



Thank you for purchasing the NaO Note II RS digital speaker system plan set. Your efforts in building this speaker will be rewarded with many hours of enjoyable listening. Your support of the Music and Design through this purchase will provide me with the opportunity to continue the development and refinement generation of NaO speakers.

I have made every effort to assure that the building and testing of the Note II RS can be accomplished with ease, and a little patience. These instructions are specifically for the Note II RS using a miniDSP digital active crossover. Please read over the instructions before starting your build. If you have any questions or are unclear about the instructions for assembly, please contact me at info@musicanddesign.com before continuing.

Again, thank you for your support and happy listening.

Best regards,

John K.....

Table of Contents

Drivers

Additional Parts

Cabinet construction:

Drawings

Woofers cabinet assembly drawing
Woofers enclosure panels
Woofers Baffle
Main Baffle
Side panels
Main Baffle Top Brace
Side Panel Construction form Hardwood
Baffle attachment strips
Cabinet Assembly Drawing
Grill Frame

Baffle Layout Instructions

Cutting the Baffle

Woofers enclosure assembly

Side Panel Construction

Cabinet assembly instructions

Installing the Drivers

Woofers
Tweeters
Midrange Drivers
Grills

Setting up the miniDSP

Speaker Set Up

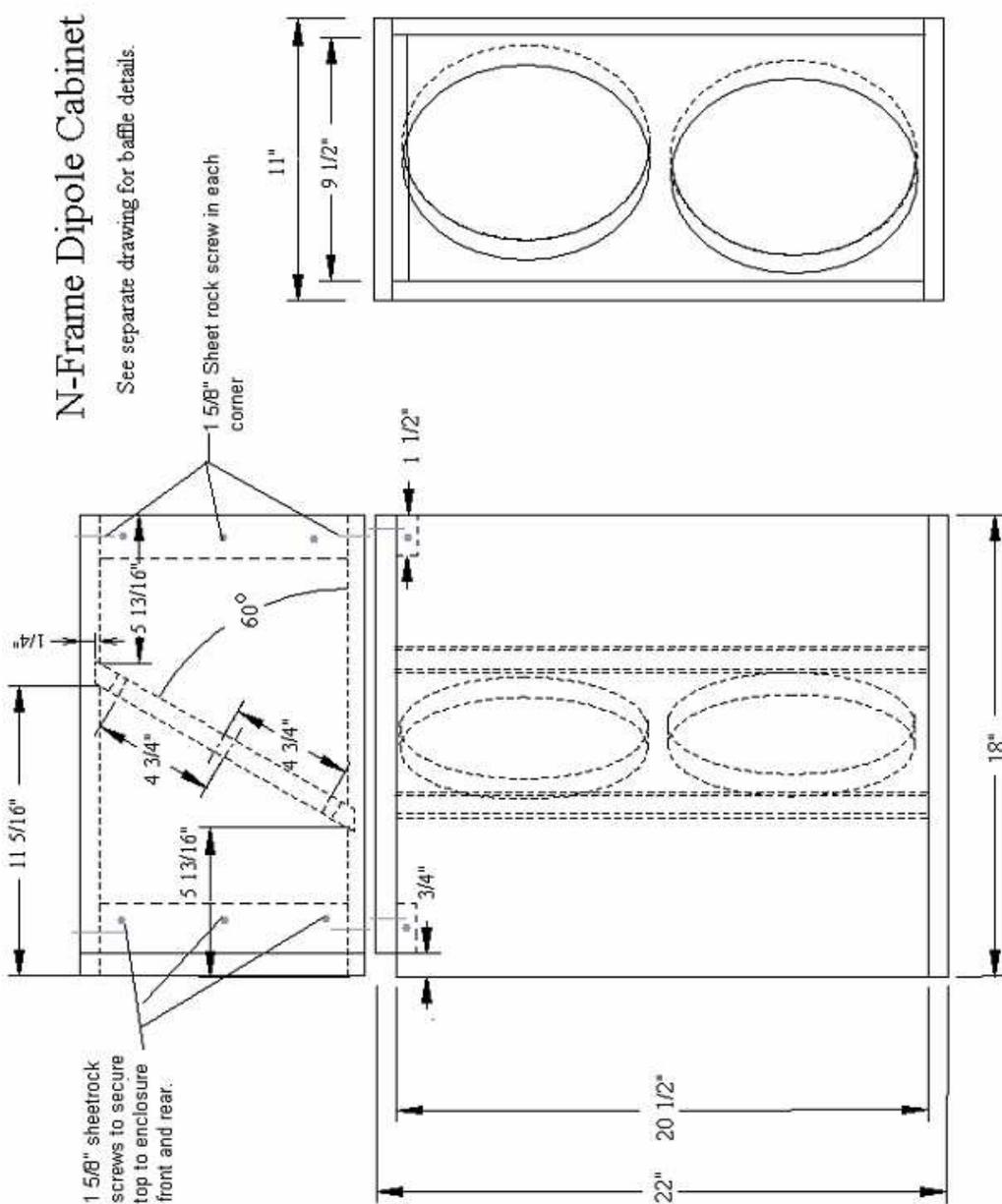
Audio Adjustments

Cabinet Construction

The cabinet of the Note II RS consists three components: The woofer enclosure, the main baffle and the side panels. The woofer enclosure and the main baffle are fabricated from $\frac{3}{4}$ " MDF. The main baffle may be constructed of $\frac{3}{4}$ " hard wood if desired. The side panels are fabricated from either the hard wood of your choice or cabinet grade plywood such as Baltic Birch. The top panel of the woofer cabinet is removable to allow "loading" of the woofers after the woofers have been secured to their baffle.

