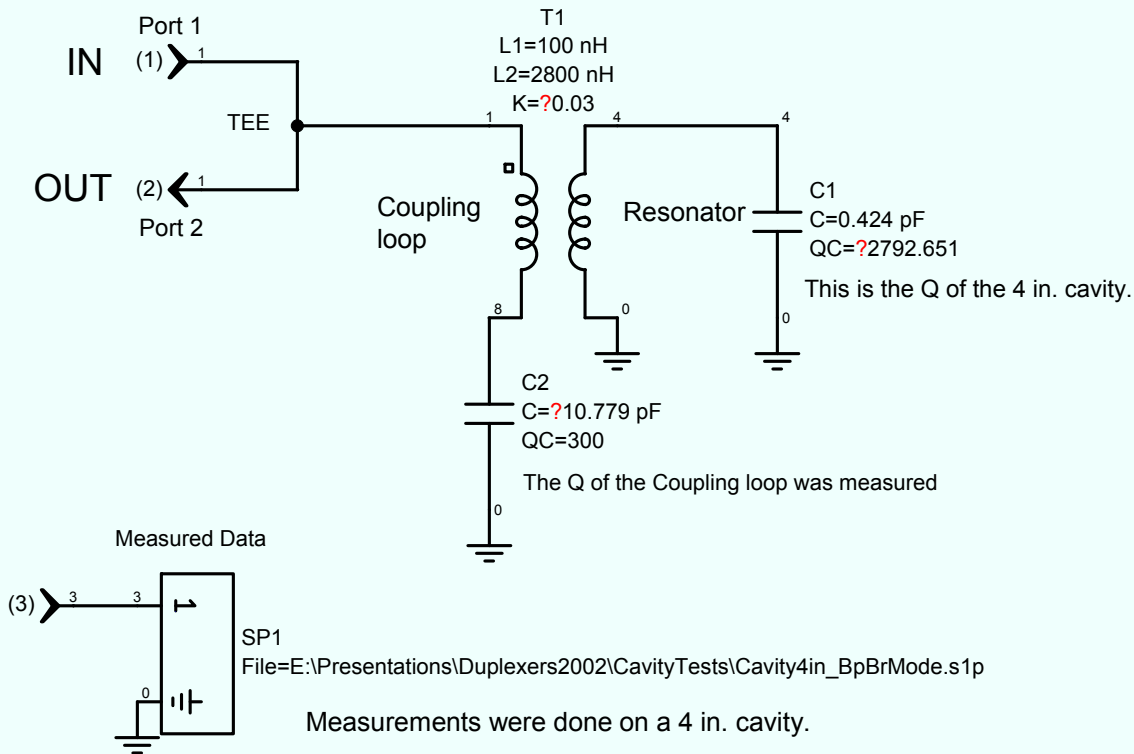# Bandpass-Band Reject (Bp-Br) Cavity Resonators

