
# T.C. YILDIZ TEKNİK ÜNİVERSİTESİ
# FEN BİLİMLERİ ENSTİTÜSÜ

Proje Raporu

Hazırlayan : ALİ RÜVEYCAN
No :22505108

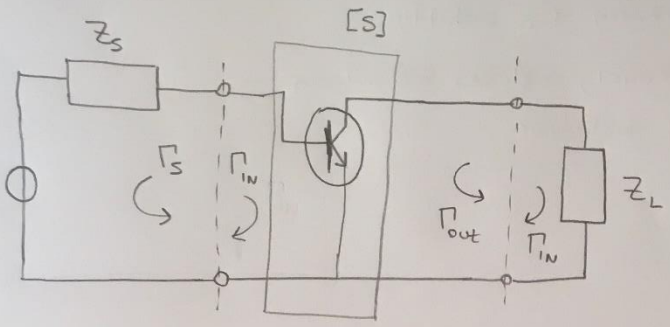
Elektronik ve Haberleşme Mühendisliği Anabilim Dalı

Haberleşme Tezli Yüksek Lisans Programı

RF Devre Tasarımı

Proje Konusu : AWR Microwave Office kullanarak Maksimum Kazanç Amplifikatörü Tasarımı ve Simülasyonu

## 1- Kazancı maksimize etmek




$$G_S = \frac{1-|\Gamma_S|^2}{|1-\Gamma_{IN}\Gamma_S|^2} \quad , \quad G_0 = |S_{21}|^2 \quad , \quad G_L = \frac{1-|\Gamma_L|^2}{|1-S_{22}\Gamma_L|^2}$$

Genel Transducer (dönüştürücü) kazancı ;

$$G_T = G_S \cdot G_0 \cdot G_L$$

## 2- Maksimum Kazanç için Tasarım

Verilen transistör için kazanç $G_0$ sabittir.
Amplifikatörün toplam kazancı, eşleşen bölümlerin $G_L$ ve $G_S$'si tarafından belirlenir.

$$\Gamma_{IN} = \Gamma_S^*$$

$$\Gamma_{out} = \Gamma_L^*$$

Kayıpsız eşleşen bölümleri varsayarsak;

$$G_{T,max} = \frac{1}{1-|\Gamma_S|^2} \cdot |S_{21}|^2 \cdot \frac{1-|\Gamma_L|^2}{|1-S_{22}\Gamma_L|^2}$$

## 3- İkili transistör için maksimum kazanç

Bir ikili transistör olması durumunda; $\Gamma_{IN}$, $\Gamma_{out}$'tan etkilenir ve bunun tersi de geçerlidir.

$$\Gamma_S^* = S_{11} + \frac{S_{12} S_{21} \Gamma_L}{1 - S_{22} \Gamma_L}$$

$$\Gamma_L^* = S_{22} + \frac{S_{12} S_{21} \Gamma_S}{1 - S_{11} \Gamma_S}$$

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1} \quad , \quad \Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2}$$

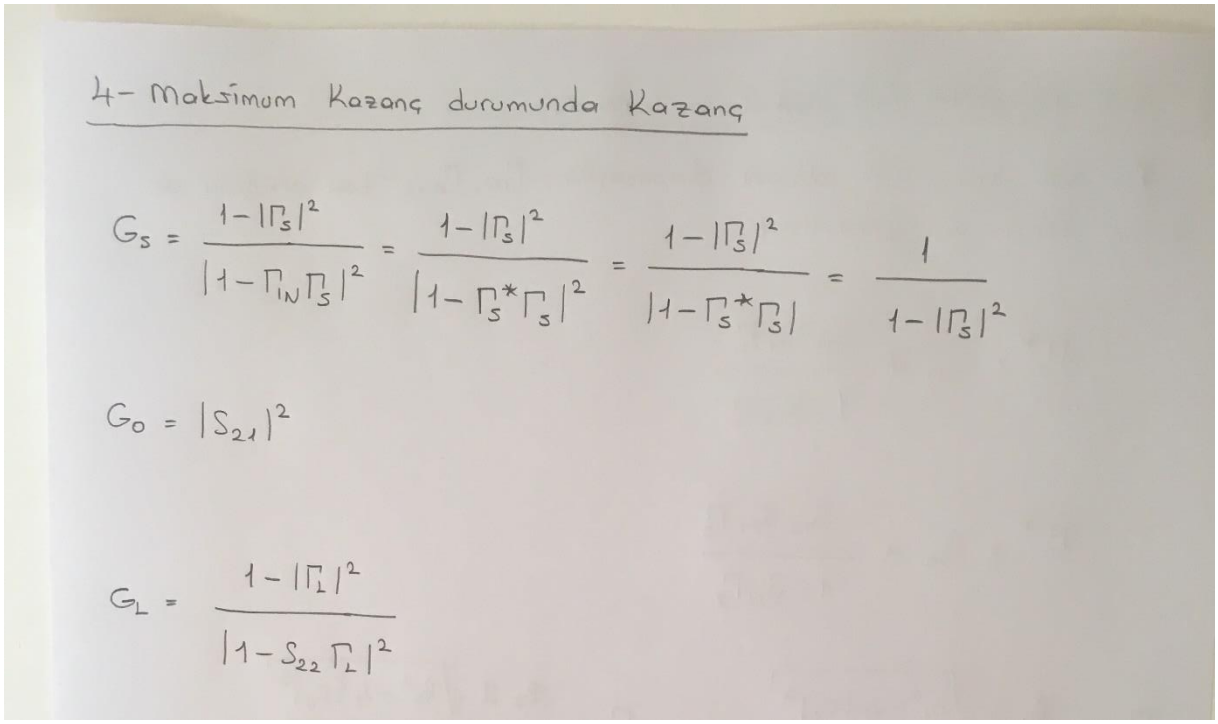
$$B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2$$