Drawings:

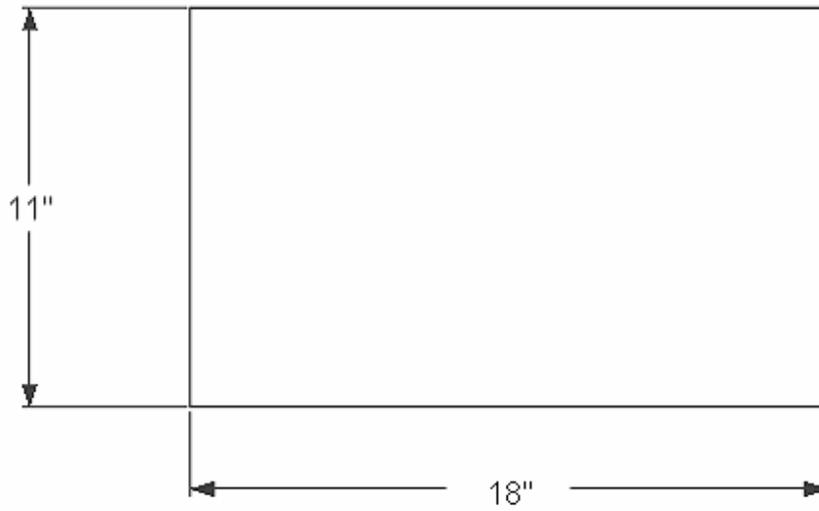
Woofer enclosure assembly drawing:



Woofers enclosure panels:

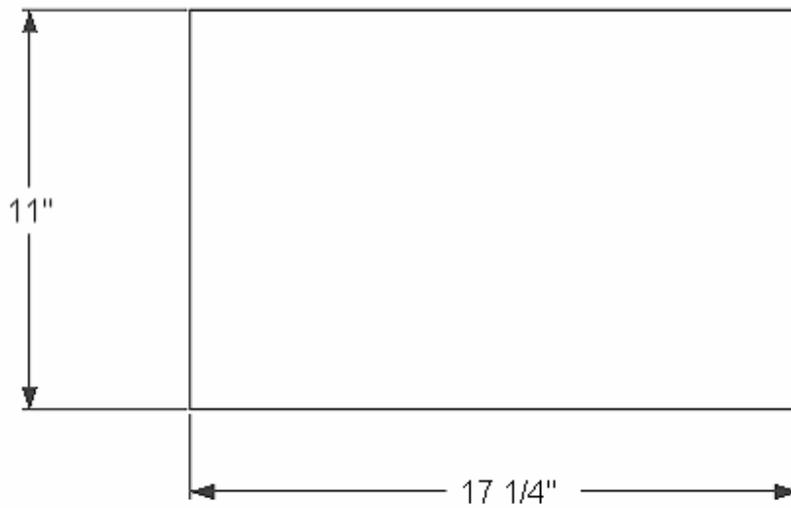
Woofers Enclosure Bottom Panel

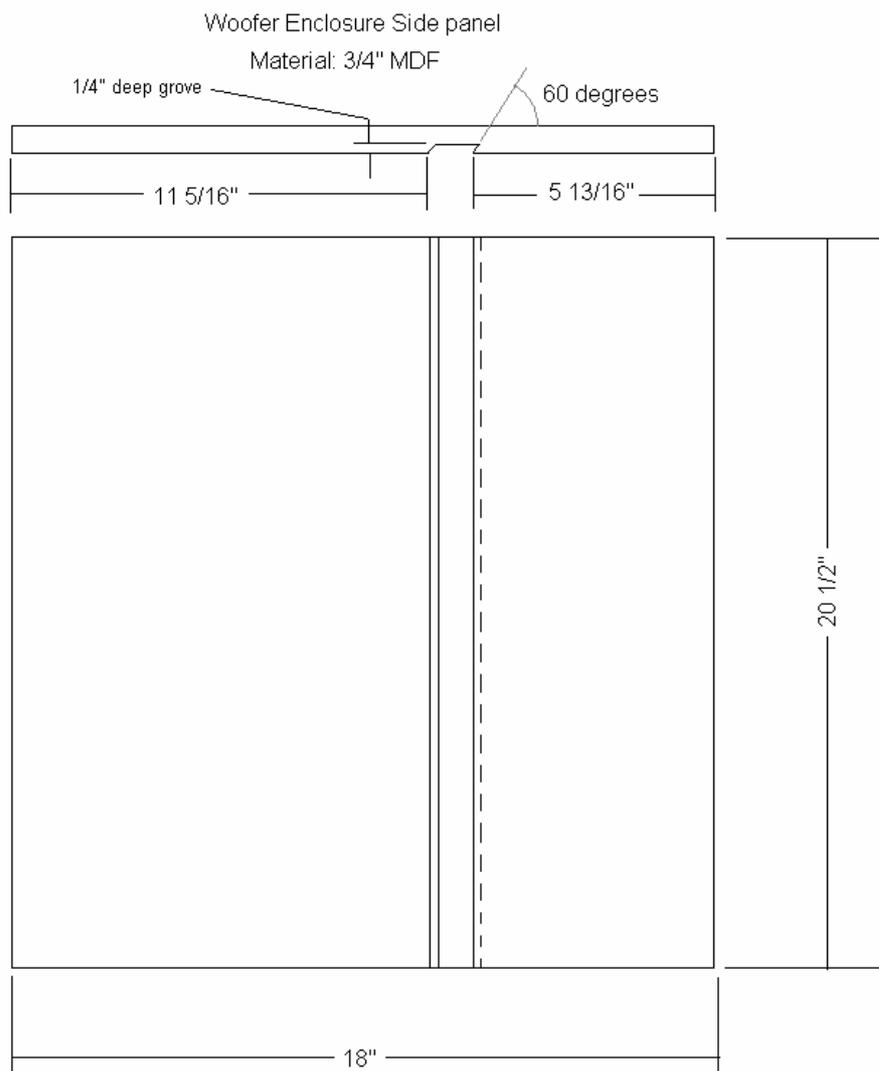
Material: 3/4" MDF



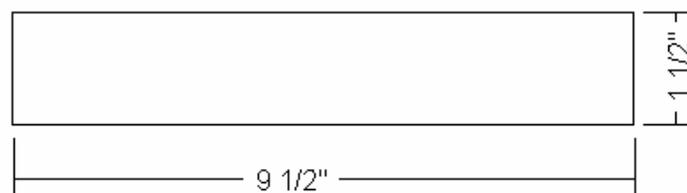
Woofers Enclosure Top Panel

Material: 3/4" MDF





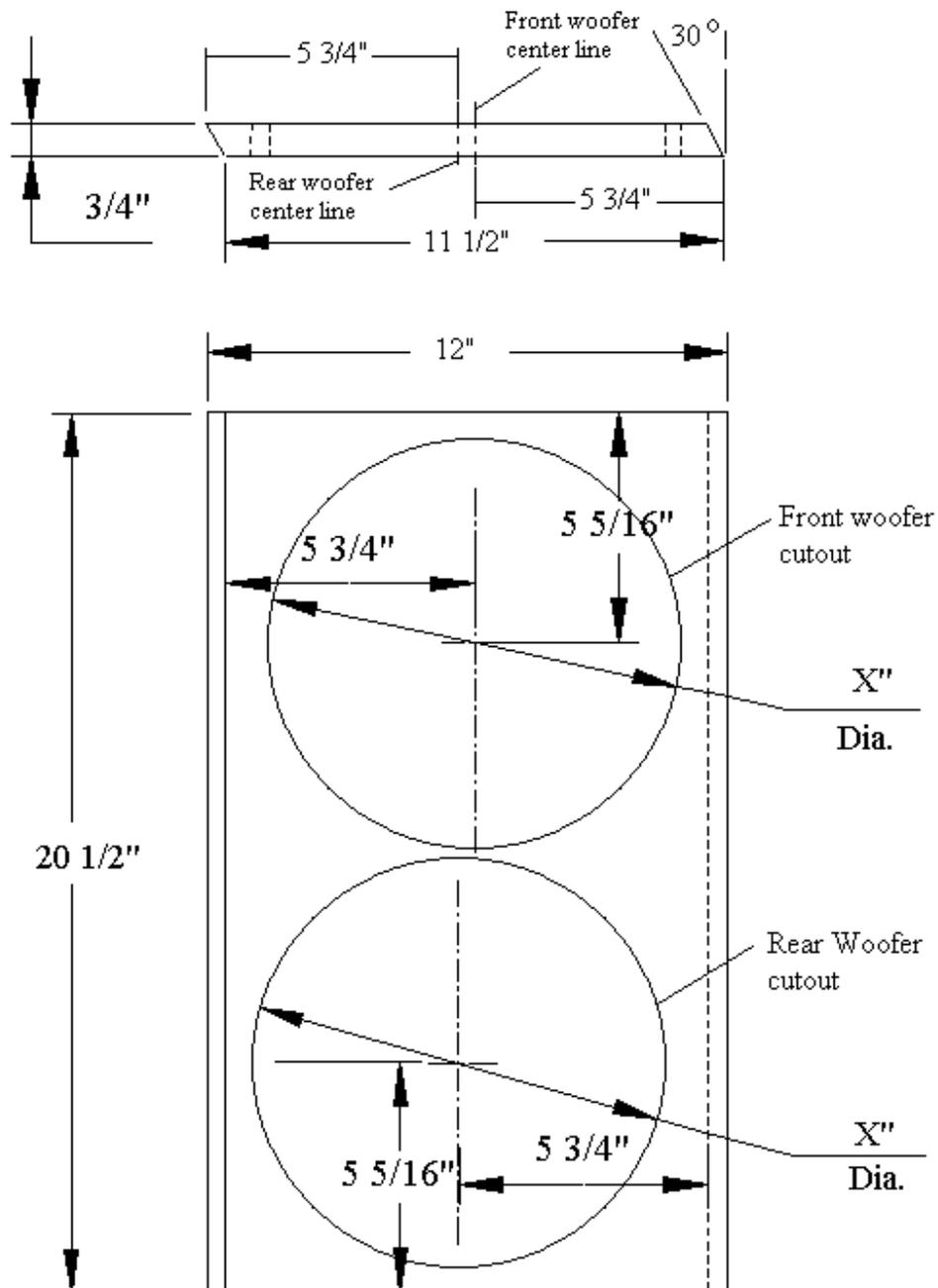
Woofer Cabinet top braces
 Material 3/4" hard wood



