MULTILAYER GENERATORS FOR POWER AUTONOMY IN THE IOT

by,

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OUTLINE

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- RLC Circuit Diagram
- Before & After Tightening
- Presence of Parasitic Resonance
- Simulation Design & Results
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INTRODUCTION

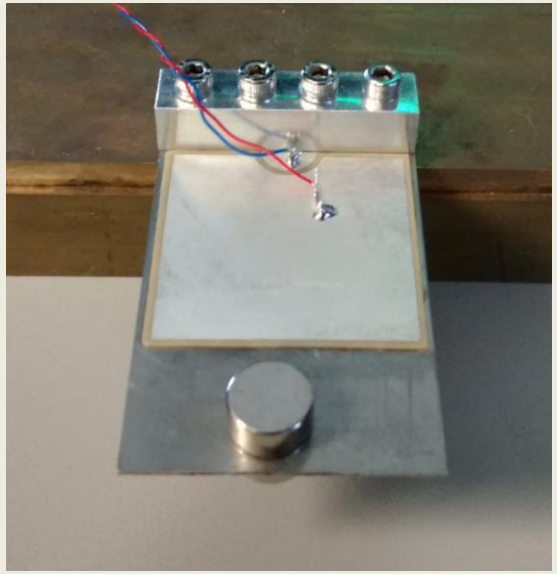
- This experiment is about the analyses and comparison of the piezoelectric beams and the capacity of piezoelectric energy harvester.
- To differentiate between single layer and multilayer generator.
- Definitions of topologies, architectures and techniques on the basis of this hierarchical presentation is given.
- Presented the comparison of the conditions for each iteration.
- The general idea is to power an electronic device using the power generated by the piezoelectric beam.

AIM

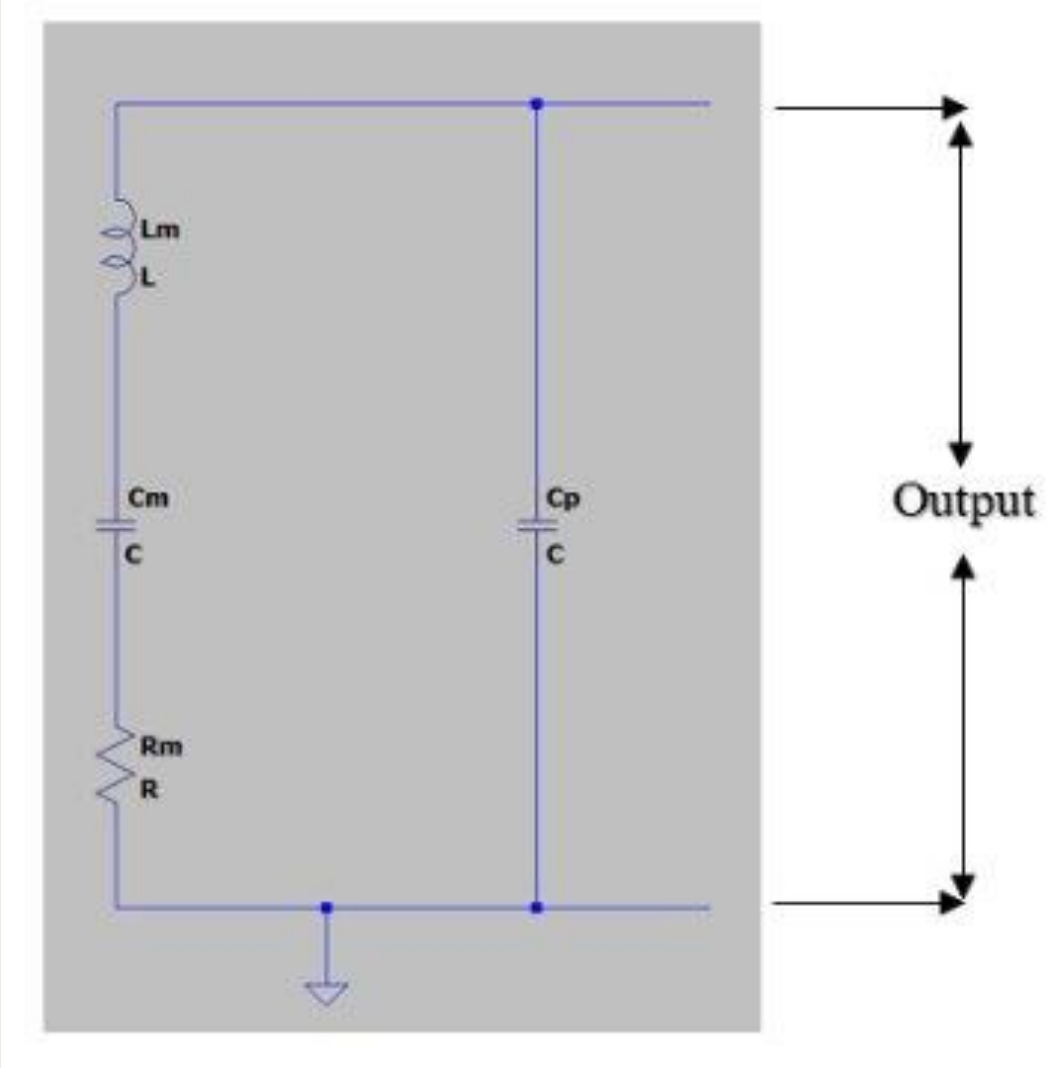
- Comparison of multi-layer generators and single-layer power generator.
- Once the multi-layer generator is capable of producing significant power to operate small electronic devices.
- They can used to power those devices without any external power supply or batteries.
- Main reason for the comparison is to check whether the multilayer is really capable of producing higher power when compared with the single-layer power generator

