Tests on Various Duplexer Coupling Loops

J. Audet
VE2AZX

- 146 MHz Notch-Bandpass Cavities with 600 KHz TX-RX Separation.

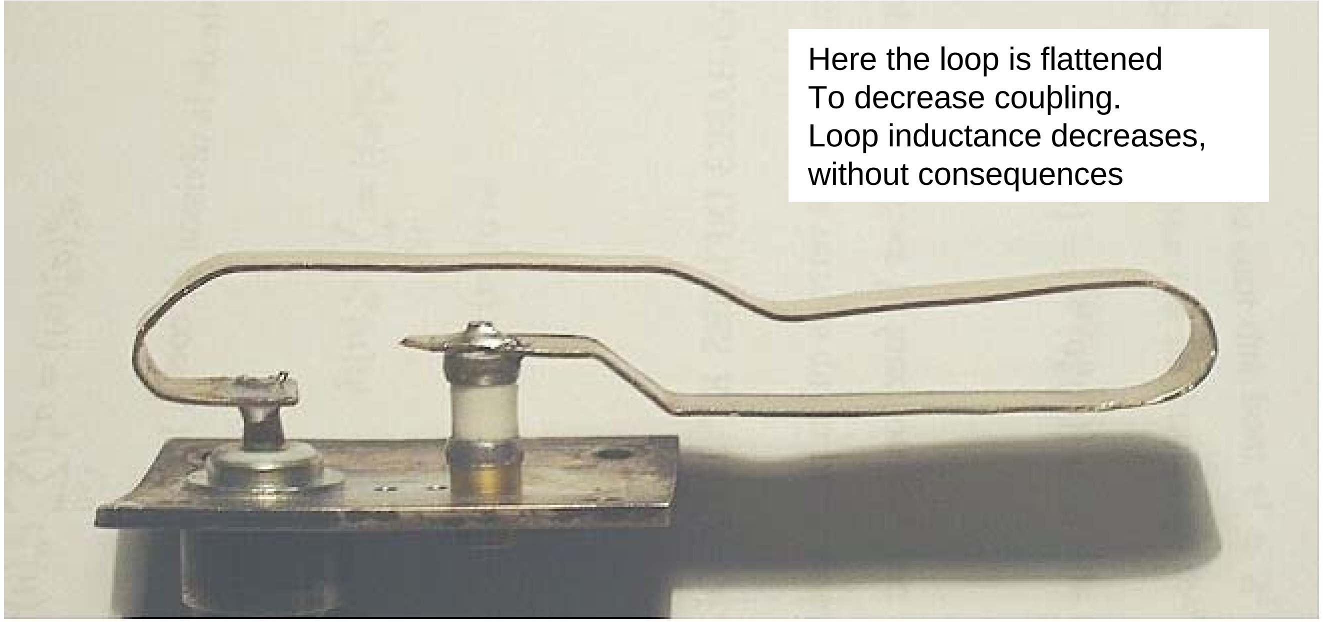
- Loops uses a Series Capacitor

- Loop Shape must be modified to get the desired insertion loss at the bandpass frequency, when the loop cannot be rotated to change the coupling

- Loops Shapes were Tested for Insertion Loss at the Bandpass Frequency and Q factor

- Q Factor Measured Using the Excel file: Calc_Series_RLC.xls and by Using a Tee at the Connector and with the Cavity Cylinder Removed.

