Q factor

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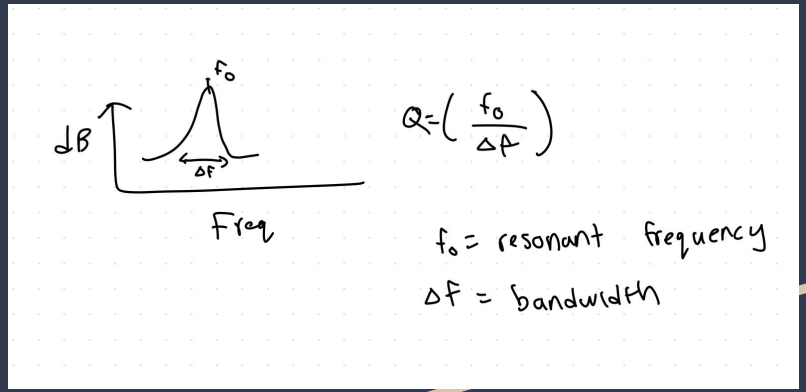
What is Q factor?



Definition: Measures energy storage vs. energy loss in resonant systems.

Meaning of High Q:

- Sharp, narrow peak in frequency response.
- Indicates low energy loss (good for MRI coils)

-Meaning of Low Q:

- Broad peak in frequency response.
- Indicates higher energy dissipation

Significance of Q: Determines system efficiency and frequency selectivity.

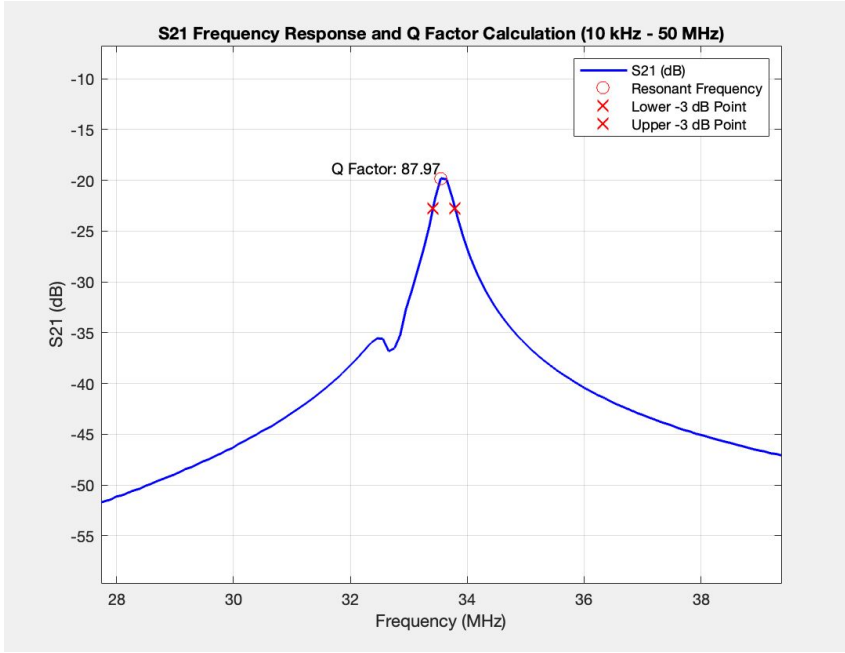
My Q factor testing

Objective:

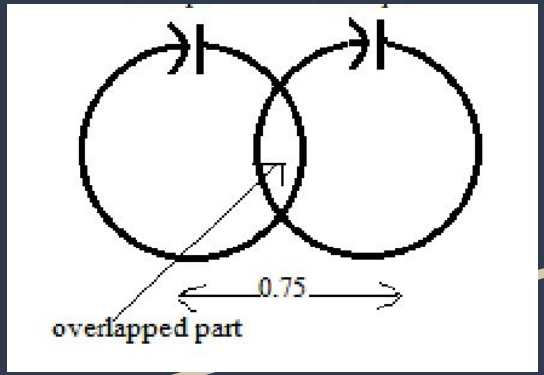
- To measure the Q-factor of future coils.
- To compare the results from the NanoVNA with those obtained from a bench-top VNA for accuracy and consistency.
- To establish a reliable method for testing coil decoupling and quality.

