EOM modification for modulation at 118MHz

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Commissioning F2F
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LIGO-G1800724

ALIGO EOM has 3 electrodes & 3 RF ports for 3 mod. freq

- Port1: 9.1MHz (IFO f_1), Port2: 24.1MHz (IMC), Port3: 45.5MHz (IFO f_2)

How do we arrange the 4 RF frequencies?

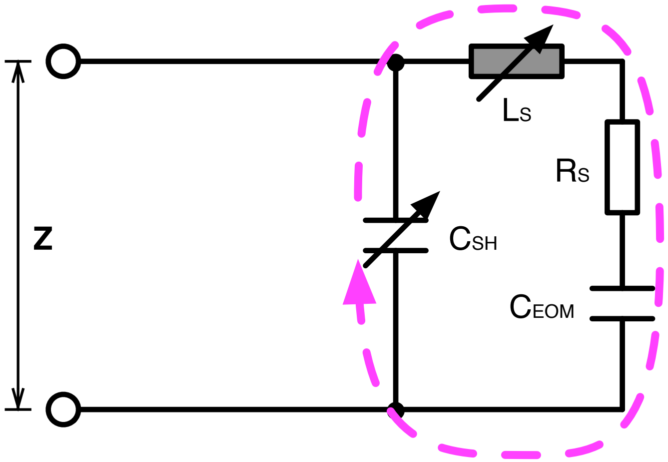
- Port2 for 118.3MHz (resonant)
- Port3 for 45.5MHz (resonant) and 24.1MHz (non-resonant)

Requirements & Results: response of the new unit

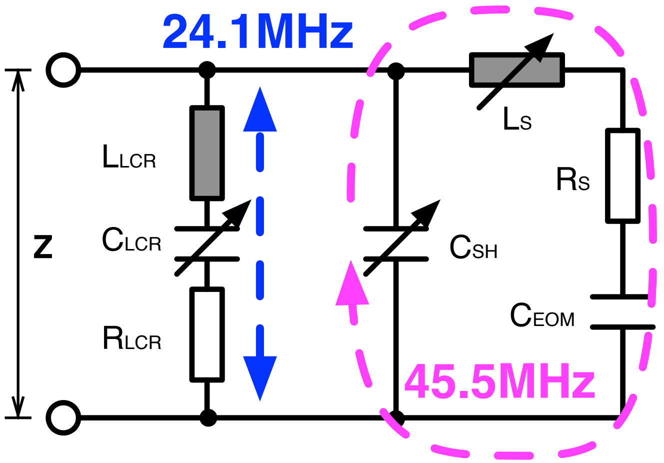
Port	Freq [MHz]	Required Mod [rad] Acq	Required Mod [rad] Opr	EOM response [$mrad_{pk}/V_{pk}$]	Required RF [dBm] Acq	Required RF [dBm] Opr
#1	9.1	0.22	0.11	42	24.3	18.3
#2	118.3	---	0.01	12		8.5
#3	24.1	0.014	---	2.4	25.4	
#3	45.5	0.28	0.20	43	26.2	23.3

EOM response

Shunt C matching (for 9.1MHz & 118.3MHz)

