เรื่อง Design a Microstrip Patch Antenna @7GHz

จัดทำโดย

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เสนอ

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รายงานนี้เป็นส่วนหนึ่งของรายวิชา ENE323 FUNDAMENTALS OF ANTENNA

AND ELECTROMAGNETIC WAVE PROPAGATION

ภาควิชาอิเล็กทรอนิกส์และโทรคมนาคม คณะวิศวกรรมศาสตร์

มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

ภาคเรียนที่ 2 ปีการศึกษา 2567

Design a rectangular microstrip antenna using a substrate (FR4) whose relative permittivity (εr) = 4.3, dielectric loss tangent = 0.025, and thickness h = 0.8 mm. Plot S11, VSWR and current distribution at the resonant frequency (last digit of student id +1) GHz using CST.

ขั้นตอนการออกแบบ

1. $W = \frac{c}{2f}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{299792458}{2\times7\times10^9}\sqrt{\frac{2}{4.3+1}} = 13.154368\ \text{mm}$
2. $\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2\sqrt{1+\frac{12h}{W}}} = \frac{4.3+1}{2} + \frac{4.3-1}{2\sqrt{1+\frac{12\times0.8\times10^{-3}}{13.15436\times10^{-3}}}} = 3.90454$
3. $\Delta L = h \times 0.412\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)} = 0.8\times0.412\frac{(3.90454+0.3)\left(\frac{13.15436\times10^{-3}}{0.8\times10^{-3}}+0.264\right)}{(3.90454-0.258)\left(\frac{13.15436\times10^{-3}}{0.8\times10^{-3}}+0.8\right)}$

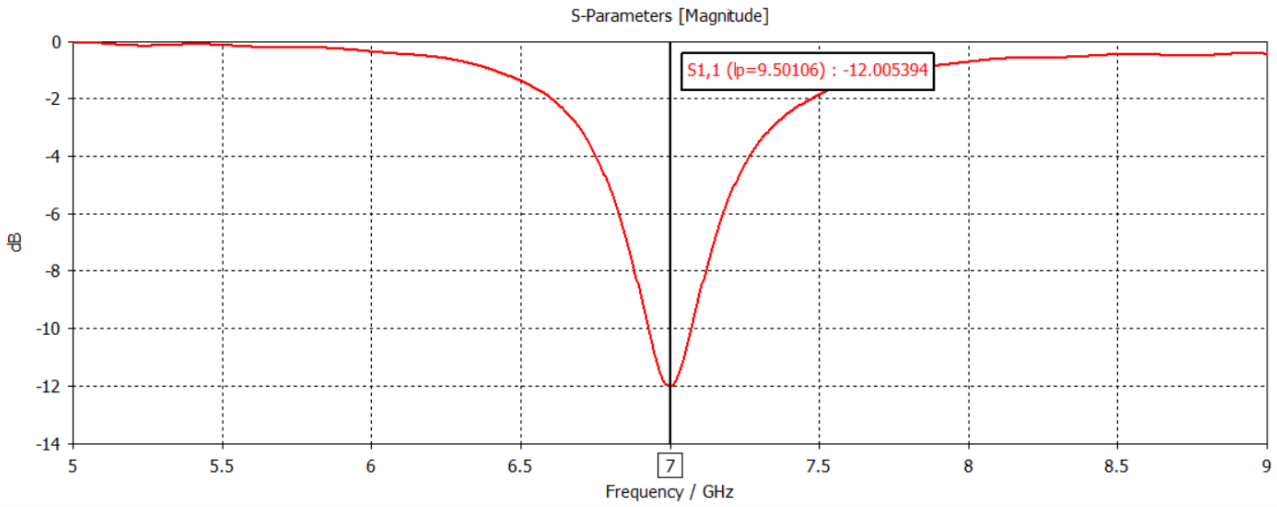
   $\Delta L = 367.94501\ \mu\text{m}$
4. $L = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}} - 2\Delta L = \frac{299792458}{2\times7\times10^9\times\sqrt{3.90454}} - 2(367.94501\times10^{-6}) = 10.10107\ \text{mm}$
5. $W_g = W + 6h = (13.15436\times10^{-3}) + (6\times0.8\times10^{-3}) = 17.95436\ \text{mm}$
6. $L_g = L + 6h = (10.10107\times10^{-3}) + (6\times0.8\times10^{-3}) = 14.90107\ \text{mm}$
7. $G_1 = \frac{1}{120}\sqrt{\frac{W}{\left(\frac{c}{fr}\right)}} = \frac{1}{120}\sqrt{\frac{13.15436\times10^{-3}}{\left(\frac{299792458}{7\times10^9}\right)}} = 2.55956\ \text{mS}$
8. $y_0 = \frac{W}{\pi}\cdot\cos^{-1}\left(\sqrt{R_{in(y=y_0)}\times2\times G1}\right)$

