

Origin and correction of the dip around 1900Hz observable on the response curve of the TAD TD2001 chamber on various horns.

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Comparison of response curve and impedance curve.

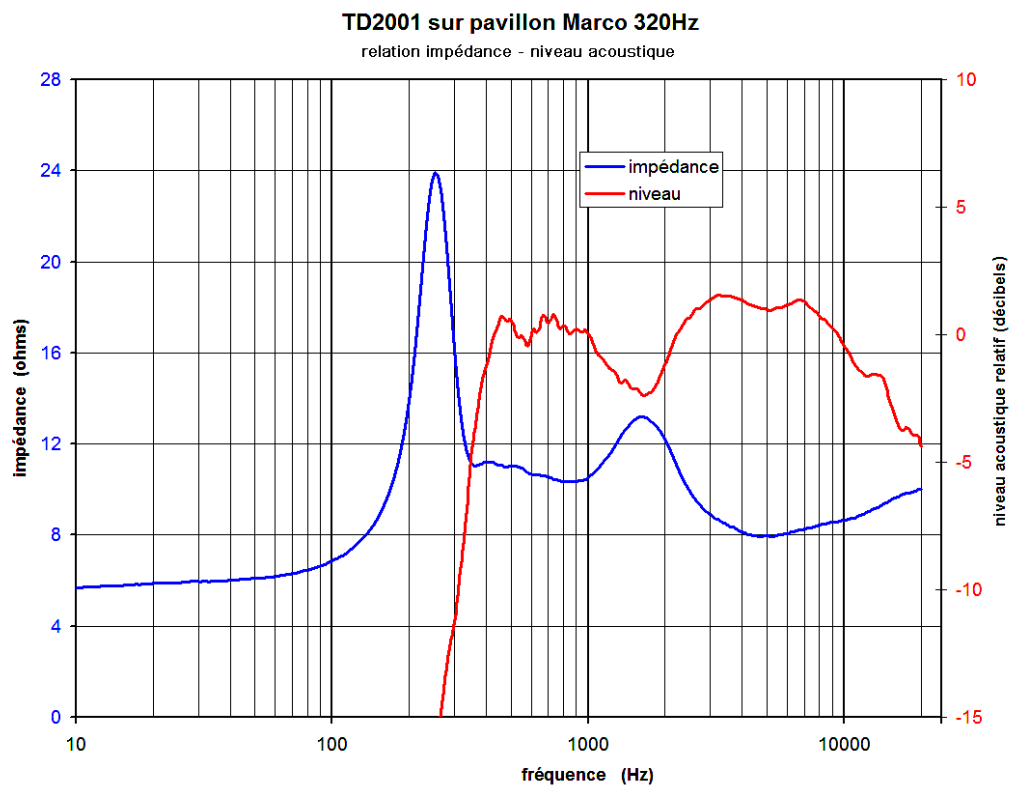
The equipment used is the TAD TD2001 compression chamber on a Marco Henry horn with a 320Hz cut-off frequency and a Bryston PP120 very low output impedance amplifier.

Measurements were made using the impulse response method using the logsweep + convolution method.

The basic data, already known, are:

- the resonant frequency of the TAD TD2001 chamber mounted on the Marco 320Hz pavilion is 250 Hz;
- the acoustic cutoff of the horn is approximately 350Hz and we also know that its acoustic reactance decreases rapidly above 400Hz until it becomes negligible around 800Hz;
- the power response of the compression chamber decreases from approximately 4000Hz.

The first graph compares the response curve to the impedance curve of the TD2001 chamber.



Note that in the frequency range from 400Hz to 4000Hz, any variation in impedance has its equivalent reversed head to tail on the response curve.

So:

- the plateau between 400Hz and 1000Hz is found on both curves;
- the dip around 1700Hz on the response curve corresponds to a peak of the same shape and width on the impedance curve;
- the plateau between 2500 and 8000Hz is found on both curves.

The amplifier used for these measurements (Bryston PP120) has a very low output impedance.

We can therefore assume that the voltage at the terminals of the chamber coil is constant whatever the impedance of the loudspeaker. In this case, the current responds to Ohm's law:

$$I=U/R$$

and U being constant the current evolves inversely to R (the loudspeaker impedance at a given frequency).

So we can interpret the level variations observed on the response curve as being due to current variations.

In conclusion:

- these measurements are a verification of the fact, often forgotten, that in the frequency range where its load is essentially resistive it is the current in the coil which controls the response of the loudspeaker (not the voltage);
- the trough at 1700Hz observable on the response curve is due to an impedance peak which culminates at 13 ohms at the frequency of 1700Hz.
- the horn is not in question (unless the amplitude of the hollow exceeds 4 decibels, in which case, check the alignment and the horn-compression chamber connection)

It can be hypothesized that if the current through the coil were more constant in the 400Hz-4000Hz range or if the impedance was more constant then the response curve should be linearized.

Study of the effect of a series resistance on the response curve of the TAD TD2001 compression chamber loaded by horn.

