250W Subwoofer Amplifier—Stereo Edition

From Rythmik Audio www.rythmikaudio.com

Thanks for purchasing this 250W Subwoofer Amplifier. The amplifier is designed for systems where ***there is no dedicated subwoofer line level output from the receivers nor pre-amplifiers***. The design of the amplifier has been enhanced to make the integration of your subwoofer to the rest of the system as seamless as possible. It features a linear phase shift control that is effective in the crossover frequency range. The crossover for the subwoofer has a 24db/oct attenuation, large enough to reduce the midrange signal played from the subwoofer. In addition, the amplifier is packed with other standard features such as both high and low level inputs, high-pass line output (12db/oct) for the satellite speakers, continuously adjustable crossover frequency (40-160hz) for the subwoofer output, automatic on/off switch (activated by input signal), and a subwoofer level control. Mated with a high quality subwoofer driver, its 250W RMS @ 4ohm output is enough to shake your room. Thermal protection and short circuit protection circuitry ensure long-term durability. **Note: this is an inverting amp. One needs to cross-wire between this amp and subwoofer to get correct operation.**

Technical specs

Crossover frequency control	Continuously variable for the subwoofer from 40hz to 160hz, 2nd order characteristic (24db/oct made of a 12db/oct fixed plus a 12db/oct adjustable).
Phase control	Continuously adjustable phase lag control on the subwoofer from 0 to 180 degrees. This control helps to align the phase shift of subwoofer and satellite for a smooth blending.
Power switch (Auto ON/OFF)	When the switch is in the auto position, the amplifier will turn on when the input signal is present. There are also ON and OFF positions that can override this function.
Volume control	Adjust the output level of subwoofer.
Line in	These are line level RCA inputs. Use to connect pre-out or preamplifier outputs. These inputs are summed as mono. It the preferred method of connecting the subwoofer. For a mono line level signal, one can connect it to either channel input. See setup section for more explanation.
Line out	This line level RCA outputs is high-pass at 100hz (-3db) for satellite output if the amplifier(s) driving the satellite has a line level direct inputs.
High Level in	Speaker level input. Use these inputs when the line level inputs and outputs are not used. Connects directly to the speaker output of the satellites (or front channels).

High Level out	Speaker level outputs (high passed at 100hz of the speaker level input). It can be used only when the speaker level inputs are used. It is not a recommended method because the impedance of satellite (or front channel) speakers may interfere with the crossover network used for this output. If one needs to use these outputs, connect these outputs to satellite speakers. Do not connect satellite speakers from the amplifier outputs.

Introduction

For those who do not have a dedicated subwoofer line level output from your receiver, it is important to select a subwoofer amplifier that provides two important features for a smooth blending between front speakers and subwoofer: 1) an effective, correctly designed phase control, and 2) a 24db/oct attenuation on the subwoofer. This amplifier is a modified version of our 250W basic model to provide these 2 features. As a result of the modification, the final phase of the amplifier is inverting. To operate this amp correctly, one needs to cross-wire the subwoofer. That means, the red wire needs to be connected to the negative

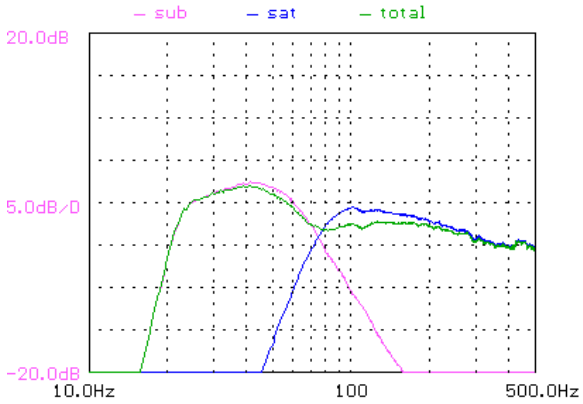

Fig 1 Response of no phase adjustment

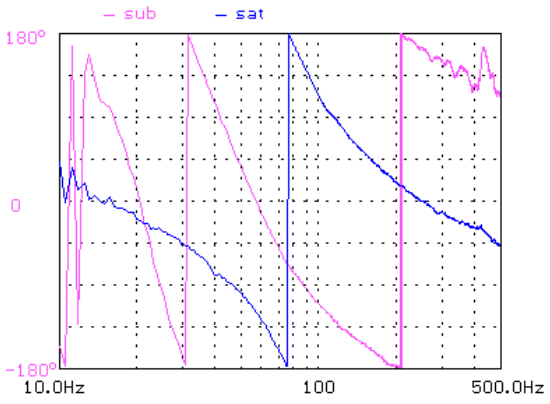

Fig 2 Relative phases (no phase adjustment)