- Simulations vs Measurements

- Impedance plots showing how it works
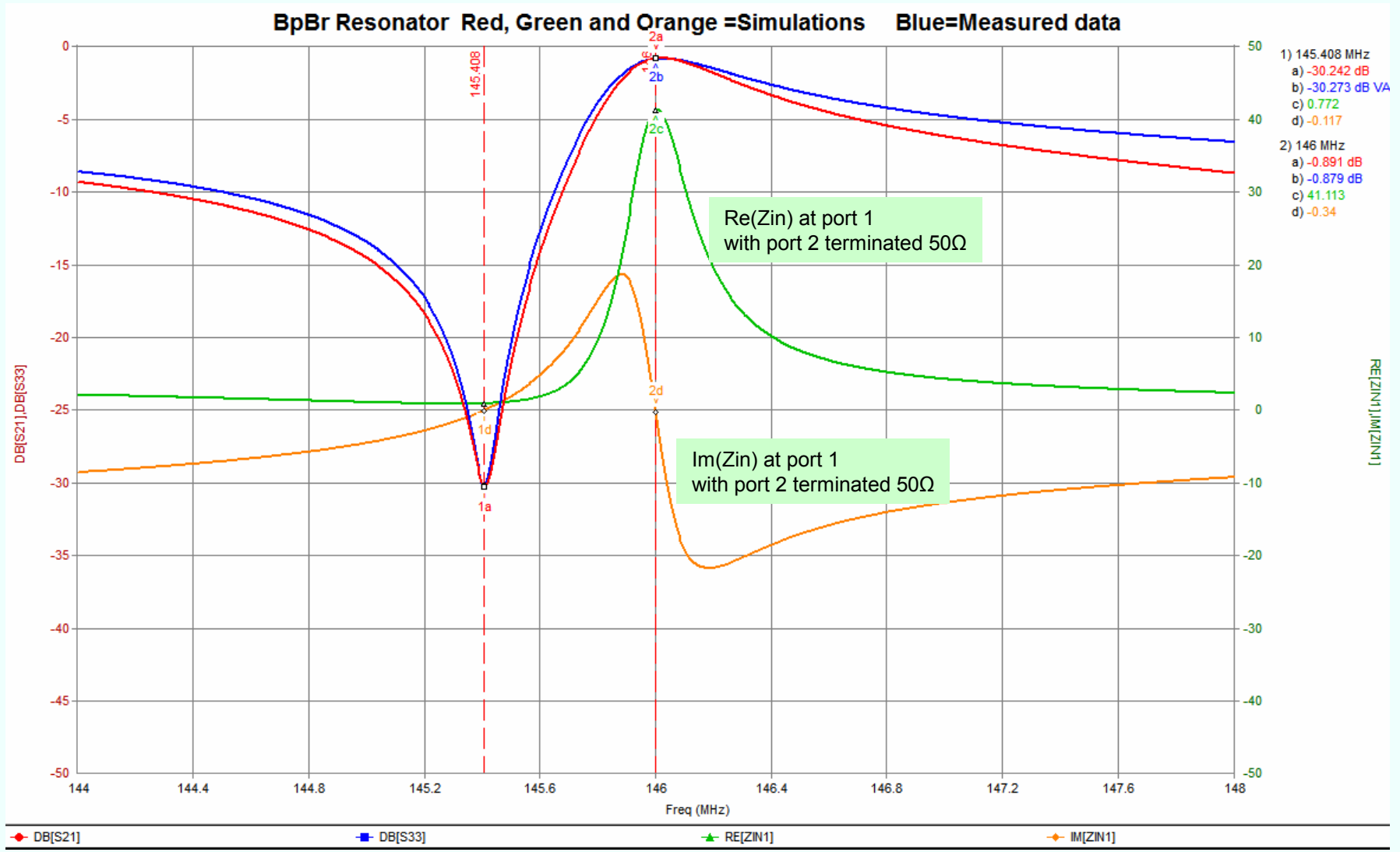
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June 2017
ve2azx.net

1

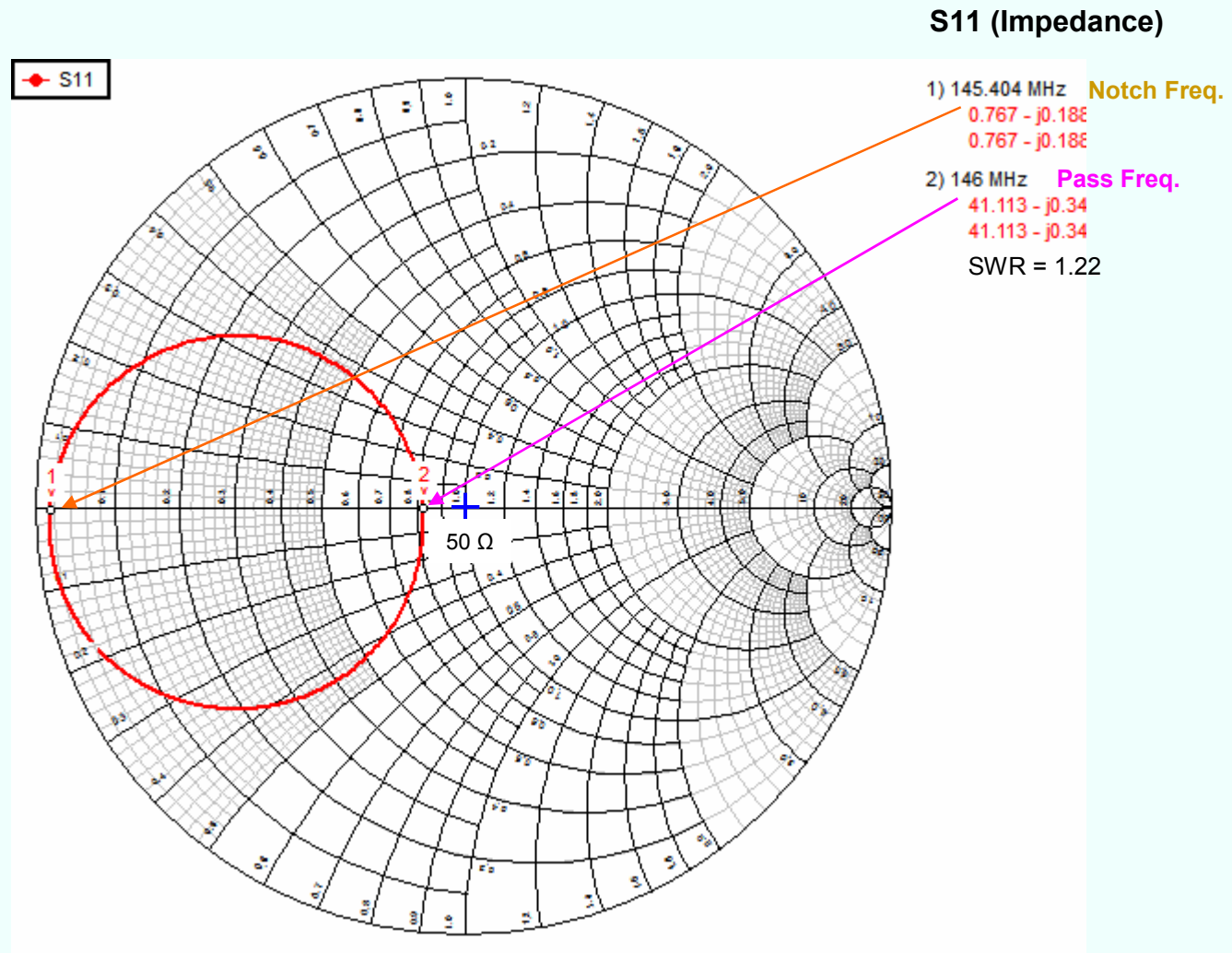# Circuit used for simulating the Bp-Br Cavity Resonator

