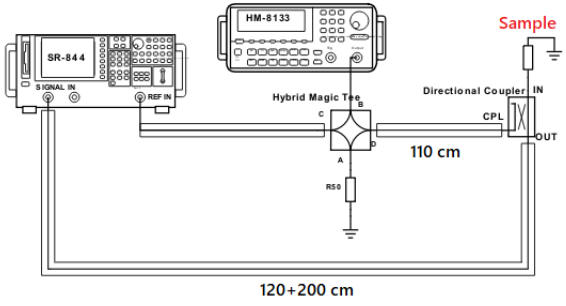
Reflectometry report

About curve fitting

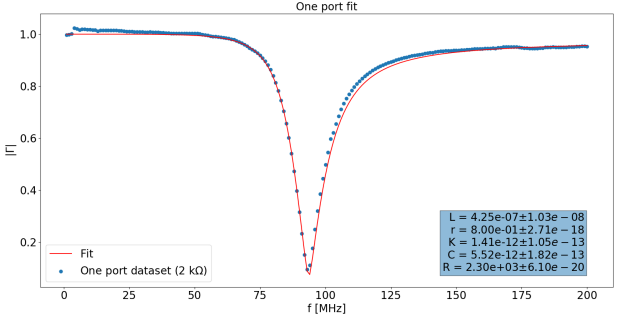
Tamas Kalmar

2019.04.01.

Previous measurments



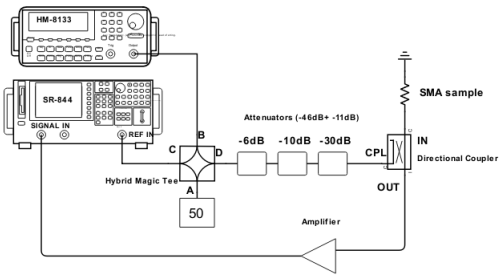
Previous measurments



- Had to restrict fit parameters to a narrow interval
- Had to play with initial guess
- Uncertainity?

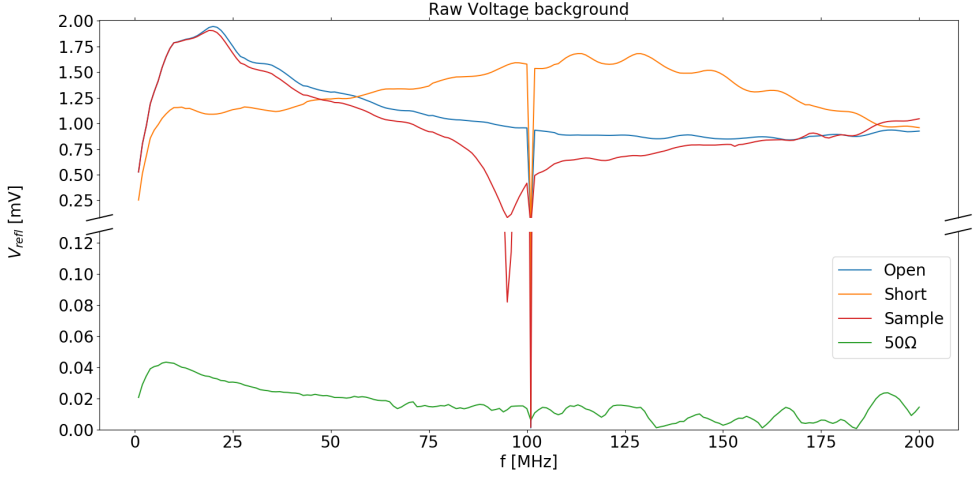
Without knowing exactly the parameters it would be impossible.