terminal of your subwoofer driver (normally color-coded as black) and the black wire needs to be connected to positive terminal of your subwoofer driver (normally color-coded as red). While this is an inconvenience, it is the only way to have correct phase control without adding extra gain stage. In the following, we will first review the control adjustment strategy and its rationale. Then graphs will be provided as a reference for performing the adjustment.

Control Adjustment Strategy and Tips

Crossover and phase controls

To get a smooth blending from a subwoofer to the satellites, we need to achieve two objectives at the crossover point: 1) 3db to 6db down in terms of output, and 2) close to 0 relative phase shift (subwoofer vs. satellite, or vice versa). Both of them are equally important. Objective 1) is achieved by crossover control knob and objective 2) is achieved by phase control knob. Very often, users have overlooked the importance of the latter. Figure 1 shows and an example response of poor integration because of failure to achieve objective 2). Figure 2 shows the phases of the sub and satellite. Note that in this case, the relative phase only deviate from the ideal objective 2) by about 90 degrees at the crossover point. Still it is enough to cause a –3db dip as shown in Figure 1. On the other hand, if one adjust the phase control to add

additional phase delay to the subwoofer so the relative phase is close to zero (as shown in Figure 4), one can get a smoother combined frequency response, as shown in Fig 3.

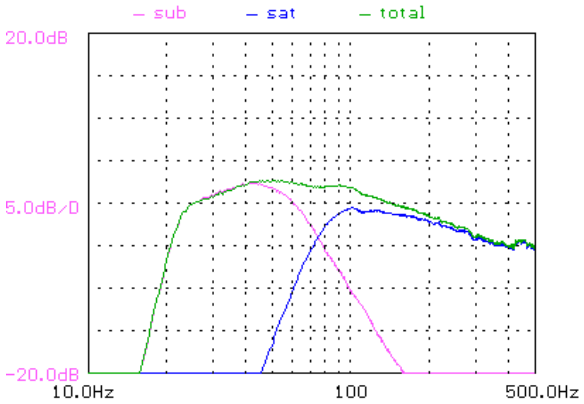

Fig 3 Response after phase adjustment

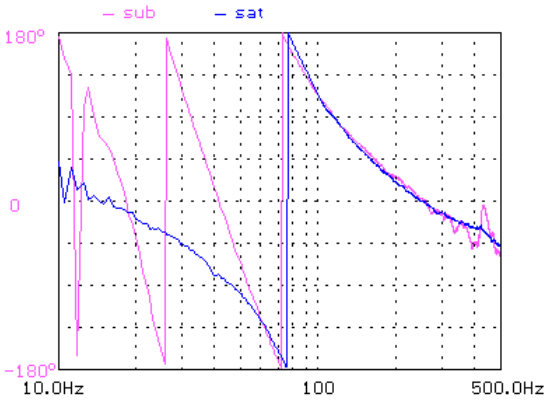

Fig 4 relative phase (after phase adjustment)

Now the question is how one can effectively adjust these controls without the help of a microphone or other tools. Fortunately, it is relatively easy to come up with a first cut educated guess and gradually fine-tune it until good result is obtained.