How I did it:

Placed a decoupled loop above a coil with an approximated Q factor of 90-100



Another example for decoupling

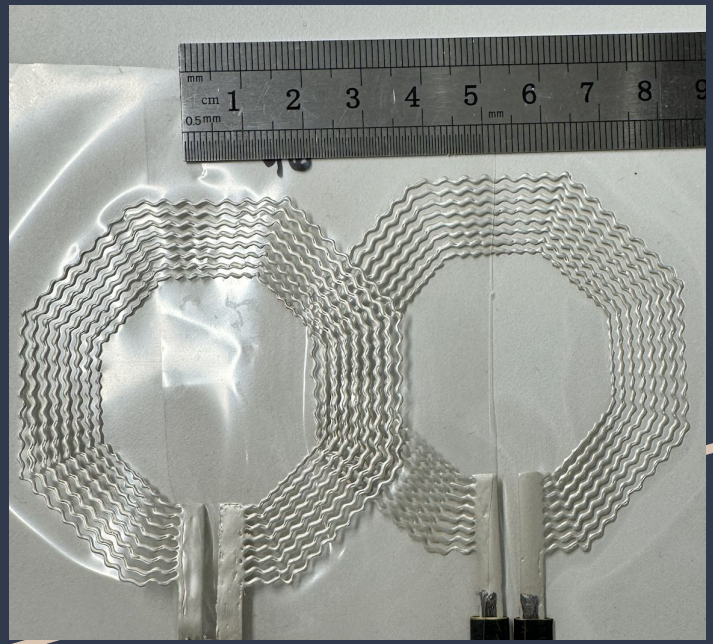


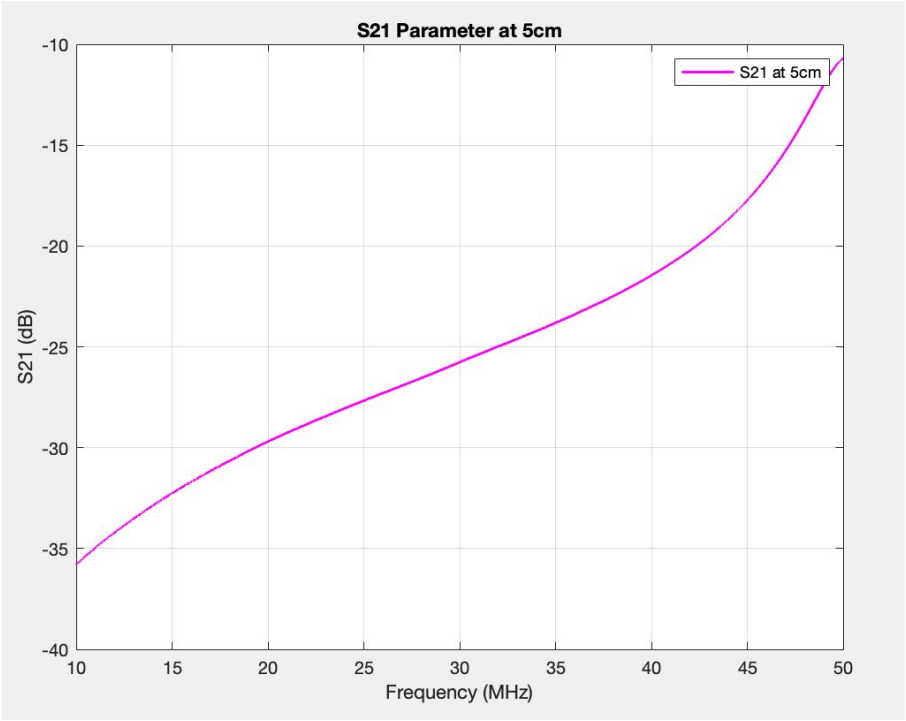
- The next experiment aims to find the minimum overlapping distance between loops to minimize coupling (S21).

- This ensures the loops are effectively decoupled, allowing independent operation and optimal performance of the coils.