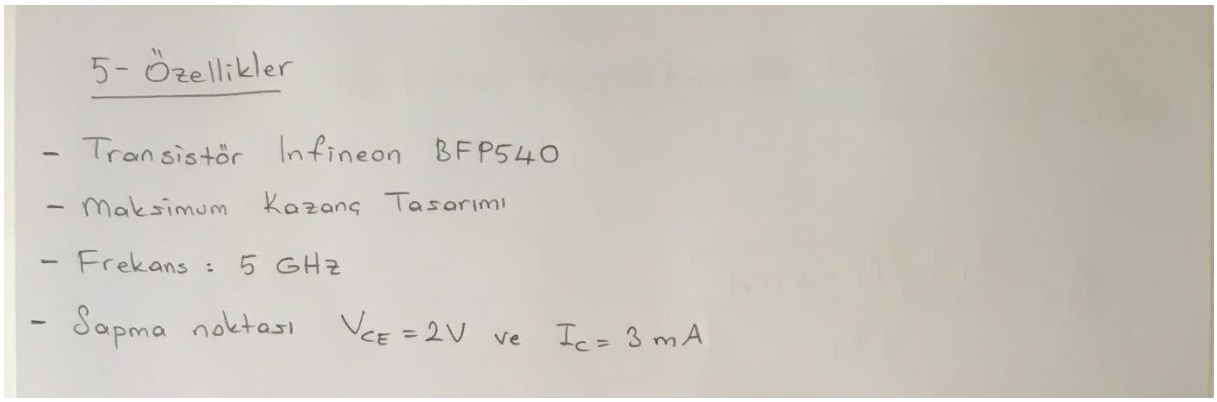
$$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2$$

$$C_1 = S_{11} - \Delta S_{22}^*$$

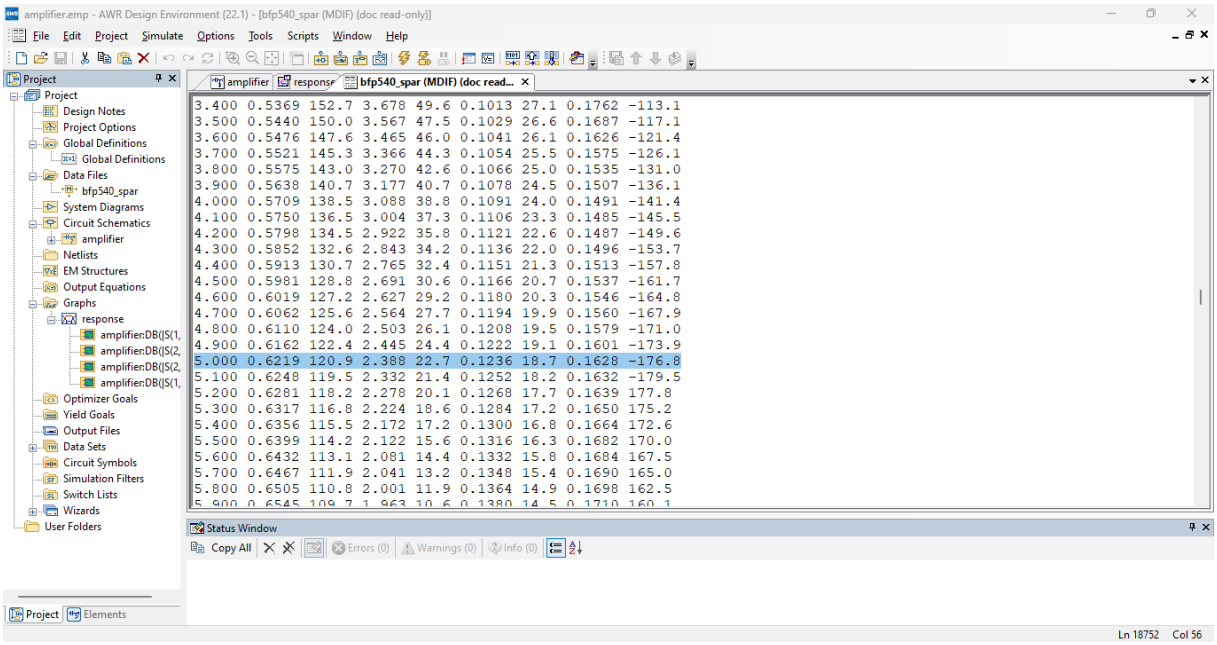
$$C_2 = S_{22} - \Delta S_{11}^*$$

$$\Delta = S_{11} \cdot S_{22} - S_{12} S_{21}$$




## BFP540 Touchstone File



Transistör şu S parametrelerine sahiptir ($Z_0 = 50\,\Omega$)

| f (GHz) | $S_{11}$ | $S_{12}$ | $S_{21}$ | $S_{22}$ |
|---|---|---|---|---|
| 5.0 | $0{,}6556 \angle 126{,}9^\circ$ | $0{,}114 \angle 7{,}7^\circ$ | $2{,}011 \angle 22{,}5^\circ$ | $0{,}200 \angle -138{,}1^\circ$ |