SMA Setup

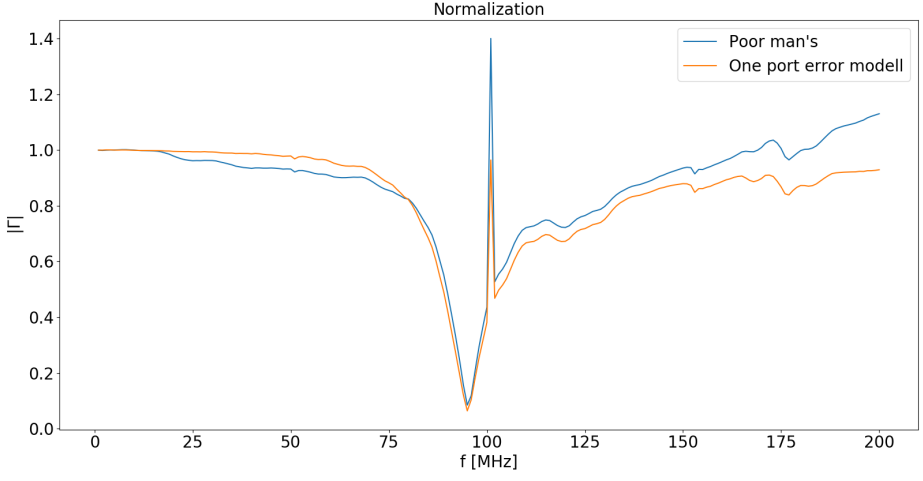


- Added attenuators and amplifier
- **Very same "sample" as before**

SMA Measurement



SMA Measurement



SMA Fit

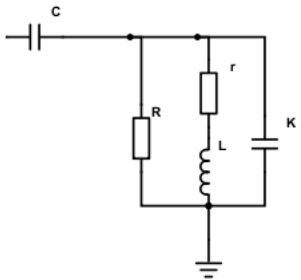
$R \approx 2\,\mathrm{k}\Omega$

$L = 430\,\mathrm{nH}$

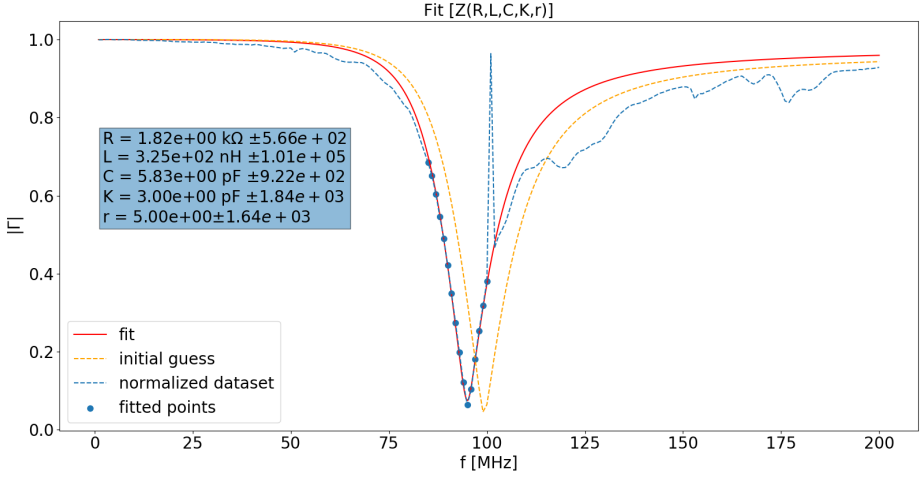
$C = 5\,\mathrm{pF}$

$K = 1{,}1\,\mathrm{pF}$

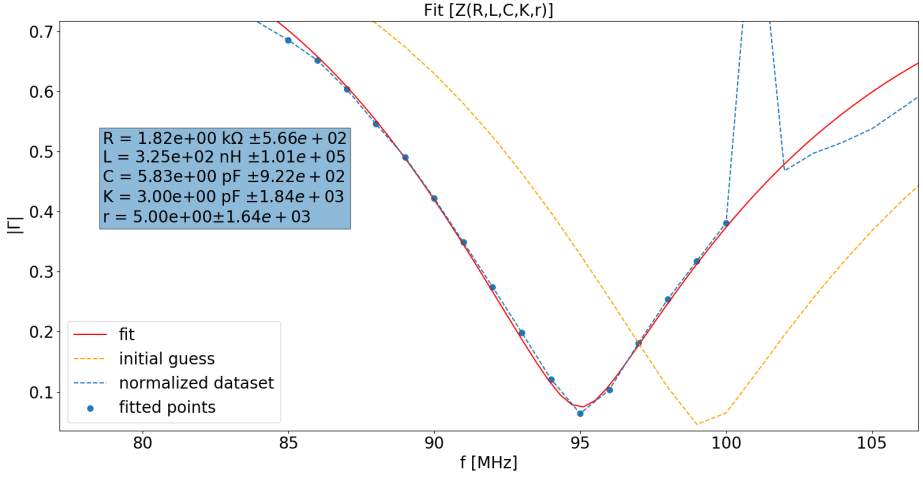
$r \approx 0$ - $10\,\Omega$



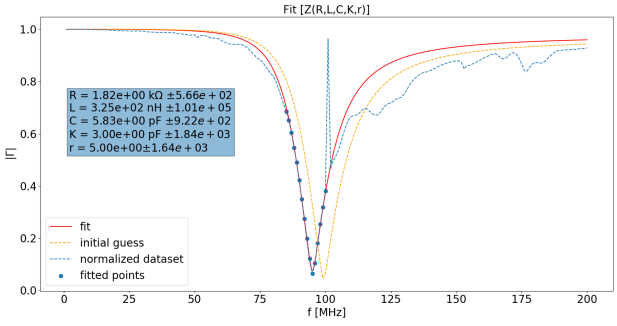
SMA Fit


Fit [Z(R,L,C,K,r)]
R = 1.82e+00 kΩ ±5.66e + 02
L = 3.25e+02 nH ±1.01e + 05
C = 5.83e+00 pF ±9.22e + 02
K = 3.00e+00 pF ±1.84e + 03
r = 5.00e+00±1.64e + 03
