Tank Input Impedance

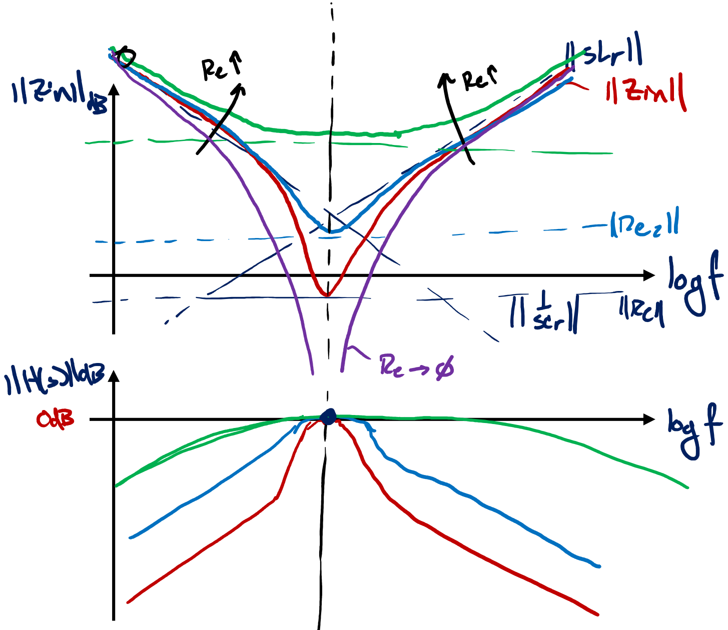
SRC example

$$Z_{in} = sL_r + \frac{1}{sC_r} + R_e$$

$$H(s) = \frac{R_e}{Z_{in}}$$

@ f_o: $\|H(s)\|_{dB} = 0\,dB$ for all R_e

- as $R_e \to 0$, $Z_{in} \to 0$
  - cannot tolerate output short circuit
- Z_{in} is Resistive



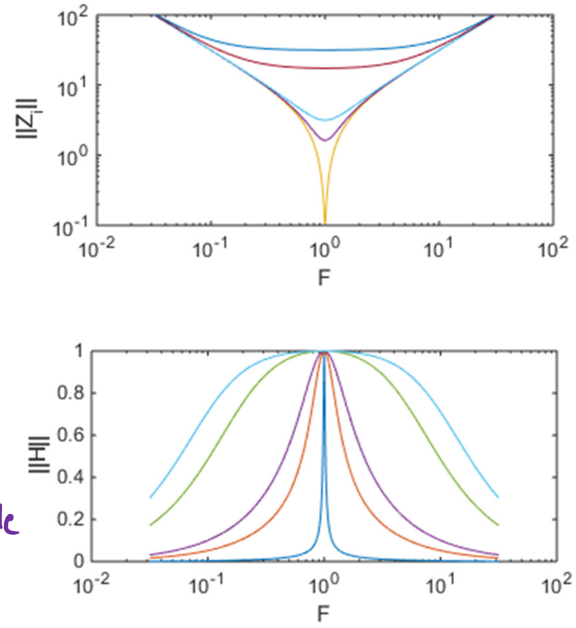
Z_{in} is capacitive ←
ZVS not possible
ZCS may be possible

