Band-Pass 1 System

Band-pass enclosure can be formed by mounting the driver inside the box, on the wall dividing of the enclosure into two chambers and installing vents in the front or front and back compartments. When dealing with band-pass enclosures, the user will observe the well known trade-offs between bandwidth and efficiency of the system. Narrow-band designs will be more efficient that broad-band implementations. Our discussion on band-pass enclosures will be supported by the previous detailed explanation of sealed and vented enclosures. Modelling of the double chamber, front vented enclosure can be easily accomplished by taking sealed box mechanical representation and replacing front loading Mmr and Rmr by a circuit identical to back loading of the vented enclosure.

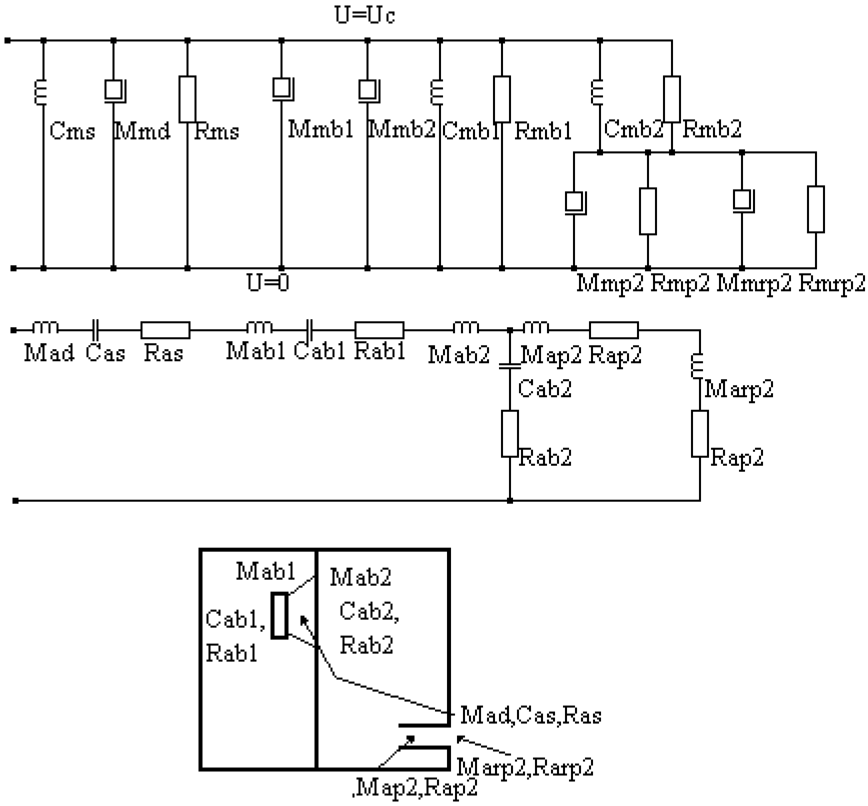

Fig 4.7

Fig 4.8 shows acoustical impedance representation adopted for the BandPass 1 enclosure model. The components are:

R0 = Rea, electrical DC resistance Re transformed to acoustical side.
C1 = Lea, voice coil inductance Le transformed to acoustical side.
C2 = Cas, equivalent compliance volume Vas transformed to acoustical side.
L3 = Mad, mass of the vibrating system Mms transformed to acoustical side.
R4 = Ras, vibrating assembly loss Rms transformed to acoustical side.
C5 = Cab, rear enclosure compliance transformed to acoustical side.
L6 = Mab, air load of the back side of the diaphragm.
R7 = Rab, rear enclosure absorption loss.
C8 = Cab, front enclosure compliance Vab transformed to acoustical side.