COMPONENTS USED

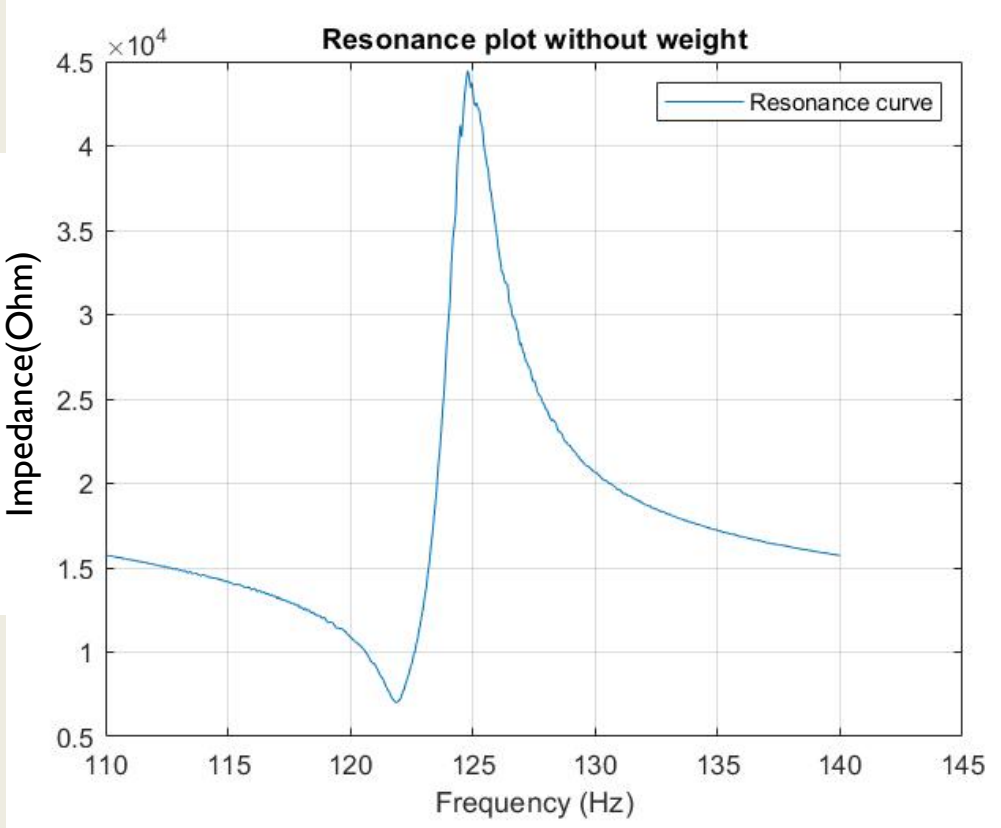
- Piezoelectric beam
- Weights
- MFIA instrument
- LABONE user interface