$$f_o = \frac{1}{2\pi\sqrt{L_r C_r}}$$

→ Z_{in} = Inverter load is inductive
ZVS may be possible
ZCS not possible

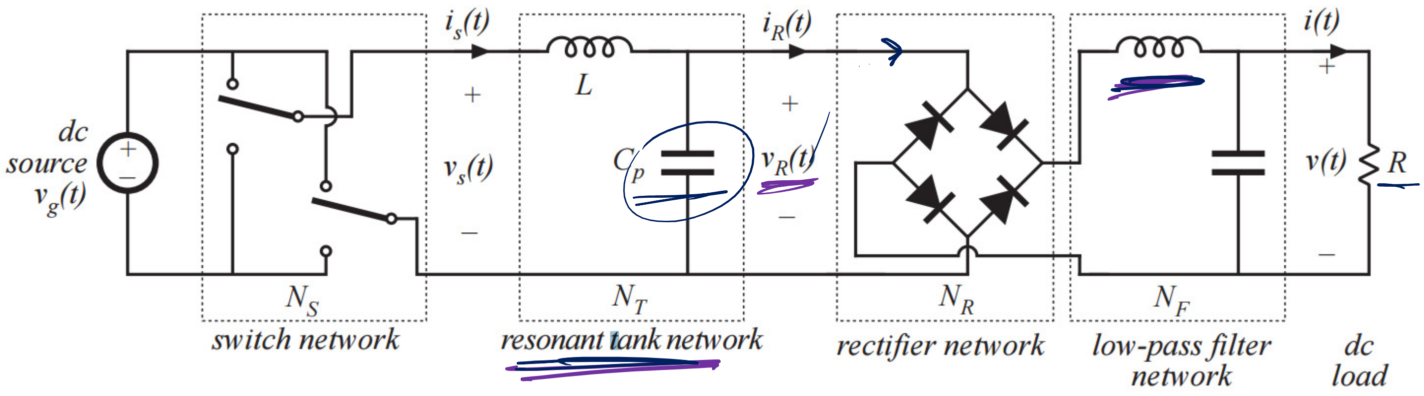
as R_e ↑, Z_{in} ↑ → P_{cond} ↓
P_{out} ↓ → Conduction losses decrease at light load