fit
initial guess
normalized dataset
fitted points
|Γ|
f [MHz]
0.0
0.2
0.4
0.6
0.8
1.0
0
25
50
75
100
125
150
175
200

SMA Fit


Fit [Z(R,L,C,K,r)]
R = 1.82e+00 kΩ ±5.66e + 02
L = 3.25e+02 nH ±1.01e + 05
C = 5.83e+00 pF ±9.22e + 02
K = 3.00e+00 pF ±1.84e + 03
r = 5.00e+00±1.64e + 03
fit
initial guess
normalized dataset
fitted points
|Γ|
f [MHz]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
80
85
90
95
100
105

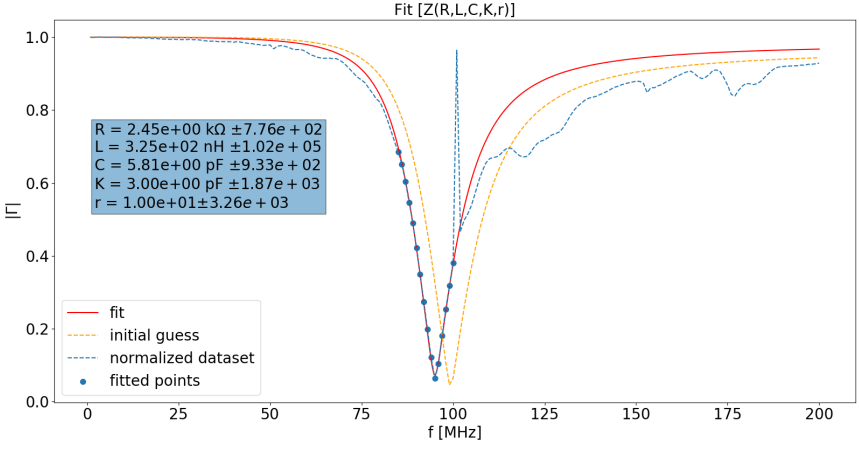
SMA Fit



- Initial guess is close to real values
- Bounds: R:[1k,10k],L:[300n,500n], C:[1p,10p],K:[0.5p,3p], r:[0,5]
- "r" fit value is on top of interval
- Uncertainity?