It is generally considered that an amplifier with low output impedance makes it possible to better limit the effect of variations in the impedance curve of a loudspeaker on its response curve.

In fact, it is necessary to distinguish what happens at the level of the main resonance frequency, for example at very low frequencies in the case of a bass speaker or even towards the cut-off frequency in the case of a horn. In these two cases the load is highly reactive and the addition of series resonance strongly modifies the transfer function.

But in the frequency range where the loudspeaker + load couple has a quasi-resistive impedance, no one has ever wondered what it was.

I will try to show that in this case it is advantageous to use amplifiers with high output impedance.

Theoretical approach:

Suppose the impedance curve of a loudspeaker shows a variation between a minimum impedance of 4 ohms and a maximum impedance of 32 ohms. With a zero output impedance amplifier, the ratio between the maximum current and the minimum current due to variations in the impedance curve will be 8.

The problem is: what is the value of this I_{max}/I_{min} ratio when a pure resistor is placed in series between the amplifier and the loudspeaker.

The results of the I_{max}/I_{min} ratio are given in the table below for different values of the resistor placed in series with the loudspeaker.

R_series	I_{max}/I_{min}
0 ohms	8.00
4 ohms	4.50
8 ohms	3.33
16 ohm	2.40
32 ohms	1.78

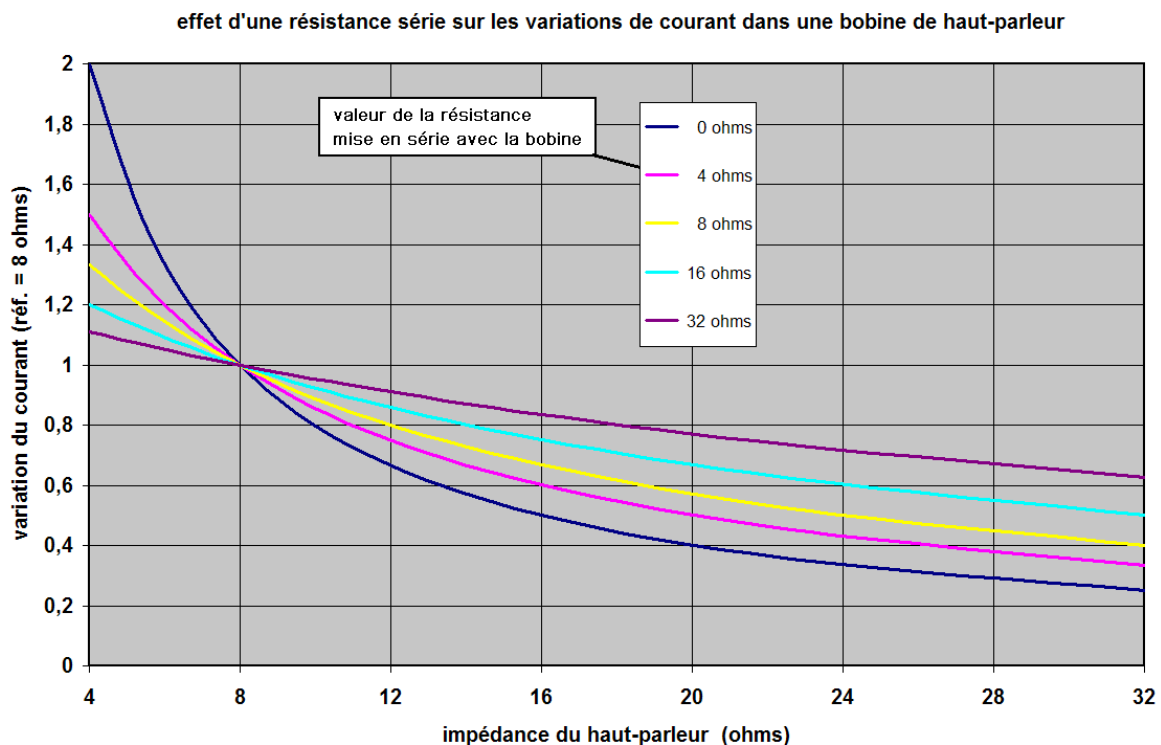
As can be seen, the addition of a series resistor has the effect of reducing the I_{max}/I_{min} ratio.

So :

— the addition of a series resistance of 5 ohms makes it possible to reduce current variations by 2;

— the addition of a 15 ohm series resistor makes it possible to reduce current variations by 3;

