Simple Disk Piezo Transformer Based Oscillator

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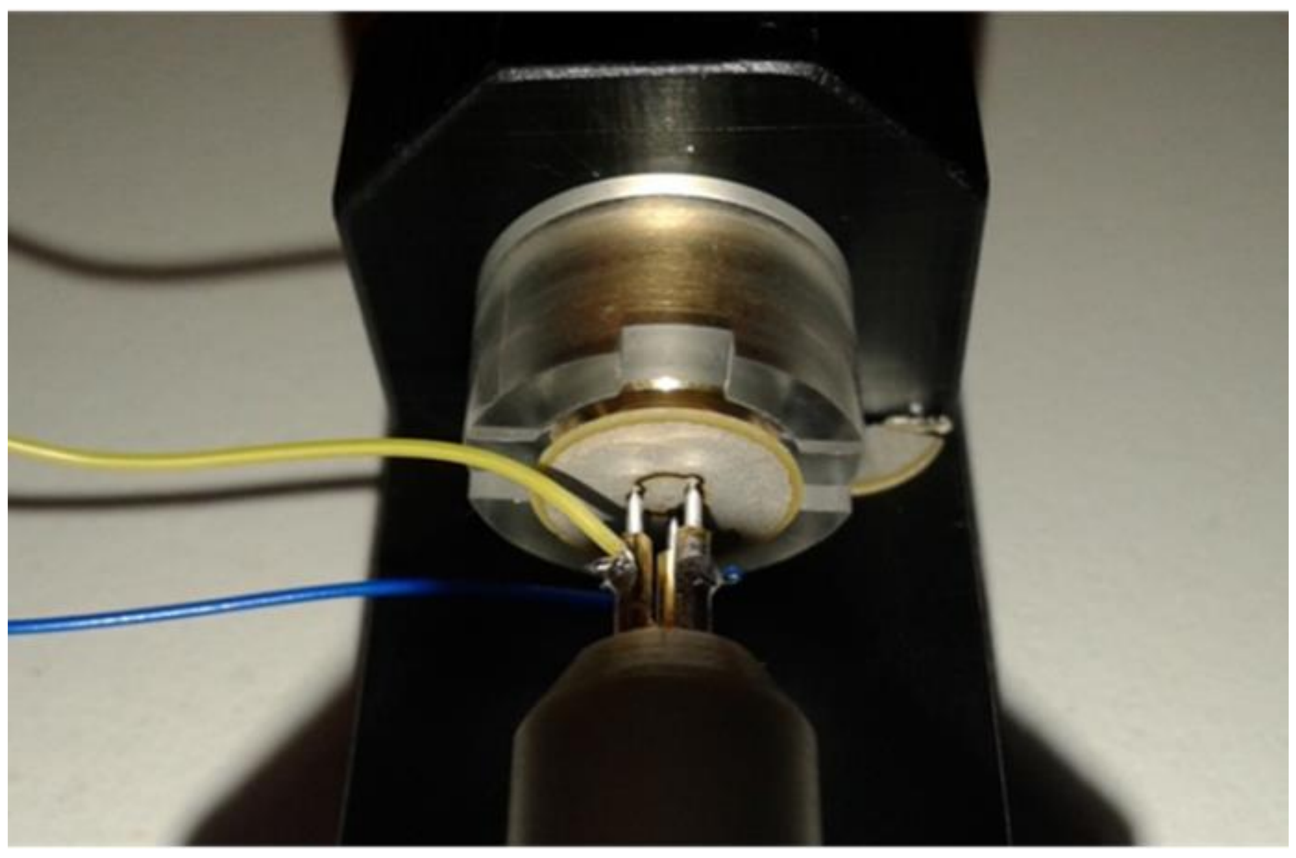
Introduction:

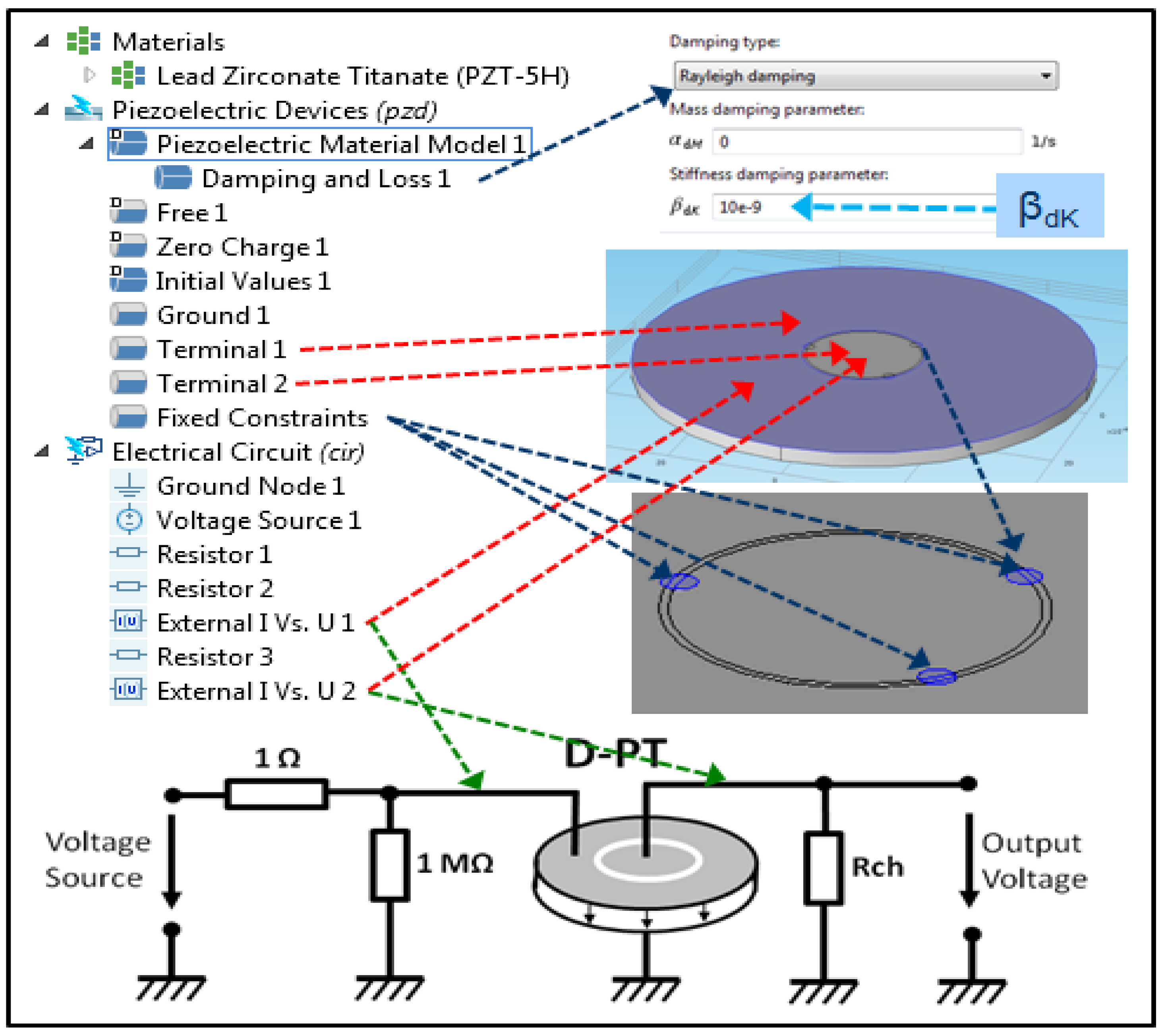
Today, many applications are using the standard magnetic transformer, but in some cases, a piezoelectric transformer (PT) can replace it in systems such as : Charge generation for high-voltage low-power application, Very low power high efficiency DC/DC converter, Step-up / step-down conversion in high magnetic field environment (IRM). The main advantages of PTs are the weight and the size reduction in low power applications while guarantying low EMI.



A disk piezoelectric ceramic transformer

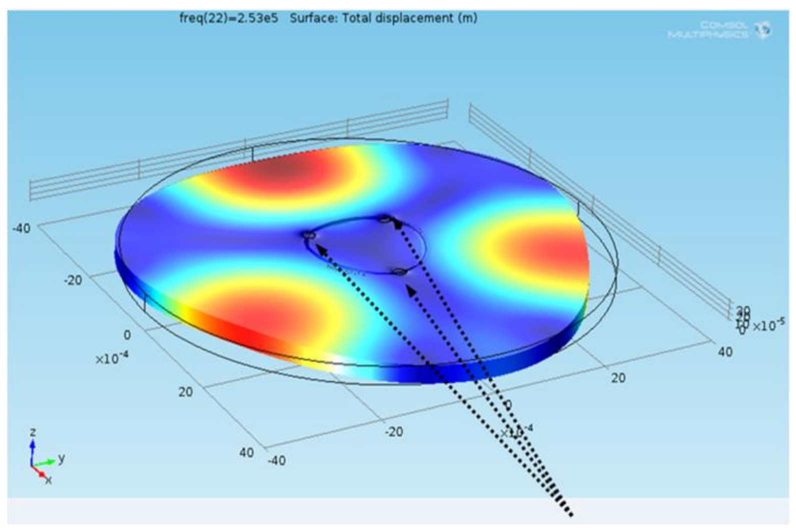
Computational Methods:

In a first simulation step, the simple disk piezoelectric ceramic transformer (D-PT) is studied without clamping points. Then, their positions are determined, as well as the essential electrical characteristics under various operating conditions. Finally, the D-PT is coupled with a bipolar NPN transistor to form an auto-oscillator. The two next physics were used for the frequency and time domain analysis with COMSOL Multiphysics 4.4 : “Piezoelectric Devices” (pzd) and “Electrical Circuit” (cir).

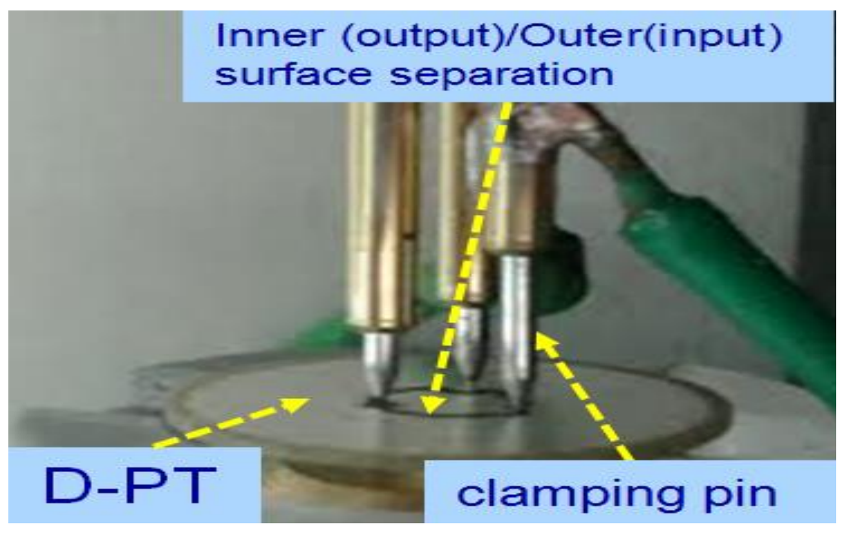


Simulation parameters

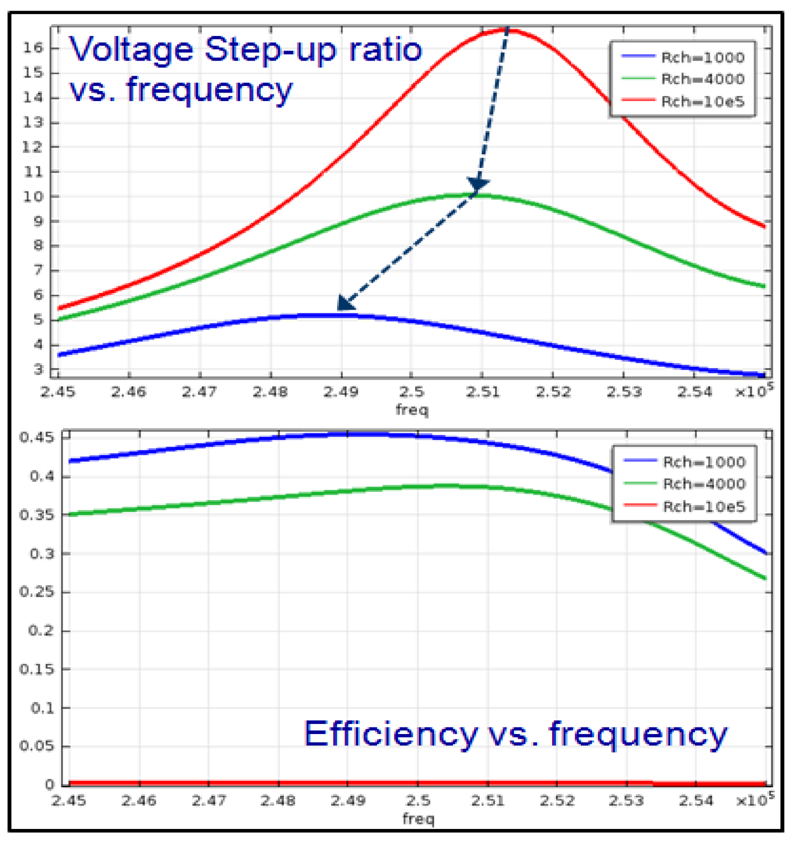
Results:



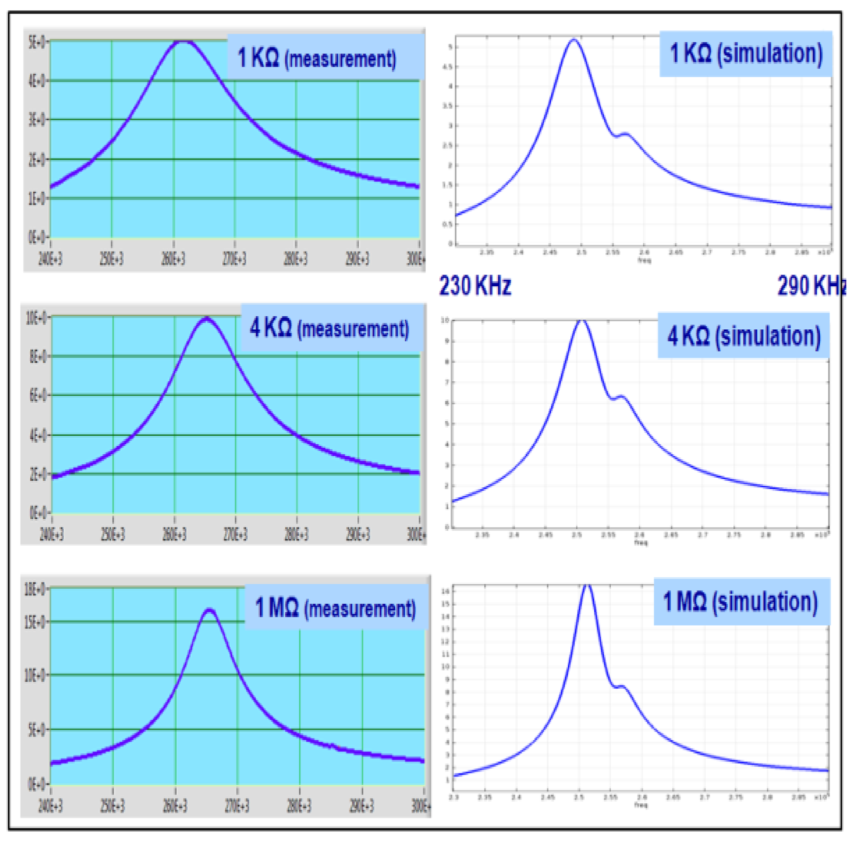
Displacement with 3 clamping points



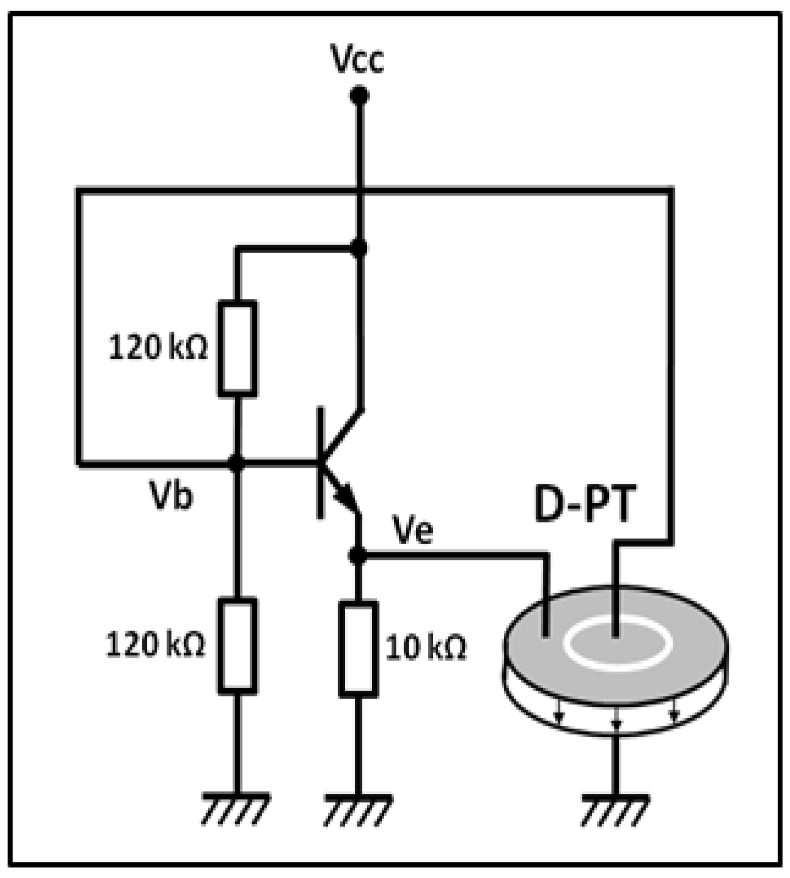
D-PT clamped between 3 movable pins and 3 fixed poles