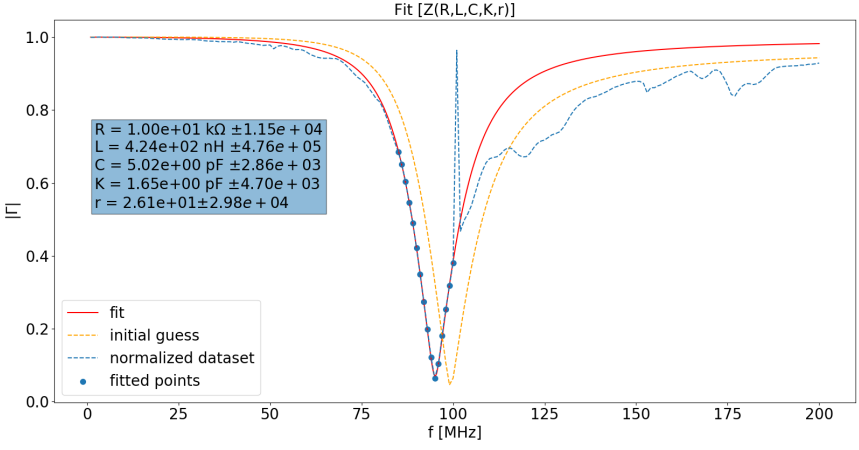
SMA Fit

$$r_{max} = 10\,\Omega$$

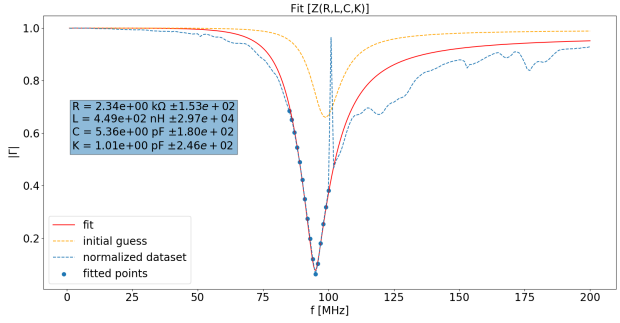


SMA Fit

$$r_{max} = 100\,\Omega$$

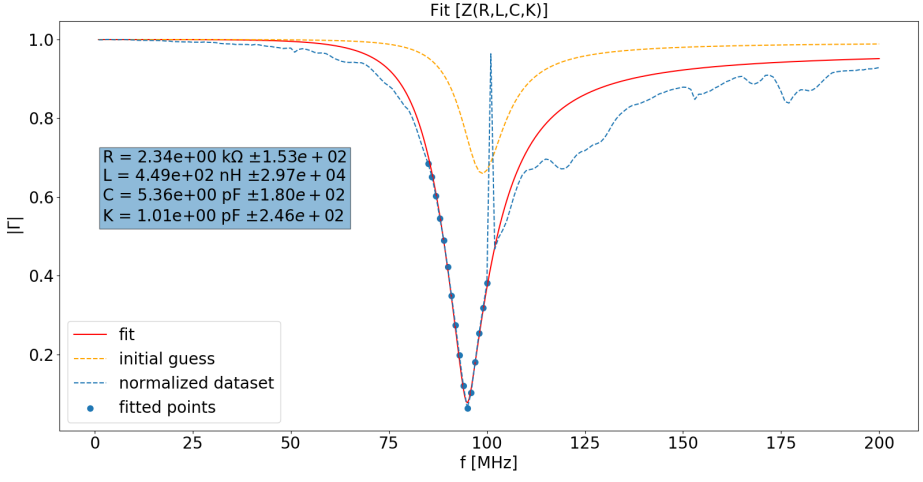


SMA Fit

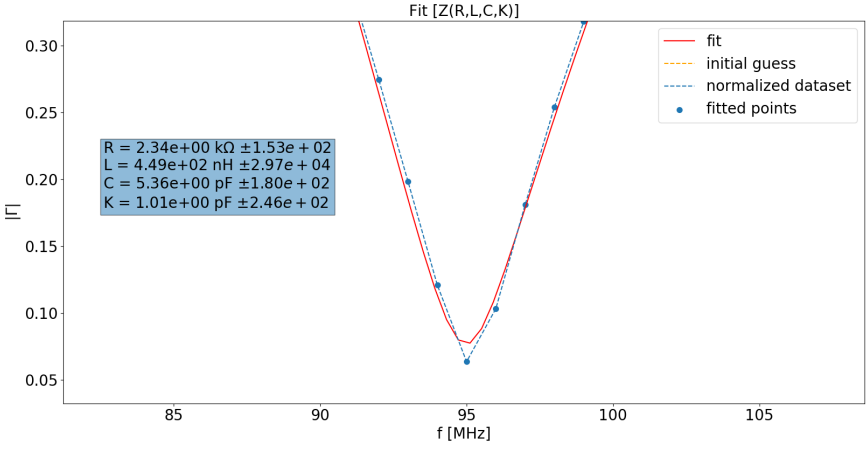


- "r" parameter caused problem, so it was removed from fit function
- Actually "R" and "r" are not independent.They can be transformed inot each other with serial-paralel conversion.
- $\sim$ Lossless inductor (superconductivity in future setups)
- Fit parameters seems to be ok
- Uncertainity?