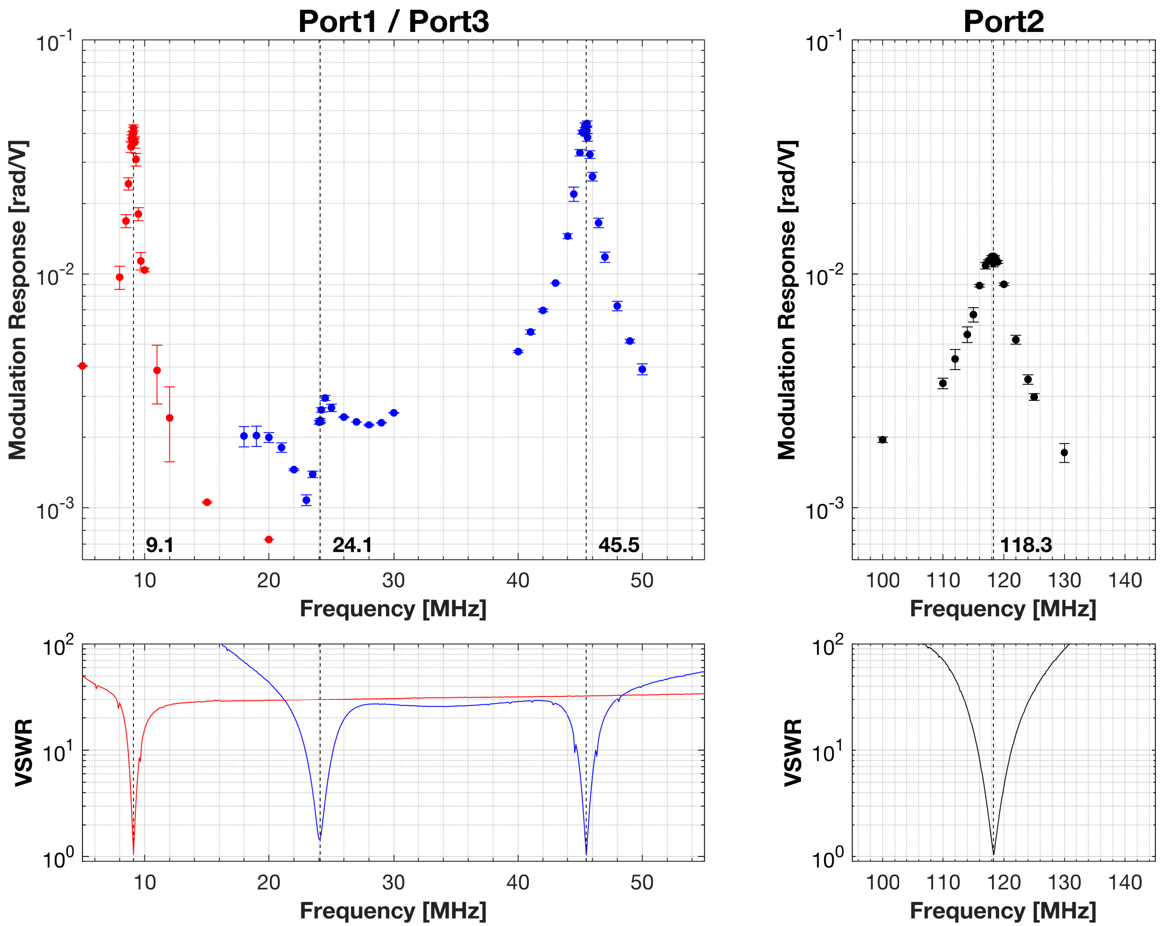


Shunt C+LCR matching (for 45.5MHz+24.1MHz)



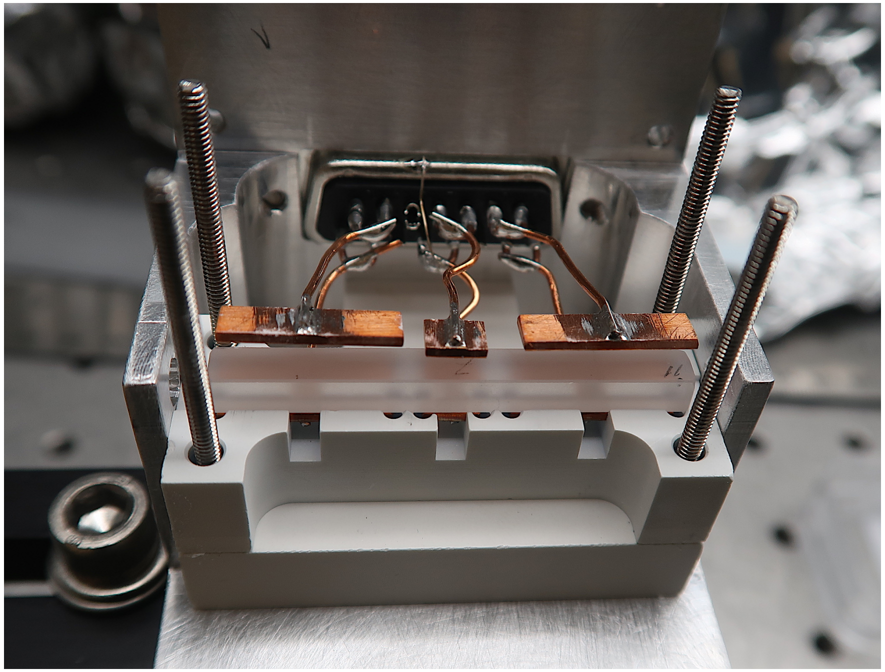
Modulation Response [radpk/Vpk]