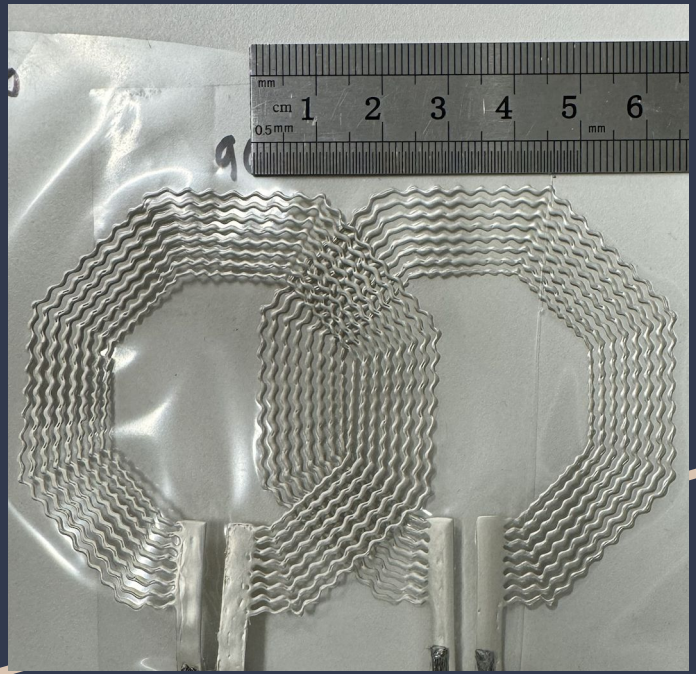
- We are trying to highlight the importance of decoupling in applications like MRI coil design, where minimal interference is critical for image quality.