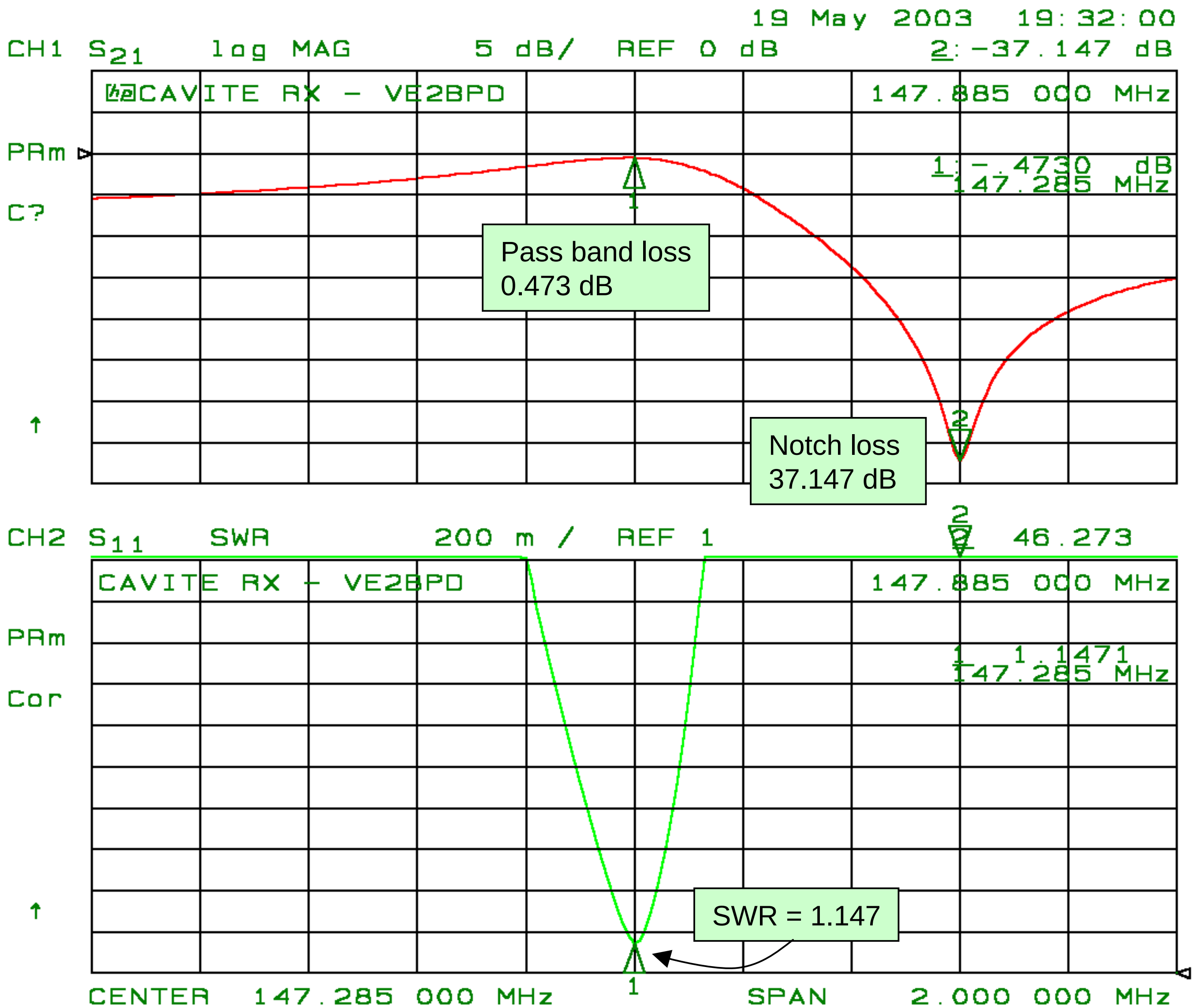
RX CAVITY



L = 59.5 nH
C = 19.5 pF
Q = 396

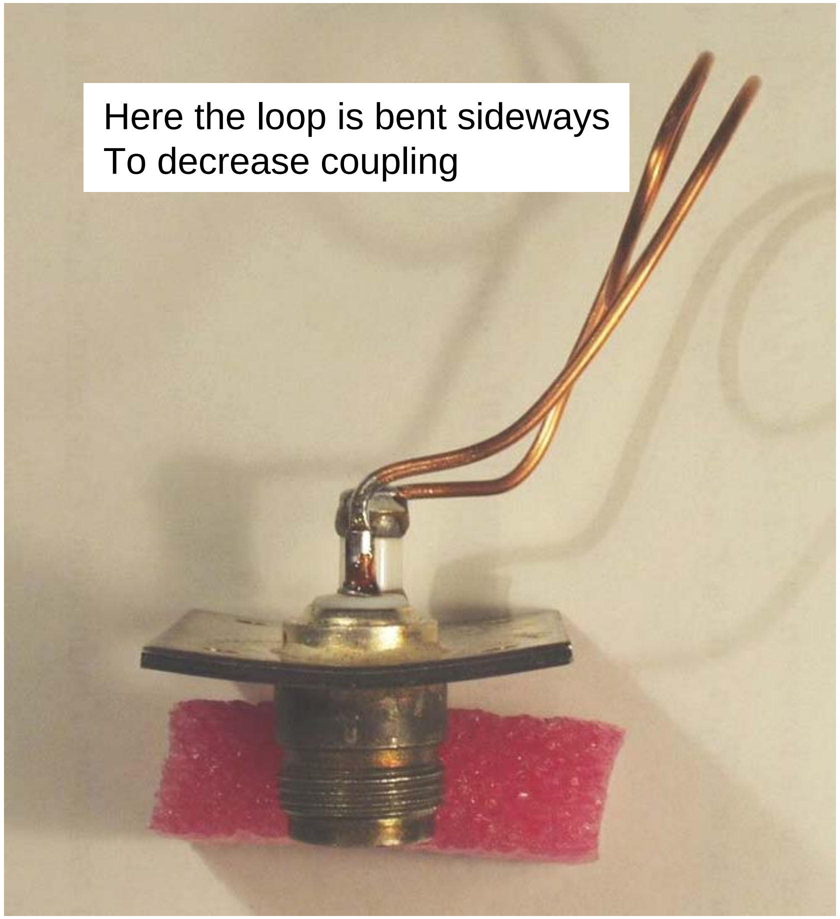
This coupling loop gives ~ 0.5 dB at the passband and –36 à –37 dB at the notch notch