Transistöre eşlenik eşleşme (conjugate match) şu şekilde belirlenebilir:

$$\Gamma_S = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1} = 0{,}793 \angle -129^\circ$$

$$\Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2} = 0{,}553 \angle 114^\circ$$

$$G_S = \frac{1}{1 - |\Gamma_S|^2} = 2{,}694 = 4{,}3\ \text{dB}$$

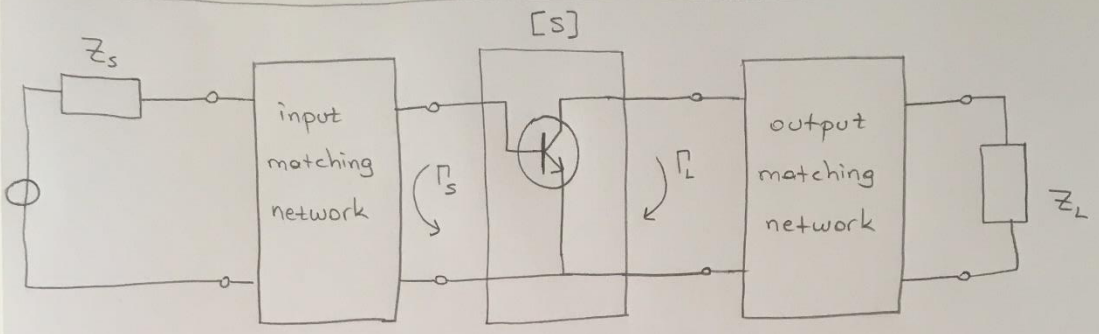
$$G_0 = |S_{21}|^2 = 4{,}044 = 6{,}07\ \text{dB}$$

$$G_L = \frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2} = 0{,}856 = -0{,}67\ \text{dB}$$

Genel transducer kazancı

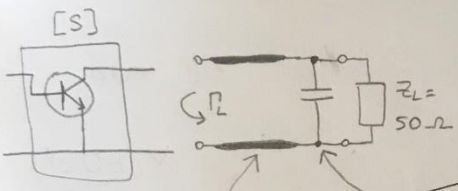
$$G_T = 4{,}3\ \text{dB} + 6{,}07\ \text{dB} - 0{,}67\ \text{dB} = 9{,}7\ \text{dB}$$