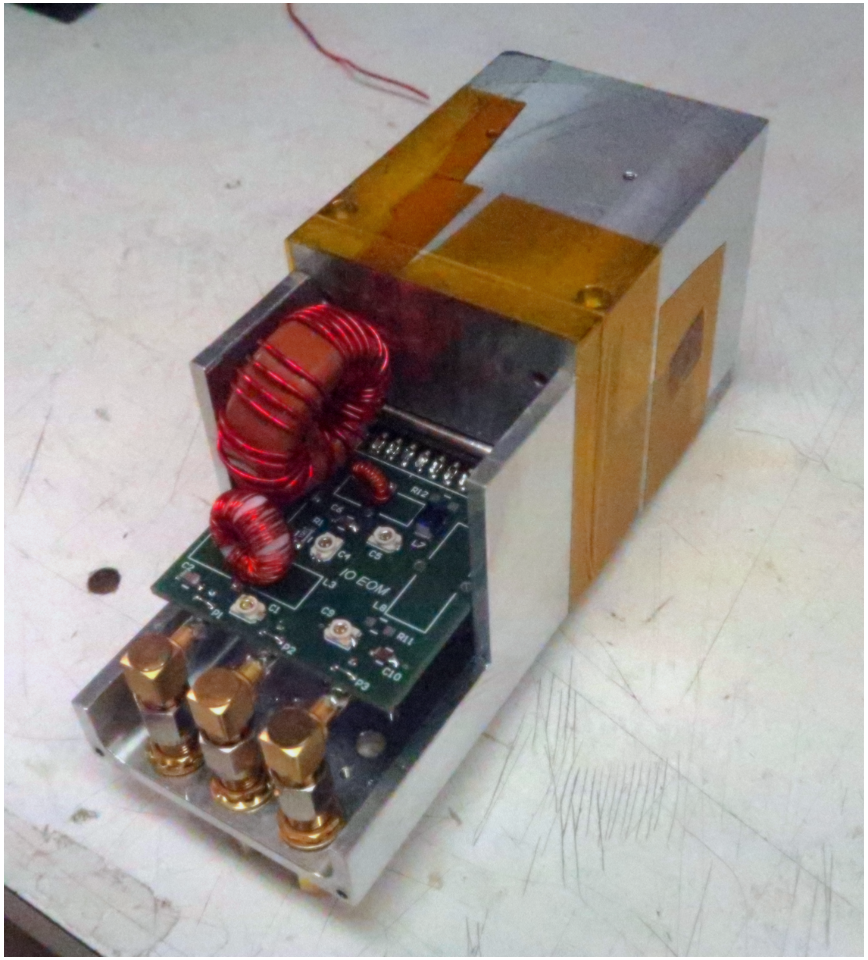
Measured with a beat note of two lasers



EOM Crystal / Matching Circuit

RTP crystal: 4mm x 4mm x 40mm
Plates: 14mm, 5mm, 14mm





Matching circuit
Toroidal cores for 24/45/118MHz
Chip L for 9MHz

Installation remarks

- **The crystal was not tested with a high power beam**
  At least, the crystal needs FC cleaning

- **The crystal and the circuit are a matched pair.**
  The circuit will not work with the existing EOM crystal without serious tuning

- **Driving power**
  24.1MHz: 25dBm ~ requires an amplifier
  45.5MHz: 26dBm ~ still in the linear region of the AM stabilized driver
  9.1MHz: 24dBm ~ almost at the edge of the linear region
- **Use a power combiner for 45.5MHz & 24.1MHz**

- **Demod. phases and some of the LSC input matrix will change**
  cf. 27MHz comes from CRxSB3, SB1xSB-2, SB1xSB4(=f2-f1), ...

- **Matching circuit has no rid**
  because of a large toroidal L & to eliminate stray C
  do not touch the inductors
  => the resonant freqs and the matching conditions will change

Remarks towards an invac EOM

o Polarization: determined by the polarization of JAC
- The JAX prelim design: S-pol
- The crystal is wedged horizontally for P-pol

o Same 4 modulation freqs

o Thermal lensing
- The input light power will be adjusted on the PSL
- Power adjustment => different thermal lense in the EOM
- How large is the lens? Which crystal should we use (RTP? SLT?)