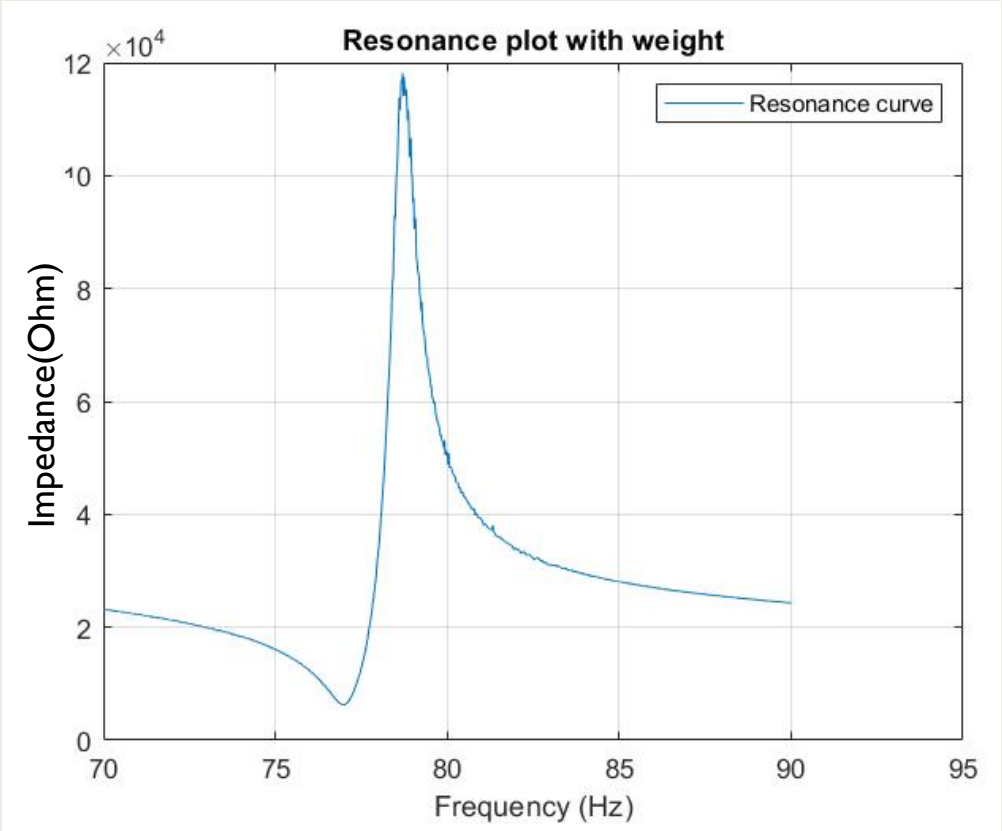


RLC CIRCUIT DIAGRAM

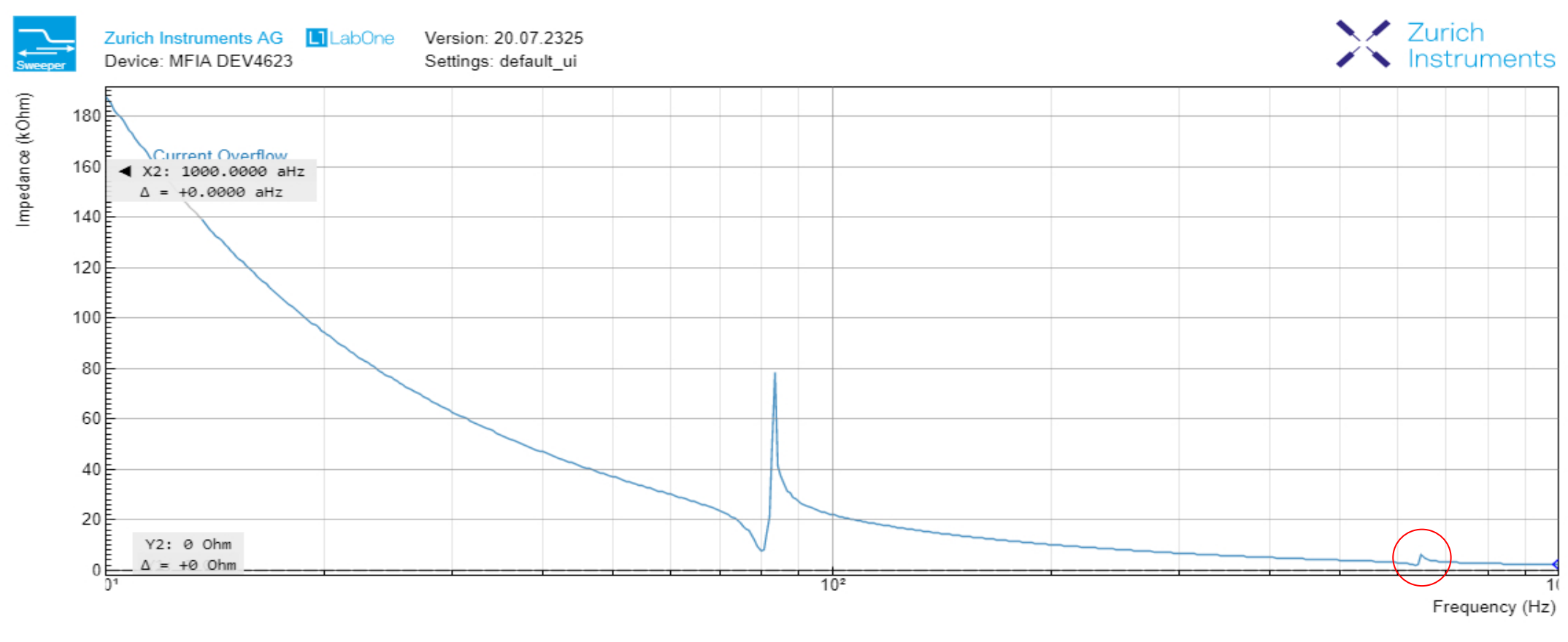


BEFORE TIGHTENING



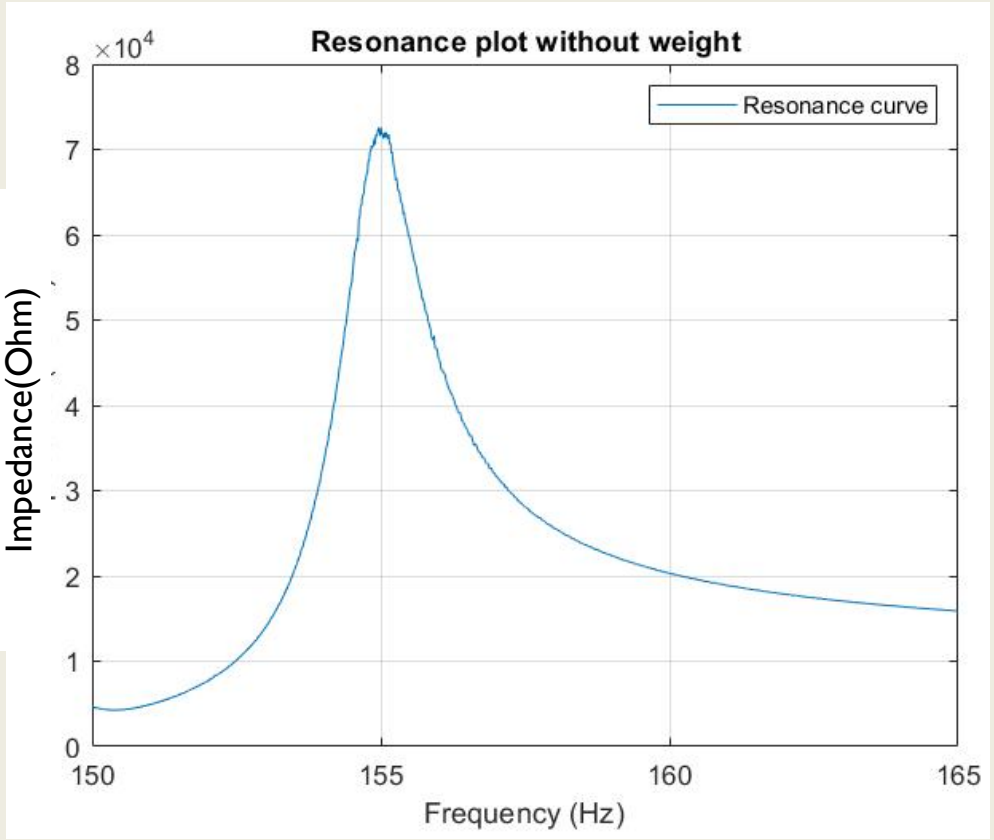


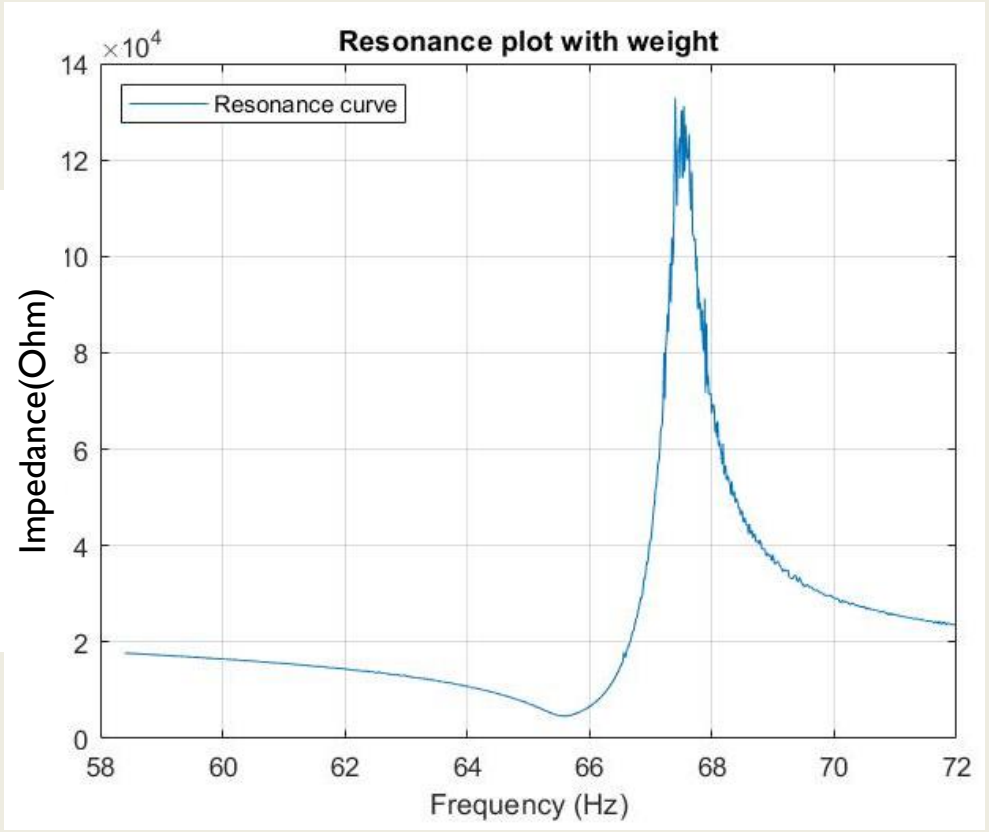
PRESENCE OF PARASITIC RESONANCE



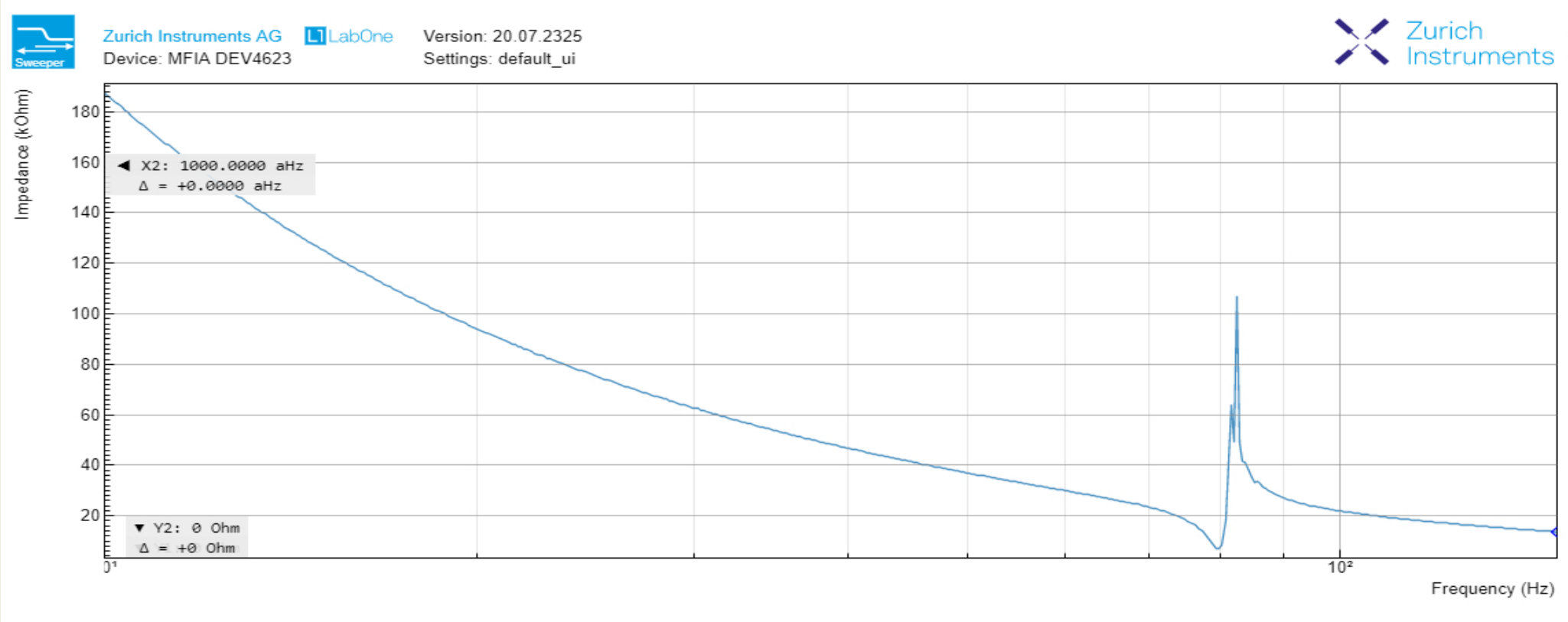