## 6- Eşlenik Eşleşme (Conjugate-Matched) Tasarımı




$\Gamma_S = 0,793 \angle -129°$ , $\Gamma_L = 0,553 \angle 114°$

# Output Matching Network Tasarimi



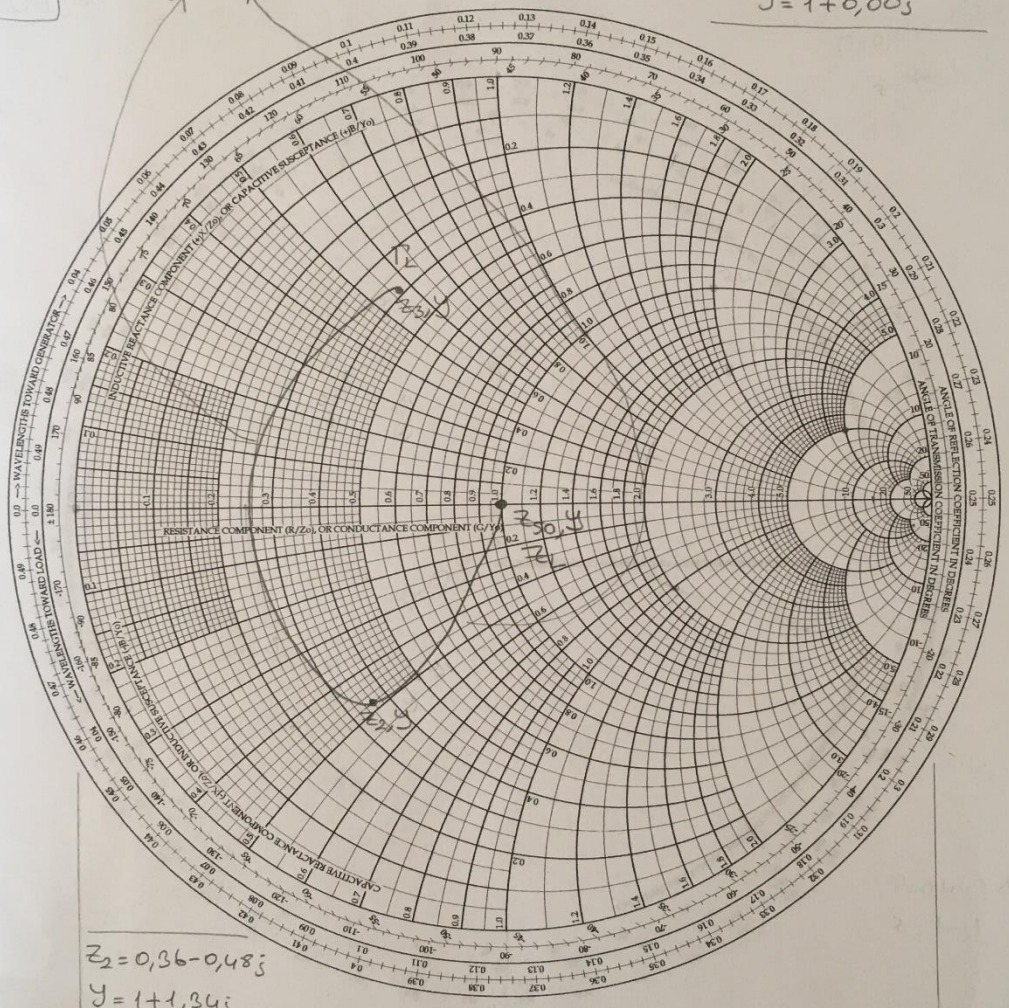

## Smith Chart

$Z_3 = 0{,}38 + 0{,}57j$

$Y = 0{,}81 - 1{,}13j$

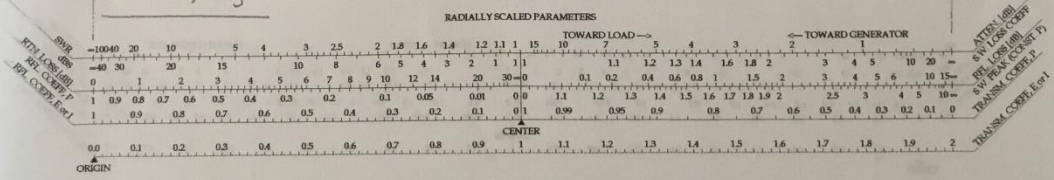
$Z_{50} = 1{,}00 + 0{,}00j$

$Y = 1 + 0{,}00j$




$Z_2 = 0{,}36 - 0{,}48j$

$Y = 1 + 1{,}34j$



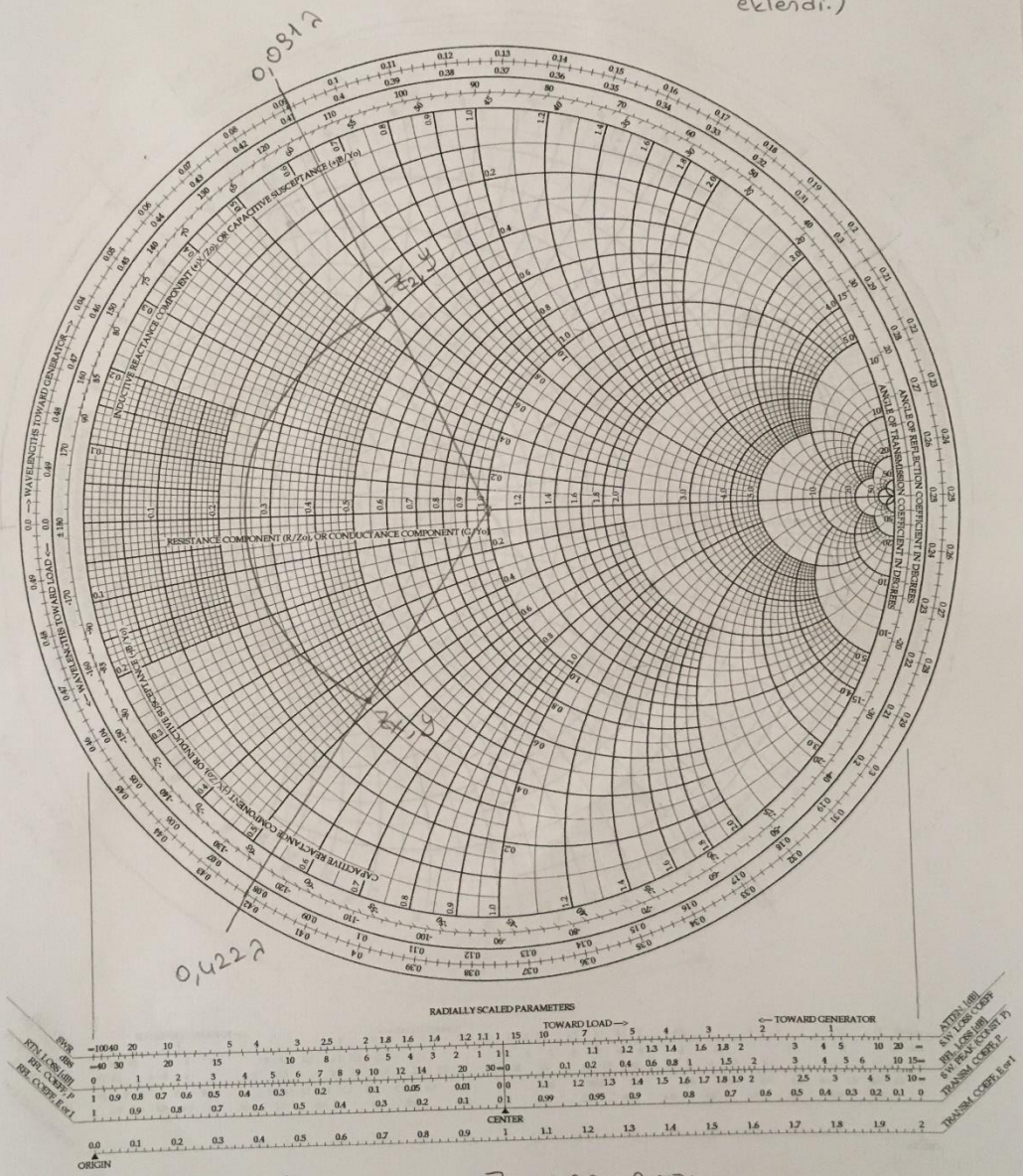
