Bachelor – Arbeit

Thema : Numerische Untersuchungen Frequenzselektiver Oberflächen (FSS) zur Anwendung bei Reflektorantennen

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Zum Verfasser

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Abstract : Frequency selective surfaces (FSS) are basically an assemble of identical elements arranged in one or two dimensional array to carry out electromagnetic filter operations such as low pass, high pass, band stop and band pass.

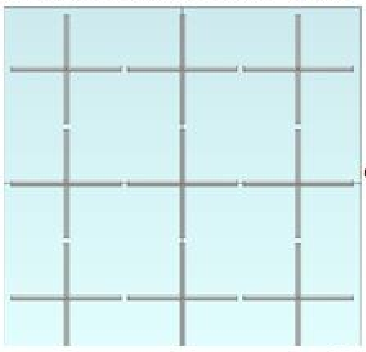
The numerous application of the FSS in practice over the last six decades – particularly in the radar and communication systems have proved to be very enduring.

In this scientific project the patch-type cross dipole, slit_in_aperture cross dipole and the slit_in_aperture jerusalem cross were designed and their filter characteristics analyzed.

For each of these FSS types both the single sheet and the cascaded sheets were intensively investigated. The entire designs and simulations were carried out by CST Microwave Studio 2012.

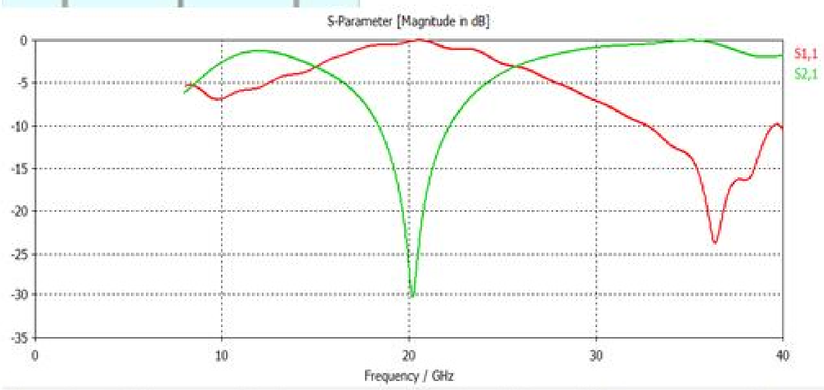
Single sheet patch_type cross dipole FSS array

An array of cross dipole FSS was designed and excited with the fundamental H_{10} wave with a frequency band 8 GHz – 40 GHz. The incident wave with different TE polarizations 0^0, 45^0 and 90^0 was excited through a square wave guide of area dimension 10,16mm x 10,16mm.



Details of geometry

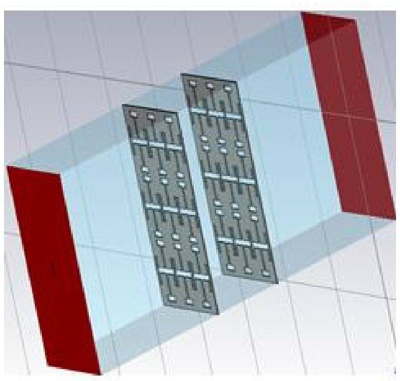
cross dipole material - PEC
substrate material - vacuum
inter element spacing – 6,61mm
cross dipole width – 0,63mm
cross dipole length – 6,23mm
cross dipole thickness – 0,508mm
substrate thickness – 0,17mm

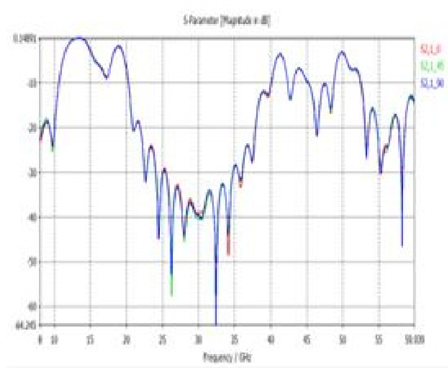


The simulation result shows a band stop filter with a resonant frequency fr = 20,22GHz . The relative bandwidth of the filter using -10dB as a reference is Brel [%] = $\frac{3,87}{20,22} * 100 = 19,14\%$