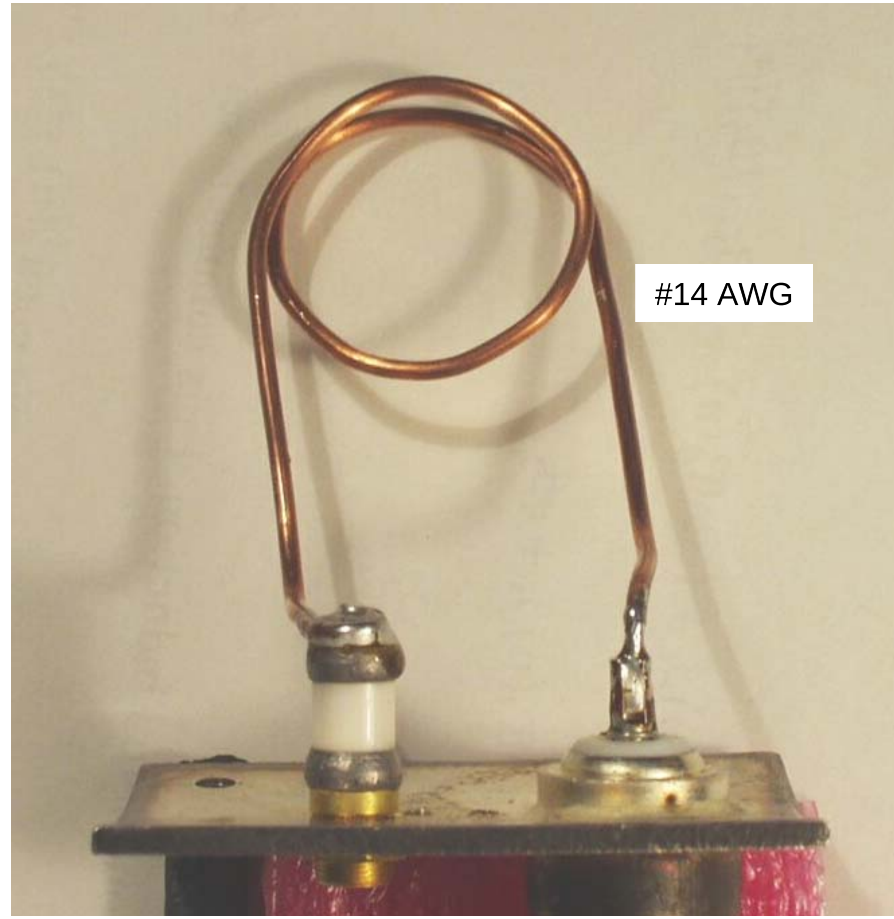
RX CAVITY



19 May 2003 19:32:00
CH1 S21 log MAG 5 dB/ REF 0 dB 2: -37.147 dB
CAVITE RX - VE2BPD
147.885 000 MHz
PRm
C?
1: -.4730 dB
147.285 MHz
Pass band loss
0.473 dB
Notch loss
37.147 dB
CH2 S11 SWR 200 m / REF 1 46.273
CAVITE RX - VE2BPD
147.885 000 MHz
PRm
Cor
1 1.1471
147.285 MHz
SWR = 1.147
CENTER 147.285 000 MHz SPAN 2.000 000 MHz