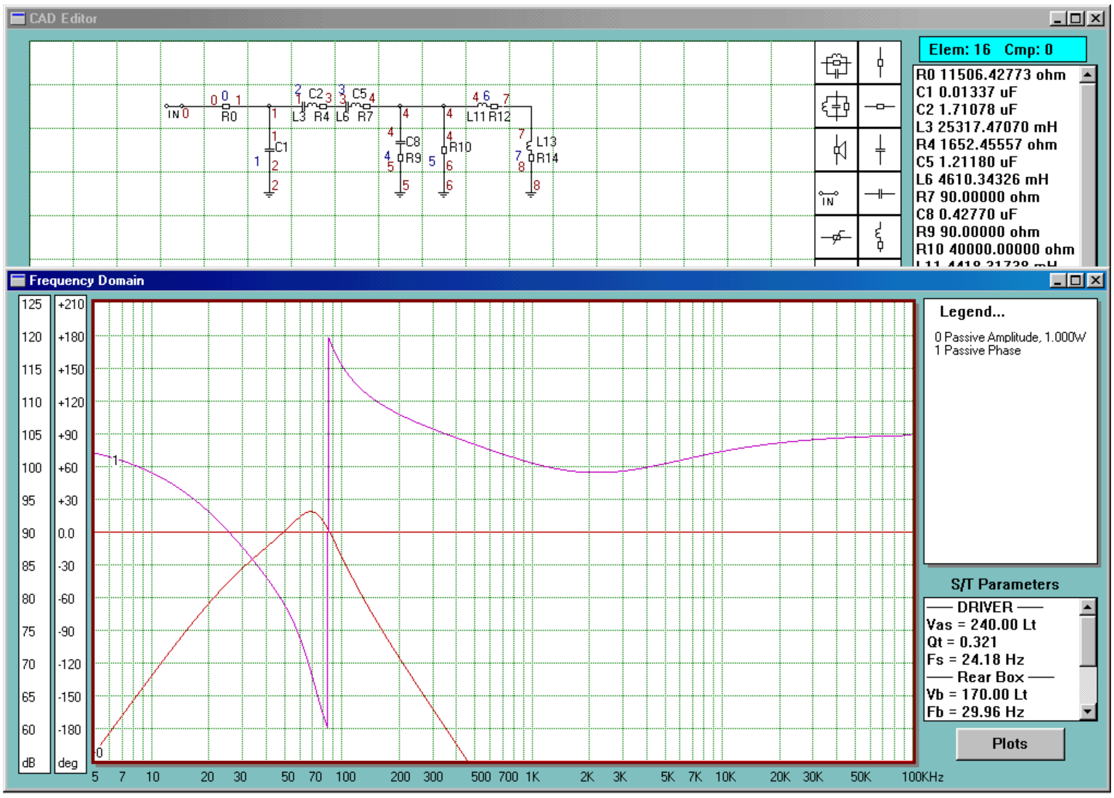

Fig 4.8 Band-Pass1 enclosure – acoustical impedance

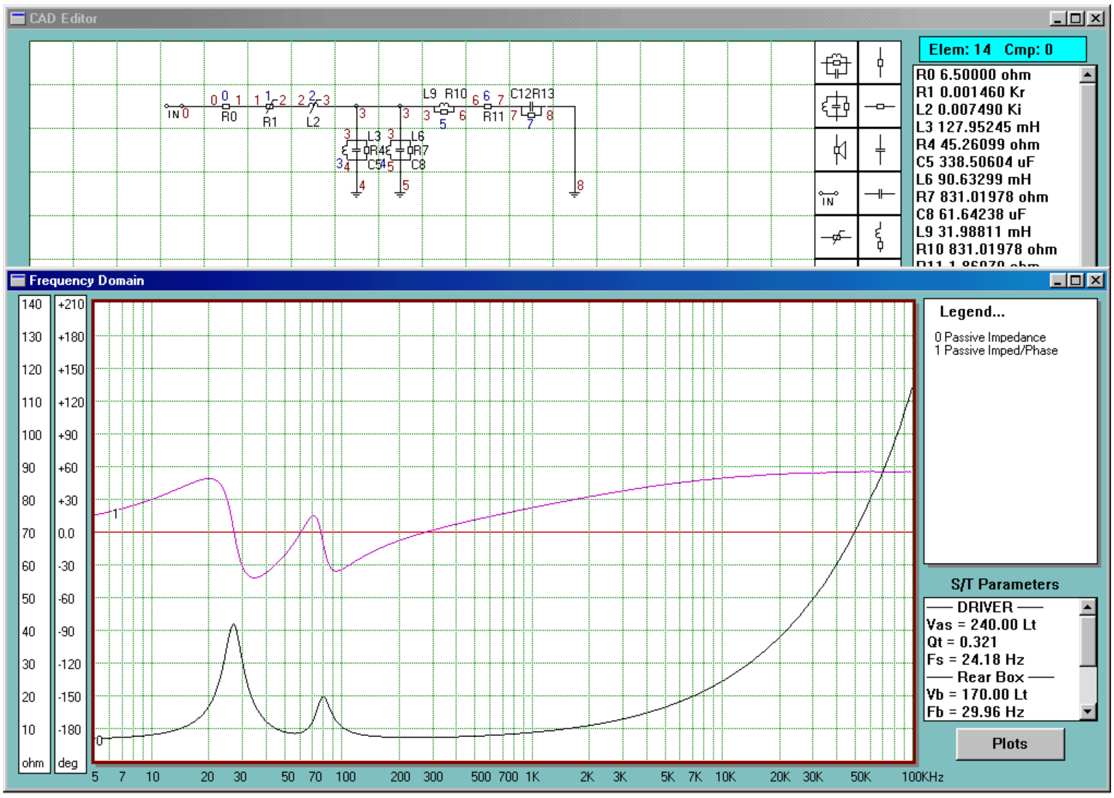

Fig 4.9 Band-Pass1 enclosure – electrical impedance

R9 = Rab, absorption losses of the front enclosure transformed to acoustical side.
R10 = Ral, leakage losses of the front enclosure.
L11 = Marp, front enclosure port radiation.
R12 = Rarp, front enclosure port radiation.
L13 = Map, front enclosure mass of the air in the port.
R14 = Rap, front enclosure frictional losses in the port.

Band-Pass 2 System

Modelling of the double chamber, double vented enclosure can be accomplished by taking vented box mechanical mobility representation and simply replacing front loading Mmr and Rmr by circuit identical to back loading of the diaphragm. Physics of the front loading is the same as the back loading, which was described in the previous paragraph. One thing worth noticing is that total system output is now produced by two ports working in opposite phase.

Since the sections representing front and back loading are connected in parallel on the mechanical mobility representation, they will appear "in-series" on the acoustic impedance representation - see "dot method". Band-pass systems will accommodate drivers with lower Qt (which typically means big magnets, high BL factor and high SPL). The acoustic impedance schematic does not imply, that output from port 1 drives the front chamber in opposite phase to the diaphragm. Therefore, when creating formula for transfer function, one must account for this issue by subtracting B5 from B9. The formula should be: B9 - B5.