The highlighted area has the parasitic resonance. Once we tight the screws properly, we were not able to see the parasitic resonance.

AFTER TIGHTENING





PARASITIC RESONANCE ARRESTED AFTER TIGHTENING



Once we tightened the screws, we were not able to see the parasitic resonance

SIMULATION DESIGN

- As we know the impedance of the components in the circuits are:

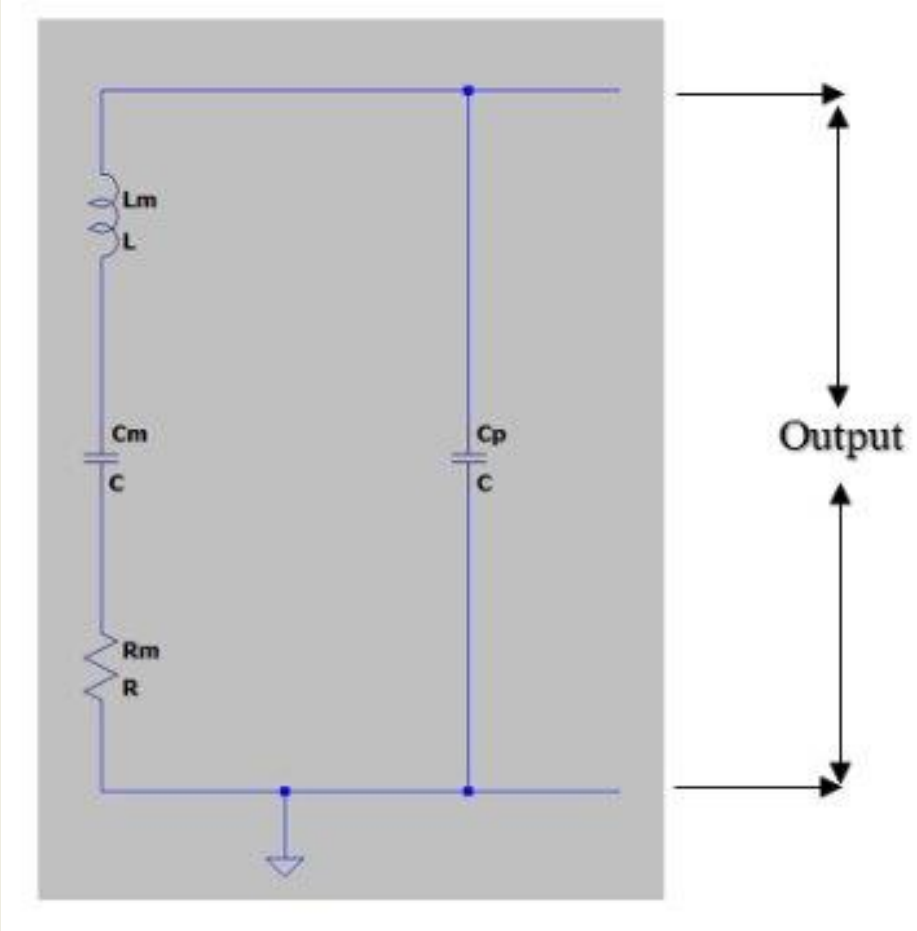
$$C = \frac{1}{j\omega C_m}; \qquad L = j\omega Lm; \qquad R = R_m; \qquad Cp = \frac{1}{j\omega C_p}$$

