On Finite Frequency Selective Surfaces

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It is customary to approximate finite periodic structures by considering infinite surfaces. While this approach works under many circumstances, there are cases where strong surface waves are excited that cannot be accounted for by the infinite array approach. An explanation of this phenomenon is shown in Figure 1.

We first consider an infinite array as shown in Figure 1(a). It is subsequently transformed into a finite array by superimposing two semi-infinite arrays outside the finite array, as shown in Figure 1(b). These two semi-infinite arrays will produce fields as shown in Figure 1(d) where we note strong components along the plane of the array. These fields can excite strong surface wave currents if the scan impedance $|Z_A|$ becomes very small in imaginary space. An example is shown in Figure 1(e) where $|Z_A|$ is very small for $r_{cx} = \pm 1.25$. This results in strong surface waves as illustrated in Figure 1(f) for these two values of r_{cx}. In addition, we observe as always the Floquet current at $r_{cx} = 0.707$ for $45°$ angle of incidence. This is directly related to the spectrum of the incident field associated with the finite array.

The radiation pattern for the Floquet current is shown in Figure 2. Similarly, the two values of $r_{cx} = \pm 1.25$ result in two opposite-going surface waves as illustrated in Figure 3. Finally, there will be one more current component usually associated with the currents reflected at the edges of the array as illustrated in Figure 4.

Note that the actual currents were obtained by direct calculation using the SPLAT program. Subsequently we ran a Fourier analysis in r_{cx} space to obtain the current component shown in Figure 1(f).

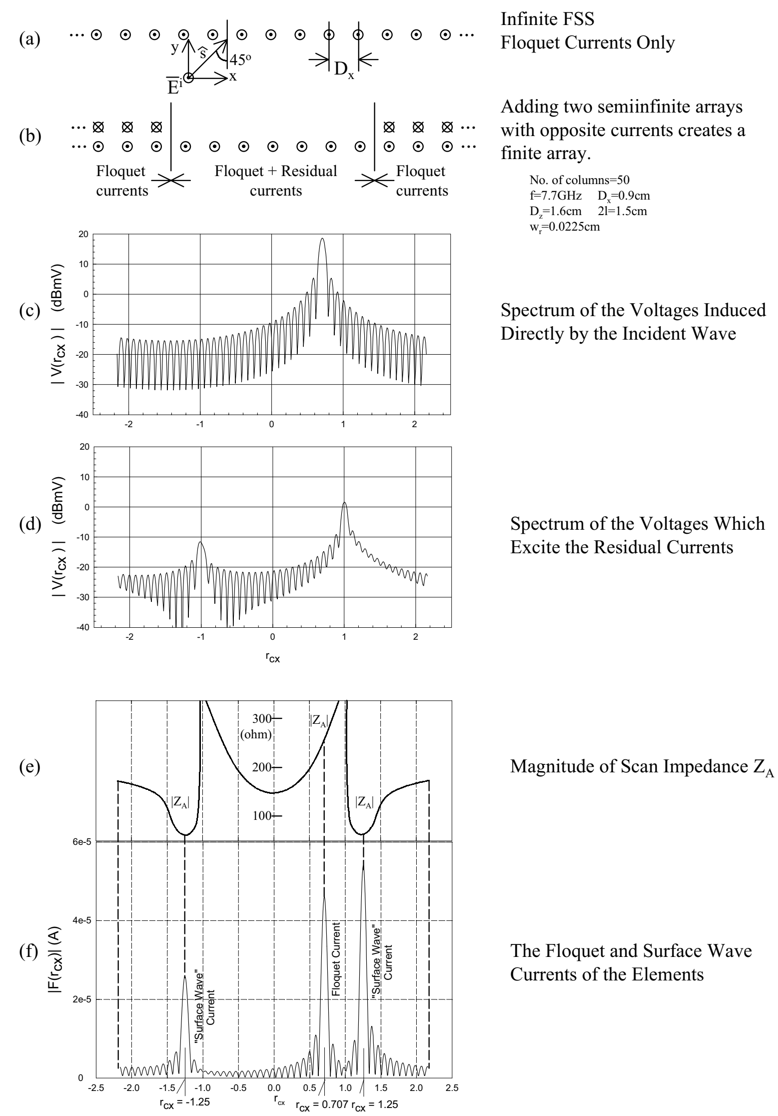

Figure 1: (a) An infinite array exposed to an incident plane wave has only Floquet currents. (b) Adding two semi-infinite arrays with negative Floquet currents creates a finite array with actual currents (Floquet and residual currents). (c) Spectrum of the voltages induced in the finite array by the incident wave. (d) Spectrum of the voltages in the finite array by the two semi-infinite arrays. Note the two peaks in the endfire directions $r_{cx} = \pm 1$. (e) The magnitude of the scan impedance Z_A as a function of r_{cx}. Note the minima at $r_{cx} = \pm 1.25$. (f) The spectrum of the element currents as a function of r_{cx}. Note the surface waves where $|Z_A|$ is minimum at $r_{cx} = \pm 1.25$, not at $r_{cx} = \pm 1.0$.