TX CAVITY - loop 1

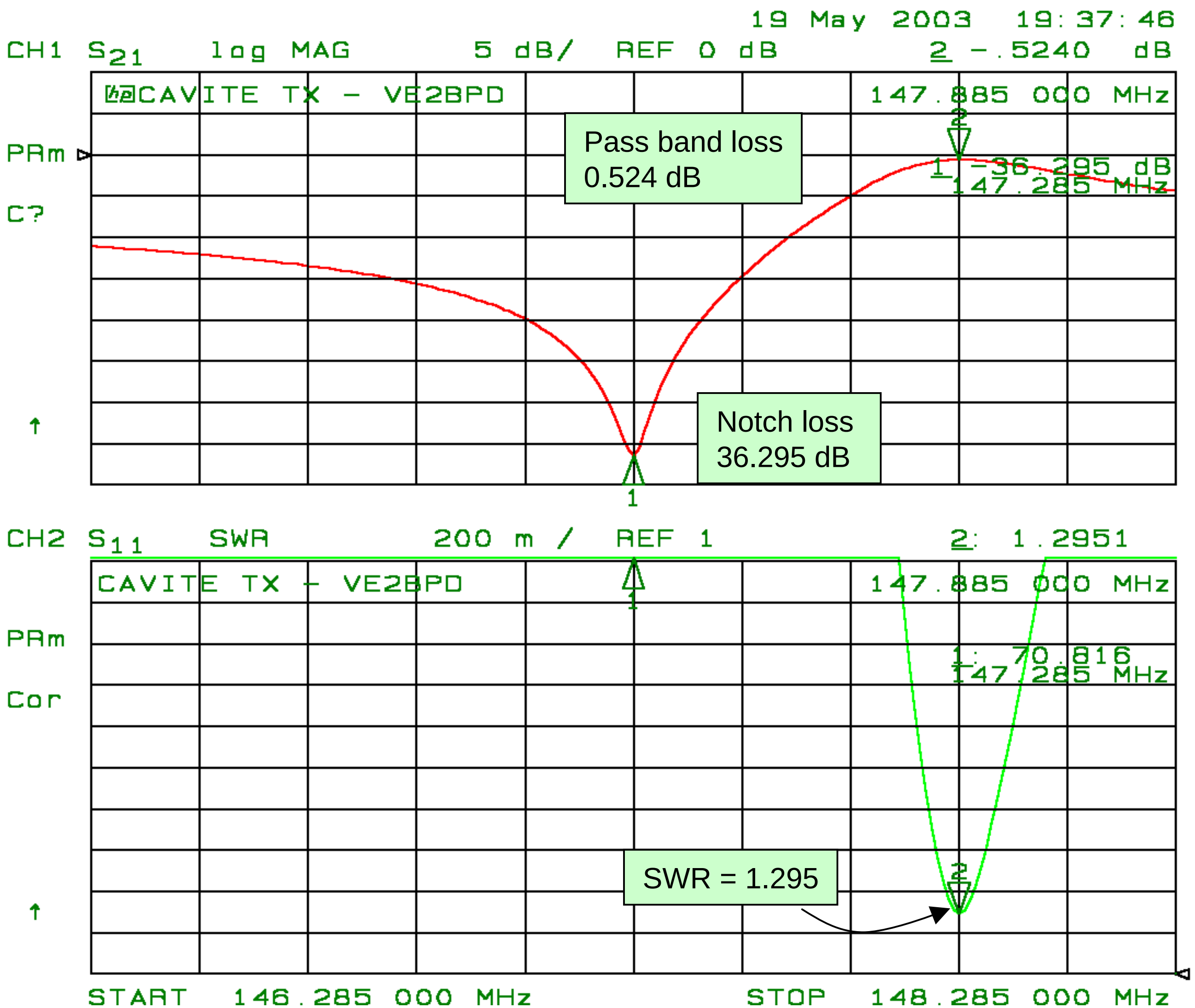




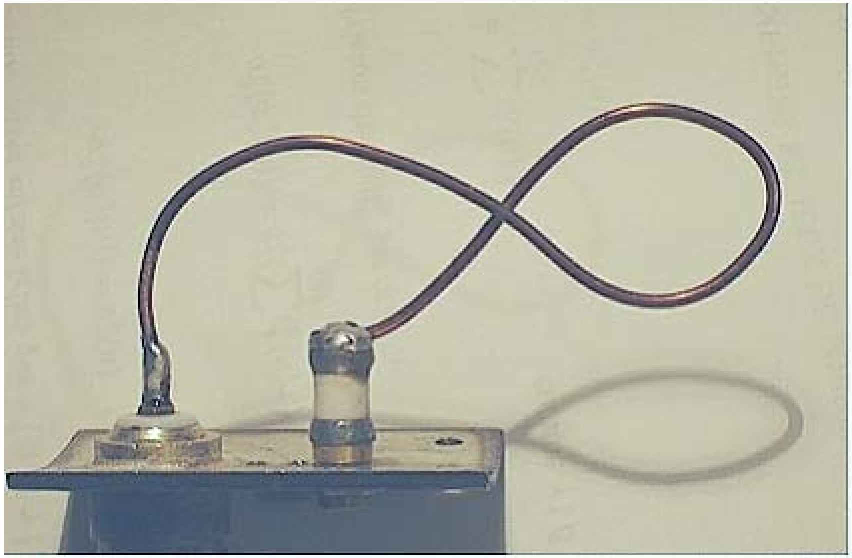
L = 160.1 nH
C = 7.28 pF
Q = 707
ESR = 0.21 ohms