Series Resonant Tank

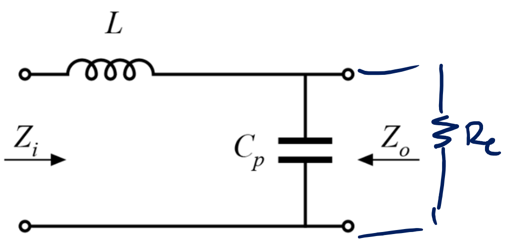


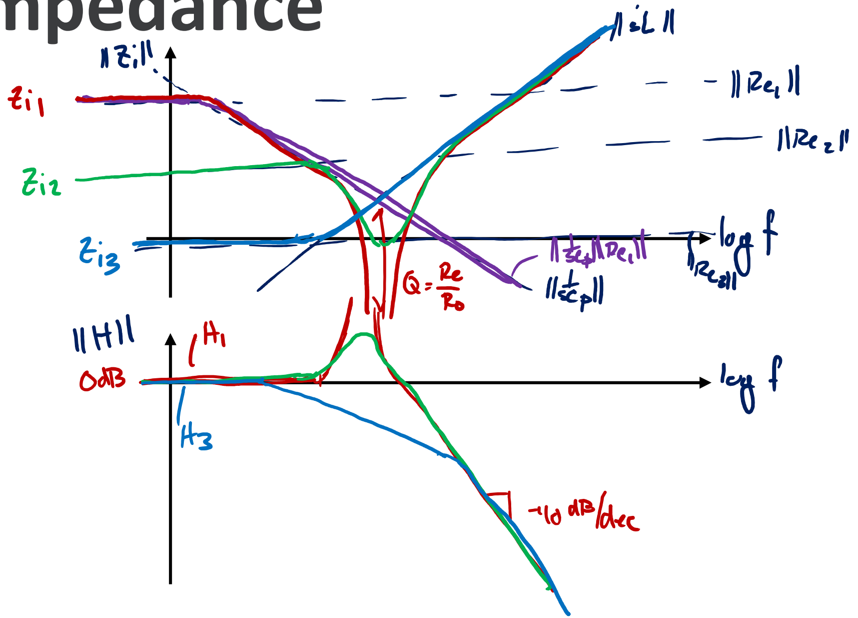
not log scale

Parallel Resonant Converter



PRC Tank Input Impedance





$$Z_{in} = sL + \frac{1}{sC_p} \| R_e$$

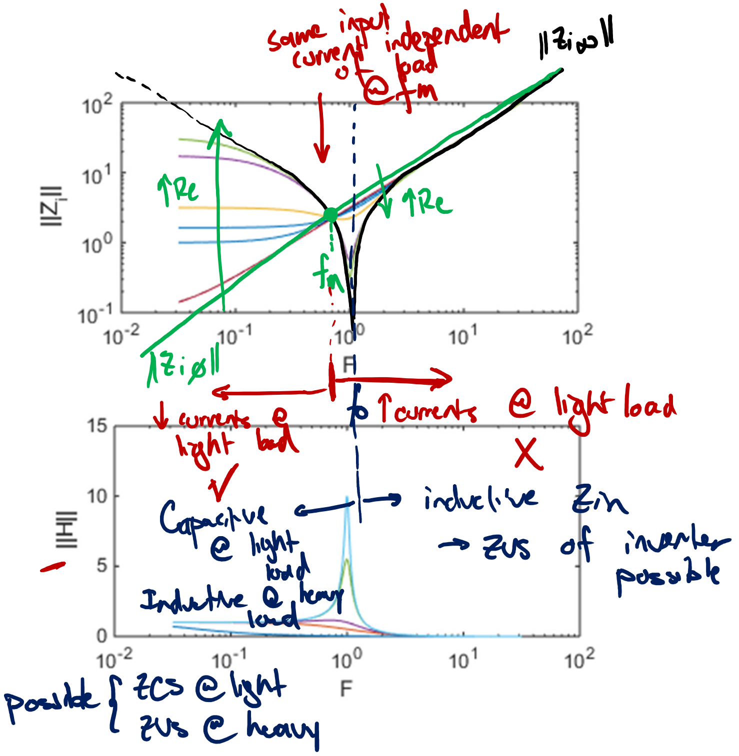
$$H(s) = \frac{\frac{1}{sC_p} \| R_e}{Z_{in}}$$

PRC Tank

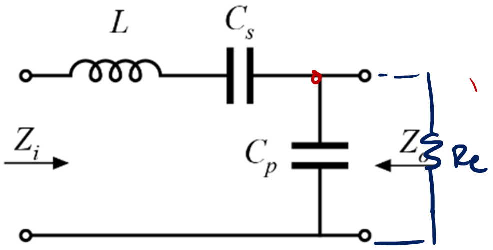