SMA Fit

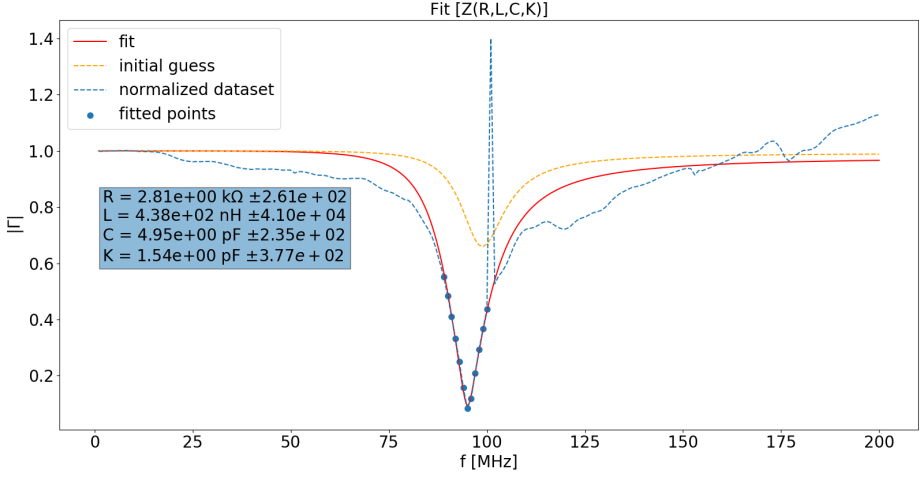

Fit [Z(R,L,C,K)]
R = 2.34e+00 kΩ ±1.53e + 02
L = 4.49e+02 nH ±2.97e + 04
C = 5.36e+00 pF ±1.80e + 02
K = 1.01e+00 pF ±2.46e + 02
fit
initial guess
normalized dataset
fitted points
|Γ|
f [MHz]
1.0
0.8
0.6
0.4
0.2
0
25
50
75
100
125
150
175
200

SMA Fit

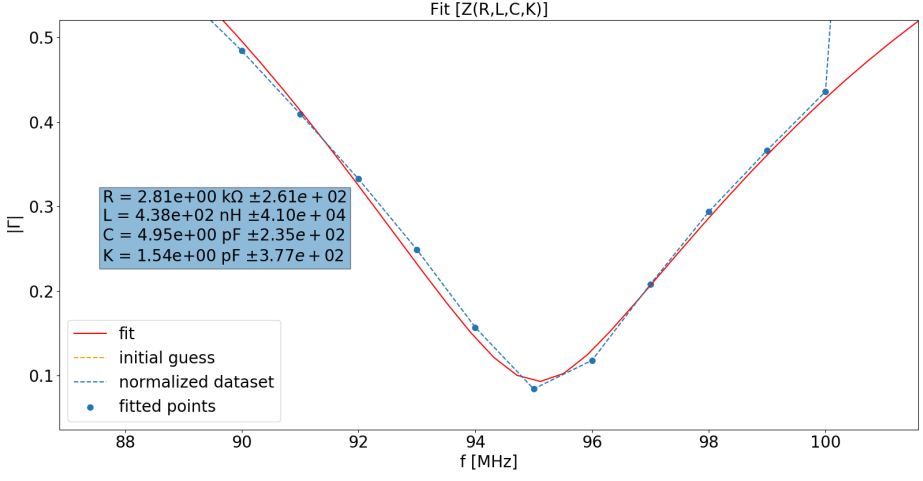


Let's see what happens with poor man's normalization.

SMA Fit


Fit [Z(R,L,C,K)]
fit
initial guess
normalized dataset
fitted points
R = 2.81e+00 kΩ ±2.61e + 02
L = 4.38e+02 nH ±4.10e + 04
C = 4.95e+00 pF ±2.35e + 02
K = 1.54e+00 pF ±3.77e + 02
|Γ|
f [MHz]
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
25
50
75
100
125
150
175
200

SMA Fit

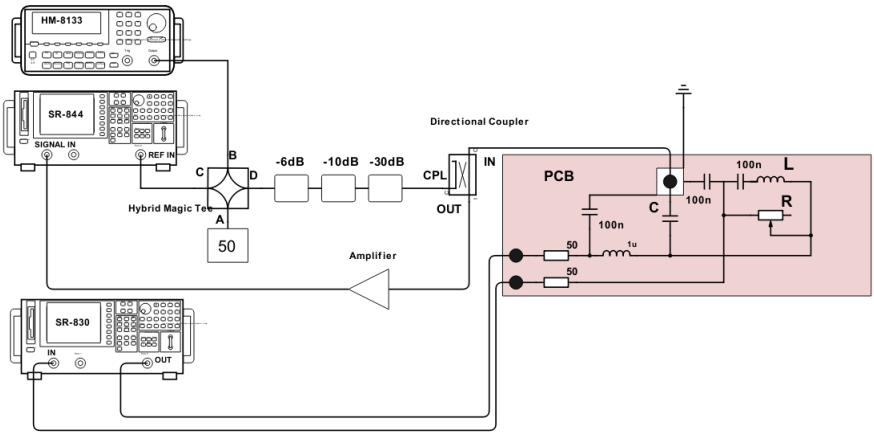

Fit [Z(R,L,C,K)]
R = 2.81e+00 kΩ ±2.61e + 02
L = 4.38e+02 nH ±4.10e + 04
C = 4.95e+00 pF ±2.35e + 02
K = 1.54e+00 pF ±3.77e + 02
fit
initial guess
normalized dataset
fitted points
|Γ|
f [MHz]
0.5
0.4
0.3
0.2
0.1
88
90
92
94
96
98
100