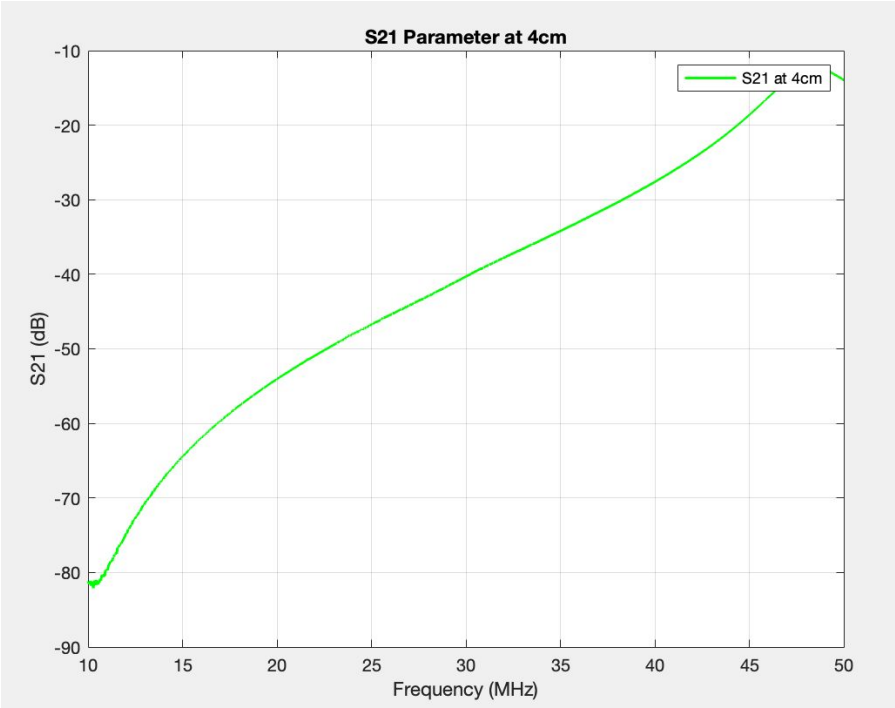
5cm


mm
cm 1 2 3 4 5 6 7 8
0.5 mm

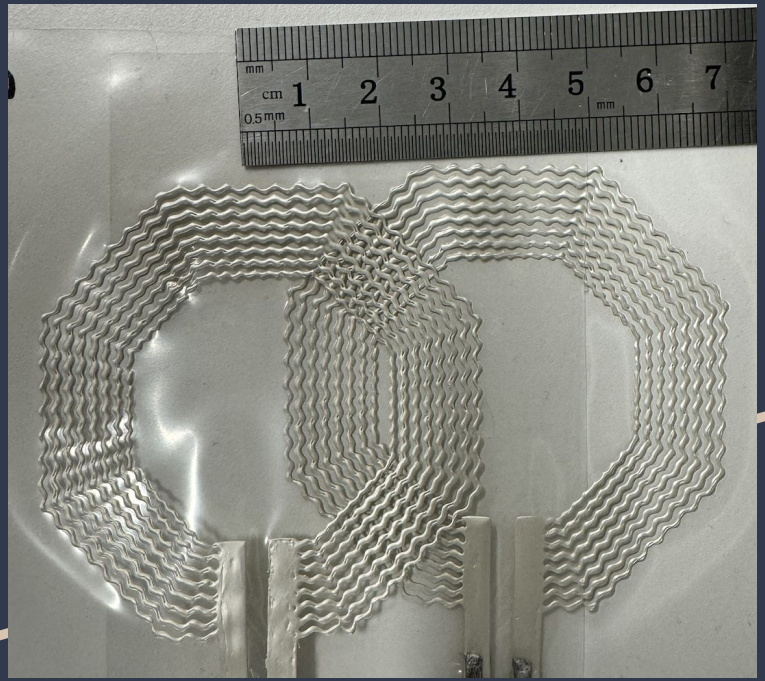

S21 Parameter at 5cm
S21 at 5cm
S21 (dB)
-10
-15
-20
-25
-30
-35
-40
10
15
20
25
30
35
40
45
50
Frequency (MHz)