Eklenen hattın hat uzunluğunu bulmak

Hat, 0,422λ'dan başlıyor

Hat, 0,091λ'da bitiyor.

Hat uzunluğu =
0,091λ − 0,422λ + 0,5λ
= 0,169λ
(0,5λ, sıfır-geçiş nedeniyle eklendi.)

# Smith Chart




$Z_x = 0{,}36 - 0{,}48j$

$Y = 1 + 1{,}34j$

$Z_2 = 0{,}39 + 0{,}57j$

$y = 0{,}82 - 1{,}19j$

Kapasitörü acik Stub Line ile değiştirmek

Kapasitör, $Y_c' = 1{,}34j$ admitansa sahip.

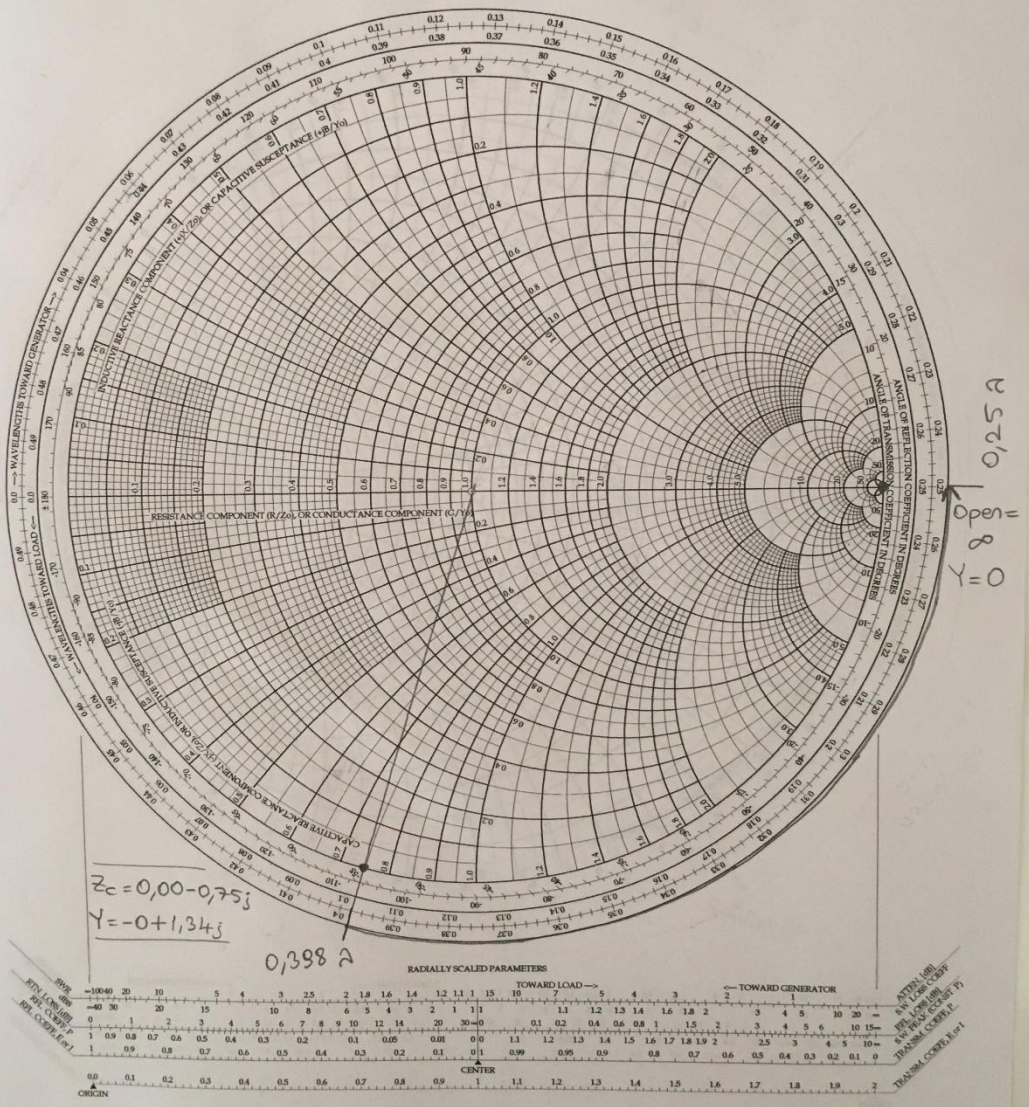
0,25 λ başla, 0,398 λ sınır girişinde dur.