SMA results

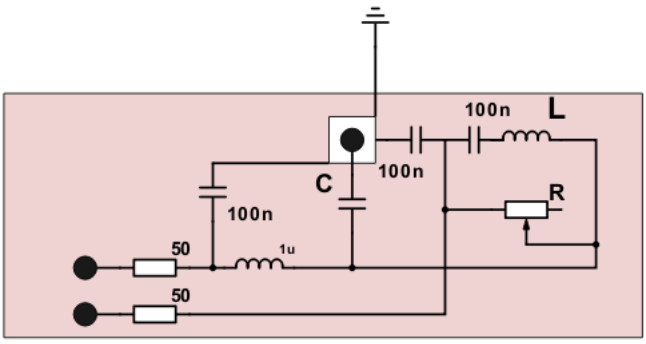
	Poorman	One port	Avg	Name value	$\Delta = \frac{One\_port - Poorman}{One\_port}(\%)$
R (kΩ)	2.81	2.33	2.57	2	20.5
L(nH)	438.33	449.03	443.68	430	2.3
C (pF)	4.94	5.35	5.15	5	7.6
K (pF)	1.53	1.01	1.27	1.1	51.6

Poorman can be actually OK and it takes half as many measurements.(Note cooling time)

PCB setup

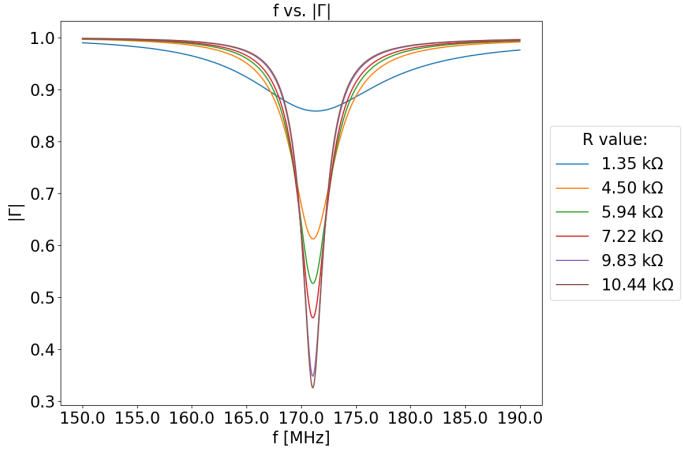

HM-8133
SR-844
SIGNAL IN
REF IN
SR-830
IN
OUT
B
C
D
A
Hybrid Magic Tee
50
-6dB
-10dB
-30dB
Directional Coupler
CPL
IN
OUT
Amplifier
PCB
100n
L
100n
C
R
100n
1u
50
50

PCB setup

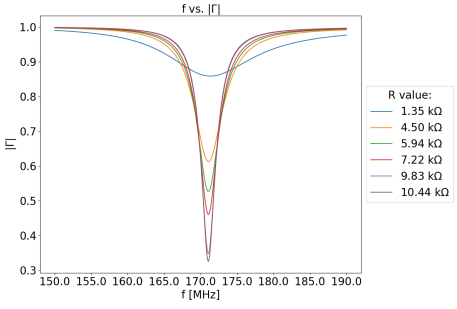


This is not an ideal setup!

PCB setup


f vs. |Γ|
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
|Γ|
150.0 155.0 160.0 165.0 170.0 175.0 180.0 185.0 190.0
f [MHz]
R value:
1.35 kΩ
4.50 kΩ
5.94 kΩ
7.22 kΩ
9.83 kΩ
10.44 kΩ

PCB setup



$$L = 100\,\text{nH}$$

$$C = 1\,\text{pF}$$

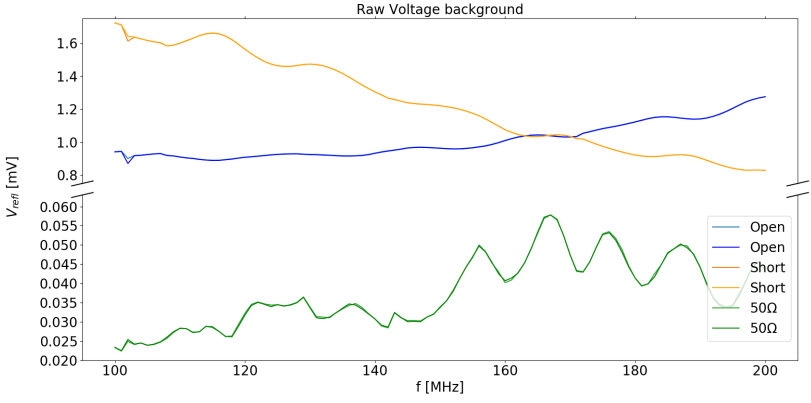
$$R = 0 \text{ - } 10\,\text{k}\Omega*$$