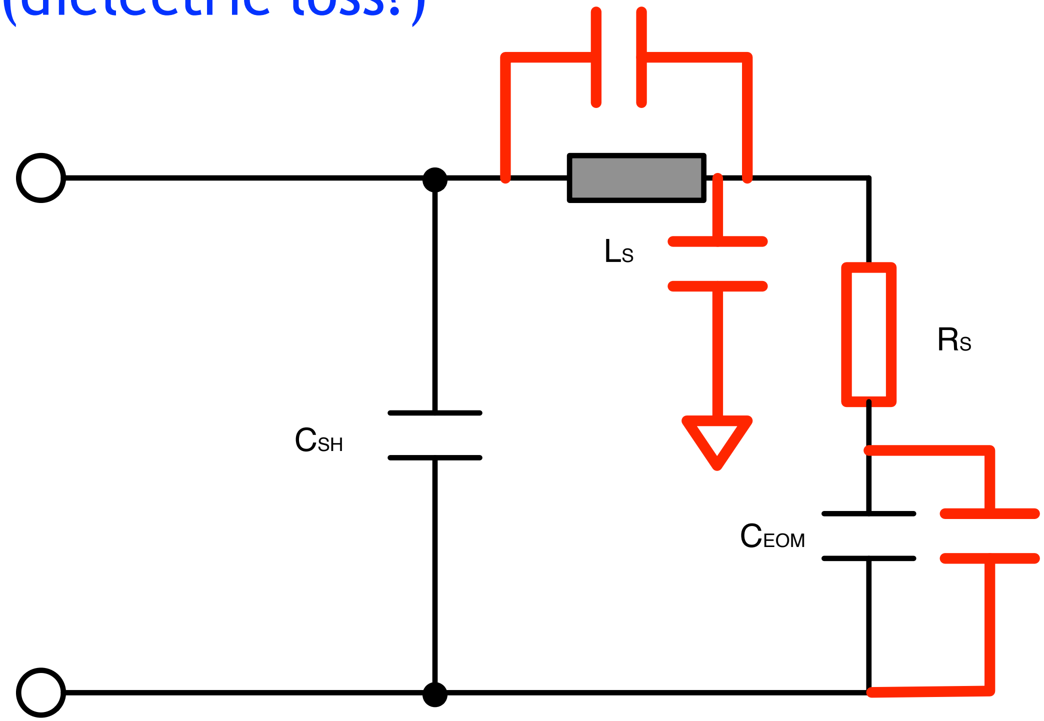
o Other thermal effect
- Temperature dependence of the inductance
  (ceramic core ~125ppm, vacuum core ?)

o Residual AM?
- Feedback control?

Production remarks

Make loss (R) as small as possible

intrinsic loss of the RTP crystal? (dielectric loss?)
inductor loss (DCR/skin effect)
loss in the PCB (skin effect)



Stray capacitance

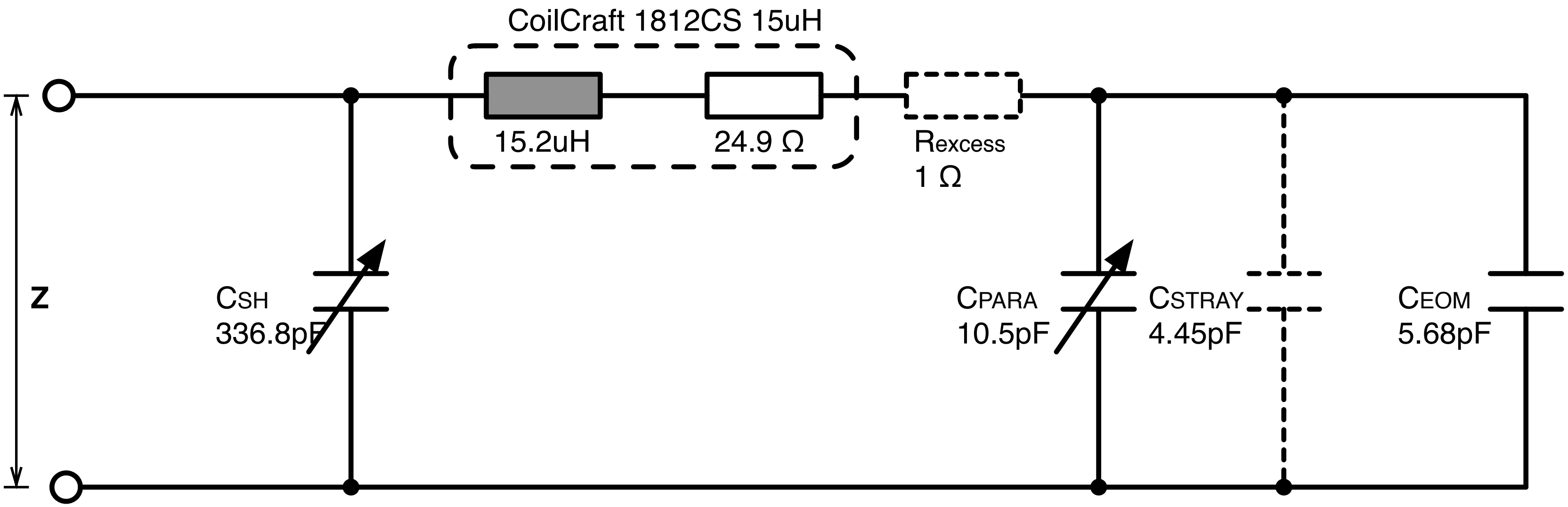
Stray shunt capacitance
capacitance in inductors
housing metal