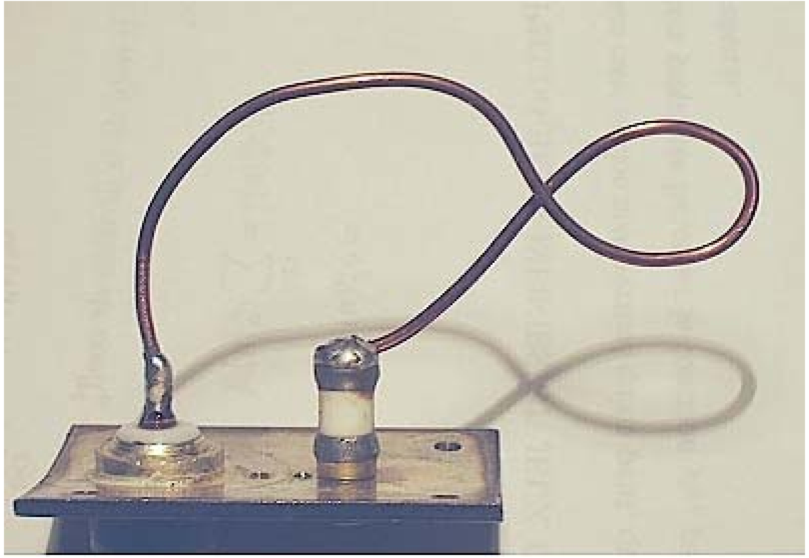
Note the high Q here.

TX CAVITY - loop 1



TX CAVITY - loop 2





5.2 dB passband loss
The coupling is weak since both loops have about the same area.

