



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 (ϵ_r) = 4.3, dielectric loss tangent = 0.025, and thickness $h = 0.8$ mm. Plot S_{11} , VSWR and current distribution at the resonant frequency (last digit of student id +1) GHz using CST.

ขั้นตอนการออกแบบ

$$1. \quad W = \frac{c}{2f} \sqrt{\frac{2}{\epsilon_r + 1}} = \frac{299792458}{2 \times 7 \times 10^9} \sqrt{\frac{2}{4.3 + 1}} = 13.154368 \text{ mm}$$

$$2. \quad \epsilon_{\text{eff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2\sqrt{1 + \frac{12h}{W}}} = \frac{4.3 + 1}{2} + \frac{4.3 - 1}{2\sqrt{1 + \frac{12 \times 0.8 \times 10^{-3}}{13.15436 \times 10^{-3}}}} = 3.90454$$

$$3. \quad \Delta L = h \times 0.412 \frac{(\epsilon_{\text{eff}} + 0.3) \left(\frac{W}{h} + 0.264 \right)}{(\epsilon_{\text{eff}} - 0.258) \left(\frac{W}{h} + 0.8 \right)} = 0.8 \times 0.412 \frac{(3.90454 + 0.3) \left(\frac{13.15436 \times 10^{-3}}{0.8 \times 10^{-3}} + 0.264 \right)}{(3.90454 - 0.258) \left(\frac{13.15436 \times 10^{-3}}{0.8 \times 10^{-3}} + 0.8 \right)}$$

$$\Delta L = 367.94501 \text{ } \mu\text{m}$$

$$4. \quad L = \frac{c}{2f\sqrt{\epsilon_{\text{eff}}}} - 2\Delta L = \frac{299792458}{2 \times 7 \times 10^9 \times \sqrt{3.90454}} - 2(367.94501 \times 10^{-6}) = 10.10107 \text{ mm}$$

$$5. \quad W_g = W + 6h = (13.15436 \times 10^{-3}) + (6 \times 0.8 \times 10^{-3}) = 17.95436 \text{ mm}$$

$$6. \quad L_g = L + 6h = (10.10107 \times 10^{-3}) + (6 \times 0.8 \times 10^{-3}) = 14.90107 \text{ mm}$$

$$7. \quad G_1 = \frac{1}{120} \sqrt{\frac{W}{\left(\frac{c}{fr}\right)}} = \frac{1}{120} \sqrt{\frac{13.15436 \times 10^{-3}}{\left(\frac{299792458}{7 \times 10^9}\right)}} = 2.55956 \text{ mS}$$

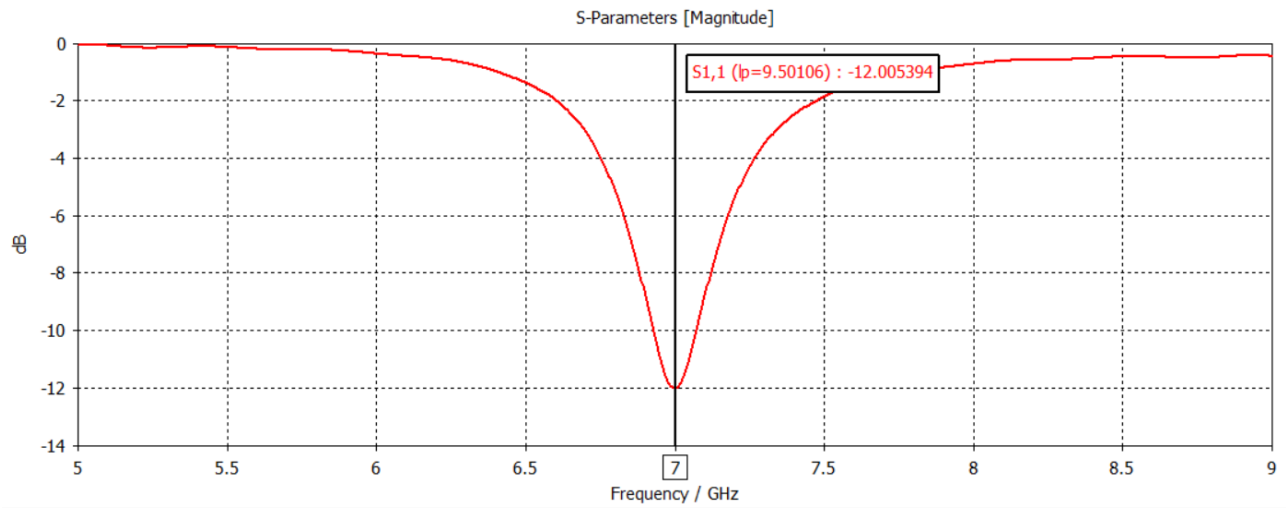
$$8. \quad y_0 = \frac{L}{\pi} \cdot \cos^{-1}(\sqrt{R_{\text{in}}(y=y_0)} \times 2 \times G_1)$$

$$y_0 = \frac{10.10107 \times 10^{-3}}{\pi} \cdot \cos^{-1}(\sqrt{50 \times 2 \times 2.55956 \times 10^{-3}}) = 3.34499 \text{ mm}$$