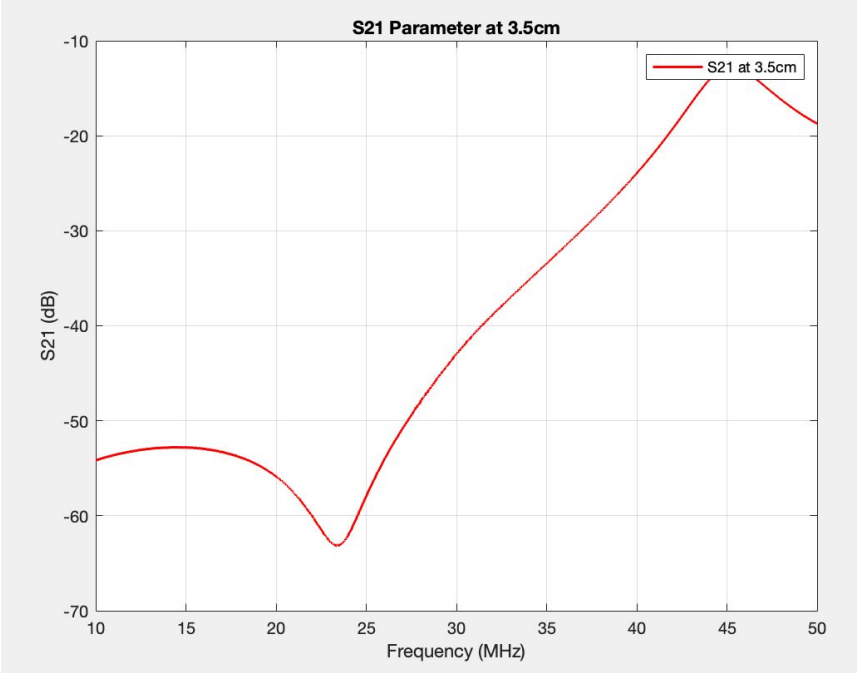
4cm


mm
cm 1 2 3 4 5 6
0.5mm
mm

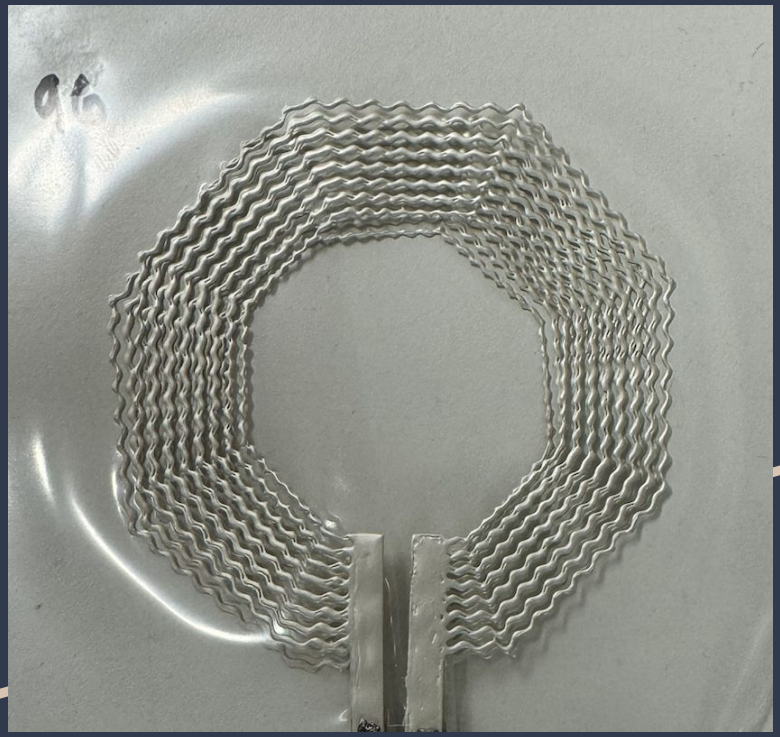

S21 Parameter at 4cm
S21 at 4cm
S21 (dB)
-10
-20
-30
-40
-50
-60
-70
-80
-90
10
15
20
25
30
35
40
45
50
Frequency (MHz)

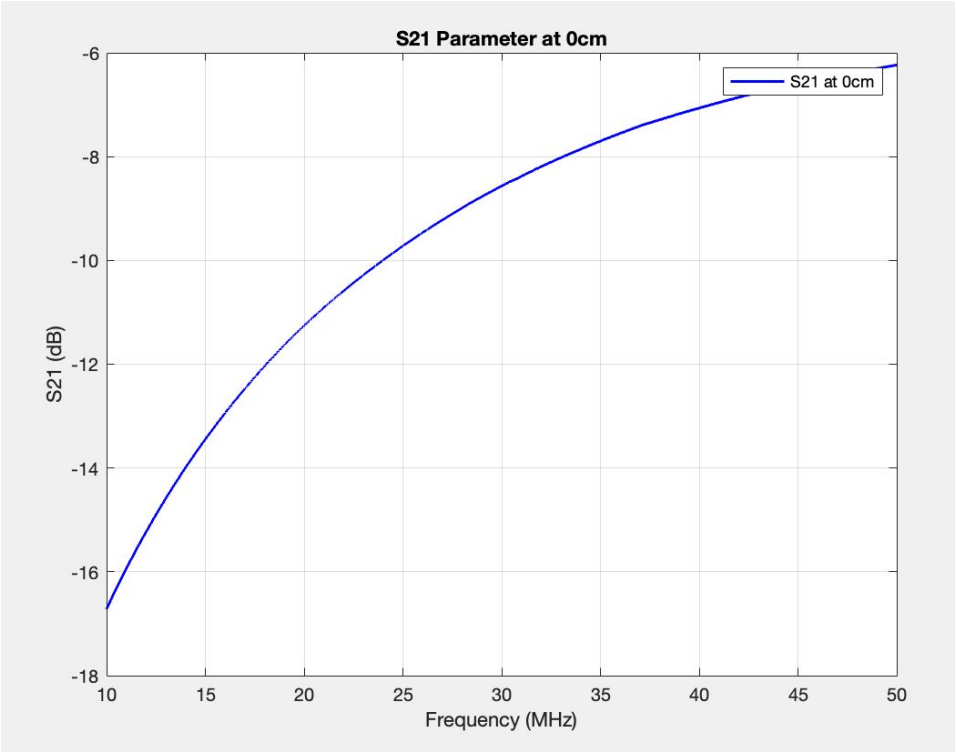
3.5cm


mm
cm 1 2 3 4 5 6 7
0.5mm
mm


S21 Parameter at 3.5cm
S21 at 3.5cm
S21 (dB)
-10
-20
-30
-40
-50
-60
-70
10
15
20
25
30
35
40
45
50
Frequency (MHz)

0cm




S21 Parameter at 0cm
S21 at 0cm
S21 (dB)
-6
-8
-10
-12
-14
-16
-18
10
15
20
25
30
35
40
45
50
Frequency (MHz)

Results

- Tested loop spacing at 5 cm, 4 cm, 3.5 cm, and 0 cm to evaluate coupling effects on Q factor.
- 3.5 cm spacing produced the highest Q factor efficiency, indicating optimal coil decoupling.
- At 5 cm and 4 cm, coupling was still present, reducing Q factor performance.
- At 0 cm overlap, coils showed strong coupling and significant signal interference.
- Results confirm that 3.5 cm is the optimal overlap distance for minimizing interference and maximizing MRI coil efficiency.
- Findings will guide future coil decoupling designs to improve image clarity and reduce energy loss.