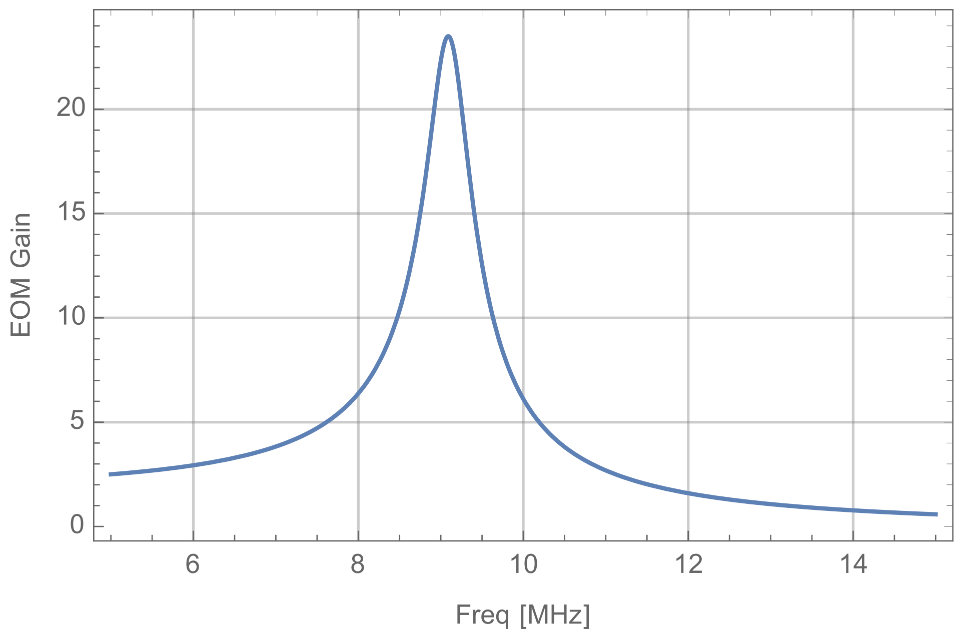
Inductor stability

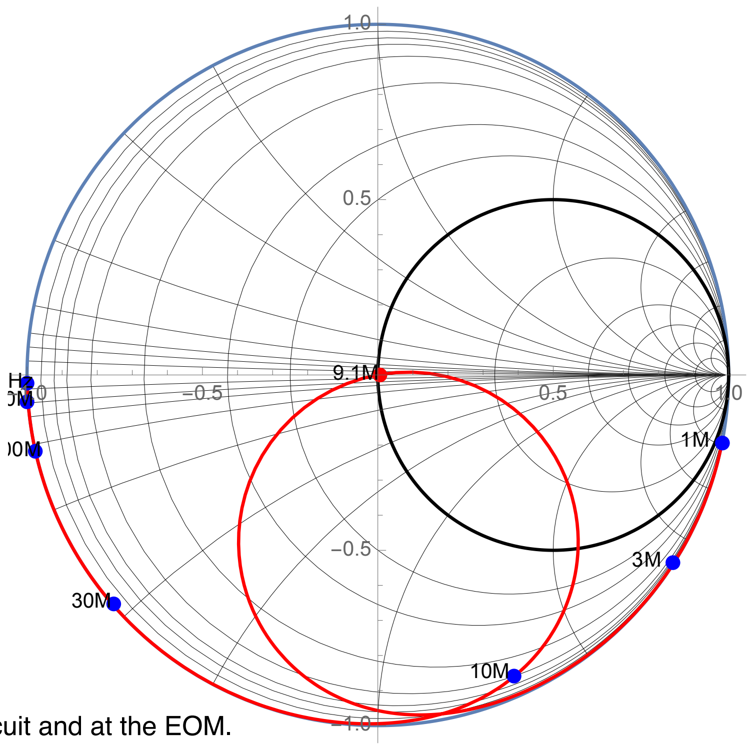
distance from the housing metal
changes stray capacitance
-> changes the resonant freq
-> changes the modulation phase & amplitude