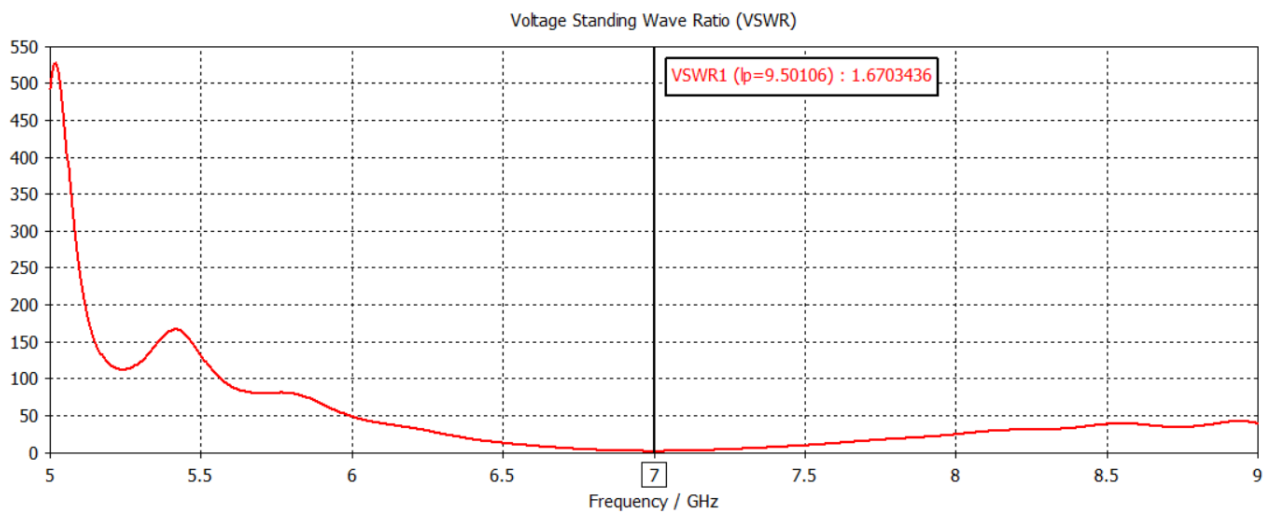
(Calculated By MATLAB at Last section of Document)

ผลการทดลอง

S11 vs Frequency

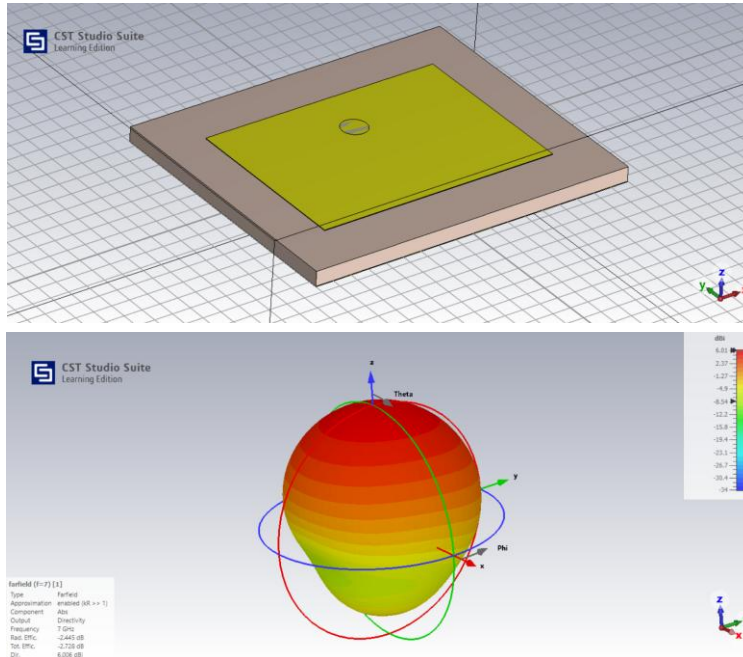


VSWR vs Frequency

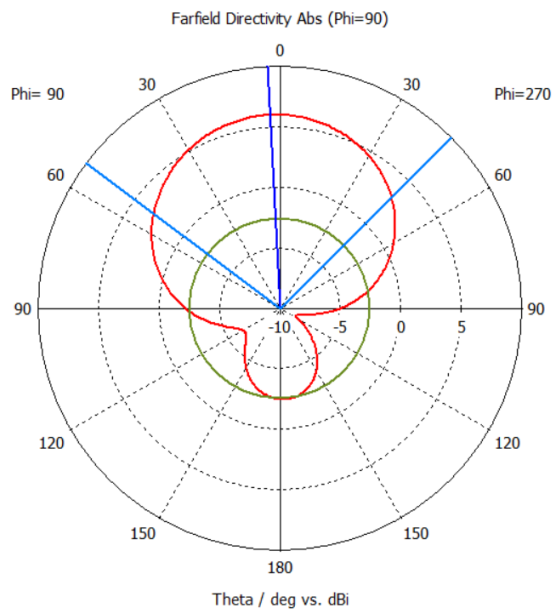


ผลการทดลอง

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

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% 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))*(lp/pi)

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