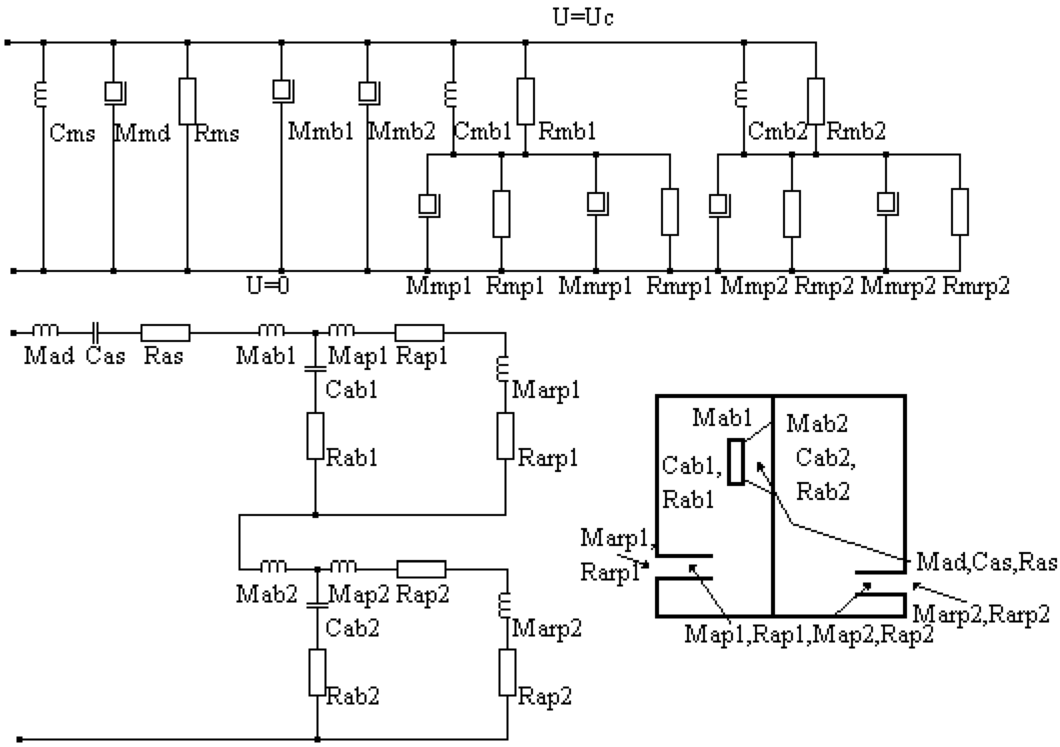

Fig 4.10

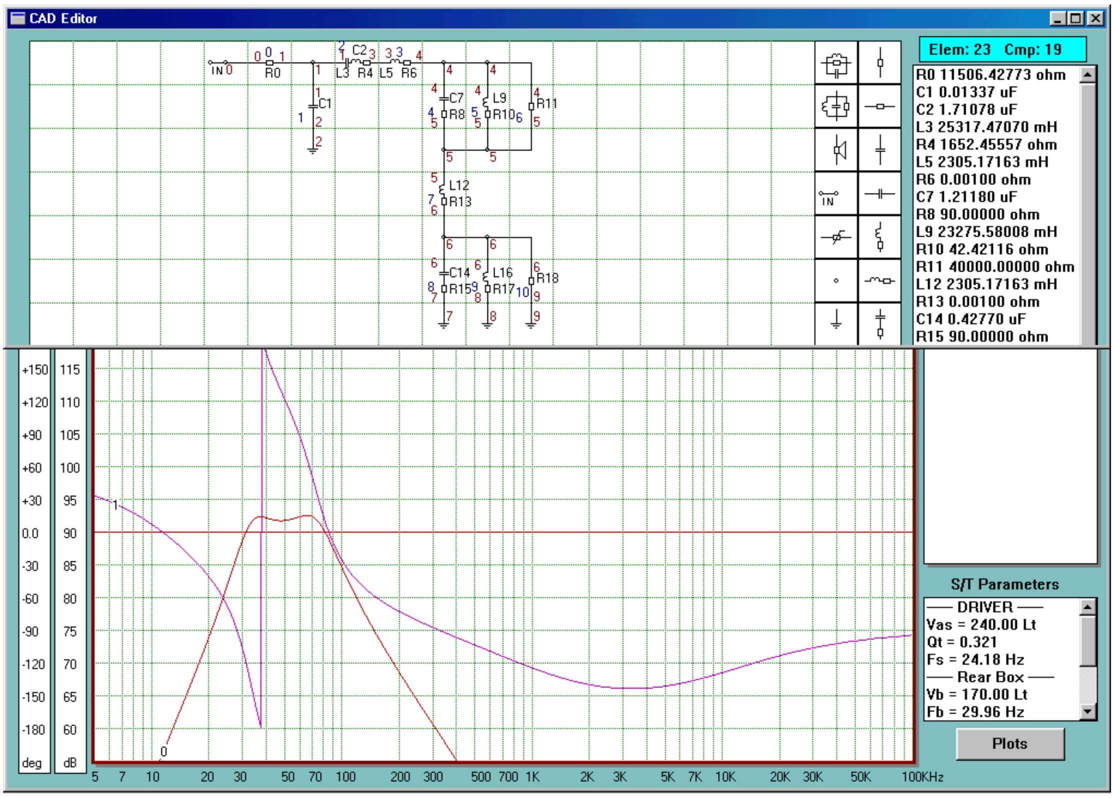

Fig 4.11 Band-Pass 2 enclosure – acoustical impedance

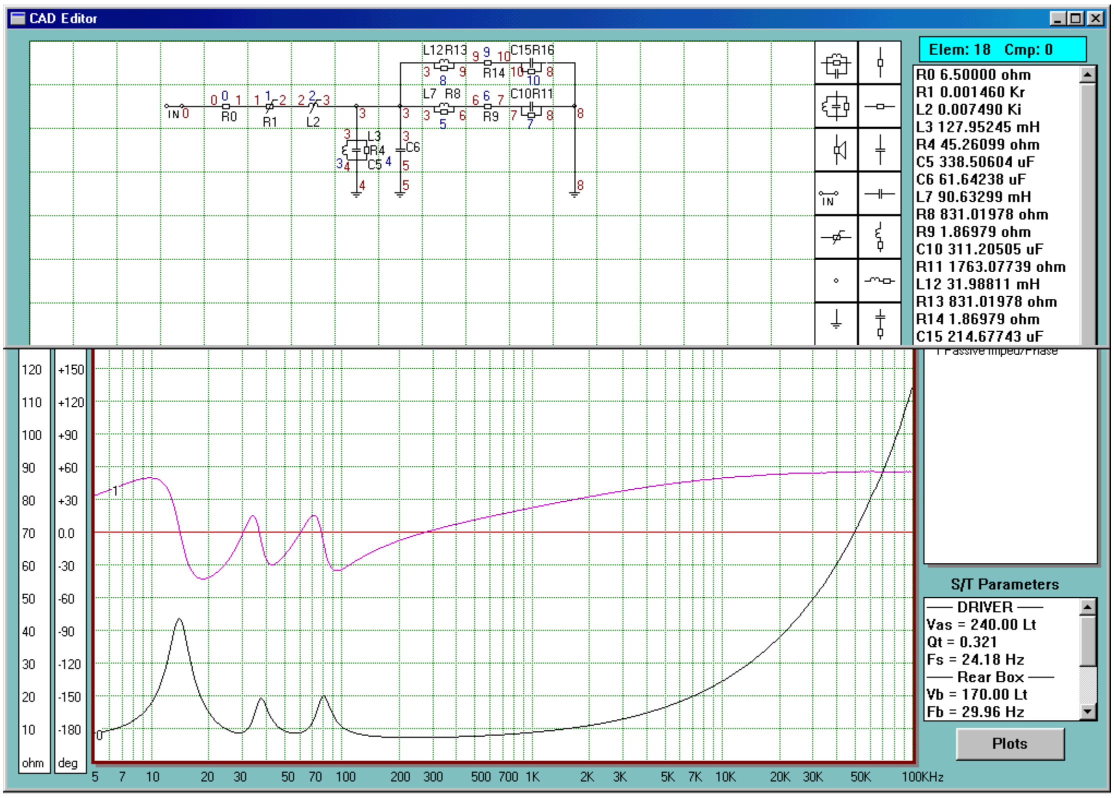

Fig 4.12 Band-Pass 2 enclosure – electrical impedance

Fig 4.11 shows acoustical impedance representation adopted for the BandPass 2 enclosure model. The components are:

R0 = Rea, electrical DC resistance Re transformed to acoustical side.
C1 = Lea, voice coil inductance Le transformed to acoustical side.
C2 = Cas, equivalent compliance volume Vas transformed to acoustical side.
L3 = Mad, mass of the vibrating system Mms transformed to acoustical side.
R4 = Ras, vibrating assembly loss Rms transformed to acoustical side.
L5 = Mab, air load of the back side of the diaphragm.
R6 = dummy resistor.
C7 = Cab, rear enclosure compliance Vab transformed to acoustical side.
R8 = Rab, rear enclosure absorption loss.
L9 = Marp+Map, rear enclosure port and radiation.
R10 = Rarp+Rap, rear enclosure port and radiation.
R11 = Ral, rear enclosure leakage losses.
L12 = Mab, air load of the front side of the diaphragm.
R13 = dummy resistor.
C14 = Cab, front enclosure compliance Vab transformed to acoustical side.
R15 = Rab, front enclosure absorption loss.
L16 = Marp+Map, front enclosure port and radiation.
R17 = Rarp+Rap, front enclosure port and radiation.
R18 = Ral, front enclosure leakage losses

Band-Pass 3 System

The last double-chamber, double-vented system under consideration can be designed by redirecting the output from the rear enclosure into the front enclosure. This is accomplished by installing the port on the same dividing wall as the woofer.

Both tuning frequencies are such, that rear enclosure is tuned to lower frequency than the front one. Mechanical mobility representation looks quite strange at the first glance.