the housing has better shorting to ground

Port1: 9.1MHz

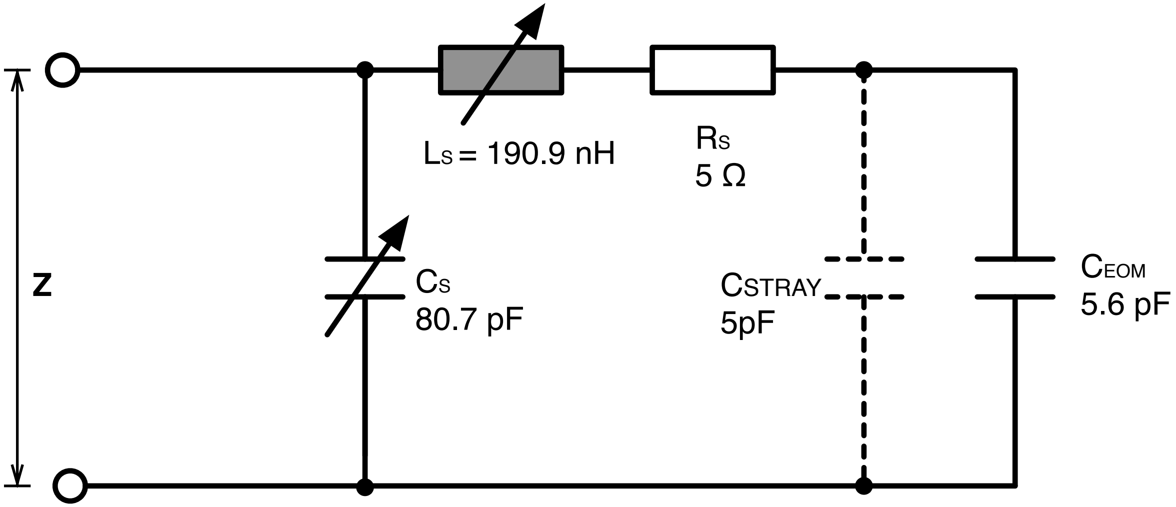


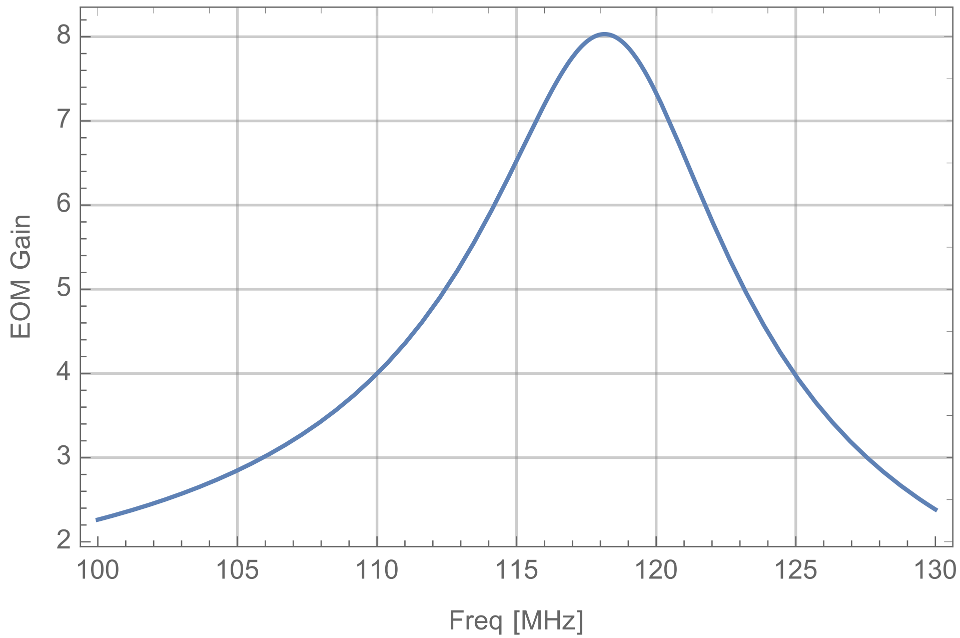