Value of C2, Coupling K and C1 Q factor were adjusted to match measured data at the bandpass and notch frequencies.

Port 1

IN   (1) — 1

TEE

OUT   (2) — 1

Port 2

T1
L1=100 nH
L2=2800 nH
K=?0.03

Coupling loop

Resonator

C1
C=0.424 pF
QC=?2792.651

This is the Q of the 4 in. cavity.

C2
C=?10.779 pF
QC=300

The Q of the Coupling loop was measured

Measured Data

(3) — 3 — 3

SP1
File=E:\Presentations\Duplexers2002\CavityTests\Cavity4in_BpBrMode.s1p

Measurements were done on a 4 in. cavity.

Note: Although the simulation s/w uses one port,
it's really the measured S21. See the blue curve next sheet.

2

BpBr Resonator Red, Green and Orange =Simulations   Blue=Measured data

Re(Zin) at port 1
with port 2 terminated 50Ω

Im(Zin) at port 1
with port 2 terminated 50Ω

1) 145.408 MHz
a) -30.242 dB
b) -30.273 dB VA
c) 0.772
d) -0.117

2) 146 MHz
a) -0.891 dB
b) -0.879 dB
c) 41.113
d) -0.34

145.408

DB[S21],DB[S33]

RE[ZIN1],IM[ZIN1]

Freq (MHz)

DB[S21]   DB[S33]   RE[ZIN1]   IM[ZIN1]

3

As seen at the Tee IN – OUT, with one side terminated in 50Ω

S11 (Impedance)

- ◆ S11

1) 145.404 MHz   **Notch Freq.**
   0.767 – j0.188
   0.767 – j0.188

2) 146 MHz   **Pass Freq.**
   41.113 – j0.34
   41.113 – j0.34

SWR = 1.22

50 Ω

Impedance seen at the coupling loop, based on the previous circuit (page 2)

T1
L1=100 nH
L2=2800 nH
K=?0.03

See: NotchBandpassSingleLoop.wsp

Coupling loop input (1)