Woofers Baffle

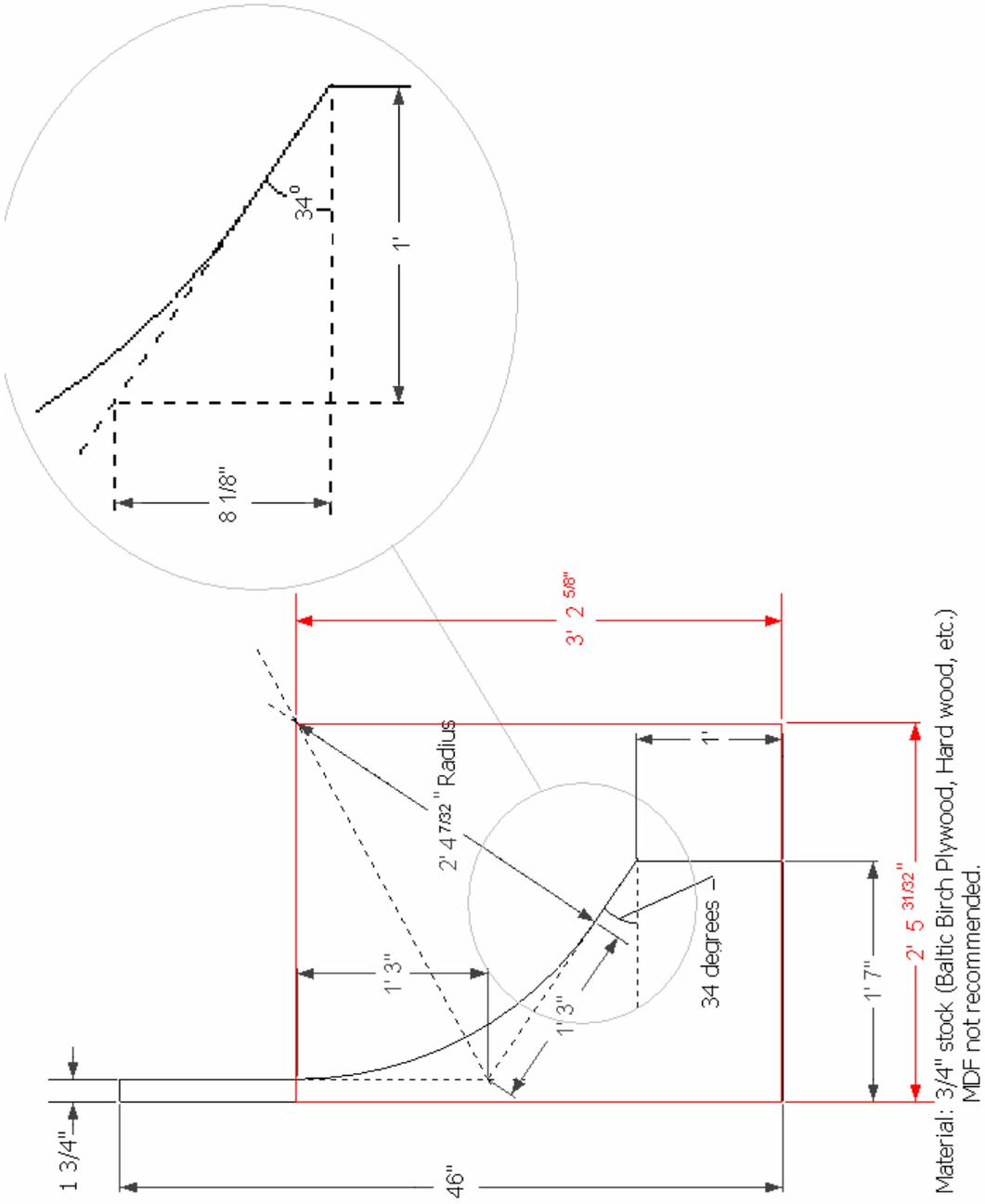
Material $\frac{3}{4}$ " MDF

Note that the front and rear woofer holes are offset.



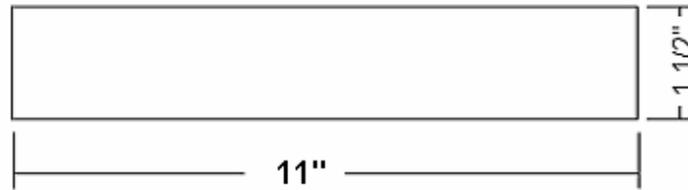
$X = 9$ " for SLS woofers, $9\frac{1}{2}$ " for XXLS woofers

Side Panels:

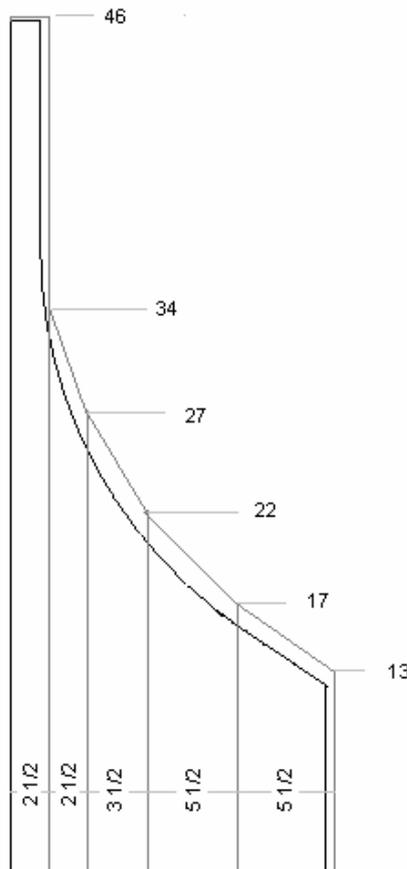


Main Baffle Top Brace

Main Baffle Top Brace
Material: Same as side panels



Side panel blank construction using hard wood boards

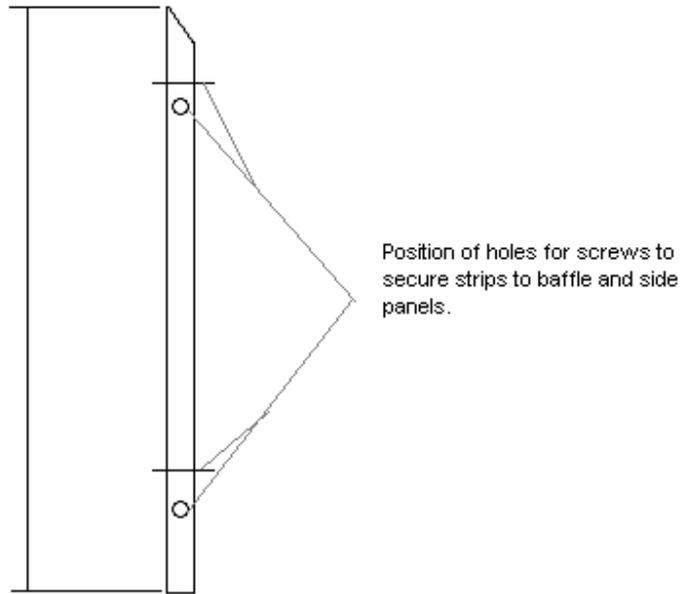


The side panels are constructed by butting 5 pieces of 3/4" stock together.
The width and height of each piece are indicated above.
Widths are stock board widths available in Oak, Maple at Home Depot.
Baskets should be used, if possible, to strengthen the joints.