Textbook Theorem 1

- 19.4.2 in 2nd Edition
- 22.4 in 3rd Edition

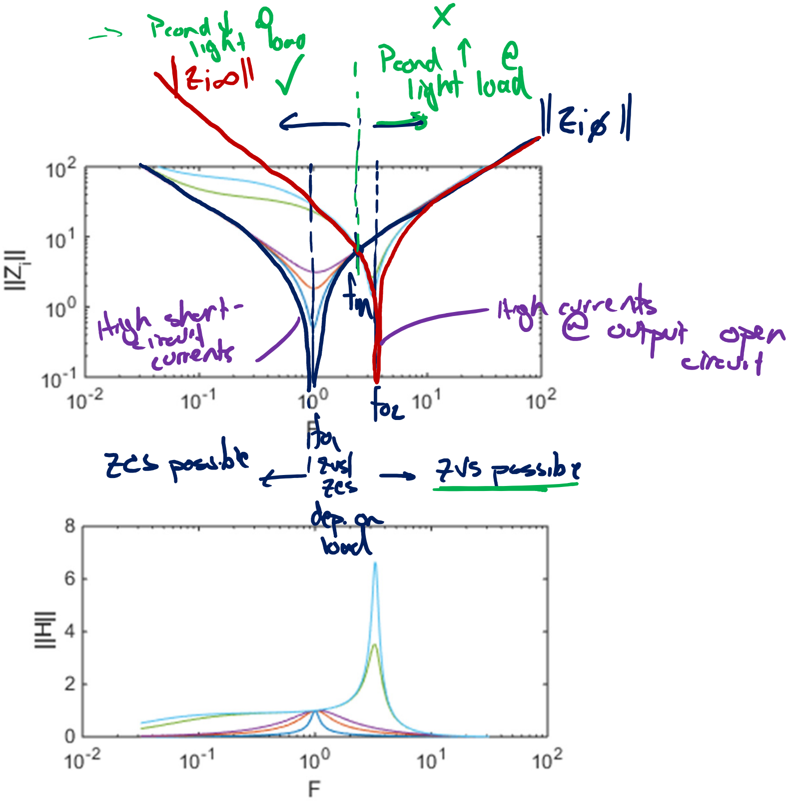
- If tank is purely reactive $\|Z_i(j\omega)\|$ is a purely monotonic function of R_e
- Only need to look at $Z_{i\infty} = Z_i|_{R_e \to \infty}$ and $Z_{i0} = Z_i|_{R_e \to 0}$; all other curves are monotonically decreasing/increasing in between