C1
C=0.424 pF
QC=?2792.651

C2
C=?10.779 pF
QC=300

The Q of the Coupling loop was measured
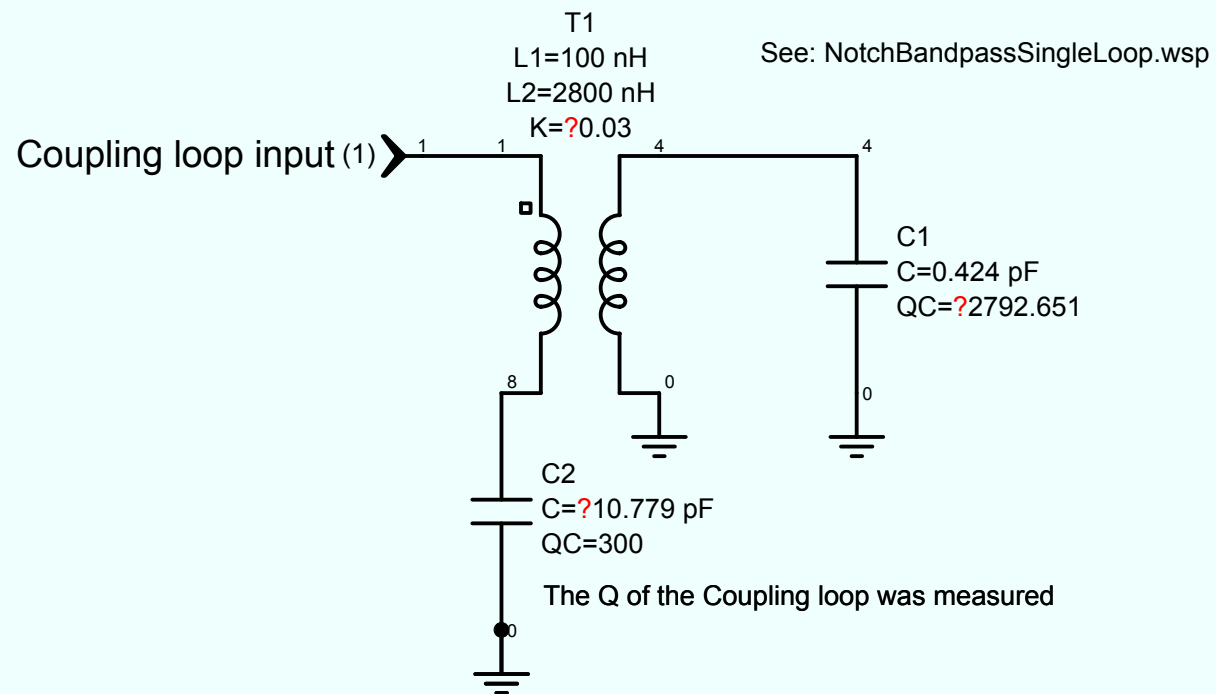
Complex impedance seen at the Coupling loop input

1) 145.4 MHz **Notch Freq.**
a) 0.772
b) -0.266

2) 146 MHz **Pass Freq.**
a) 230.894
b) -10.734

Re(Zin)

Im(Zin)
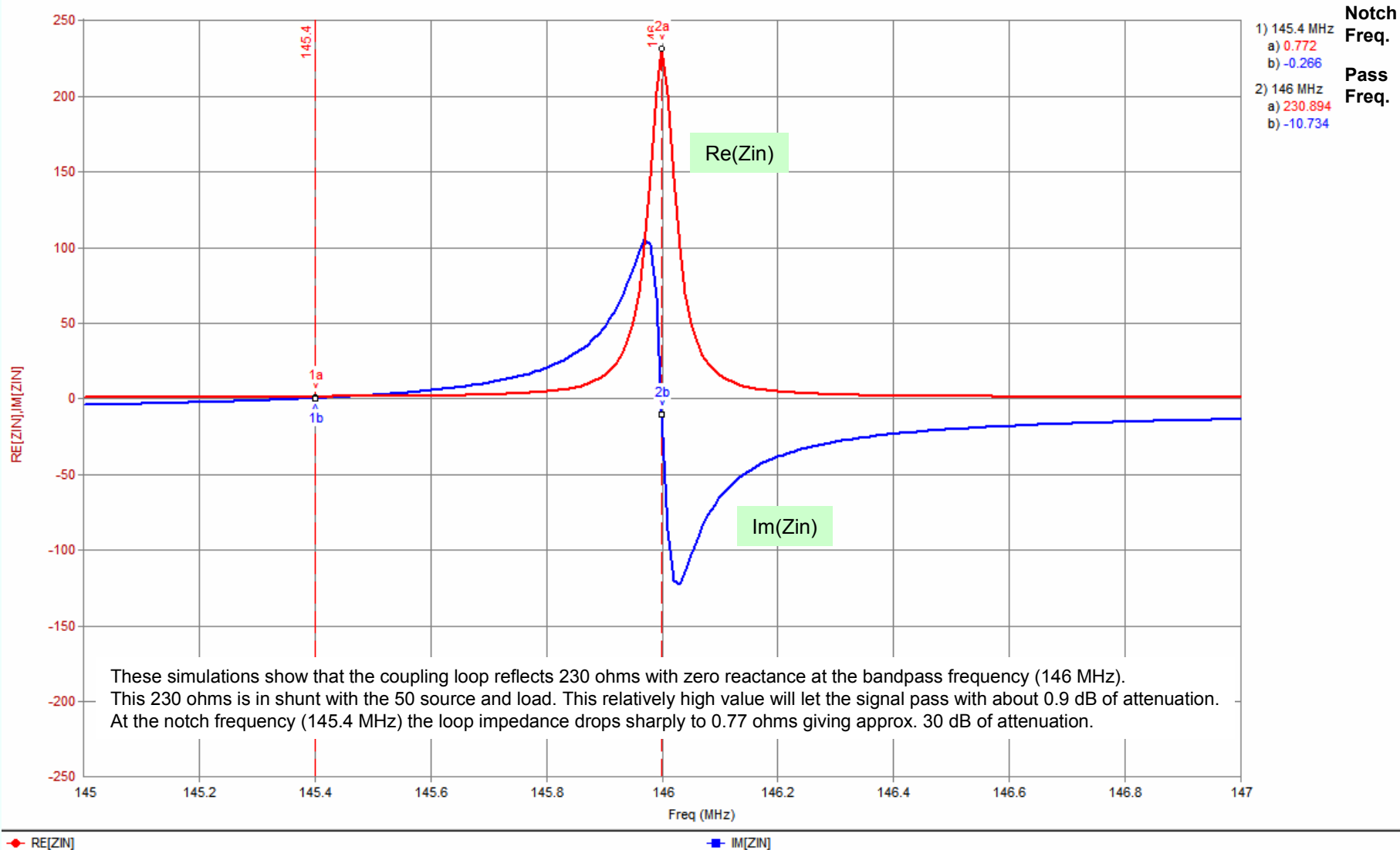
These simulations show that the coupling loop reflects 230 ohms with zero reactance at the bandpass frequency (146 MHz).
This 230 ohms is in shunt with the 50 source and load. This relatively high value will let the signal pass with about 0.9 dB of attenuation.
At the notch frequency (145.4 MHz) the loop impedance drops sharply to 0.77 ohms giving approx. 30 dB of attenuation.