Section of the circuit representing back loading is now quite familiar to the user and is represented by series resonant circuit Cmb1 and masses of port 1. Port 1 no longer radiates into free space, but into the front chamber. As discussed in the vented box case, around the rear box resonant frequency range, the front side of driver's diaphragm contributes almost nothing to the system output - the front chamber is driven entirely by the pressure coming from port 1.

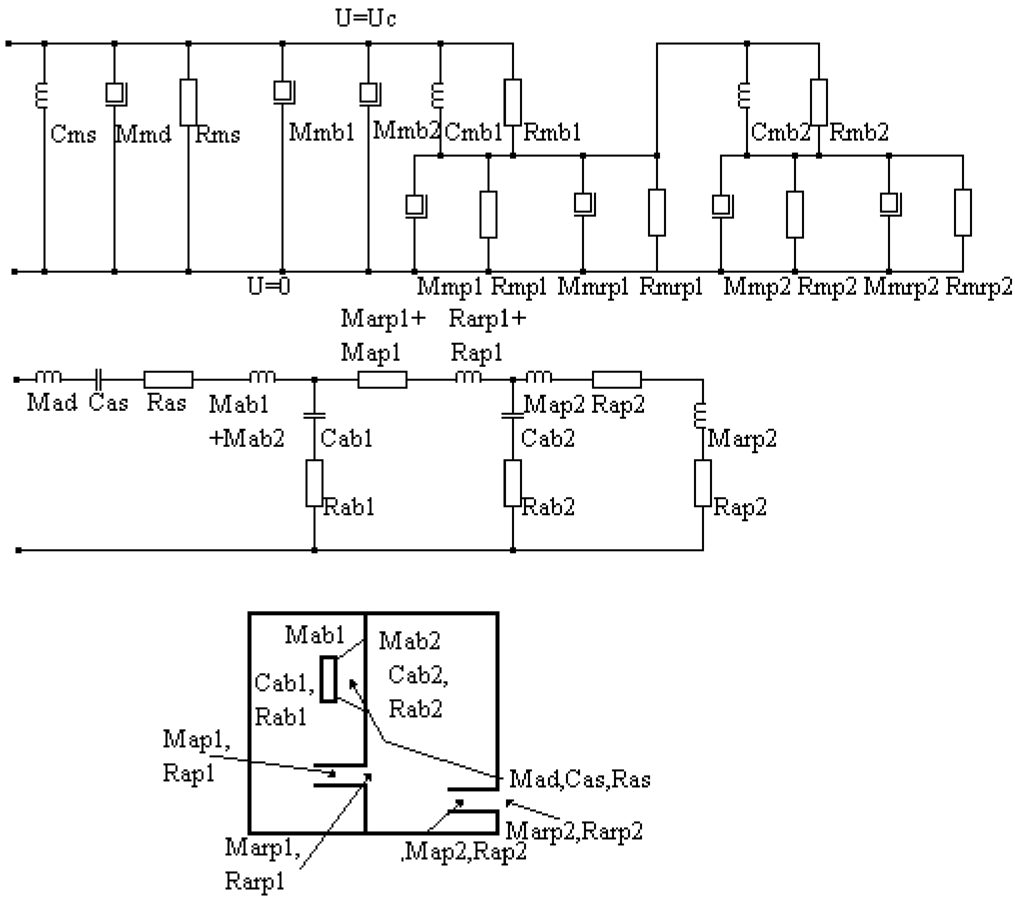

Fig 4.13

One may recall, that masses must be connected to the ground, so that compliance Cmb2 representing front chamber can only be connected to the top end of the port 1 masses. The other end Cmb2 connects to elements representing port 2. Electrically, the front chamber is a tuned (Cmb2 plus masses of the port 2) series resonant circuit connected in parallel with the mass of port 1. Series resonant circuit is capacitive below resonance and inductive above its resonance. This variable reactance will modify port 1 mass such a way, that the mass will appear larger below front box tuning frequency Fb2 and smaller above it. As a result of this, the system frequency response will exhibit two peaks spread further apart and a shallow dip in the middle making it quite difficult to tune.