$$K \sim 5\,\text{pF} \text{ - } 7\,\text{pF} **$$

**Minimal resistance of potmeter is* $\sim 10\,\Omega$

***Good guess according to previous measurements.*

PCB measuremens

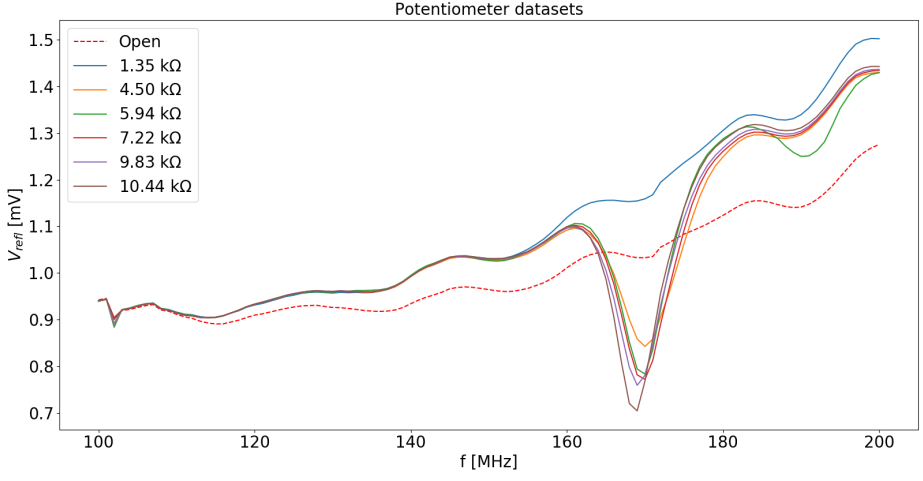


They

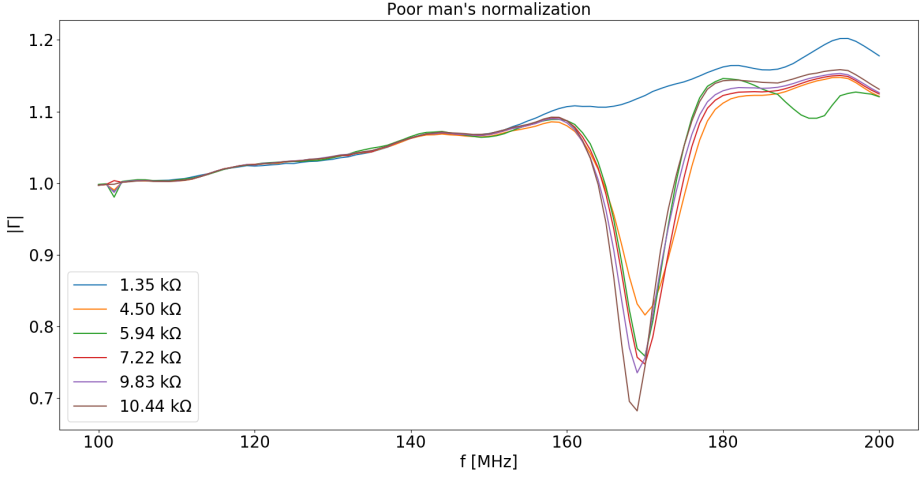
overlap→no contact problems.

We used "home made" terminations!