LCC

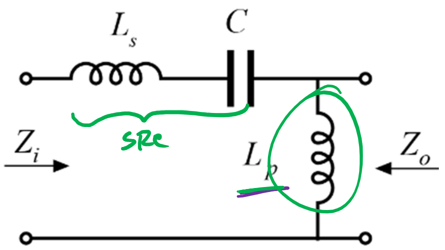


L
C_s
Z_i
C_p
Z_o
Re

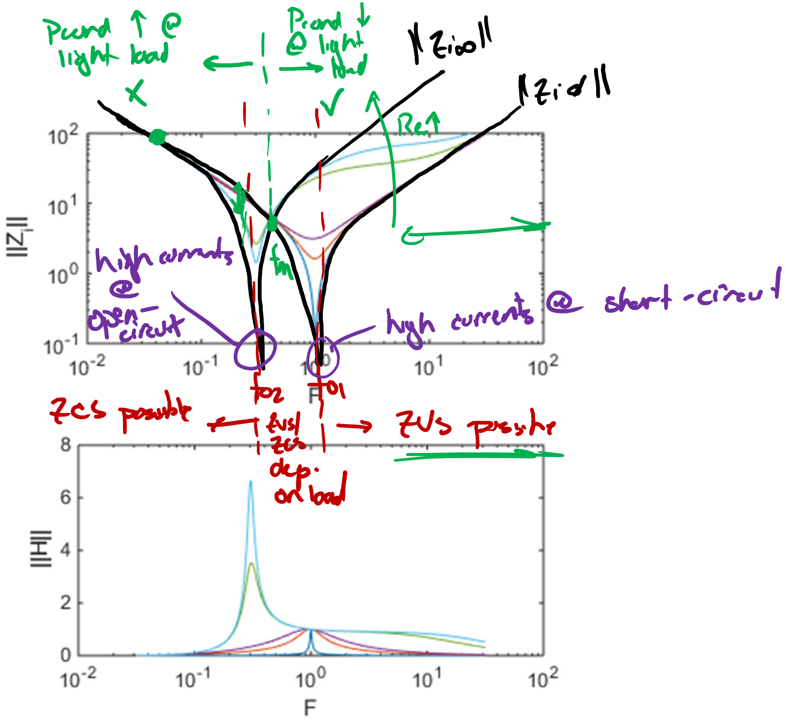


||Z_i||
F
||H||
Pcond @ light load
||Zi∞||
Pcond ↑ @ light load
||Zi0||
fm
fo2
High short-circuit currents
High currents @ output open circuit
ZCS possible
ZVS possible
fo1
ZVS/ZCS dep. on load