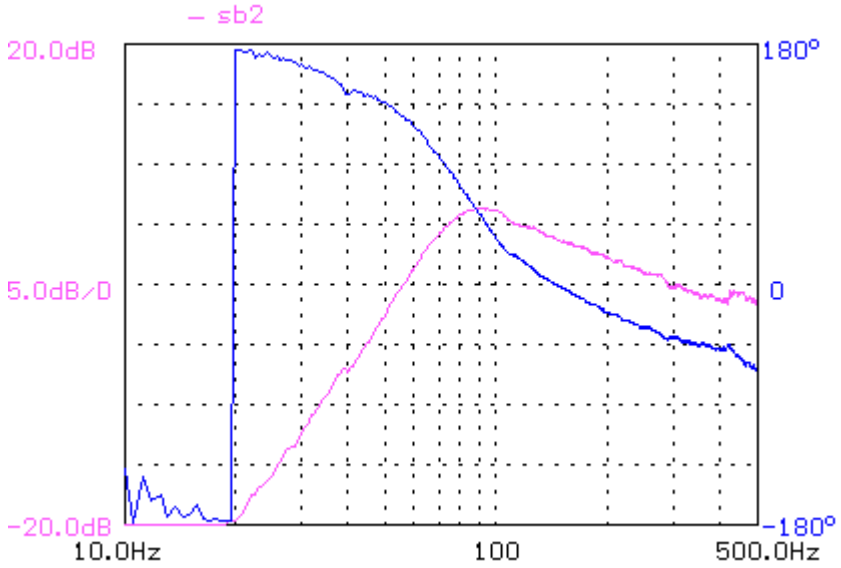

Fig 5 Response of a sealed box (SB3)

Phase: Keep in mind that for each order in a high-pass filter, there is a 45-degree phase lead at the crossover point. Our amplifier uses a 2nd order high pass filter for satellites. So there is a 90-degree phase lead. In addition, the satellite has its own high pass filter characteristic already: for sealed box design it'2nd order, and for vented box design, it is 4th order. In Figure 5, the satellite is a sealed box design. That means the total phase lead at the crossover point is about 90+90=180. As for the subwoofer crossover, our low pass is 4th order, that means there is a 45x4=180 phase lag at the crossover point. Note that 180 degee phase lead is same as 180 degree phase lag. Keep in mind this is a very ideal case. Most likely in reality one needs to adjust the phase control by only up to 90 degrees.

Crossover: One may notice that in Figure 1 the actual crossover point is about 70hz. But this is different from the –3db@100hz that we stated in this manual. This is the result from a technique that I referred to as "***delayed roll-off***" that several bookshelf speaker designers used to give an impression of higher bass output. The way it works is that the Q value of low-end roll-off is purposely made higher so that the response will have a hump before it rolls off. This high Q roll-off interferes with crossover and actually shifts the crossover point lower. Figure 5 shows the frequency response from a commercial speaker with

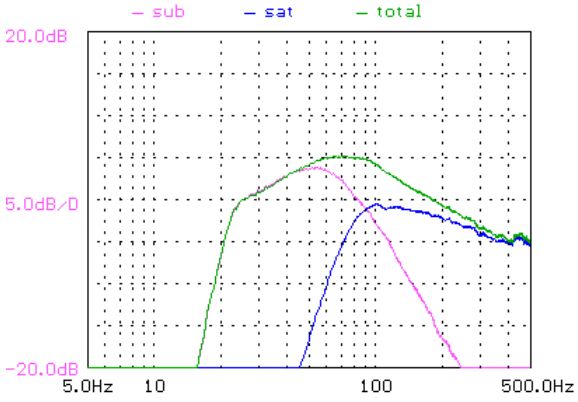

Fig 6 Sub crossover is too high

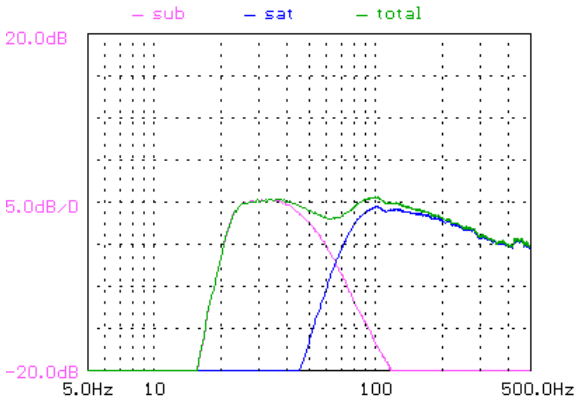

Fig 7 Sub crossover is too low

this characteristic. The shelf-down frequency response above 100hz implies that this speaker is designed to be placed well off the wall. If we had not considered this "delayed roll-off", we would have set the crossover control at higher frequency and cause more overlap in the crossover as shown in Figure 6. On the other hand, if we set the crossover point too low, the response will not blend well either. Figure 7 shows such a result. The phase in Figures 6 and 7 is already correctly compensated so the effect is simply caused by crossover control.