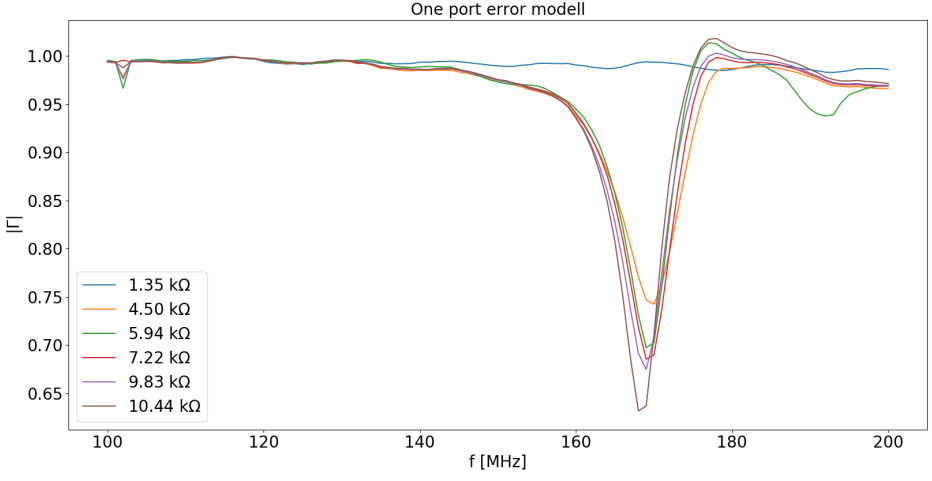
PCB measuremens



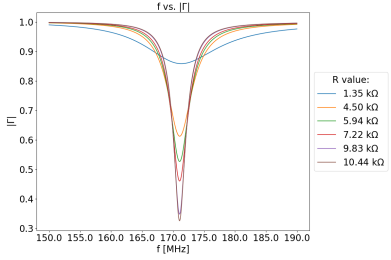
PCB measuremens

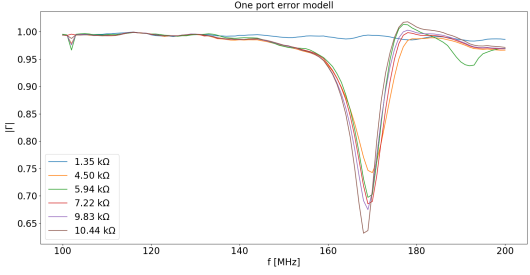


PCB measuremens



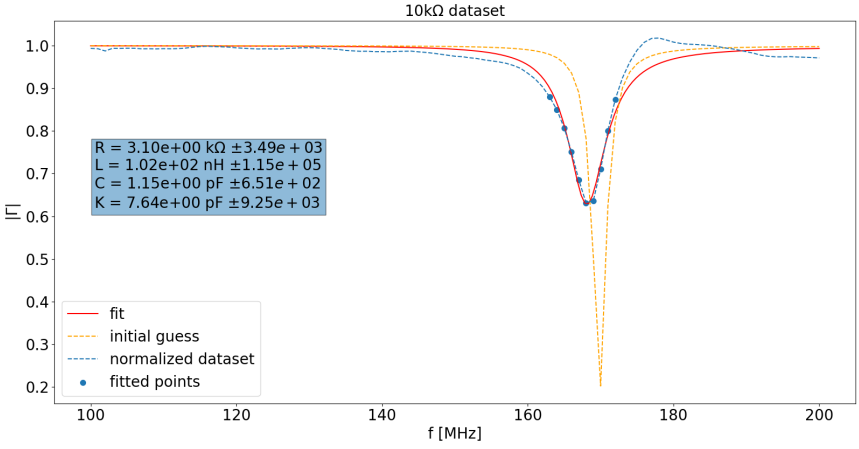
PCB measuremens





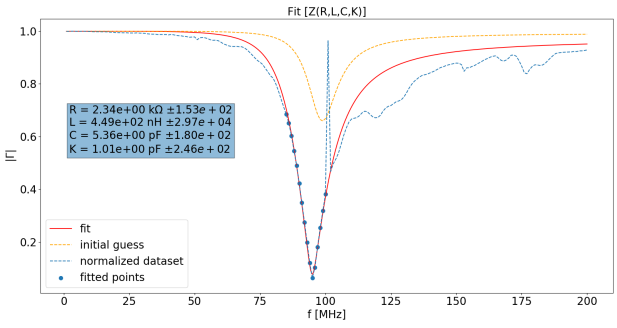
We can see the effects of the mentioned problems.

PCB fitting



Same fit setting as for SMA.

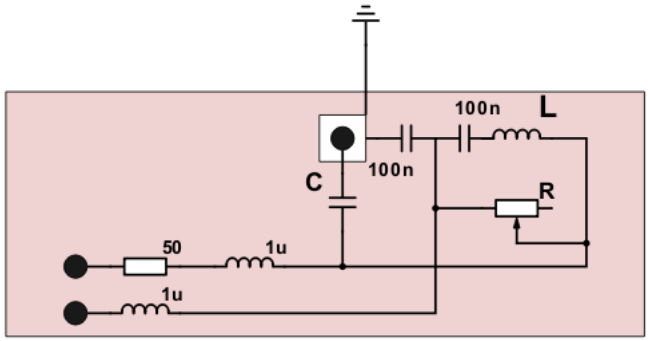
Conclusion:SMA



- We can actually fit and get proper values.
- Uncertainity?
- Might improve if we lock C, L.
- "r" and "R" are not independent.
- Poorman's normalization should be taken into consideration (twice as fast as One port)$\rightarrow$ need more measurements to compare

Conclusion

Resolder PCB



Conclusion:PCB

- Resolder PCB.
- Measure with "official" short and 50 Ω.
- Try to fit again.

Thanks for your attention!