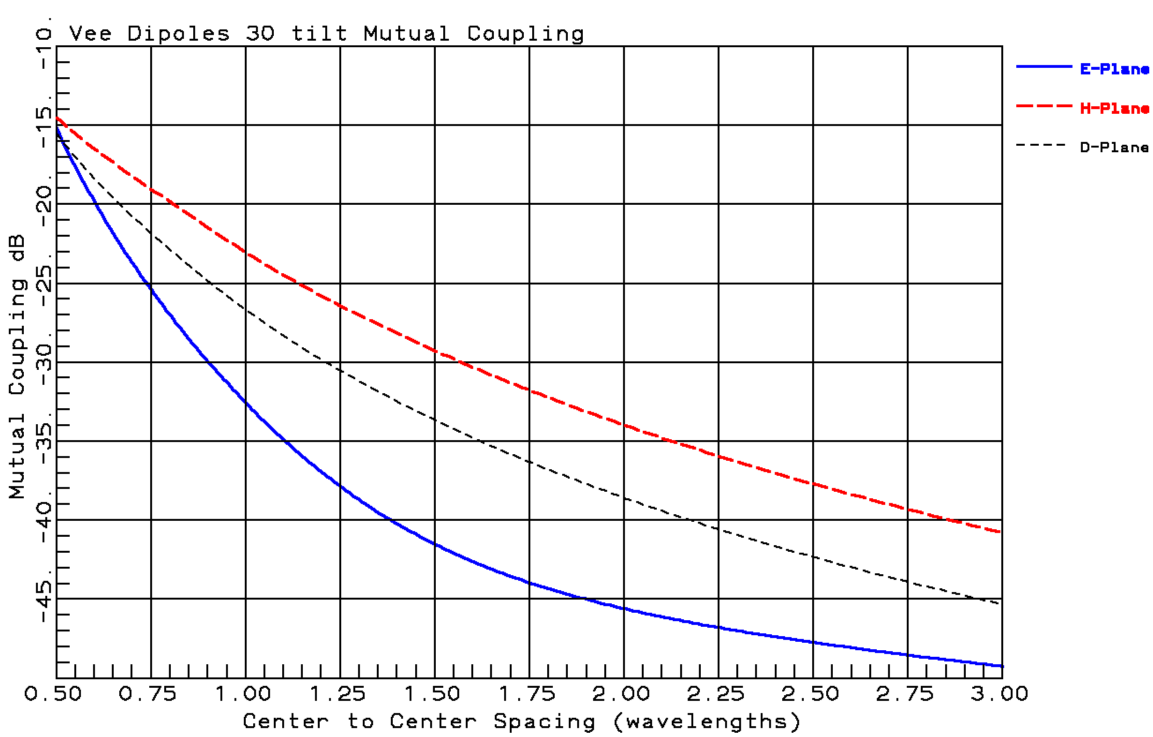

Figure 6-10.1.10 Tilted V-Dipole on Ground Plane Mutual Coupling

The tilted V-dipole gain is 6.6 dB while the patches have gains about 7.5 dB. The antennas with similar gains have similar mutual coupling. Section 1-12 discusses how mutual coupling relates to a first order to vector effective height dependent on effective area and antenna gain.

The executable **VDICOC** computes mutual coupling between tilted V-dipoles located over a ground plane. The program assumes a sinusoidal distribution on the dipole (1st order mode) and computes the self impedance by using a model of two filament dipoles spaced the dipole radius using many segments. Fewer segments are used for the pattern. Many segments are required to converge to the proper reactance. **VDICOC** uses a true impedance method in it modeling unlike patches which finds edge magnetic current level from directivity. Note the separate number of points in the integration along each pole from the input text file for **VDICOC**

```
5.45     dipole length
1        units: inches
0.14     dipole diameter
30       tilt from horizontal
1        frequency
201      points in self integrals
21       points mutual impedance integrals
yes      dipoles over ground
3.54,3.54        dipole heights
.
.
.
```

```
 Mutual coupling between identical Vee dipoles
 Resonant Length:             5.4500 in.
 Element diameter:            0.1400
 Dipole tilt:                  30.00
 Frequency (GHz):             1.0000
 Points in self integrals:  201 Mutual integrals:           21
 Dipoles over ground
 Heights of elements:    3.540   3.540
 Self impedance of dipole 1:    57.66    1.53
 Self impedance of dipole 2:    57.66    1.53
```