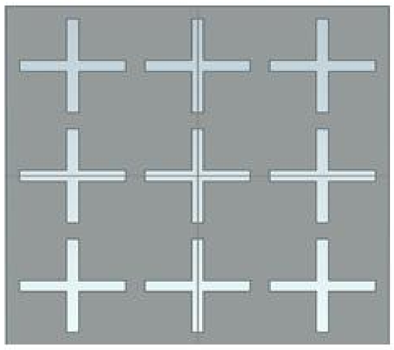
Cascaded 2_sheets slit_in_aperture jerusalem cross FSS array

Two sheets of the slit_in_aperture were stacked behind each other and excited with the fundamental H_{10} wave of TE polarizations 0^0, 45^0 and 90^0 through a square wave guide of 10,97mm x 10,97mm. The reflection and the transmission responses show multiple band pass filters with a flatter top and faster roll-off.



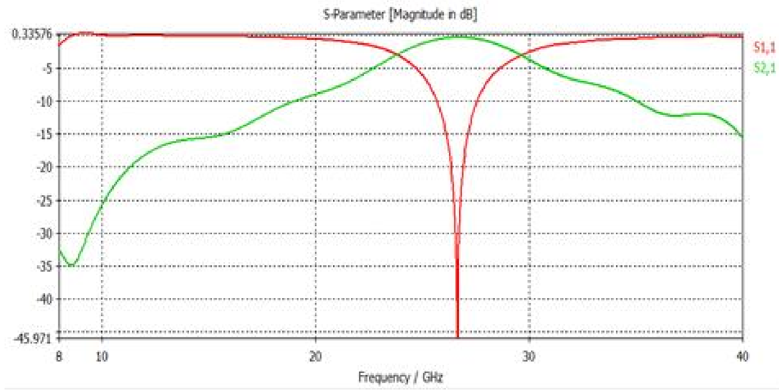


Single sheet slit_in_aperture cross dipole FSS array



Details of geometry

cross dipole material - vacuum
substrate material - PEC
inter element spacing – 6,61mm
cross dipole length – 6,63mm
cross dipole width – 0,63mm
substrate thickness – 0,17mm
cross dipole thickness – 0,17mm

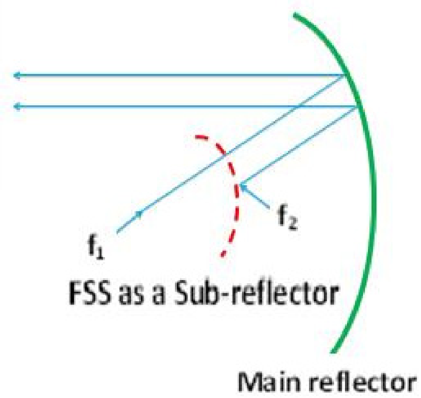


After the design and simulation of the above FSS array, the responses show a band pass filter with a resonant frequency , fr = 26,66GHz. The relative bandwith using -10dB as a reference is accordingly calculated as Brel [%] = $\frac{1,94}{26,66} * 100 = 7,28\%$

Main Application for the designed FSS array

Radome [picture from wikipedia]

Cassegrain system [ZAKARI]



Both the slit_in_aperture cross dipole and the slit_in_aperture jerusalem cross produced a filter with a band pass characterisitcs. They are used in the practice as radome to reduce the radar cross section (RCS) of an antenna outside their operating band.

The patch_type cross dipole produced a band stop filter characteristic. It is however used in the practice as a sub-reflector in the Cassegrain system where the FSS is transparent at frequency band, f_1 but opaque at another frequency, f_2.