   $y_0 = \frac{13.15436\times10^{-3}}{\pi}\cdot\cos^{-1}\left(\sqrt{50\times2\times2.55956\times10^{-3}}\right) = 4.35610\ \text{mm}$

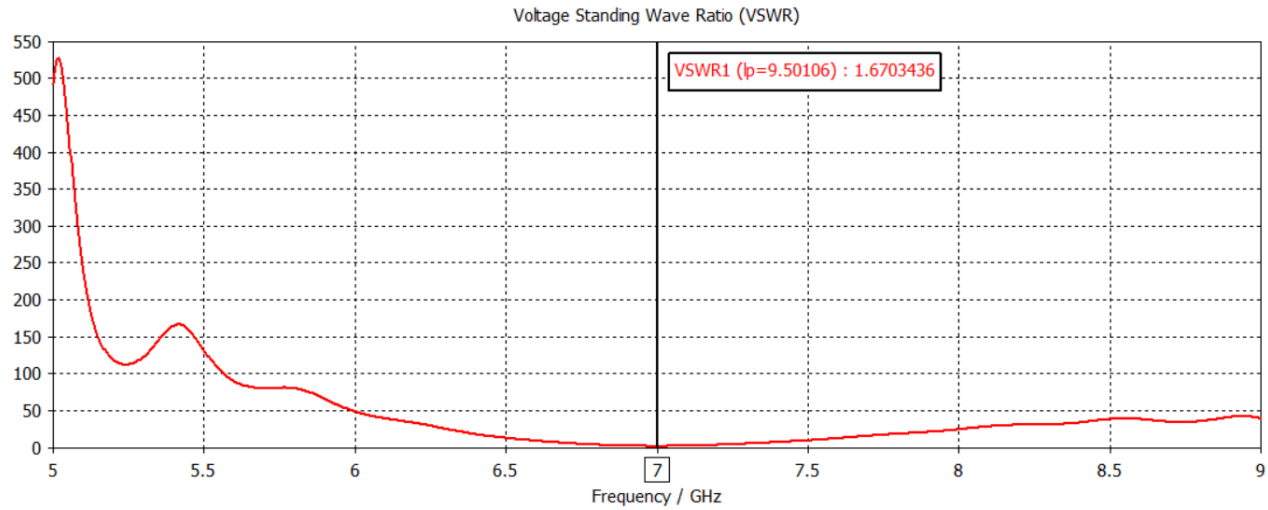
(Calculated By MATLAB at Last section of Document)