Stub Line uzunluğu =

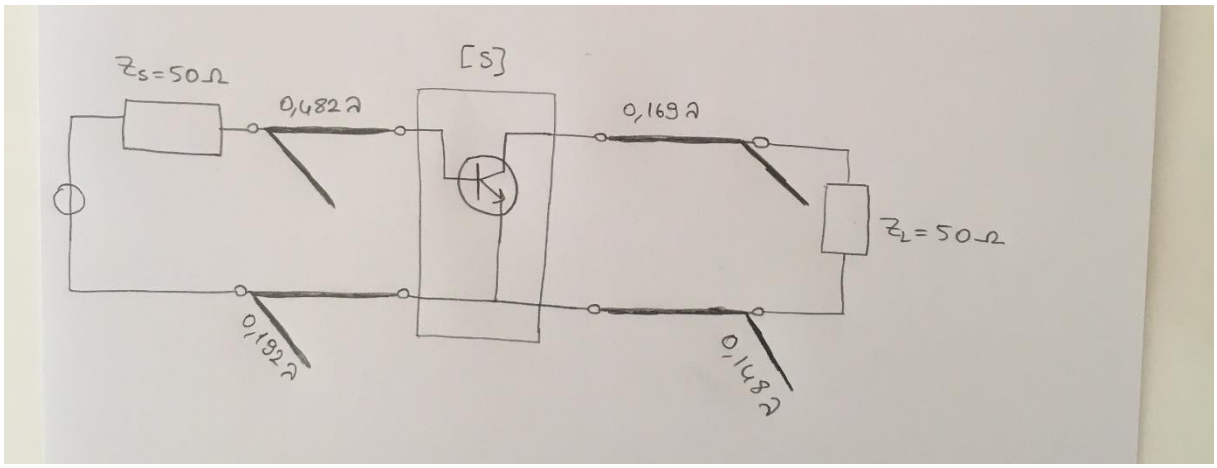
0,398 λ − 0,25 λ =

0,148 λ

# Smith Chart



Son Amplifikatör Devresi



$Z_2 = 0,13 - 0,33j$

$Y = 1 + 2,62j$

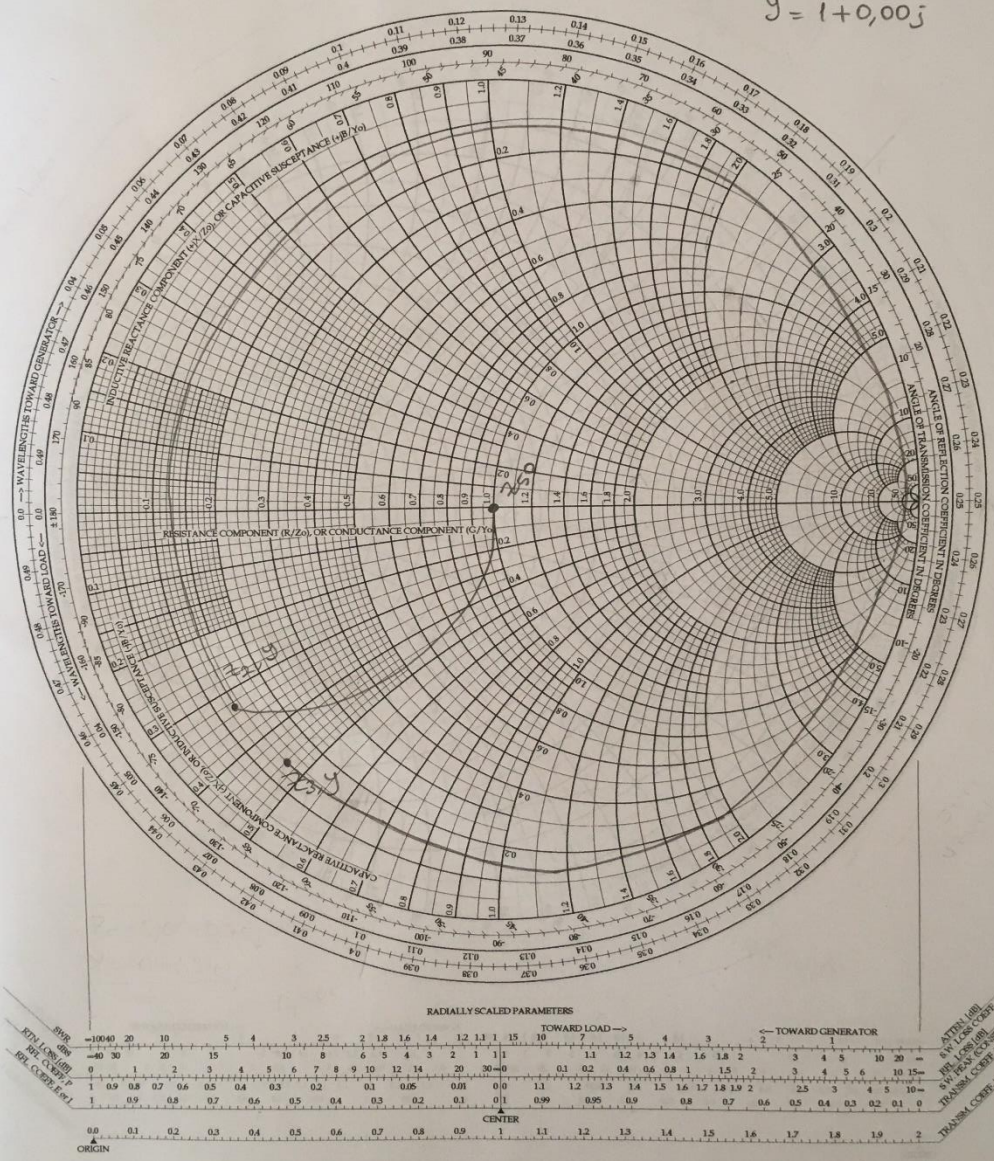
$Z_3 = 0,14 - 0,46j$

$Y = 0,59 + 1,88j$

# Smith Chart

$Z_{50} = 1,00 + 0,00j$