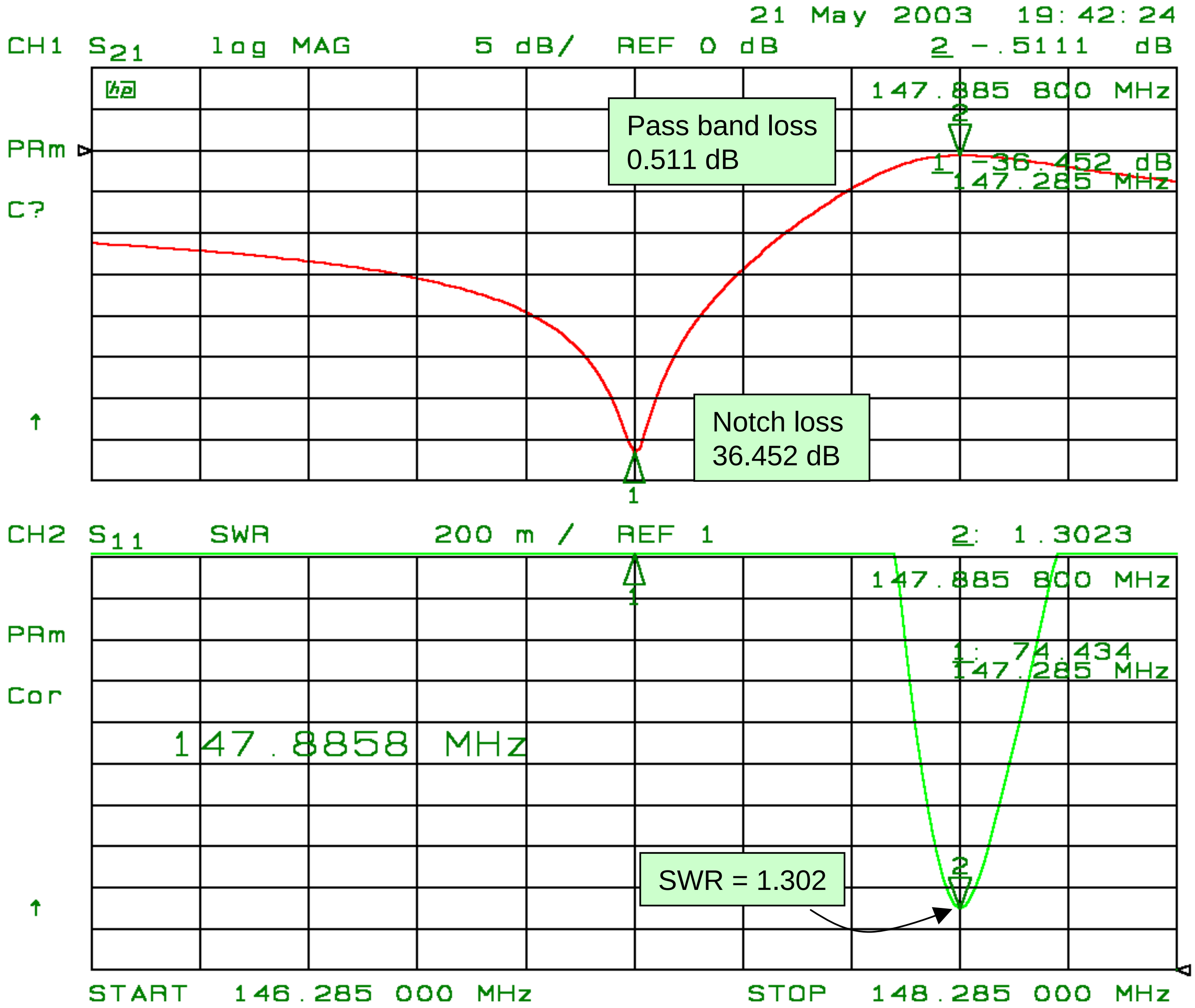
0.5 dB passband loss

<u>This is the loop that was used.</u>

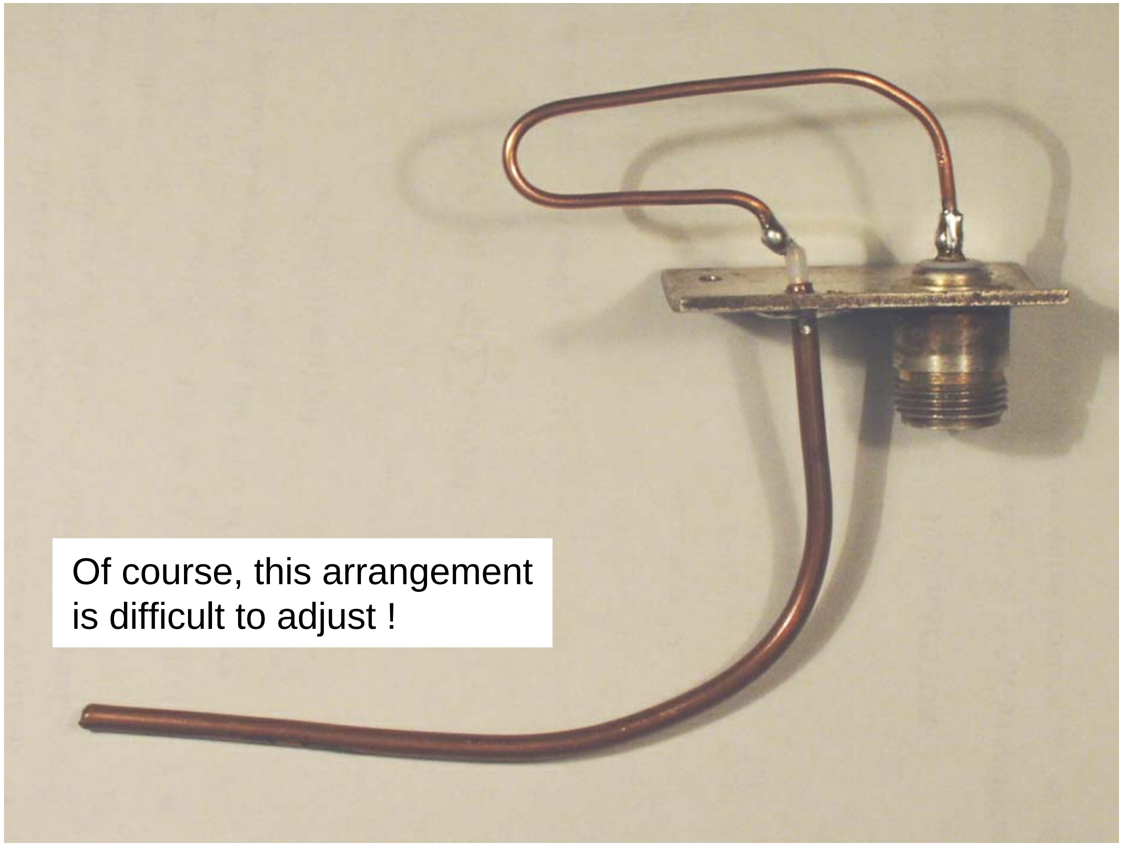
NOTE: This loop with an 8 shape allows control of the coupling by changing the area of each loop.
The magnetic field in each loop has opposite directions and partly cancel each other, reducing the inductance and coupling