LLC

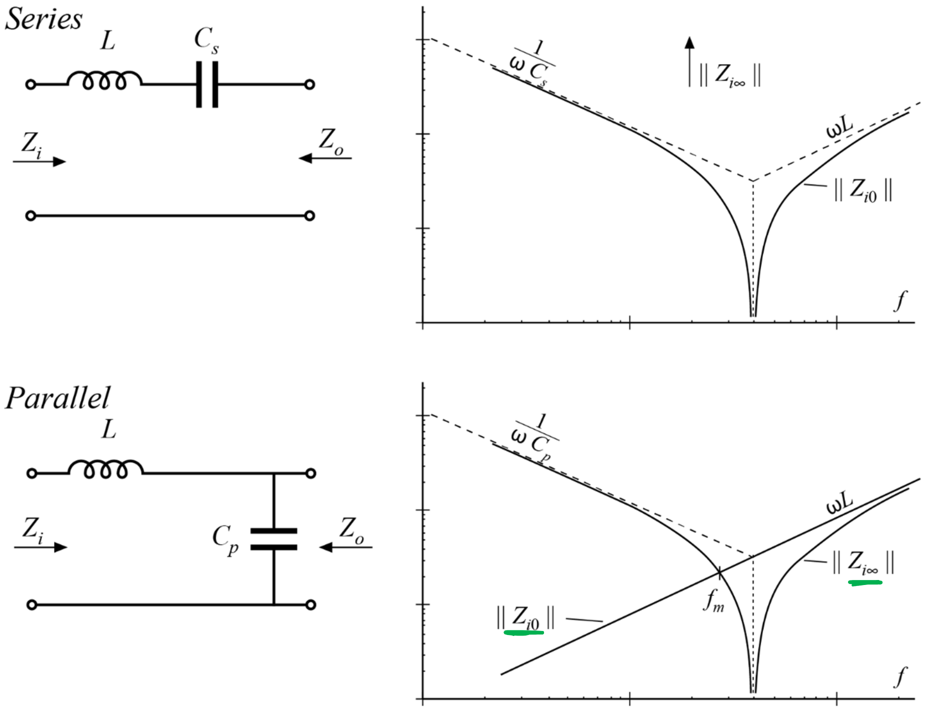


L_s
C
Z_i
L_p
Z_o
SRC

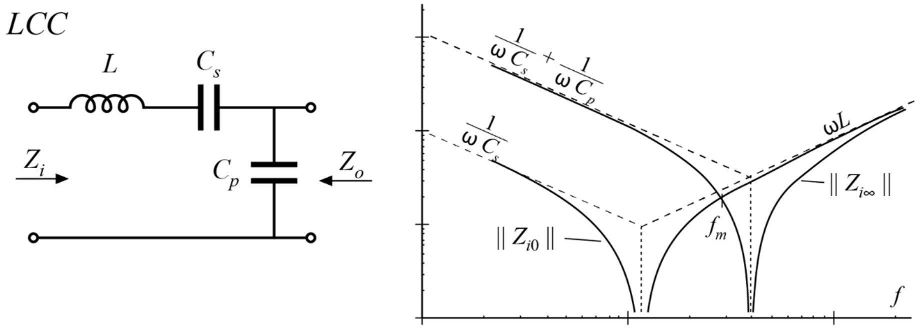


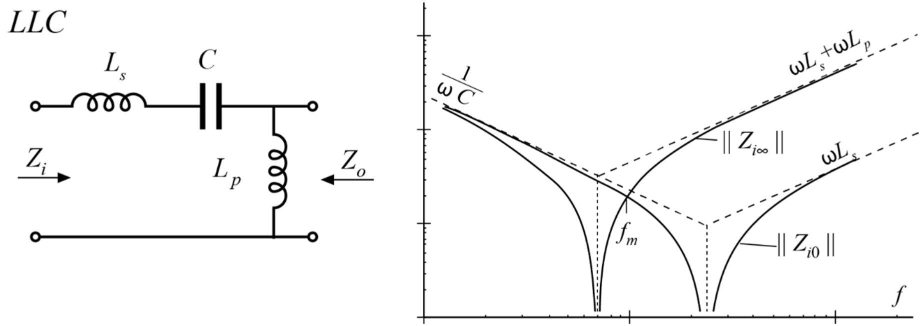
||Z||
10^2
10^1
10^0
10^{-1}
10^{-2}
F
||H||
8
6
4
2
0
Pcond ↑ @ light load
Pcond ↓ @ light load
||Zi∞||
||Zi0||
Re↑
fm
high currents @ open-circuit
high currents @ short-circuit
fo2
fo1
ZCS possible
ZVS/ZCS dep. on load
ZVS possible