RE[ZIN]   IM[ZIN]

6

As seen at the coupling loop input

S

1) 145.4 MHz
0.772 – j0.266
0.772 – j0.266

Notch Freq.

2) 146 MHz
230.894 – j10
230.894 – j10

Pass Freq.

50 Ω

7
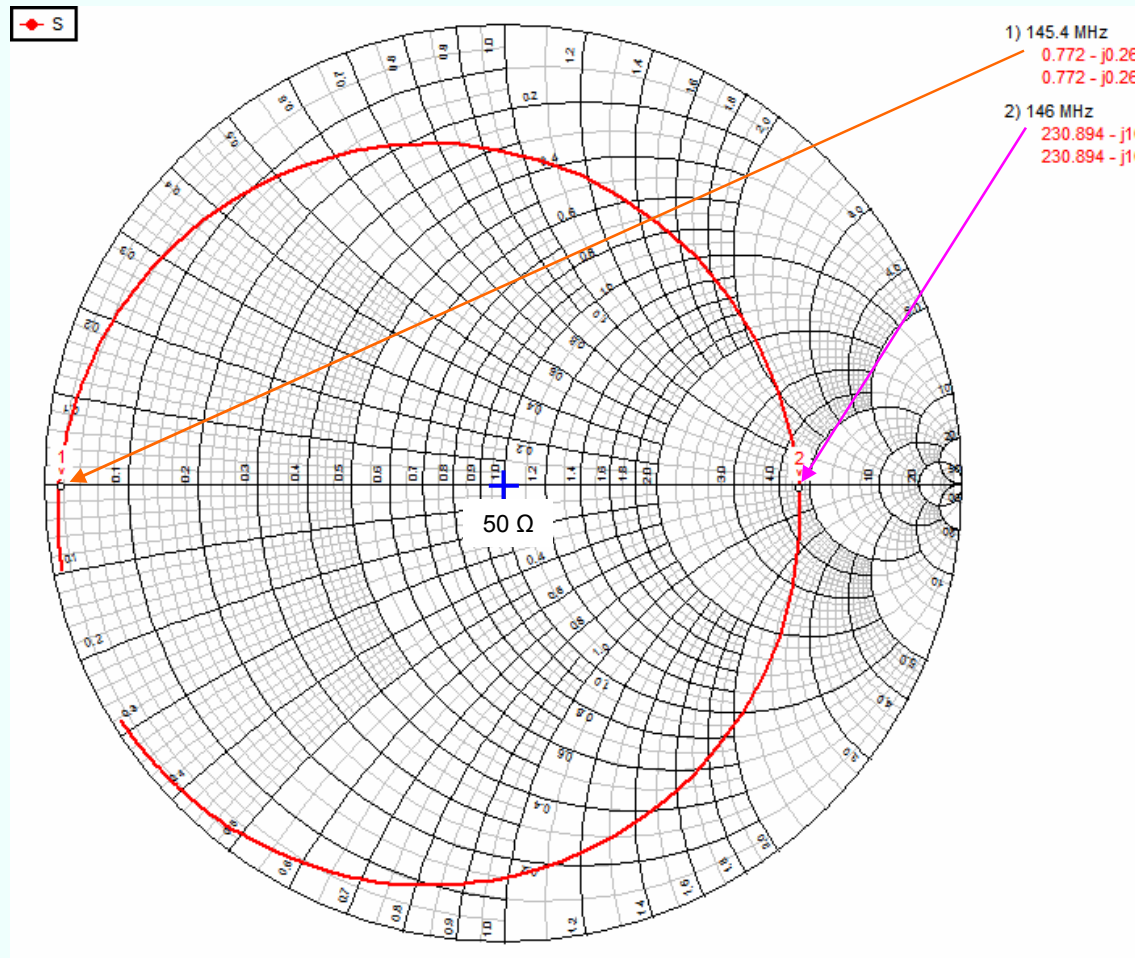
Coupling loop tests
Q Factor of 4 in. Cavity Loop - Bp-Br mode