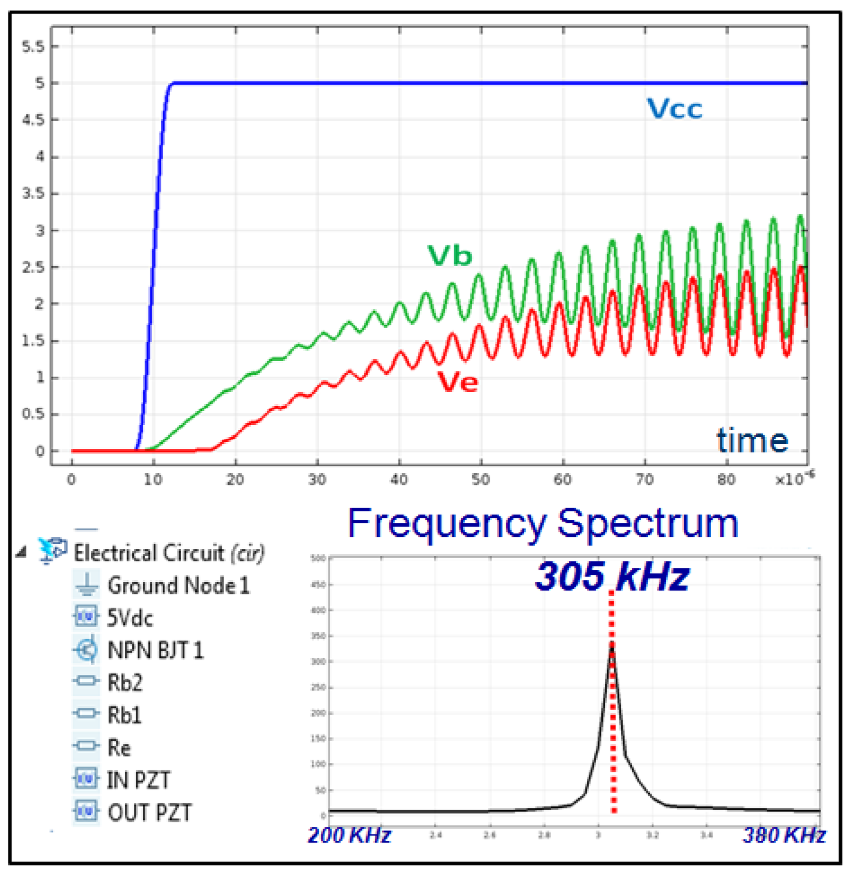


Gv(f) & η(f), 3 clamp. points



Gv(f),230 KHz → 290 KHz





Oscillator Electronics Schematic & Resulting simulation

Conclusions:

The use of COMSOL Multiphysics® turned out to be a very effective way to find good locations for the D-PT clamping points, a particular challenging issue with such a light weight device. Moreover, the coupling of “pzd” with “cir” gives the key electrical parameters (e.g. input impedance, efficiency....), the influence of the device geometry and of the clamping positions upon them.

References:

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2. Yang S.-L., Chen S.-M., Tsai C.-C., Hong C.-S., Chu S.-Y., Fabrication of High-Power Piezoelectric Transformers Using Lead-Free Ceramics for Application in Electronic Ballasts, *IEEE Trans. on UFFC*, **VOL. 60**, p408-413 (2013)

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