

Ultra-stiff mechanical coupling

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1 Motivation

The drivers of a loudspeaker systems should work in such a way to convert into sound energy all the electrical energy supplied by the amplifier. In fact, it must be strictly forbidden that other components of the system catch and store part of this energy, giving up it after a while to the environment or back to the drivers themselves. Both these effects are highly harmful:

1. The energy wasted in vibration of the structure and of the prop/stand and in parasitic sound emission are simply noise added to the unperturbed emission;
2. The incoherent back transfer of energy to the drivers disturbs their correct working, further increasing noise and distortion.

The necessary condition to warrant the absence of those deleterious phenomena is that of minimizing perturbation effects. In the following we present an extremely simple but useful model for those phenomena.

2 The model

To describe the interaction between a “machine” m affected by vibration to the “rest of Universe” M , we can use the mechanical model of Fig.1 where k stands for the elastic constant of the equivalent linear ‘spring’ and a represents damping and friction. To this it corresponds the equivalent electrical scheme of Fig.2, where $C_m = 1/k$ is the mechanical compliance and all damping is lumped in an element with effective mechanical ‘resistance’ R .

The transfer function of the filter family is

$$\frac{F_{\text{tr}}}{F} = \frac{1 + i\frac{s}{Q}}{1 - s^2 + i\frac{s}{Q}}, \quad (1)$$

where $s = \omega/\omega_0$ and

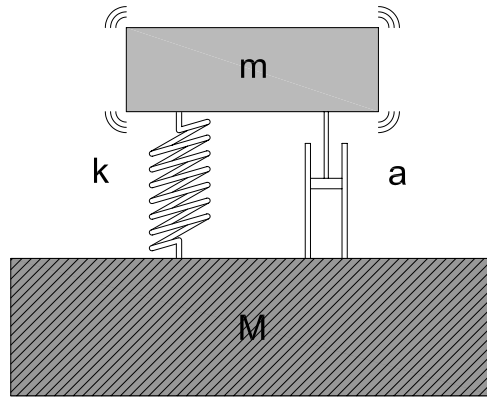


Figure 1: Mechanical model of the interaction between a “machine” m affected by vibration to the “rest of Universe” M .

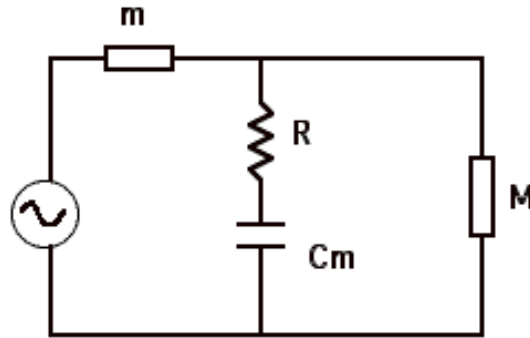


Figure 2: Equivalent electrical scheme of the mechanical model of fig. 1.

$$\omega_0 = \frac{1}{\sqrt{mC_m}}, \quad (2)$$

$$Q = \frac{1}{R} \sqrt{\frac{m}{C_m}}. \quad (3)$$

It can be seen how, the higher the value of ω_0 , the greater is the vibration bandwidth shared with M . If m has a value fixed by the structure and character of the machine, we have that, in order to maximize the bandwidth, we need to minimize the compliance C_m by strenghtening the mechanical structure.

Moreover, it is useful to maximize the quality factor of the coupling system because, as it can be seen from the curves in Fig.3, the band ‘gain’ results increased. We have therefore to devise a strongly ‘lossless’ structure taking care of all possible sources of dissipation in the electromechanical

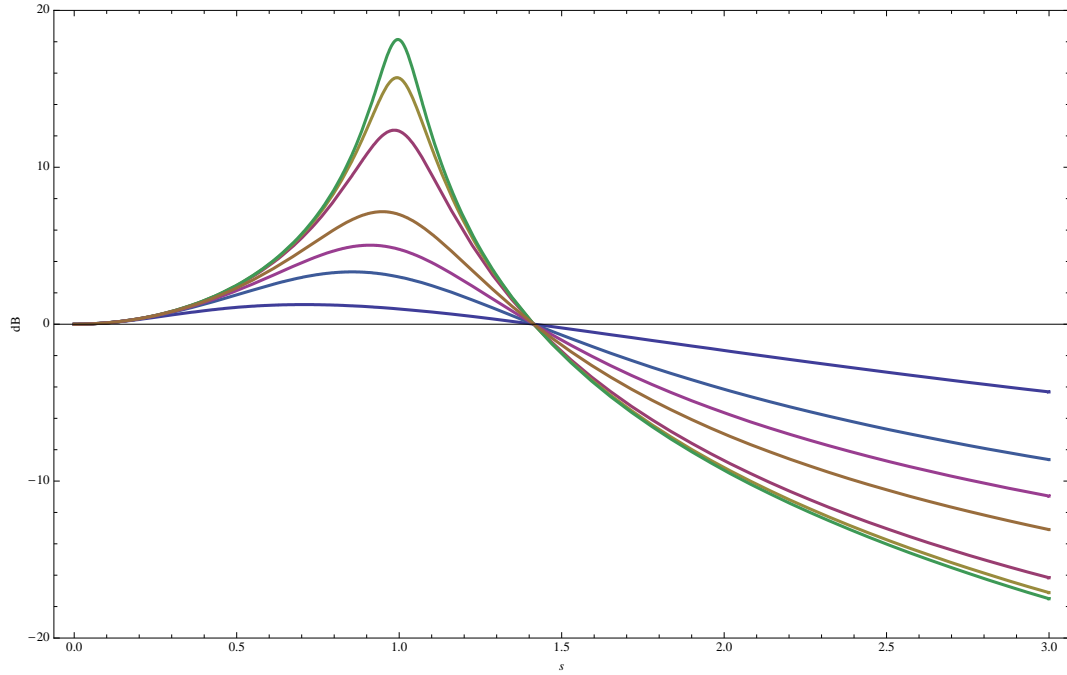


Figure 3: Transfer functions family (1) for several values of Q .

chain.

3 Realization

This objective is reached through a perfect coupling of the drivers to the cabinet and an ideal matching of the cabinet-prop-environment chain, with the cancelation of the effects due to the resonant modes of the mechanical system.

In the new Albedo loudspeakers this is achieved by an ultra-stiff mechanical coupling of the cabinet to the prop and to the Earth by means of:

1. a damped steel binding bar;
2. a massive basement with adjustable ultra-rigid spikes;
3. a loaded sandwich tapered cabinet;
4. Ceramic low-moving-mass drivers with ultra-stiff basket.