See: http://ve2azx.net/technical/Calc_Series-Par_RLC.xls

For this test, the cavity is opened, leaving the coupling loop exposed, without the cylinder.

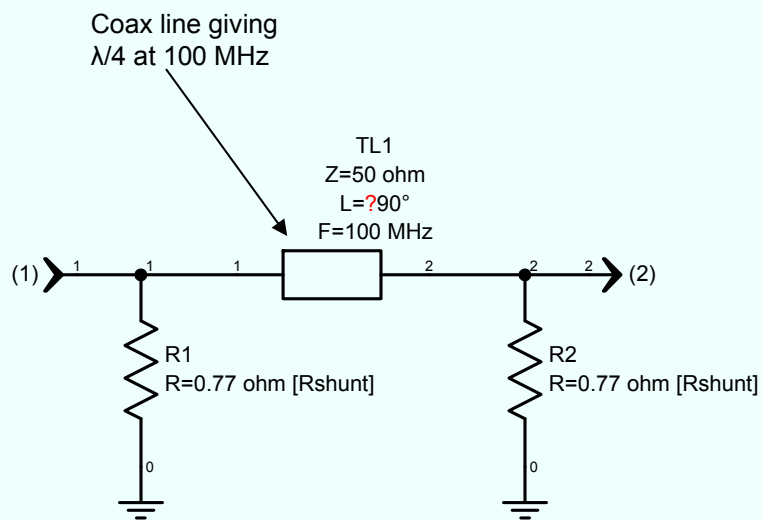| SERIES MODE RESULTS	
SERIES Ls in nH	103.50
SERIES Cs in pF	10.72
SERIES Rs ohms	0.330
SERIES Xs ohms	98.266

Q FACTOR =	298.14
3 dB BANDWIDTH (KHz)	507
CALC. RESONANT FREQ in MHz	151.1028
% OFF FROM MEAS. RESONNANCE	-0.038

Note that the series Rs of the coupling loop alone is 0.33 Ω
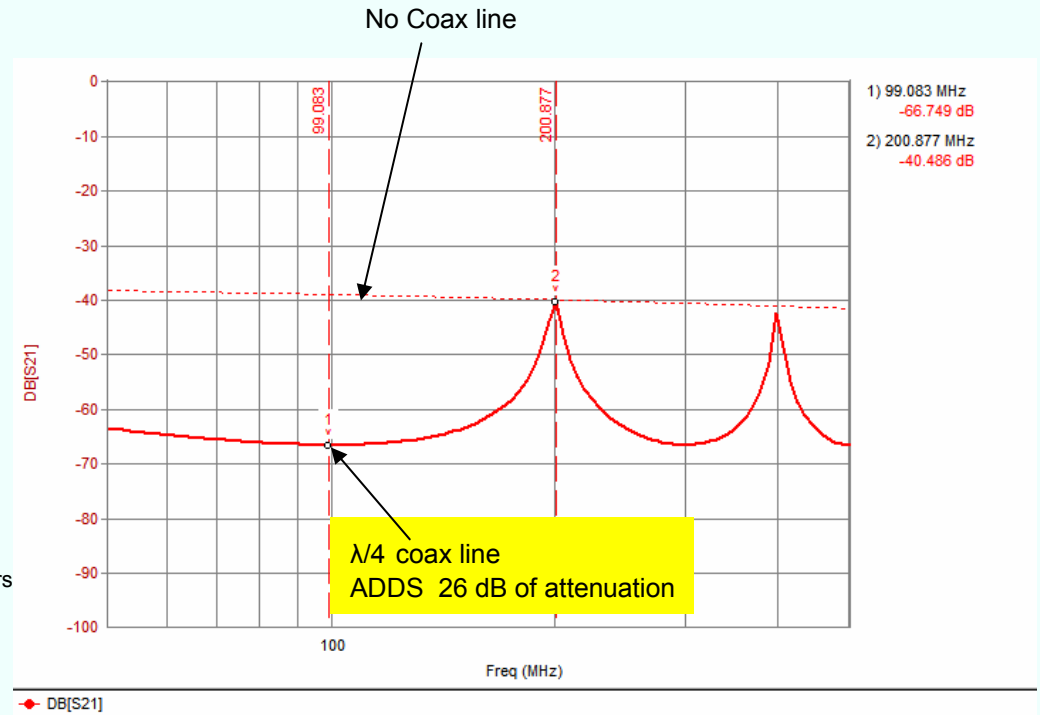When it is used as part of the Bp-Br cavity it is 0.77 Ω.