L = 103.2 nH
C = 11.3 pF
Q = 565
ESR = 0.169 ohms

TX CAVITY - loop 2



RX CAVITY with semi-rigid coax for the capacitor

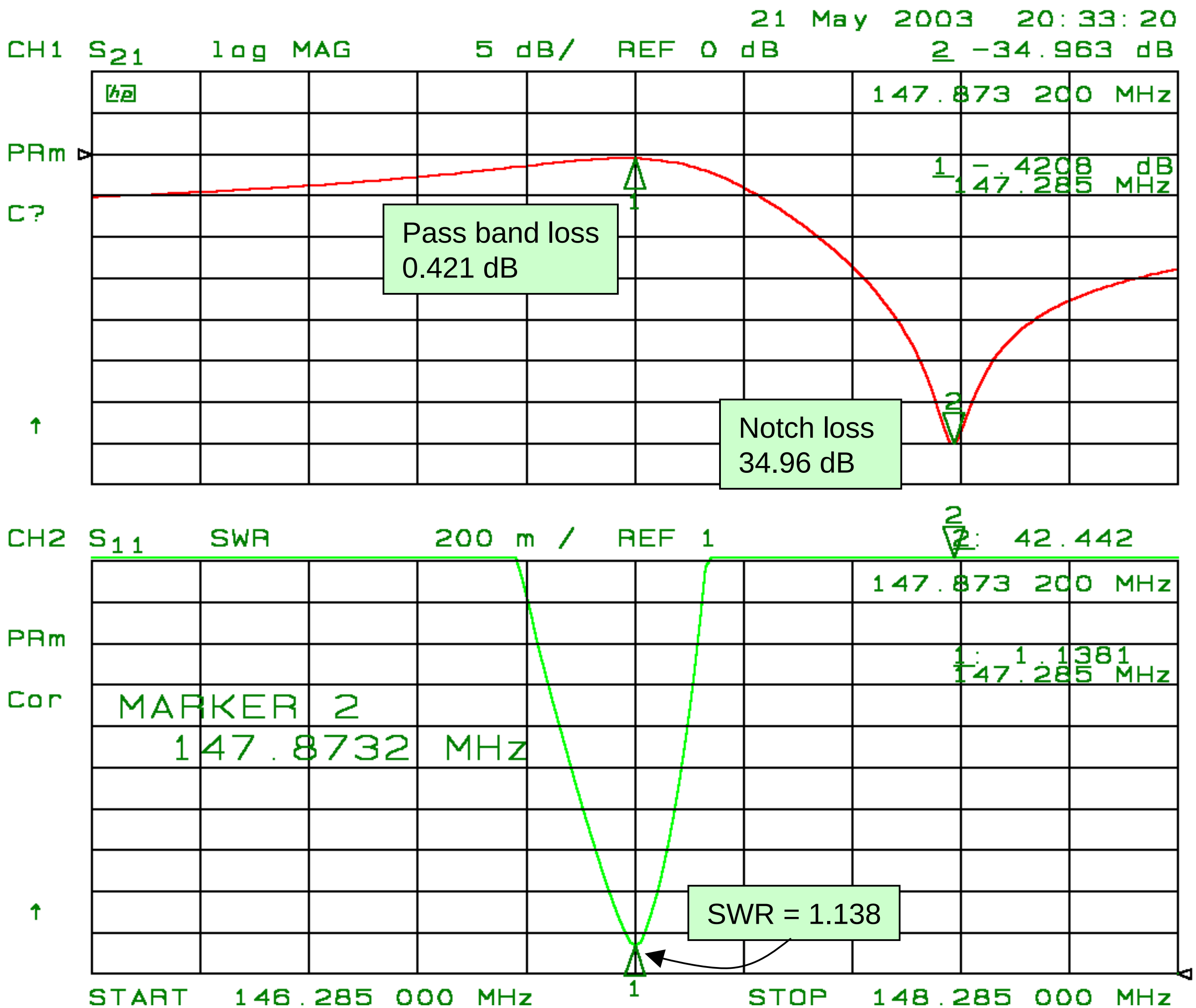


Of course, this arrangement is difficult to adjust !

Note the lower Q here, but still OK.

L = 85 nH
C = 16 pF
Q = 381
ESR = 0.191 ohms

RX CAVITY with semi-rigid coax for the capacitor



Remember:

The size of the coupling loop is not that important.
You can make a bigger coupling loop and place it further away from the center resonator.
If the coupling is the same then big or small it makes little difference.

The size is not important, but the coupling is.
The only impedance associated with the loop itself, is its self inductance, which is not critical.
There are no 50 ohm loops as such.
Consider the bandpass cavity with an input and an output loop.
At the resonant frequency the impedance seen at the input will be close to 50 ohms IF the output is also terminated into 50 ohms.
Basically there is a one to one impedance transformation at the resonant frequency, assuming that the loops have the same number of turns and the bandpass filter is adjusted (read: coupling) for reasonable values of insertion loss.
So with the output loop terminated into 75 ohms, the input impedance will also be around 75 ohms.
What causes the input impedance to deviate from the output ?
It's the insertion loss. The higher the insertion loss, the more the input impedance will deviate from the output.
The losses associated with the cavity resonator are the main contributor to insertion losses.
Keep in mind that insertion loss is closely related to the input/output impedances.
In general, the lower the insertion losses, the lower the SWR will be at the input.