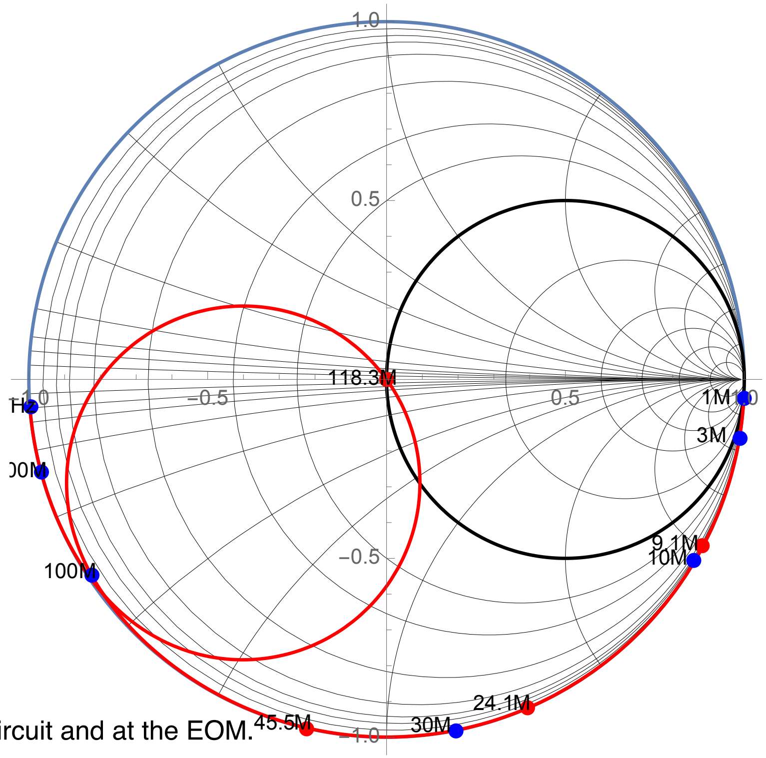


The EOM gain here is defined by the ratio of the voltages at the input of the matching circuit and at the EOM.