- The impedance Z of the C_m, L_m, R_m is given by the equation:

$$Z = C + L + R$$

- Now the values of components are:

$$L_m = \frac{1}{K_m{}^2 * \omega_o{}^2 * C_p}; \qquad C_m = C_p K_m{}^2; \qquad R_m = \frac{1}{K_m{}^2 * Q * \omega_o * C_p}$$



SIMULATION DESIGN *(….CONTINUITY)*

- On substituting the values in the in Z, we obtain the equation:

$$Z = \frac{1}{K_m{}^2 * Q * \omega_o * C_p} + \frac{1}{j\omega * C_p * K_m{}^2} + j\omega \frac{1}{K_m{}^2 * \omega_o{}^2 * C_p}$$

- The total impedance of the circuit:

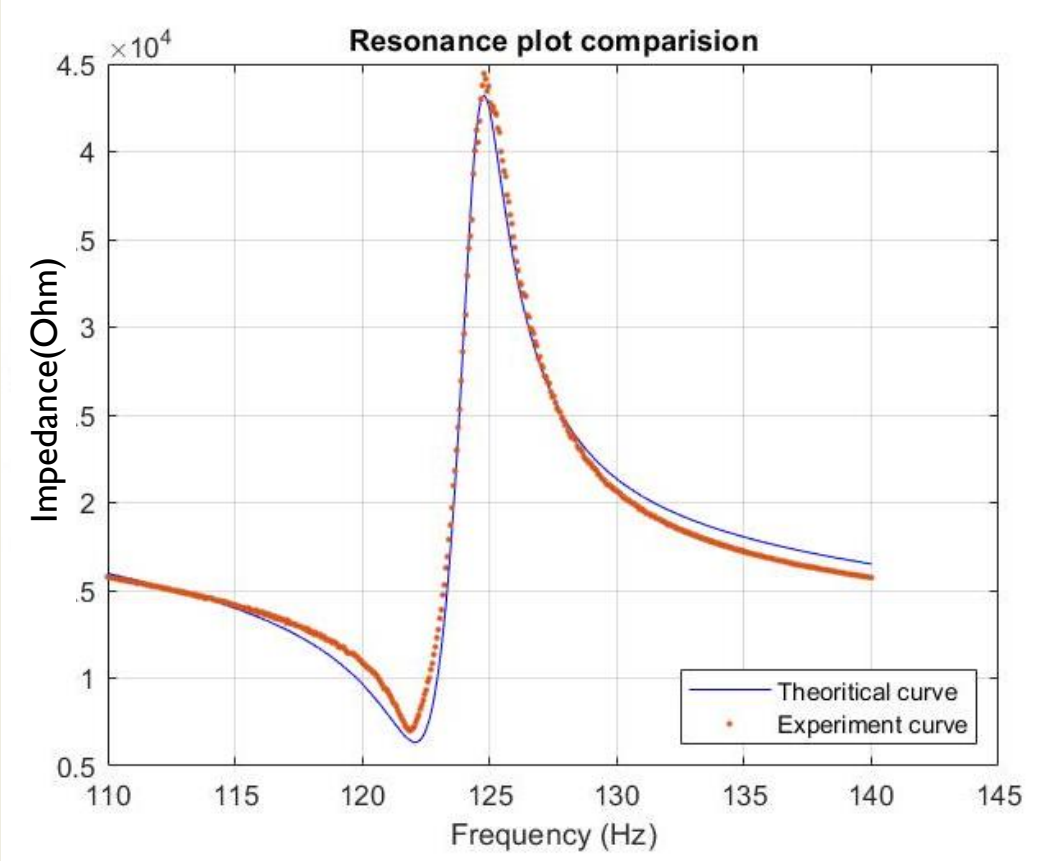
$$Z_{tot} = \frac{Z}{1 + j\omega * Cp * Z}$$

- On simplifying (we used **simplify( )** function in MATLAB) we get:

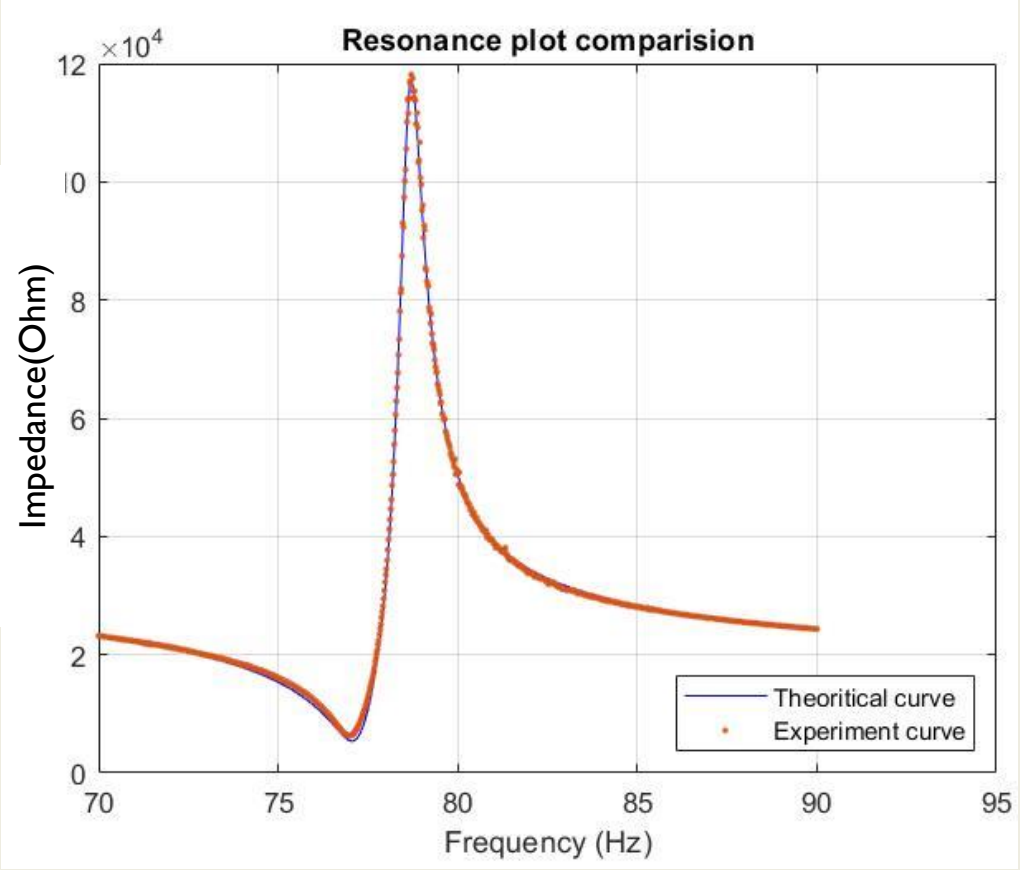
$$Z_{tot} = \frac{jQ\omega^2 + \omega * \omega_o - jQ\omega_o{}^2}{C_p * \omega\,(Q * \omega_o{}^2 - Q * \omega^2 + K_m{}^2 * Q * \omega_o{}^2 + j\omega * \omega_o)}$$

- As the equation is a non-linear one, we used a MATLAB function called **lsqnonlin( )** to solve it.