8

Cascading TWO Bp-Br cavities interconnected with a quarter wavelength cable:

Simulating the shunt resistances at the notch frequency.

Coax line giving
λ/4 at 100 MHz

No Coax line

TL1
Z=50 ohm
L=?90°
F=100 MHz

(1) 1   1   1   2   2   2 (2)
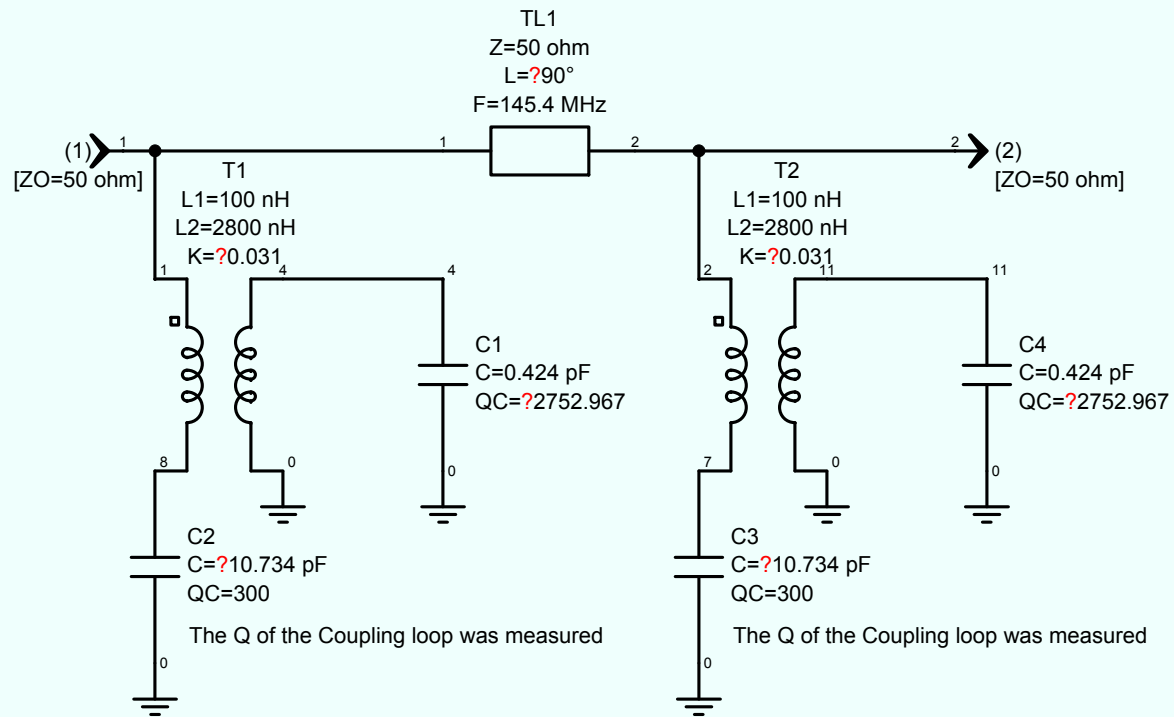
R1
R=0.77 ohm [Rshunt]

R2
R=0.77 ohm [Rshunt]

0   0

The 0.77 ohm resistors are the shunt resistance at the notch freq of 2 resonators
Addind a quarter wavelength increases the losses 26 dB (at 100, 300 MHz)

