DESIGN OF A 3dB, 2.4 GHz EMBEDDED FILTER FOR A WIRELESS LAN

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RESEARCH EXPERIENCE

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PURPOSE
• DESIGN A BANDPASS FILTER
• KEEP ABREAST OF WHAT IS HAPPENING IN CURRENT ACADEMIC RESEARCH ENVIRONMENT
• DISCOVER CONNECTIONS BETWEEN RESEARCH AND CLASSROOM PRACTICES
• BE IN A BETTER POSITION TO ADVICE STUDENTS ABOUT ENGINEERING CAREERS
FRONT END FOR WIRELESS RECEIVER

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DEFINITIONS

• RF Front End Receiver: consists of antenna, filter, low noise amplifier, mixer (VCO- voltage control oscillator), filter, and AD Converter (analog digital).

• Band Pass Filter: a filter that passes frequencies in a desired range and attenuates frequencies below and above that range

• Bandwidth: Frequency at which the received power is half of the transmitted power.

• S or Scattering Parameters: reveal how much power or voltage is reflected or transmitted when there is an incident wave or when power or voltage is delivered to a network.

  \[ S_{11} = \frac{b_1}{a_1}, \quad b_1 \text{ is the reflected wave and } a_1 \text{ is the incident wave. A high } b_1 \text{ is undesirable since most of the signal will be reflected.} \]

  \[ S_{21} = \frac{b_2}{a_1}, \quad b_2 \text{ is power out at port 2 while } a_1 \text{ is power in at port 1. A high } b_2 \text{ is desirable since most of the power incident at port 1 will be transmitted through port 2. An efficient filter has a small } S_{11} \text{ and a large } S_{21}. \]

• Quality Factor – Q: is a measure of the idealness of a circuit from the perspective of internal energy loss. A large Q indicates a more ideal behavior of a circuit.

• INDUCTOR: IS A PIECE OF CONDUCTOR WIRE THAT IS SHAPED IN A COIL

• CAPACITOR: IS A SPECIAL KIND OF BREAK IN THE CIRCUIT THAT ALLOWS AC CURRENT TO PASS. IT CONSISTS OF TWO PARALLEL PLATES SEPARATED BY DIELECTRIC.
ARCHITECTURE OF FILTER BEFORE Q’S ARE ADDED - ADS
FILTER SCHEMATICS AND SIMULATION RESULTS
AFTER Q’S ARE ADDED -ADS 8nH

\[ Z = 50 \, \text{Ohm} \]

Term 1
Num = 1
Term 3
Z = 50 Ohm
Num = 2

freq = 2.120 GHz
dB(S(2, 1)) = -0.520
FILTER SCHEMATICS AND SIMULATION RESULTS

ADS 6nH

**Equation:**

$$m^2$$

**Frequency:**

freq $= 2.430$ GHz

$$\text{dB}(S(2,1)) = -0.001$$
FILTER AND SIMULATION RESULT - SONNET
FINDINGS

• The ADS is a circuit simulator that allows you assemble components then simulate the circuit. It is a faster simulation software than the Sonnet software.
• If the desired results are not obtained from the simulation then the components are tweaked to obtain the desired results as shown on the circuits with 8 nH and 6 nH inductors.
• The size of the inductor is decreased if the center frequency is too low or increased if it is too high.
• The Sonnet software allows you to map electrical parameters (C, L) to geometrical parameters.
OVERALL ACCOMPLISHMENTS

• Inductors and capacitors with high Q’s were designed

• A pass band filter was successfully designed and simulated

• Simulation results of the filter shows that it has an insertion loss of -.84575 dB, and insertion loss of 0 is ideal.

• The bandwidth of the filter is 2.34 - 2.44 GHz (100MHz) with the highest frequency being 2.4 GHz. This shows that most of the signal received at the input port will be transmitted through the output port.
FILTERING AC WITH CAPACITORS

Goal: Students will investigate the properties of capacitors and discover that capacitors block DC and filter AC.

- Slide one shows a voltage of 3.93 V across the capacitor.
- Slide shows a voltage of 0.04 V across the resistor. The capacitor has effectively blocked the voltage from getting to the resistor.
- It can be concluded that capacitors block DC from going through the circuit.
FILTERING AC WITH CAPACITORS

**Goal:** Students will investigate the properties of capacitors and discover that capacitors block DC and filter AC.

- Slide one shows a voltage of 0.0 V
- Slide two shows a voltage of 11.9 V
- It can be concluded that capacitors allow AC to pass through uninterrupted.
Lesson: Charging and discharging capacitors

Goal: Students investigate the role of resistors and capacitors in a circuit and ideas about the RC product and time constant.

• The slide shows the capacitor discharging.

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