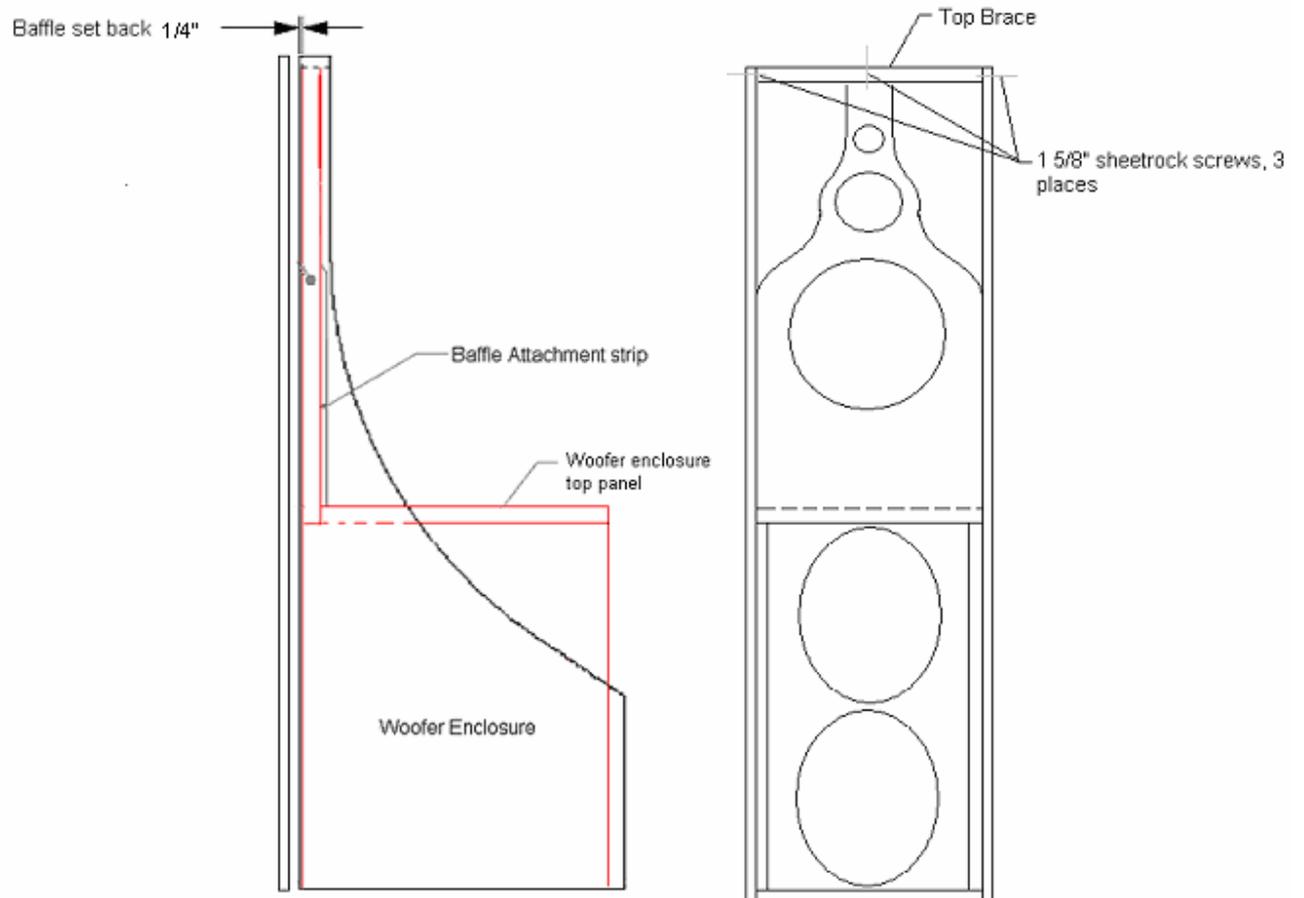
Baffle Attachment Strips:

Baffle Attachment Strip

Material 1/2" x 1/2" Polpar

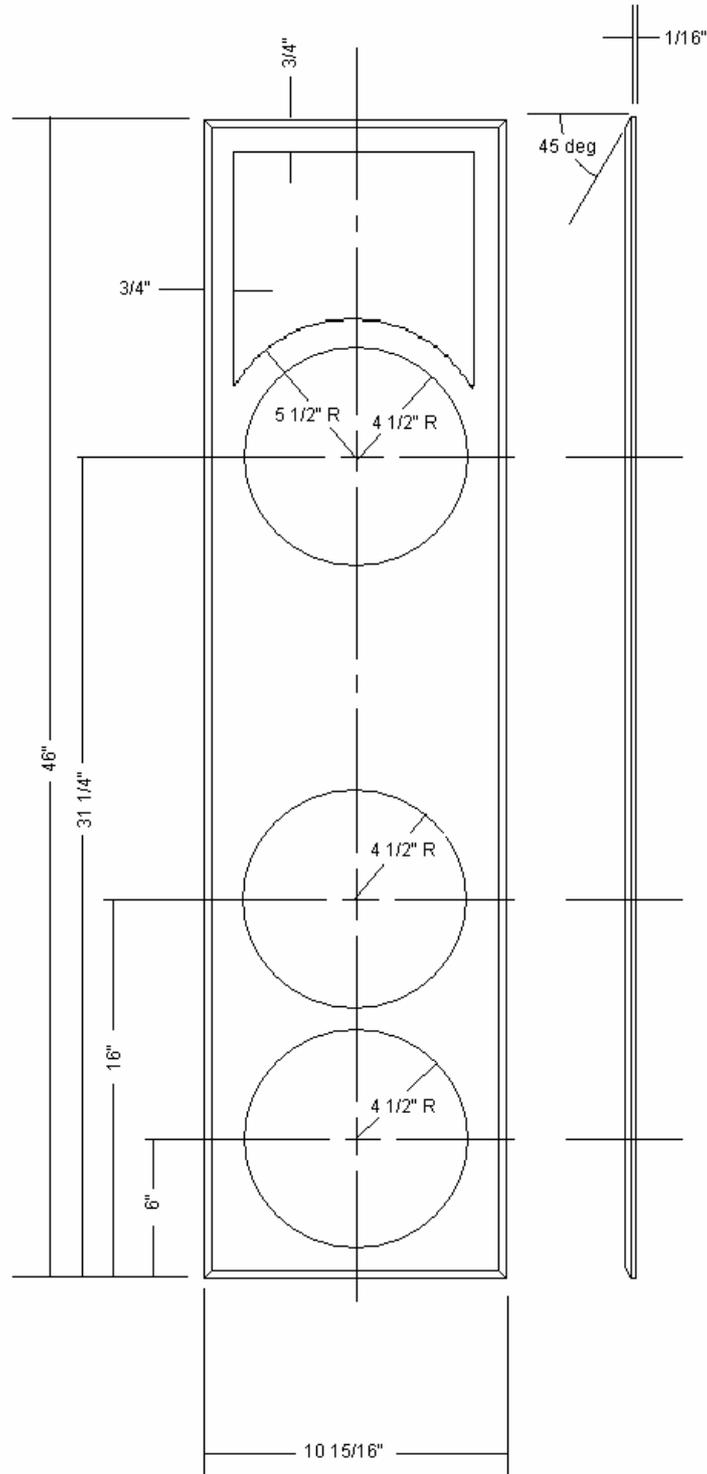


Cabinet Assembly Drawing



Grill Frame

Material: 1/4" MDF or Plywood



Baffle Layout

Start with a piece of $\frac{3}{4}$ " thick stock, 11" wide x 24" high.

