Master Thesis Presentation

Stripline Coil for Magnetic Resonance Tomograph

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• Introduction
• 3-D Simulation
• 90° hybrid
• Matching
• Experimental measurement
• Conclusion
• Futur work
Introduction

- Two parallel strip conductors of length ($\lambda/4$).
- Both are shorted from one side to ground and connected to Ports to the other side, such that the short Ends are not on the same ends.
- Both Ports are excited instantaneously and are $180^\circ$ out of phase.
• Due to the vicinity of the strip conductors, electromagnetic coupling occurs between them.

• Two modes of propagation appear even and Odd, and are different because of two different propagated medium.

• Superposition of both magnetic field of I1 & I2 leads to more homogeneous and less bending.
• $L = \lambda/4$ → Maximum Coupling

• This coupling causes to Power losses.

• Compensate the capacitive coupling using inductive coupling (Air inductor).

• The decoupling Inductor is mounted in a such way that its magnetic Field is perpendicular to the Field of the Coil.
View of the overall System

- Two modes
- Two different matching needed
- Couplings depends upon excitation
- Coupling upset the Input impedance
3-D Simulation

• Empire Simulator
• The main constant (7 Tesla) magnetic Field is in the direction of X-axis (direction of current distribution in the conductors of the coil), so that we are only interesting with the Field components that are perpendicular to the main Field to produce circulation magnetic Field.

  ➡️ Both Hy & Hz have to by investigated

• Otherwise we ignore half the power
Magnetic Field investigation

- Superposition of Fields

when the ground is bigger:

- surfaces are more flat
- Substrate collects the stray fields
When the ground is bigger
2-D representation of Fields gives more informations:

• Values and
• Locations
• decays with square of \((1/r)\).

• \textbf{Hz} decays with the \((1/r)\).

• Current density (Jx) distribution along the Coil.
Investigation of the input Impedance of the coil

Phantom at 5cm from the coil

Phantom at 10cm from the coil

Same results!! (high coupling)

Real part is negative??
Assume two side by side Coil

\[ Z_{12} = Z_{21} \]
\[ Z_{22} = Z_{11} \]  Symmetry

Equivalent Circuit
• 90° Hybrid

Substrate: Roger4003: $\varepsilon_r = 3.55, H = 1.52$ mm

• Sensitive to unbalanced loads.
• Used as: Splitter/Combiner/Phase shifter.
•90° Hybrid

Momentum Layout

Main characteristics:

m2
freq=300.0MHz
phase(S(3,1))=167.433

m1
freq=300.0MHz
phase(S(2,1))=-102.768

dB(S(1,1))
dB(S(3,1))

freq, MHz
• **90° Hybrid**

- Insertion loss = \(-0.472/2\)  
  = \(-0.236 \text{ dB}\)
• 90° Hybrid

Experimental Results

\[ I.L = -0.0975 \text{ dB} \]

\[ \begin{align*}
   & S_{(1,1)} \\
   & S_{(4,4)} \\
   & S_{(4,1)} \\
\end{align*} \]

freq, MHz

\[ \begin{align*}
   & \text{dB}(S_{(2,1)}) \\
   & \text{dB}(S_{(3,1)}) \\
   & \text{dB}(S_{(2,1)>)} \\
\end{align*} \]

freq, MHz

\[ \begin{align*}
   & m1 \\
   & \text{freq}=300.0 \text{MHz} \\
   & \text{DB}(S_{(2,1)})=-0.195 \\
\end{align*} \]

\[ \begin{align*}
   & m1 \\
   & \text{freq}=300.0 \text{MHz} \\
   & \text{phase}(S_{(2,1)})=-102.392 \\
\end{align*} \]

\[ \begin{align*}
   & m2 \\
   & \text{freq}=300.0 \text{MHz} \\
   & \text{phase}(S_{(3,1)})=167.833 \\
\end{align*} \]
• Matching

\[ Z_1 = 4.5 - 152.5j \quad \Omega \]
\[ Z_2 = 10.5 - 125j \quad \Omega \]
• Matching

[Diagram of a circuit with labeled components: series air inductor, parallel short stub, 90° coupler, matching, 90° phase shift, impedance of the coil.]
• *Experimental measurement*

Phantom
● Mode **W** is matched

● **Mode K** is not matched
Magnetic Nearfield measurement
• From Empire

• From experiment
• From Empire

• From experiment
Conclusion

• Coupling & decoupling must be handled carefully.

• Increasing the size of the ground and consequently the space between the conductor strips leads to smaller coupling and more homogeneous magnetic fields.
• Futur Work

• Using the concept of Inverted F antenna
• No need for matching elements.
• adjust the feed input point to get $Z_{in}=50$ ohm
THANK YOU VERY MUCH
Odd/Even mode