SIMULATION RESULTS
BEFORE TIGHTENING

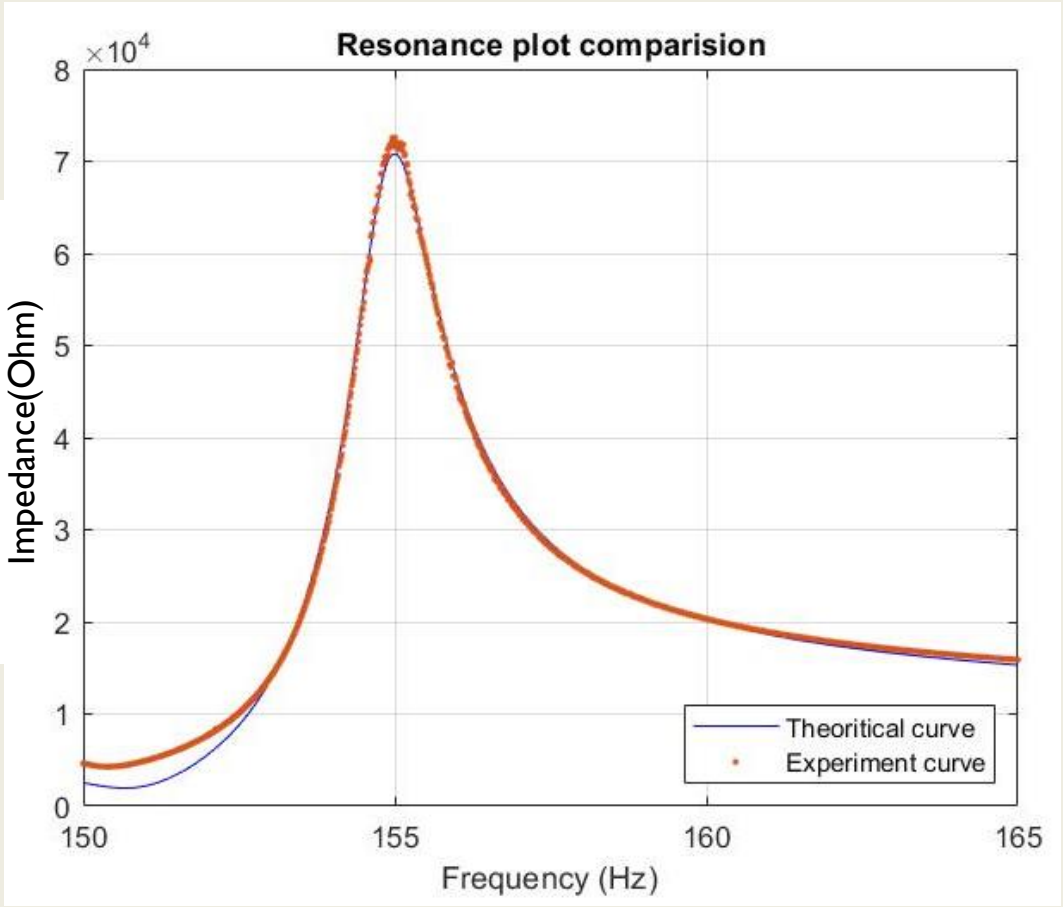


Without weight

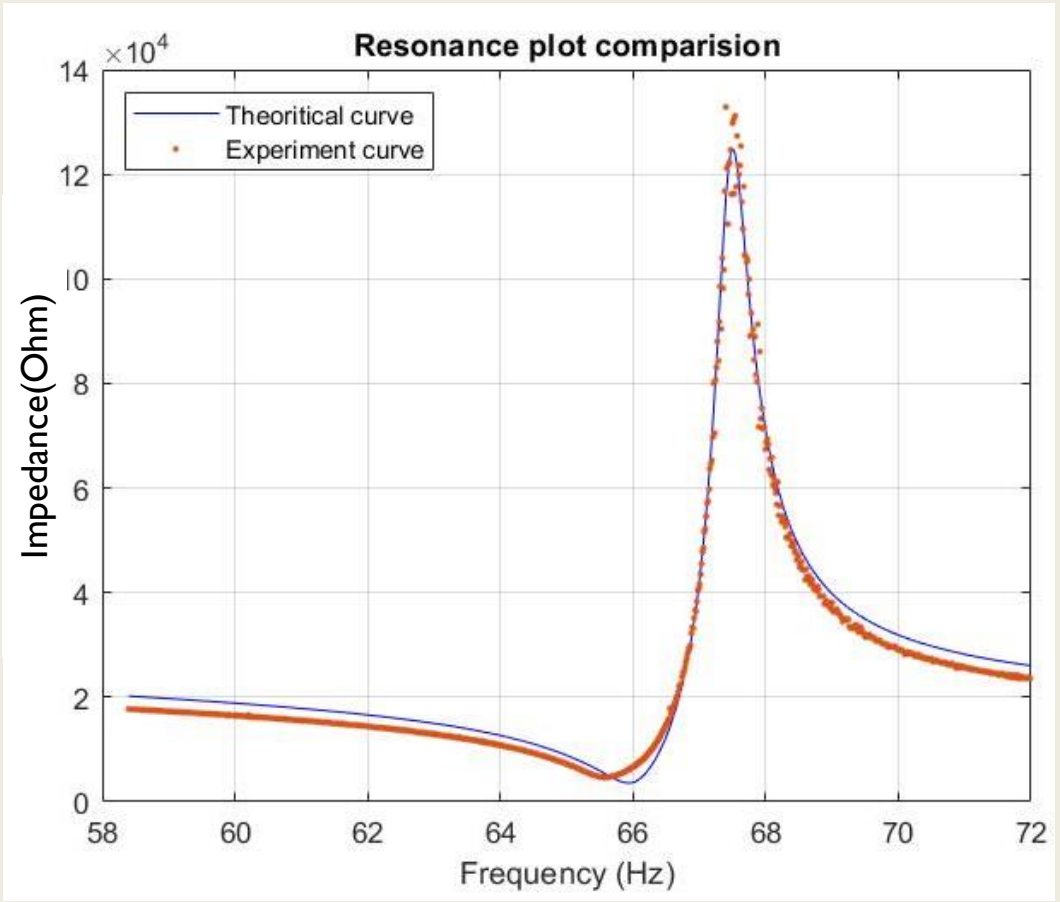


With suspended weight

SIMULATION RESULTS (.....CONTINUITY)
AFTER TIGHTENING



Without weight



With weight

COMPARISON TABLE

Type	K_m^2	W_o	C_p	Q
Starting values	0.05	753.6	1*e-7	40
Without tightening without weight	0.0335	122.4165	4.8534*e-7	68.0068
Without tightening with weight	0.0397	77.1272	5.0701*e-7	114.7989
With tightening without weight	0.052	150.7799	5.4848*e-7	108.9138
With tightening with weight	0.0506	65.8	7.855*e-7	128.9676

Factor	K_m^2	W_o	C_p	Q
Starting values	0.05	753.6	1*e-7	40
Without tightening without weight	Decreased by 33%	Decrease by 83.76%	Increase by 385.34%	Increase by 70.02%
Without tightening with weight	Decrease by 20.6%	Decrease by 89.77%	Increase by 407.01%	Increase by 186.99%
With tightening without weight	Increase by 4%	Decrease by 79.99%	Increase by 448.48%	Increase by 172.28%
With tightening with weight	Increase by 1.2%	Decrease by 91.27%	Increase by 685.5%	Increase by 222.42%

OBSERVATION

- On addition of weight gives a better resonance.
- If the beam is tightly screwed to the base, the result is much better.
- This is due to the vibration of the beam in multiple angles.
- Results in parasitic resonance.
- Adding weight helps in higher resonance.
- Also the resonance appears much earlier.
- Current generated is more when beam is suspended with weight

CONCLUSION

- So, if the beam is tightened well with its base and weight is suspended, output it is better.
- Thus the experiment generates expected power.
- This will be enough to power a small electronic device without external power supply.
- Achieved the AIM.