$Y = 1 + 0,00j$

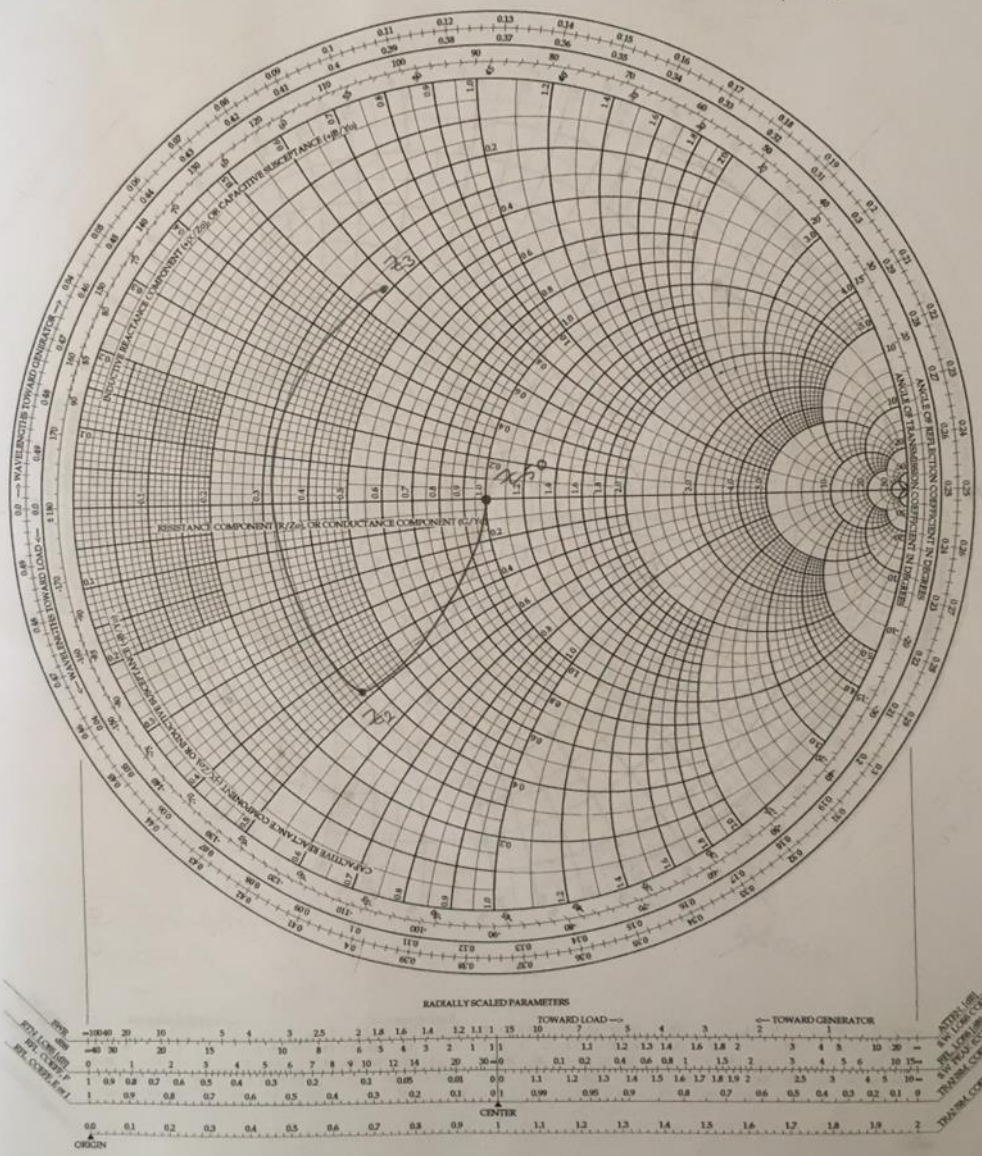


$z_3 = 0{,}39 + 0{,}57j$
$y = 0{,}81 - 1{,}19j$

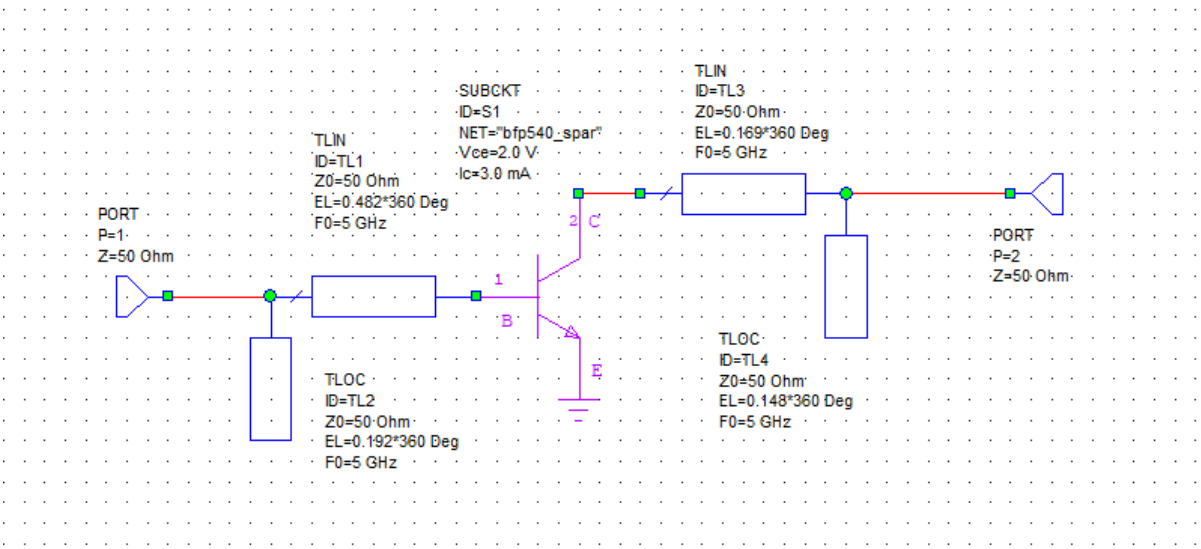
$z_2 = 0{,}36 - 0{,}48j$
$y = 1 + 1{,}34j$

# Smith Chart

$z_{50} = 1{,}00 + 0{,}00j$
$y = 1 + 0{,}00j$