Tank Summary (1/2)

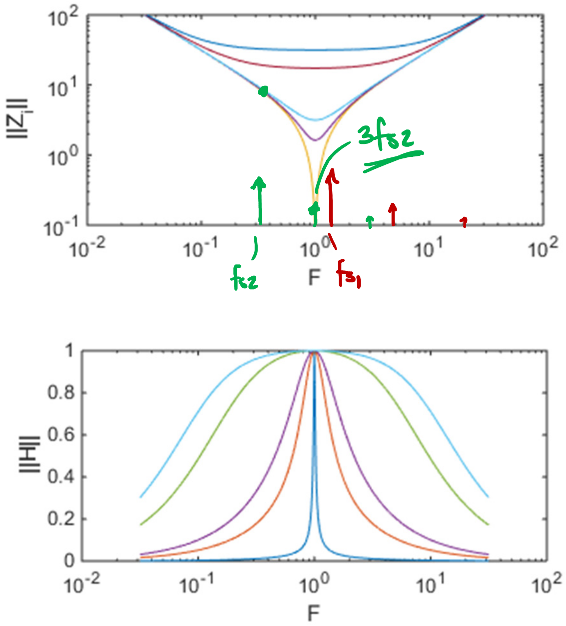


Tank Summary (2/2)

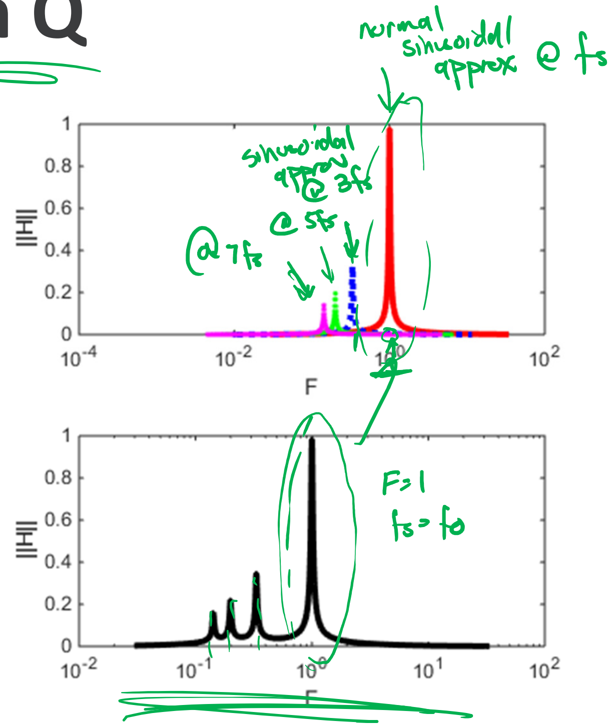




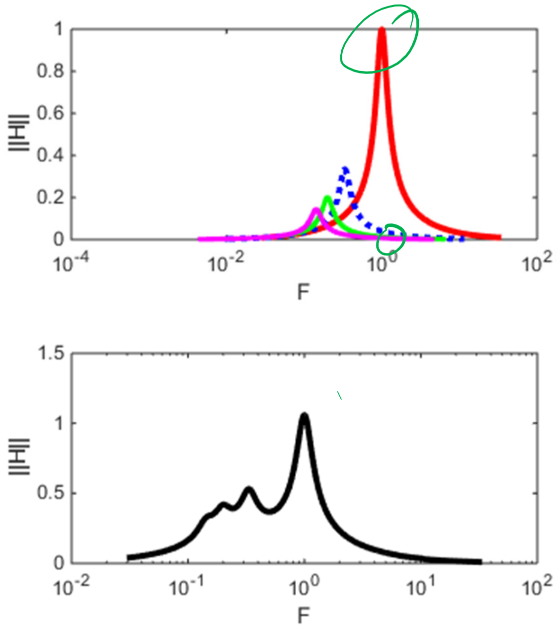
Series Resonant Tank – Subharmonic Modes



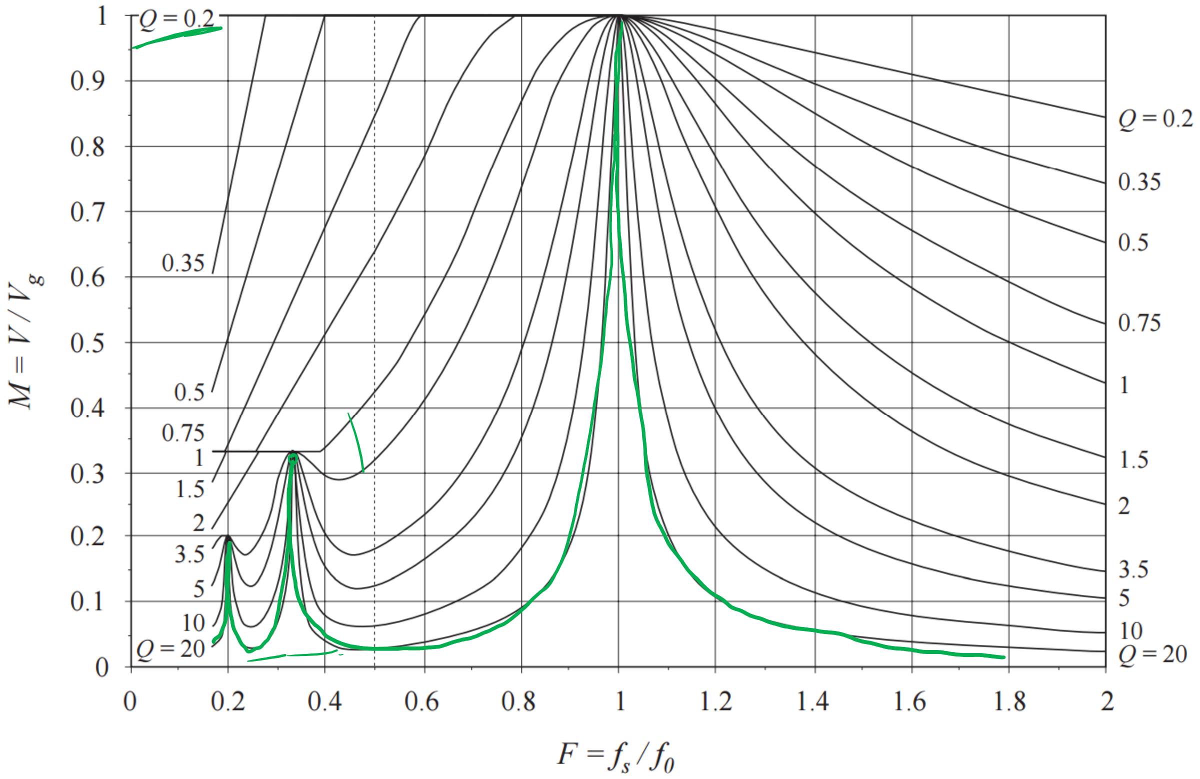
Subharmonic Modes - High Q



Subharmonic Modes – Low Q



SRC Control Plane



SRC Mode Boundaries