Extension Filter (Rumble filter)

The default extension filter (12hz with Q=0.7) is good for sealed box subwoofers. It provides a gradual attenuation at the bottom end without introduce ringing in the time domain response. On the other hand,

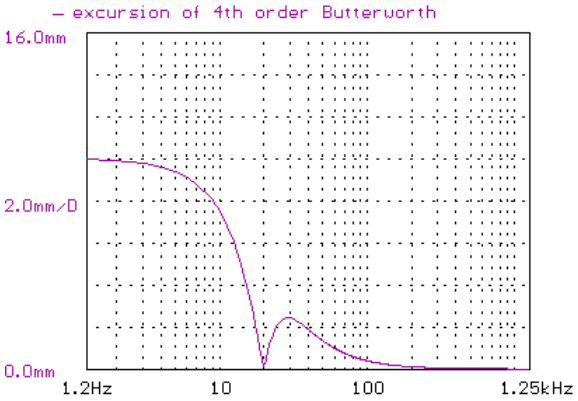

Fig 8 Excursion of vented box sub

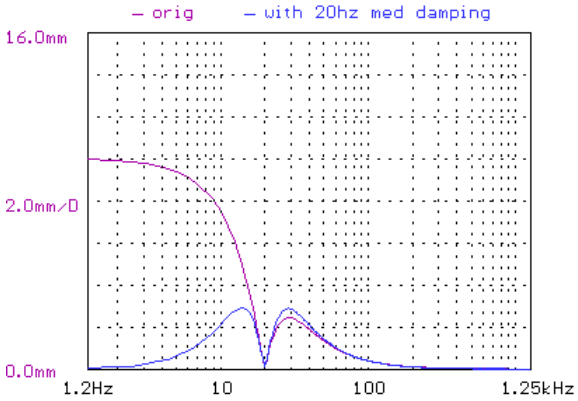

Fig 9 Excursion comparison w/ and wo/ rumble filter

extension filter plays a very important role in preventing over-excursion (or bottoming) in vented box subwoofers. If you will be using this amplifier with a vented subwoofer, we strongly recommend that you

let us know so that we can solder a resistor for you. To demonstrate how rumble filter help to prevent over-excursion in vented box, 2 graphs are shown below.

Figure 8 shows the excursion plot of a perfectly designed 4th order Butterworth vented box tuned to 20hz without any rumble filter. The largest excursion occurs at frequency below 20hz. On the right hand side, we apply a rumble filter of 20hz, Q=1.0. The result is compared with the original, as shown in Figure 9. As one can see the improvement is quite dramatic. For small vented box (3 cu ft or below), we recommend Q value around 1.0. For large vented box (more than 3 cu ft), we recommend Q around 0.7.