Again, the acoustic impedance schematic does not imply, that output from port 1 drives the front chamber in opposite phase to the diaphragm. Therefore, when creating formula for transfer function, one must account for this issue by subtracting B6 from B8. Therefore the formula should be: B8 - B6.

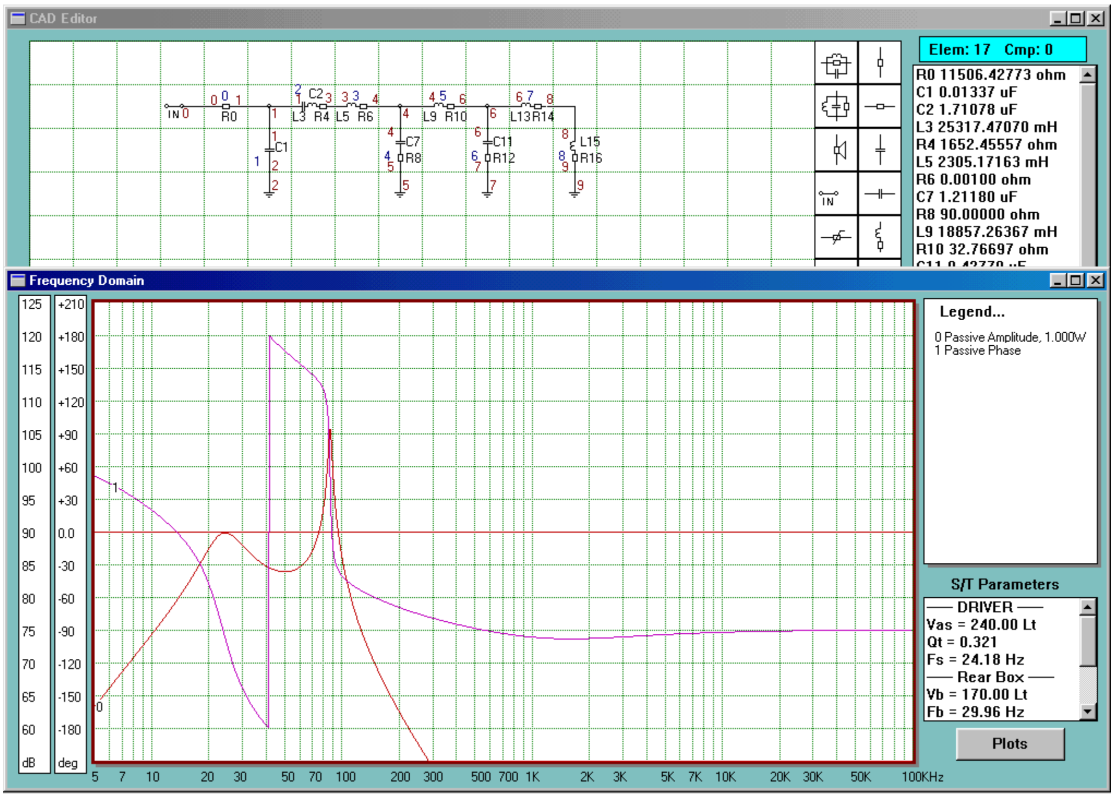

Fig 4.14 Band-Pass 3 enclosure – acoustical impedance

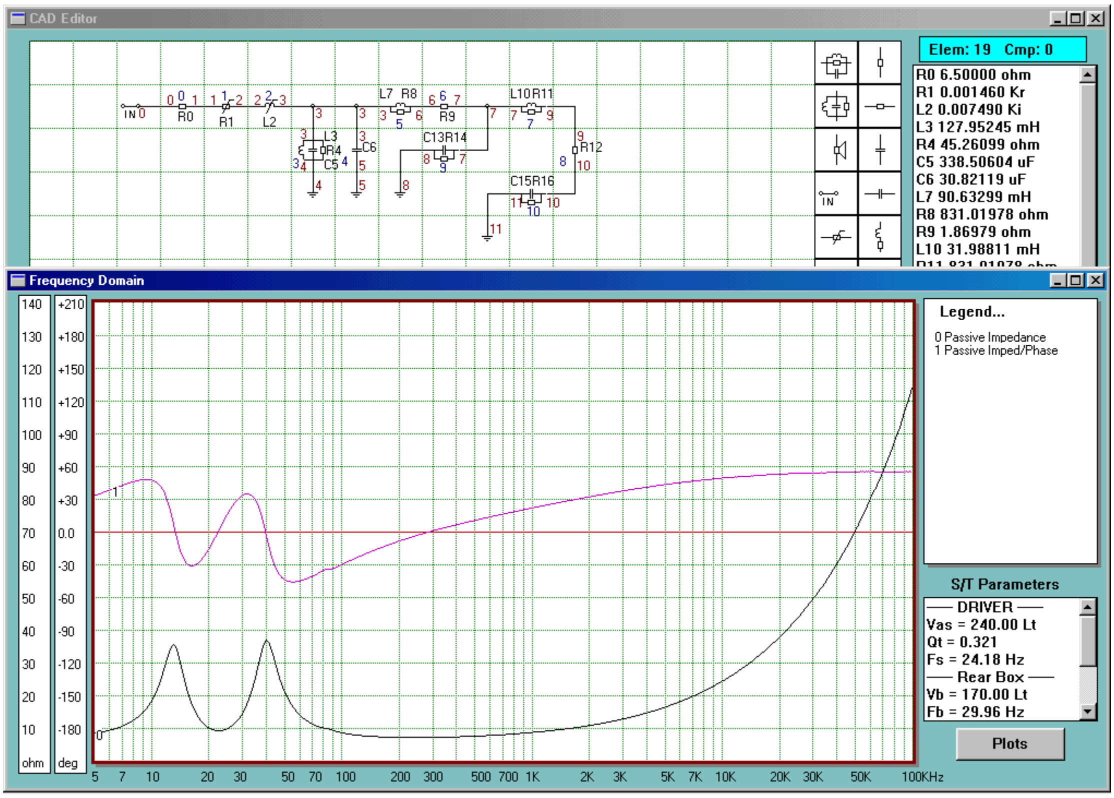

Fig 4.15 Band-Pass 3 enclosure – electrical impedance

Fig 4.14 shows acoustical impedance representation adopted for the BandPass 3 enclosure model. The components are:

R0 = Rea, electrical DC resistance Re transformed to acoustical side.
C1 = Lea, voice coil inductance Le transformed to acoustical side.
C2 = Cas, equivalent compliance volume Vas transformed to acoustical side.
L3 = Mad, mass of the vibrating system Mms transformed to acoustical side.
R4 = Ras, vibrating assembly loss Rms transformed to acoustical side.
L5 = Mab, air load of the back side of the diaphragm.
R6 = dummy resistor.
C7 = Cab, rear enclosure compliance Vab transformed to acoustical side.
R8 = Rab, rear enclosure absorption loss.
L9 = Marp+Map, rear enclosure port and radiation.
R10 = Rarp+Rap, rear enclosure port and radiation.
R11 = Ral, rear enclosure leakage losses.
L12 = Mab, air load of the front side of the diaphragm.
R13 = dummy resistor.