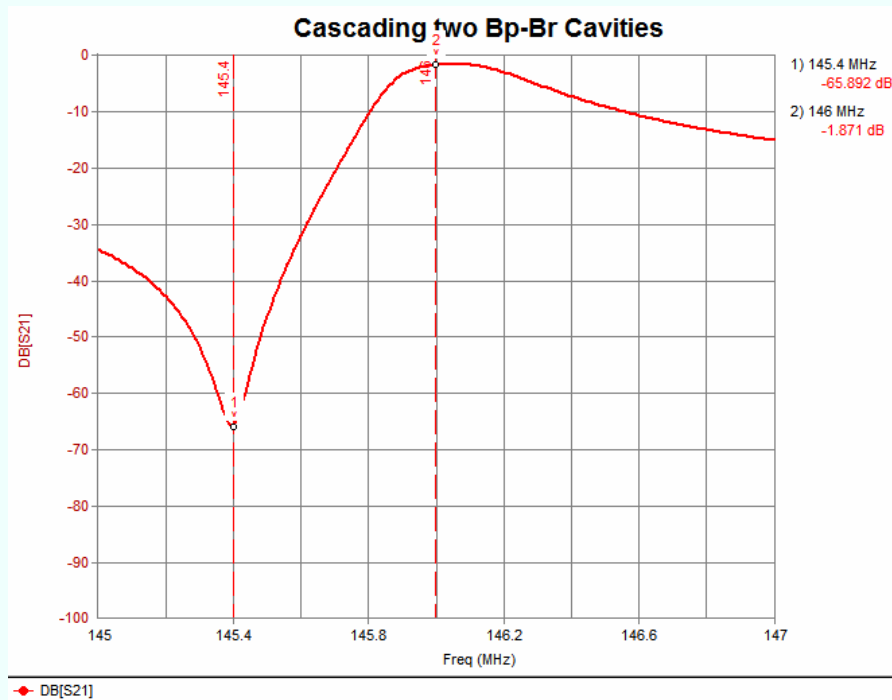See: NotchBandpassSingleLoop.wsp

1) 99.083 MHz
   -66.749 dB
2) 200.877 MHz
   -40.486 dB

99.083   200.877

DB[S21]

100

Freq (MHz)

λ/4 coax line
ADDS 26 dB of attenuation

DB[S21]

9

Cascading TWO Bp-Br cavities interconnected with a quarter wavelength cable:

TL1
Z=50 ohm
L=?90°
F=145.4 MHz

(1)
[ZO=50 ohm]

T1
L1=100 nH
L2=2800 nH
K=?0.031

T2
L1=100 nH
L2=2800 nH
K=?0.031

(2)
[ZO=50 ohm]

C1
C=0.424 pF
QC=?2752.967

C4
C=0.424 pF
QC=?2752.967

C2
C=?10.734 pF
QC=300

C3
C=?10.734 pF
QC=300

The Q of the Coupling loop was measured

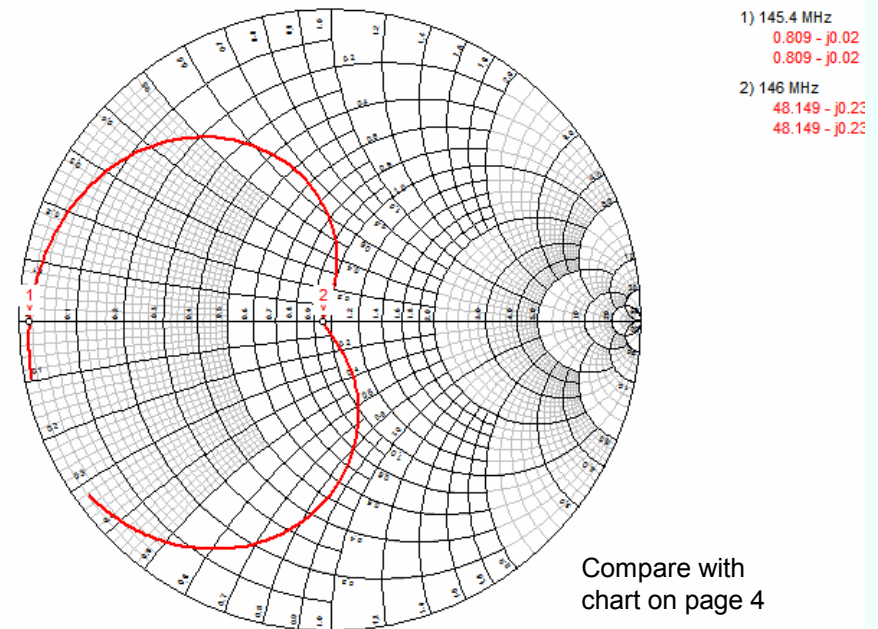The Q of the Coupling loop was measured

10

Cascading TWO Bp-Br cavities interconnected with a quarter wavelength cable:

The notch depth increases by ~26 dB with the 2nd cavity
Insertion loss is now 1.87 dB.
Was 0.8 dB with one cavity. See page 3.

Cascading two Bp-Br Cavities

1) 145.4 MHz
   -65.892 dB
2) 146 MHz
   -1.871 dB

Input impedance at port 1

1) 145.4 MHz
   0.809 - j0.02
   0.809 - j0.02
2) 146 MHz
   48.149 - j0.23
   48.149 - j0.23

Compare with
chart on page 4

Total notch depth with 2 cavities = 6 dB + Notch depth of one cavity in dB x 2
(assuming the cavities have similar notch depths)