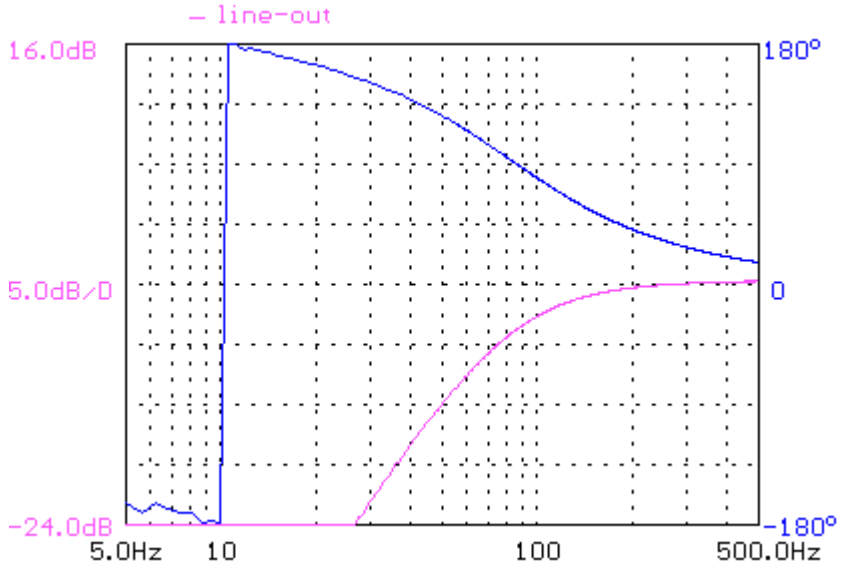

Fig 10 Line-out

Graphs

In the following, graphs are provided to illustrate the characteristics of controls. It serves the purpose of helping users to achieve better integration.

Line out: Line out is essentially a 2nd order high-pass filter as shown in Figure 10. The –3db point is at 100hz. The Q value is designed to be 0.6 to better match high Q roll-off associated normally with front speakers.

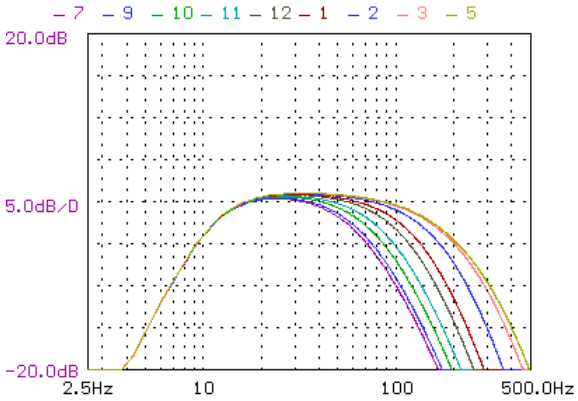

Fig 11 Frequency response of cross-over control

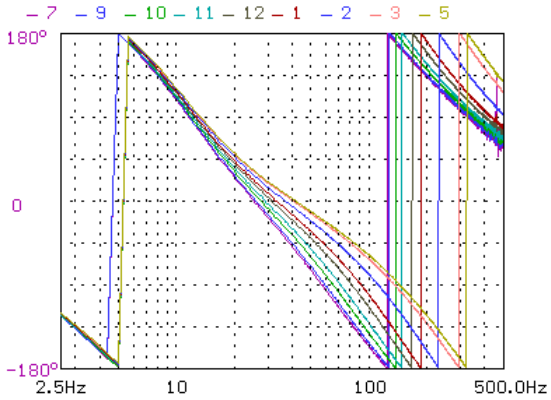

Fig 12 Phase response of cross-over control

Crossover: the crossover controls the crossover frequency of the subwoofer. Figure 11 shows, from left to right, amplitude responses from 7 o'clock to 5 o'clock position. The control is fairly linear. 7 o'clock setting has almost same effect as 8 o'clock. Similarly 4 o'clock has similar effect as 5 o'clock.

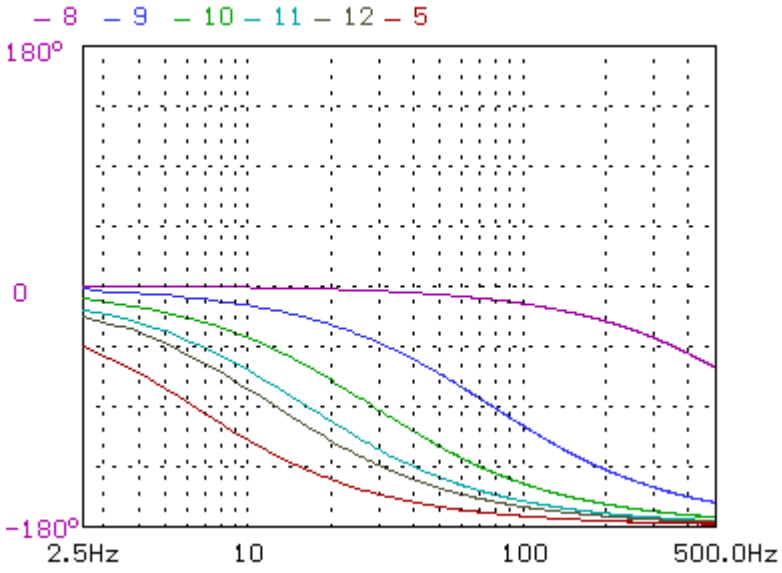

Fig 13 Phase response of phase control

Phase: Figure 13 Shows the phase shift from 8 o'clock to 12 o'clock positions, in one o'clock increment (from top to bottom) and 5 o'clock positions. For crossing-over at 80hz-100hz range, the adjustment should never be greater than 9 o'clock position.