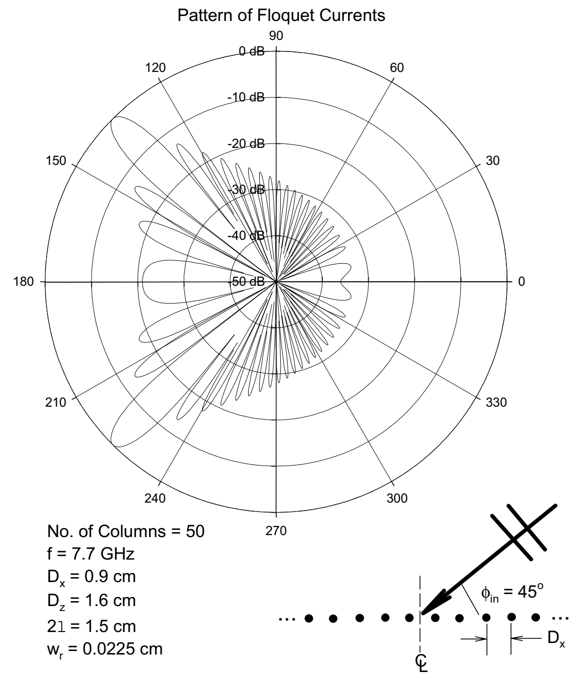

Figure 2: The bistatic scattering pattern for the Floquet currently only. Angle of incidence is 45°. Number of columns=50.

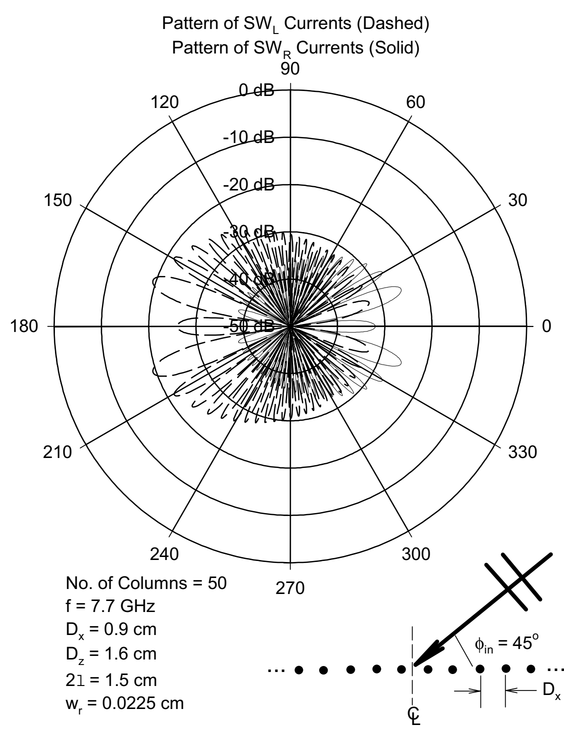

Figure 3: The bistatic scattering pattern for the left and right-going surface wave. Angle of incidence is 45°. Number of columns=50.

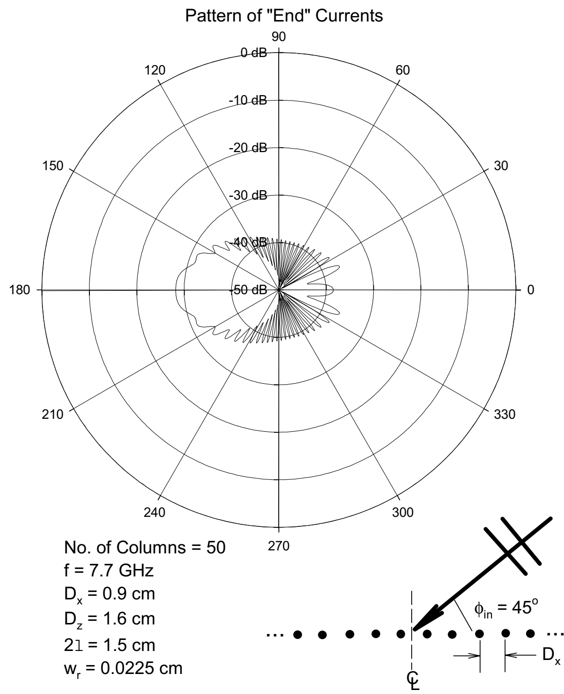

Figure 4: The bistatic scattering pattern of the "end" currents. Angle of incidence is 45°. Number of columns=50.