Phono Cartridge Loading Capacitance Is Important

I am trying to determine the phono input capacitance on my Luxman L-410 amplifier. I am aware that I have to take into account the total capacitance of the tone-arm wiring and interconnect cables which I can measure (around 120pF).

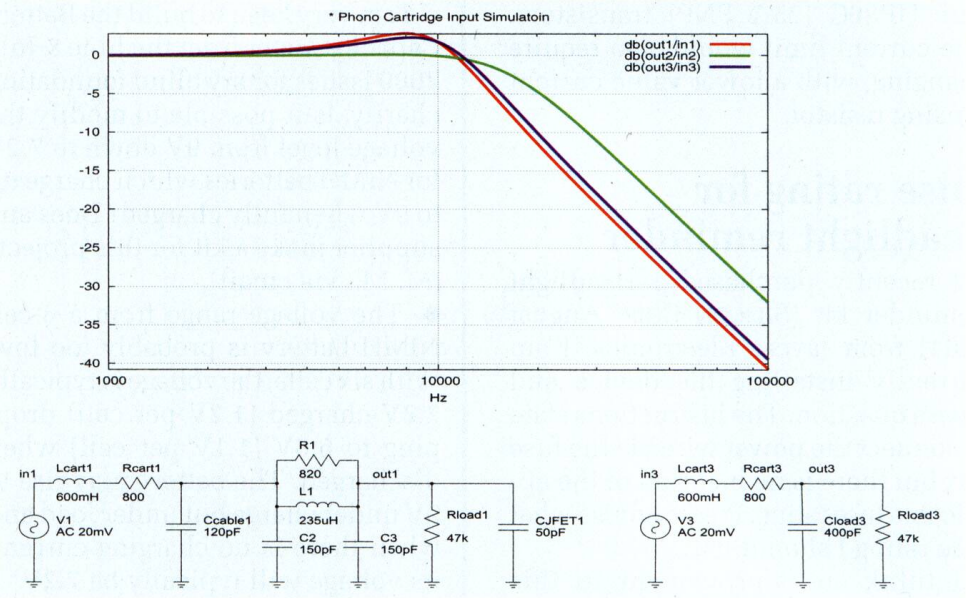
My Ortofon VMS 20E Mkll requires a resistive load of 47kΩ (no problems) and a capacitive load of 400pF. I don't have the necessary null bridge to measure the amplifier input capacitance so I am trying to deduce it from the circuit diagram.

The signal from L or R goes directly to the base of an FET at the start of the preamp chain. Can I assume that the input capacitance from this circuit is 300pF (150pF + 150pF in parallel); or if the 0.047µF capacitor comes into play, 298pF? Or is this reasoning just too simplistic? If my logic is correct, then it seems that I have the ideal loading without the use of the 210pF additional capacitor supplied by Ortofon (CAP210).

I can measure the tone-arm and interconnect cables using my Brymen multimeter. However when I connect it across the phono input terminals of the amplifier, the "auto sensing" jumps around the capacitance ranges but "finds" nothing, with the amplifier switched on. It is not essential that I know the precise input capacitance as I'm not planning to fine-tune it. What I am trying to do is determine whether the Ortofon-supplied 210pF "clip on" capacitor should be used or not.

Therefore I only need to know if the input capacitance is 100pF, in which case I would need the cable (120pF) and the Ortofon 210pF to achieve the target of around 400pF. However, if the input capacitance is 300pF then the additional capacitor is unnecessary.

What makes me suspicious of my simplistic calculation of 300pF from the schematic is that this is a high figure and would be unsuitable for many MM cartridges which typically only require 100-200pF maximum loading. Ortofon is somewhat unusual in requiring 400pF and their knowing that most amplifiers/cables have lower capacitance is the reason they supply the additional capacitor. (M. F., via email).



● Because you have piqued our interest we decided to answer this query in more detail than normal.

First of all, we thought that the total input capacitance of the amplifier is likely to be around 350pF, when allowing for about 50pF of gate capacitance for the input junction FETs. Taken with your tone-arm and connecting cable capacitance, this gives a result of about 470pF which is probably too high for the Ortofon VMS-20E.

But rather than just leave it at that, we decided to simulate your cartridge when driving the total tone-arm and connecting cable capacitance plus the amplifier's input capacitance. In fact, we suspected that Ortofon's recommended capacitance loading for the cartridge was itself too high and was likely to give a response peak that was too low in frequency, leading to excessive loss of treble above 10kHz.

Anyway, we plugged all the details into *NGSpice* simulator and ran it. As we suspected, the resulting peak was too low, at around 7kHz (red trace).