- 1) Mark the centerline.
- 2) Mark the center of the midrange drivers and front tweeter.
- 3) Draw vertical lines $1\frac{3}{4}$ " to each side of the centerline from the top down about 6".
- 4) Draw vertical lines to each side of the centerline $2\frac{3}{8}$ " from each side of the centerline.
- 5) Measure $13\frac{1}{4}$ " up from the bottom edge of the baffle along each side. Draw lines at 45 degrees from these points.
- 6) The layout should now look like this:



- 7) Set a compass to a 157 mm radius. From the lower midrange center point draw ark "A" on both sides, from the baffle edge that become tangent to the 45 degree lines. Some fine adjustment of the radius may be required. See figure below showing the left side.



- 8) On each side measure out toward the edge $1\frac{1}{2}$ " from the vertical line which is $2\frac{3}{8}$ " from the baffle centerline and draw a vertical line.
- 9) On each side draw a line parallel to the 45 degree line but $1\frac{1}{2}$ " above it. See figure below. Where these lines cross is the center point for the next step



- 10) Set the compass for a $1\frac{1}{2}$ " radius and on each side draw an ark as shown below for the left side.



11) Set the compass to a $2 \frac{3}{8}$ " radius. From the center point for the upper midrange draw a $2 \frac{3}{8}$ " ark on each side, as shown below for the left side.



12) Set the compass to a $4 \frac{3}{4}$ " radius. From the center point for the upper midrange draw an ark on each side, as shown below for the left side.



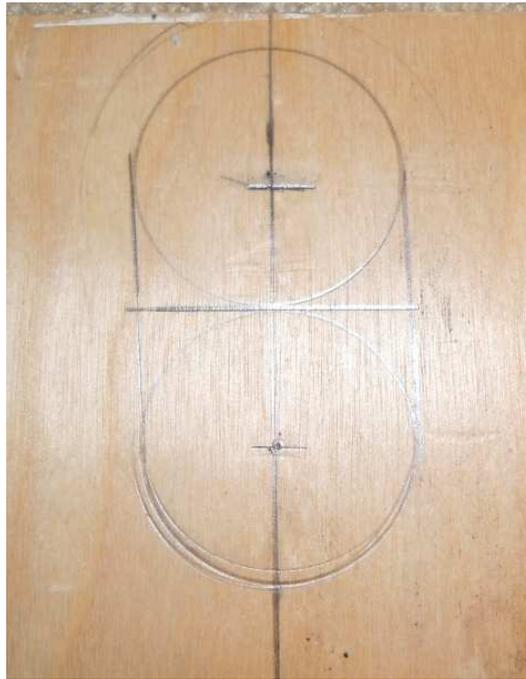
- 13) On each side draw a vertical line $2 \frac{3}{8}$ " further out toward the baffle edge from the vertical line previously drawn $1 \frac{3}{4}$ " from the centerline as shown above by the dotted line.
- 14) On each side, from the point where the dotted line and the ark cross (circled in the figure above) draw a $2 \frac{3}{8}$ " ark as shown below.



- 15) When finished you should see the shape of the baffle as highlighted in blue magic marker below.



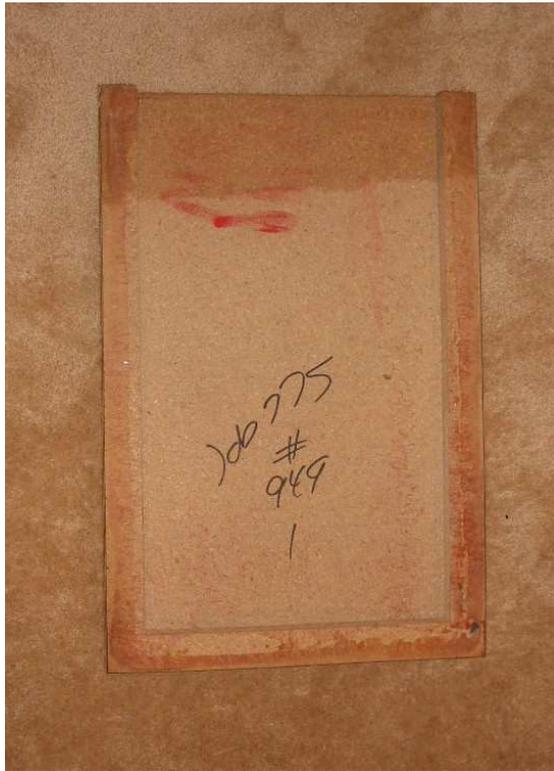
- 16) Using the compass set to the appropriate radius, draw the driver cut outs and rebates for the midrange and tweeter drivers.
- 17) Flip the baffle over.
- 18) Draw a vertical centerline.
- 19) Measure up 21 ¼" from the bottom edge of the baffle and make a mark for the center point of the front tweeter on the centerline.
- 20) Measure up 1 ½" from this point and mark the center point for the optional rear tweeter.
- 21) Set the compass to a ¾" radius and draw 1 ½" diameter circles at the center of the front and rear tweeters.
- 22) Draw vertical lines on the sides of these circles and a horizontal line ½ way between the centers. As shown below.



23) This outline will be routed below the horizontal line to a depth of $\frac{1}{4}$ " for the mounting of the front tweeter and above the horizontal to a depth of $\frac{1}{2}$ " for clearance of the back of the rear tweeter (if installed).

Cutting the Baffle:

Before cutting the baffle shape the driver cut outs and rebates and the tweeter wave guide should be cut. To facilitate this you should make a simple jig. The jig can be fabricated from a scrap piece of $\frac{3}{4}$ " thick board approximately 26" x 16". Strips $1\frac{1}{2}$ " wide x $\frac{3}{4}$ " thick should be securely fastened (glue and screw) around 3 edges. Any screws should be counter sunk. An example of the jig is shown below.



- 1) Position the baffle in the jig and secure with wedges. Use a scrap piece of $\frac{3}{4}$ " stock to protect the baffle edge as shown below. Make sure the bottom of the baffle butts against the bottom of the jig.



- 2) Using sheetrock or other flat head screws, secure the baffle to the jig through what will be the upper and lower midrange cut outs. Use two screws in each as it is important that these cut outs not rotate. The screws must be counter sunk. See below, screws circled.