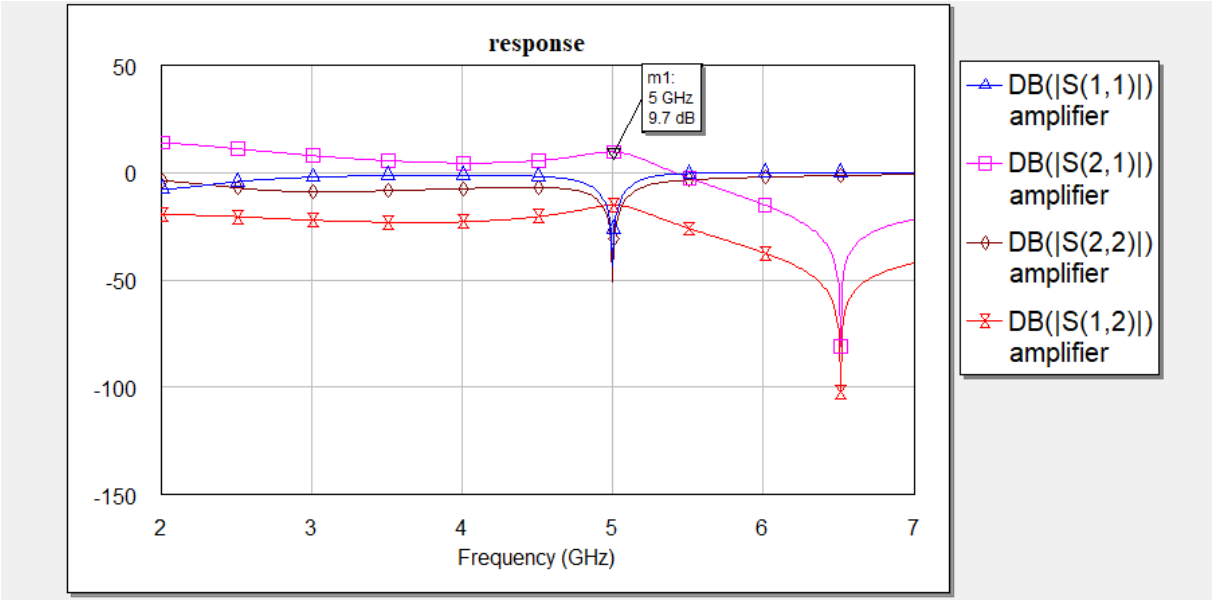
AWR Microwave Office Devre Kurulumu Şeması




Add New Graph > response

Add Measurement to “response” > S11,S12,S21,S22 ‘yi oluşturuyoruz.

>Analyze ile simülasyon sonucunu görüntülüyoruz.



Rectangular Plot Properties > Min : -50 Max: 20 ayarlarsak;