Just to check our figures, we also ran the simulation with the Ortofon driving the recommended 47kΩ and 400pF. This was better, with the peak at about 8kHz (blue trace) but that is still not good. Finally, we ran the simulation with the cartridge driving your Luxman amplifier but with the two 150pF input capacitors removed. This gave the best result of all, with no peak and a gentle rolloff above 10kHz to -5dB at 20kHz (green trace).

The accompanying simulation diagram shows the results. Note that the simulated results are not what the cartridge actually delivers because its mechanical resonances will also come into play. But the electrical resonance depicted in the simulations certainly will play a big part.

By the way, your Luxman amplifier, a mid-1970s design, would now be pretty ordinary in its performance, especially compared to the latest SILICON CHIP designs.

This reader followed up our answer with the following letter:

I thought you may be interested in

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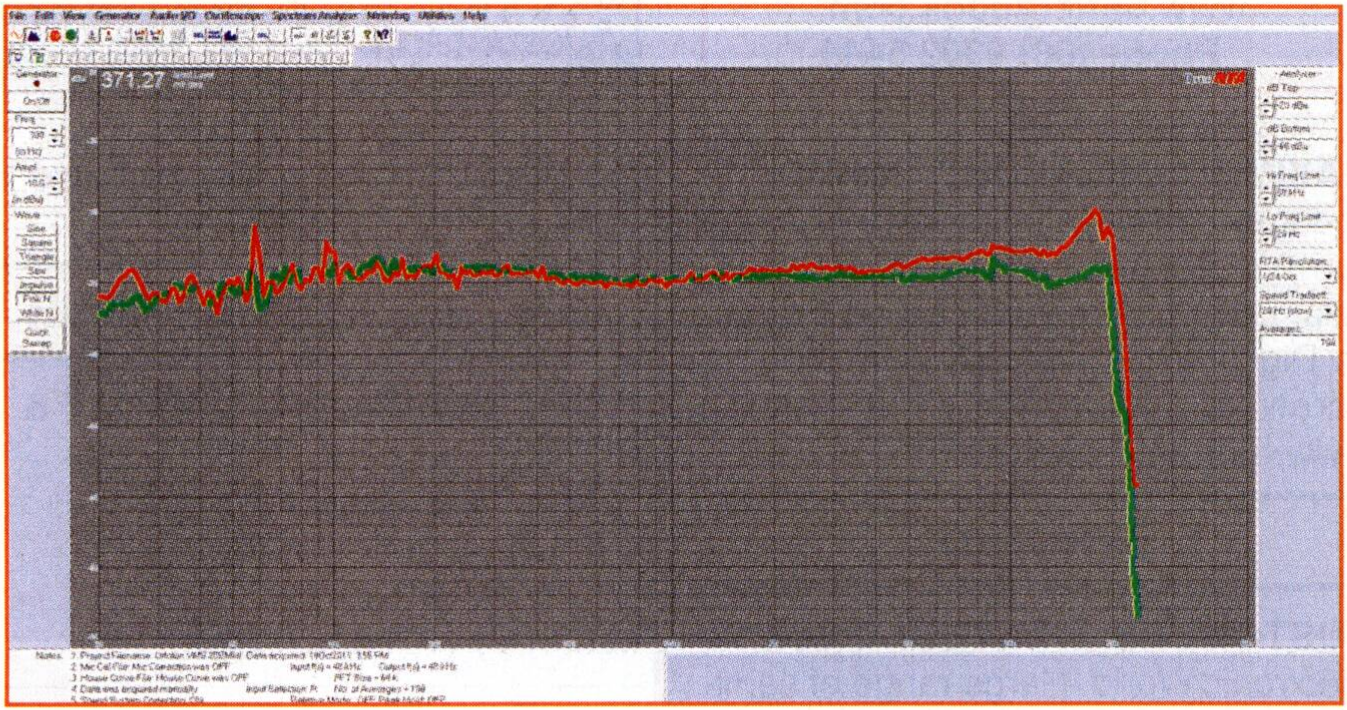

this "real life" measurement of the Ortofon VMS20EMkll and Luxman L-410. The capacitive loading is around 470pF, as per your estimation, while resistive loading is 47kΩ. I used the *HiFi News Test Record* pink noise track for the input and the output fed into the True RTA software (thanks for the great recommendation in October 2011 SILICON CHIP!). The signal path is from the cartridge via phono direct input (which excludes tone and balance controls) and the speaker terminals have 8Ω resistive loads.

The resulting RTA plot is attached (see above). As you can see, the frequency response extends to 20kHz which is well above the electrical simulation and supports the theory that the mechanical (cantilever) effect is significant. **SC**