ผลการทดลอง

S11 vs Frequency

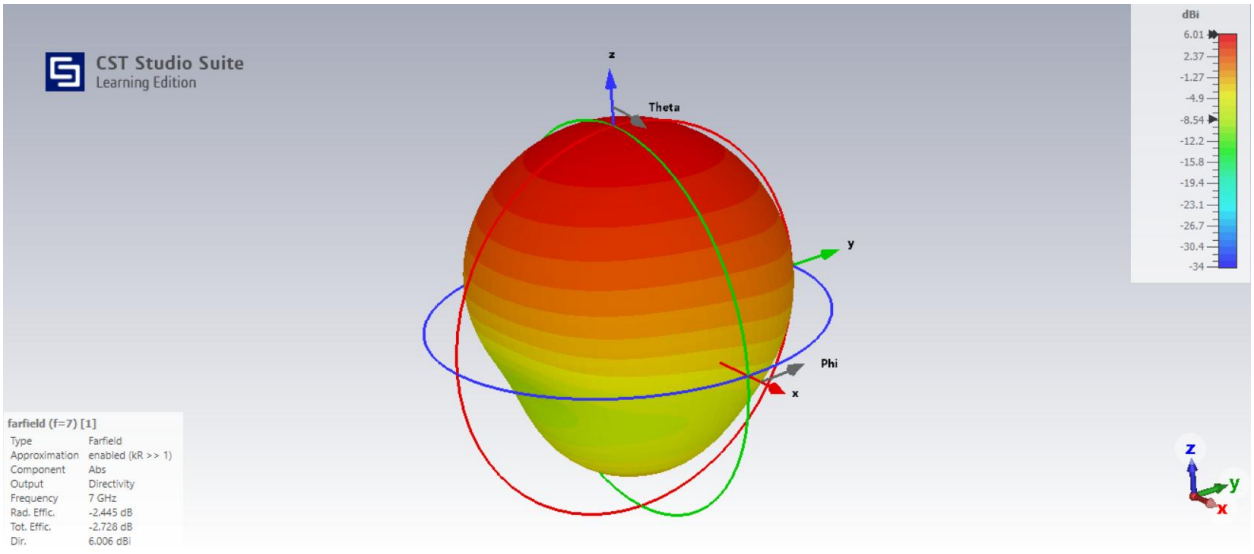


VSWR vs Frequency

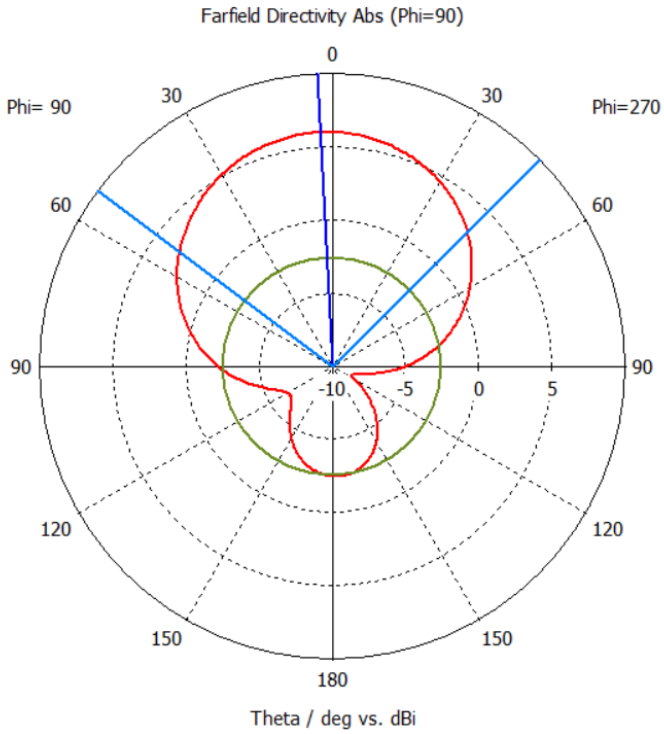


ผลการทดลอง

Far-Field 3D Radiation Pattern



The Directivity



farfield (f=7) [1]

Frequency = 7 GHz
Main lobe magnitude = 6.01 dBi
Main lobe direction = 3.0 deg.
Angular width (3 dB) = 98.2 deg.
Side lobe level = -8.5 dB

```
% ENE323 Microstrip Patch Antenna Design /Matlab
% 65070502406 Kittiphop Phanthachart

clear all;
clc;

% Input Parameter
er = 4.3   ;   %input('Relative Permittivity(er): ');
lt = 0.025 ;   %input('Dielectric loss tangent(lt): ');
h  = 0.8   ;   %input('Thickness(h[mm]): ');
fr = 7     ;   %input('Resonant Frequency(fr[GHz]): ');


% The Constant
c = 299792458; % Speed of light


% Unit Transformation
h = h*1e-3;    % to mm
fr= fr*1e9;    % to GHz


% Calculation
wp      = (c/(2*fr))*(sqrt((2)/(er+1)))

e_eff   = ((er+1)/2)+((er-1)/(2*sqrt(1+(12*(h/wp))) ))

delta_L = (h*0.412*(e_eff+0.3)*((wp/h)+0.264 ))/((e_eff-0.258)*( (wp/h)+0.813))

lp      = (c/(2*fr*sqrt(e_eff)))-(2*delta_L)

wg      = wp + (6*h)

lg      = lp + (6*h)

G1      = (1/120)*(wp/(c/fr))

y0      = acos(sqrt(50*2*G1))*(wp/pi)
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