C14 = Cab, front enclosure compliance Vab transformed to acoustical side.
R15 = Rab, front enclosure absorption loss.
L16 = Marp+Map, front enclosure port and radiation.
R17 = Rarp+Rap, front enclosure port and radiation.
R18 = Ral, front enclosure leakage losses

Band-Pass 4 System

It is observable, that in the design presented below, both drivers compress the air in the middle enclosure, increasing the pressure in front of the diaphragms by a factor of two, when both drivers are connected in-phase. When constructing mechanical impedance model, one will remember, that pressure corresponds to voltage and to double the voltage available from the source, one has to connect the sources in series. Therefore the pressure generators on the mechanical side and all components corresponding to vibrating assembly (Cms1,Mmd1,Rms1) and rear enclosures (Mmb1, Rmb1,Cmb1) will have to be connected "in-series" with the same representation of the other driver. The U=Uc line will then become U=2Uc. The air in the middle (front) enclosure is compressed between 2Uc and U=0 pressures, hence all components representing front enclosure and its port (Cmb3, Rmb3, Mmp3, Rmp3, Mmrp3 and Rmrp3) are connected between U=2Uc and U=0 lines. When fine tuning the design, the user may observe, that the volume of the middle chamber must be twice of the front chamber of Band Pass 1 system.