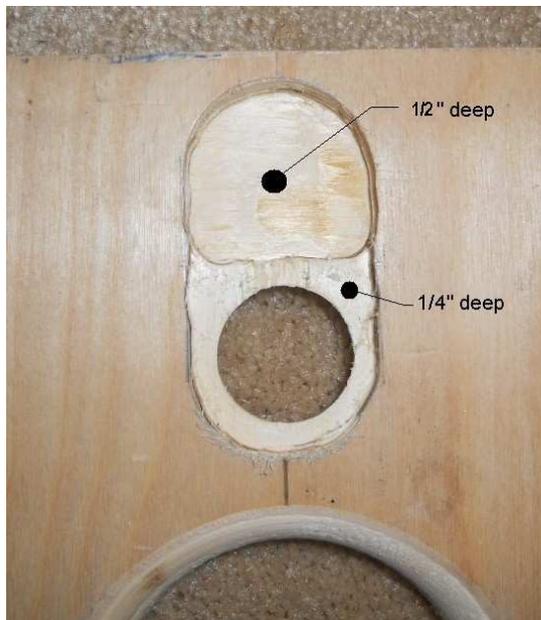
- 3) Drill the required pilot holes for the router pin and rout the driver cut outs for the midrange drivers as shown below. **The rebates should not be routed at this time.**
- 4) Using a 1 1/8" hole saw cut the hole for the front tweeter (also shown in the above picture).
- 5) Remove the baffle from the jig leaving the midrange cut outs attached to the jig.
- 6) Using a 1/2" round over bit rout the wave guide from the front tweeter. Make sure the depth is adjusted so that the round over is flush with the baffle surface.



- 7) Flip the baffle over and from the rear round over the midrange cut out using the same 1/2" round over bit.



- 8) Using a straight bit, from the back side rout the lower part of the tweeter position to a depth of $\frac{1}{4}$ ". Then rout the upper half to a depth of $\frac{1}{2}$ ". This isn't very critical and can be done free hand. See below.



- 9) Place the baffle back in the jig and secure with wedges.
10) Rout the rebates for the upper and lower midrange drivers. The cut outs will serve as the center points.



- 11) Remove the baffle from the jig.
- 12) You can now cut the baffle shape using a band saw or jig saw. Cut outside the lines and sand to the final shape.
- 13) Using a 3/8" round over bit with bearing, round over the edge of the baffle above the red line shown on the baffle drawing. Do not round over the top edge. Important. Round over the front side first. Then flip the baffle over and round over the back edge. If you are going to install a rear tweeter stop the round over on the back side below where the rear tweeter mount will mate with the main baffle.

Rear Tweeter Mount:

The rear tweeter mount is identical to the top 3 3/4" of the main baffle turned upside down. Once the cut out, wave guide and recesses are routed, the bottom and side outer edges should be rounded over on one side using a 1/2" round over bit or simply beveled at 45 degrees. The mounting surface should remain flat, so as to mate with the main baffle. The rear tweeter mount, if used, should be notched at the bottom to allow the leads from the tweeters to pass.

Woofers Enclosure Assembly:

The woofer enclosures should be built in mirror imaged pairs. However, this does not require any special setup. The woofer enclosure side panels are all identical for both left and right speakers. Once all the panels are cut start assembling one enclosure. Place the bottom panel on a flat surface. Next position the side panels and woofer baffle on the bottom panel and make sure that the sides are

flush with the edges of the bottom panel. It may be necessary to make slight adjustments to the width of the woofer baffle of the depth of the slots in the woofer side panels. The woofer baffle should slide smoothly in the slots. Once you are sure everything lines up glue the side panels to the bottom panel and clamp. This is easier if the woofer baffle is left in place as it helps align and support the sides. When the glue has set locate the woofer cabinet top braces (the two 1 1/2" x 3/4" x 9 1/2" hard wood pieces). One of these braces should be positioned at the top rear of the enclosure so that it is flush with the back and top edges of the enclosure. The second brace should be positioned so that it is flush with the top edge of the sides but recessed 3/4" from the front edge of the enclosure. Glue these two braces in place. When the glue sets drill pilot holes through each side panel and further secure these braces with 1 1/2" screws. The holes should be countersunk so that the screw heads are flush with the sides. (See photo). Check to make sure the woofer baffle will slide smoothly in the slots. If necessary the edges of the baffle can be sanded to improve clearance. The top panel can now be fitted. Position the top panel so that the rear edge is flush with the rear edge of the enclosure. The front edge should leave 3/4" of the top edge of the sides exposed. The top panel should be secured to the enclosure braces using six 1 1/2" screws, three at the front and 3 at the rear, through the top into the hardwood braces as indicated on the enclosure assembly drawing. The top panel holes should be countersunk so the screw heads are flush. **Note:** the 1 1/2" screws may protrude slightly through the hard wood braces and the tips are sharp. After the screws are inserted the first time you may wish to remove them and grind the ends down to shorten them slightly.

To assemble the second woofer enclosure, follow the same procedure. However, to make the second enclosure the mirror image of the first the side panels must be flipped over. Use the first enclosure as a reference and flip the sides so that the woofer baffle is angled in the opposite direction.

Side Panel construction:

If the side panels are to be cut from a single piece of plywood, simply follow the layout shown on the drawing and cut the panels. The outside edges of the side panels may be rounded over using a 1/4" round over bit if desired. Make sure to make left and right side panels.

If the side panels are to be made of hard wood it is typically necessary to butt glue boards of different widths together to form the blank for the side panel. Glued butt joints are sufficient; however, if possible biscuits should be used for added strength. See the Side panel drawing for a suggested layout of board widths. The widths shown are standard widths available at Home Depot.

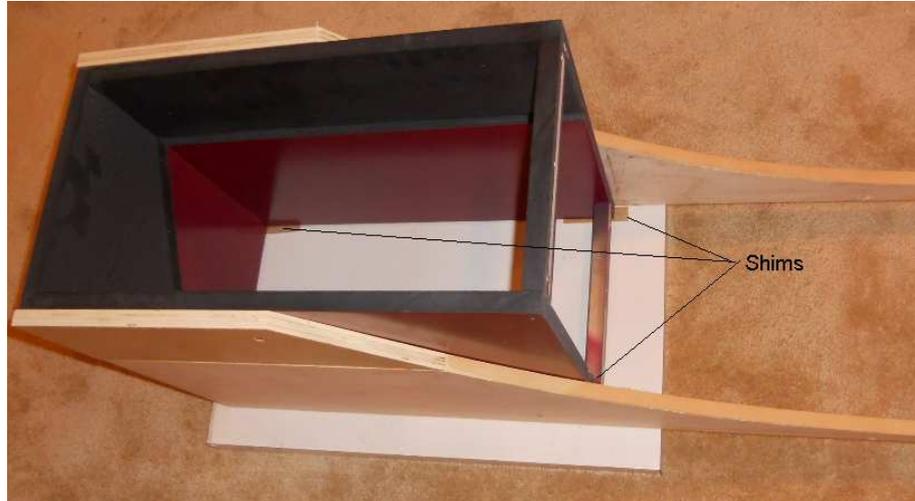
Cabinet Assembly Instructions:

Once the woofer enclosures, main baffles and side panels are fabricated and finished as desired it is time to assemble the cabinet. This should be done without any drivers installed. See the **Cabinet Assembly Drawing** for reference.