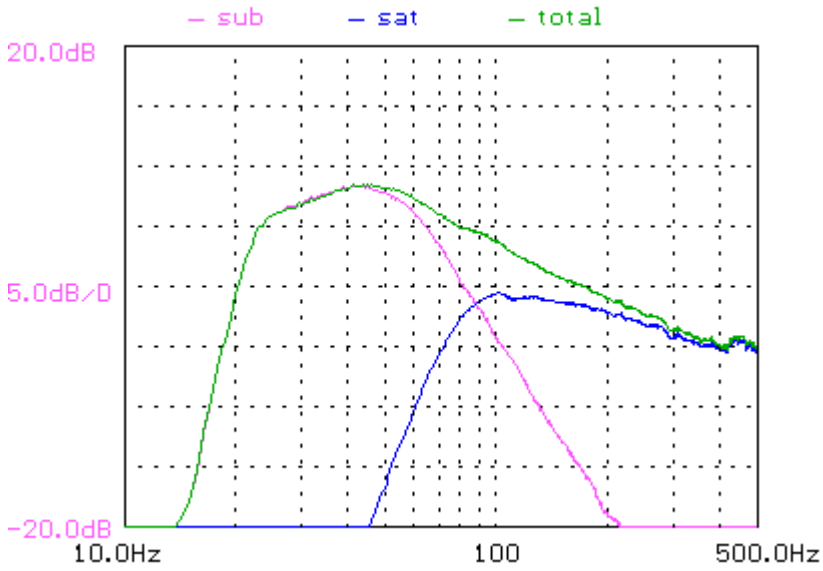

Fig 14 Subwoofer volume is increased by 6db

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System hookup

Setup 1: using line level inputs and line level outputs

If your system has line level RCA outputs for your front channels and you also have dedicated power amplifier inputs, we would recommend this setup. Connect the outputs from the pre-amp to line-level inputs of on this subwoofer amp. Then connect the line-level outputs to the inputs of the power amplifier that drives the satellite/front speakers. Use music with good mid bass recording to fine tune the crossover and phase controls. As long as the crossover and phase are set correctly, the sweet spot of the volume control is quite large. In another words, even if the volume is cracked up by 6db, the frequency response will still be very smooth with a hint of tilting up at the bottom end, as shown in Figure 14.

Setup 2: using line level inputs only

If your system does have line level RCA outputs, but it **does not** have dedicated power amplifier input, we would recommend connect that outputs to line-level inputs of on this subwoofer amp. Essentially in this setup, the front speakers will receive full spectrum signals. The subwoofer will augment the bottom end. In this case, add 90 degrees to the phase control only if the front speakers are sealed box.

Setup 3: using speaker level inputs only

If your system does not have line level RCA outputs, connecting the speaker level output of your front speakers to the speaker level inputs of this plate amp. Do not use the speaker level outputs from this plate amp if possible because the filtering on these outputs is less than optimal. They are provided for

convenience. Connect your front speakers to the speaker outputs of your receiver (so now you have 2 sets of connections from those outputs now, one set to front speakers, and one set to the plate amp). Essentially in this setup, the front speakers will receive full spectrum signals. The subwoofer will augment the bottom end. In this case, add 90 degrees to the phase control only if the front speakers are sealed box.

Other Recommendations

This subwoofer amplifier is **NOT** recommended for sealed box speakers with DC voice coil resistance of less than 2.5 ohm, nor for vented box (passive radiator) speakers with DC voice coil resistance of less than 3.0 ohm. Otherwise, the thermal protection circuitry will be activated more often.

Support

Your satisfaction is paramount to us. Please feel free to ask us questions or give us feedback.