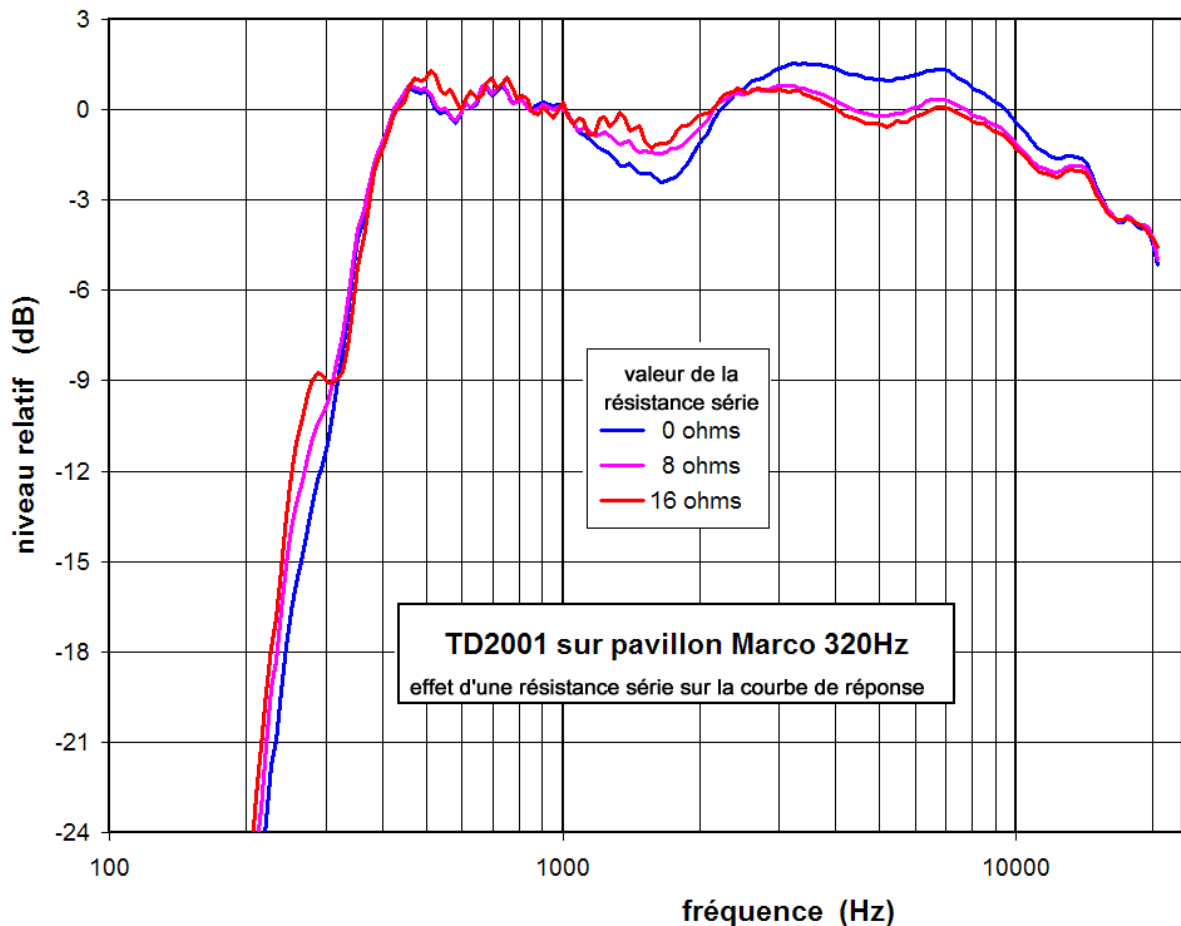
— the addition of a series resistor of 25 ohms makes it possible to reduce current variations by 4.



The graph above also shows that the addition of a series resistance not only reduces the amplitude of current variation but that this current variation is much more linear according to the variation on the impedance curve.

Experimental verification.

I noted, by the method of obtaining the impulse response of Angelo Farina, the response curve of the couple TAD TD2001 + Marco horn 320Hz powered by a Bryston PP120 amplifier whose output impedance is almost zero. Then I redid two more readings of the response curve after inserting a resistor of 8 ohms then 16 ohms between the amplifier and the coil of the compression chamber.



The figure above shows the linearization effect of the response curve provided by the addition of a series resistor.

In the frequency range from 100Hz to 800Hz, the response curve without series resistance ($R_{\text{series}} = 0$ ohms) shows an amplitude variation of 3.94 decibels.

The response curve obtained after inserting an 8 ohm series resistor shows a variation amplitude of 2.28 decibels.

The response curve obtained after inserting a series resistor of 16 ohms shows a variation amplitude of 1.98 decibels.

The measurements carried out make it possible to validate the hypothesis that the insertion of a series resistor makes it possible to linearize the response curve of a loudspeaker.

We understand a little better by contemplating this linearization effect that fans of horn systems like to use tube amplifiers which generally have a fairly high output impedance.

While this type of high output impedance amplifier is generally not recommended for driving a woofer, I highly recommend the use of this type of amplifier for horn-loaded compression chambers.

Whether it's my Shabda amplifier or my new Palimpseste amplifier, both have an output impedance considered high. This is probably partly why I prefer them to all other low output impedance amplifiers.

I advise those of you who use their compression chamber with a transistor amplifier with low output impedance to insert a resistor of 8 ohms (25 watts) or if possible 16 ohms (25 watts) between the output of their amplifier and the compression chamber. It will of course be necessary to review the level at the amplifier's input, but this is the price to pay to benefit from this strong improvement in linearity.