Port2: 118.3MHz







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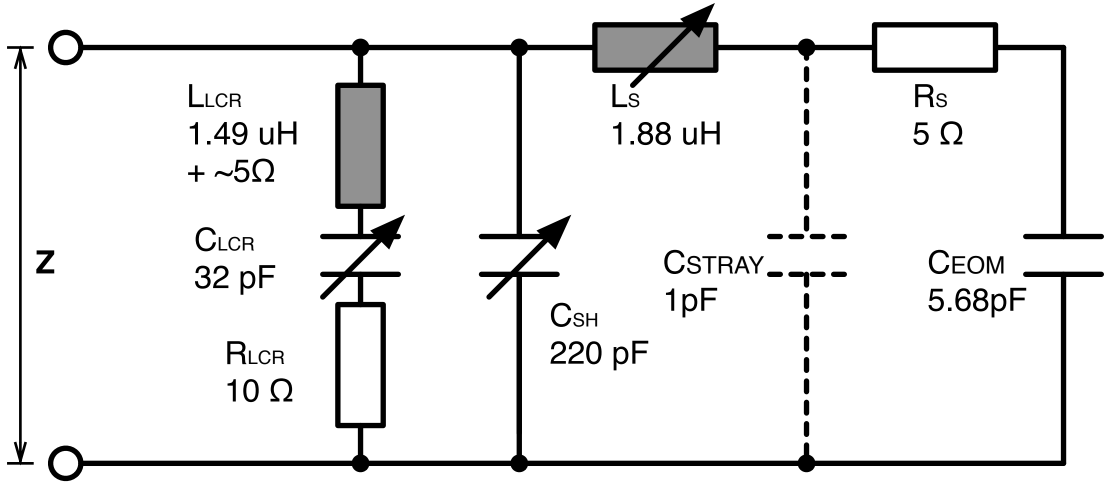
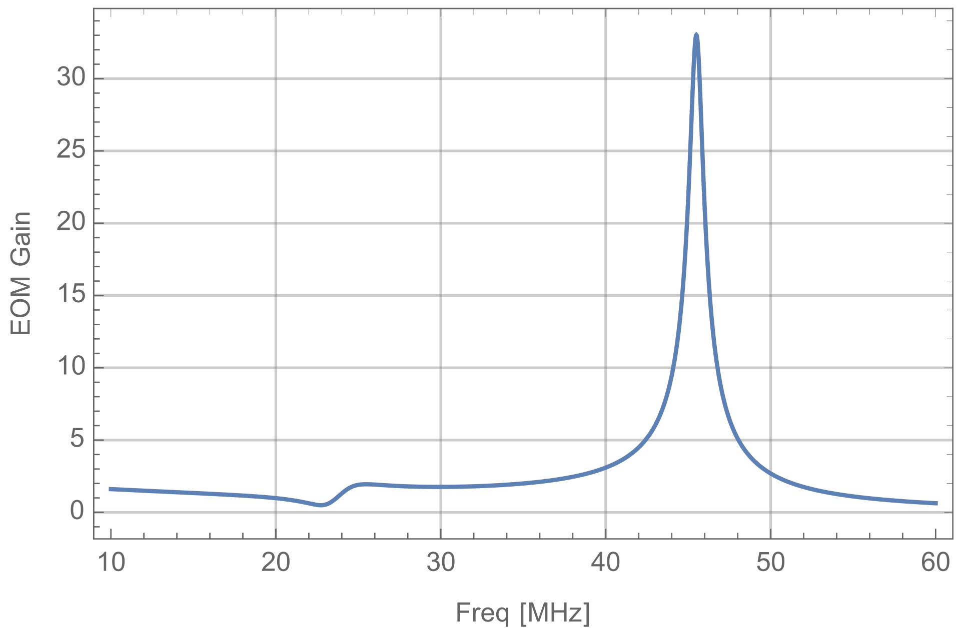
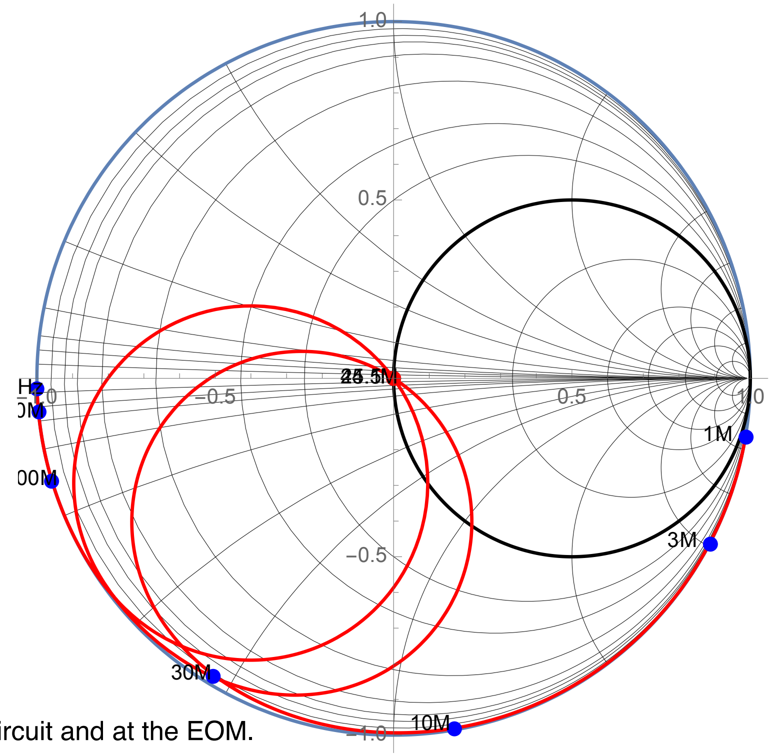
Port3: 45.5MHz + 24.1MHz







The EOM gain here is defined by the ratio of the voltages at the input of the matching circuit and at the EOM.

EOM impedance