- 1) Locate a smooth flat surface.
- 2) Place the woofer enclosure front face down on this surface.
- 3) Place 1/4" shims under the woofer enclosure to raise the front off the flat surface.
- 4) Place one of the side panels against the side of the woofer enclosure with the front edge lying on the flat surface. The front edge of the side panel **should not** be on the shims. Make sure the bottom of the side panel is flush with the bottom of the woofer enclosure. Secure the side panel

to the woofer enclosure using 1 ¼” screws. If you do not want the screws to be visible, secure from the inside of the woofer enclosure at the back.

- 5) Secure the other side panel to the woofer enclosure in the same manor. The front edges of the side panels should be parallel if the flat surface is truly flat.



Woofer enclosure positioned on flat surface with shims and side panels.

- 6) Carefully stand the cabinet up and secure the side panels at the front edges from the inside of the woofer enclosure with 1 ¼” screws.
- 7) Position the top baffle brace between the side panels. It should be flush with the very top edges of the side and set back the same amount as the woofer enclosure is set back from the front edges of the side panels (1/4”). See the cabinet assembly drawing for reference. Secure it in place with 1 ½” screws (drill pilot holes to avoid splitting the side panels and top brace and counter sink).



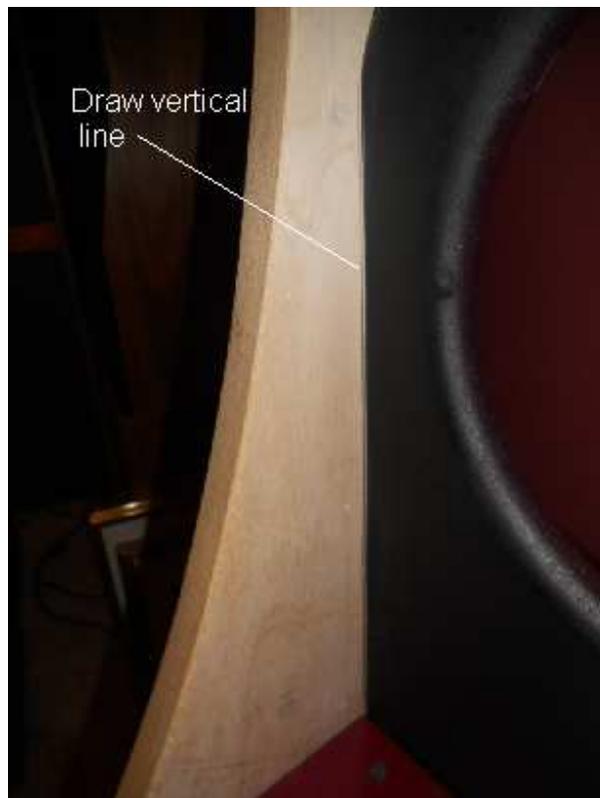
Top baffle brace positioned between side panels and secured with screws.

- 8) The front edge of the woofer enclosure top panel and the top edge of the woofer enclosure sides will form a step on which the main baffle will rest. Position the main baffle so that it rests on this step and the front surface is flush with the front edges of the woofer enclosure and the top brace. This should place the baffle front surface parallel to, but back from the front edge of the side panels by $\frac{1}{4}$ ".



Step at front of woofer enclosure which main baffle rest on.

- 9) With the baffle positioned correctly, draw vertical lines along the intersection of the back side of the main baffle and the side panels to mark the location of the baffle mounting strips.



- 10) Remove the baffle.
- 11) Apply 3 pieces of foam weather stripping about 1/2" long to the front edge of the woofer enclosure top panel. This will eliminate vibration when the main baffle butts against the woofer top panel.



Apply foam pads.

- 12) Secure the baffle mounting strips to the side panels with 1" screws (and glue if desired), aligning the front edge of the strips with the vertical lines. The lines should be 1" behind the front edge of the side panels. Check this dimension before the strips are secured.
- 13) Mount the main baffle to the mounting strips using 1" screws from the rear. Do not over tighten or the mounting strip may split.



- 14) Secure the top of the baffle to the top brace using a 1 ¼” screw (drill a 1/8” pilot hole to avoid splitting the baffle).



Installing the drivers:

Woofers

Remove the top panel from the woofer enclosure and pull out the baffle. The front and rear oriented woofers must be mounted in the correct holes or the mounting flanges will interfere with the slots in the side panel. The front oriented woofer will be connected to the amplifier with normal polarity. The rear oriented woofer must be connected with inverted polarity so that it moves in the same direction as the front woofer when a signal is applied. Additionally, the woofers are connected in parallel. Two short pieces of wire are used to connect the front and rear woofers. Connect the negative lug of the rear woofer to the positive lug of the front woofer. Connect the positive pole of the rear woofer to the negative lug of the front woofer. The second set of lugs on the front oriented woofer is used to connect to the amplifier, positive to amplifier positive, negative to amplifier negative. A piece of foam weather stripping should be applied to the top and bottom edge of the baffle for sealing the enclosure and eliminating vibrations. Then load the woofers into the enclosure. Weather stripping should also be applied to the bottom of the woofer enclosure top panel, around the perimeter, before securing the top panel to the enclosure with 1 ½” screws.



Woofers mounted on baffle.



Loading the woofers.

Tweeters

The front tweeter is secured to the main baffle using silicon or other panel adhesive. Make sure the tweeter is centered in the wave guide and apply a bead of adhesive to secure. Be patient. Similarly, the rear tweeter is secured to the rear tweeter mount. When the adhesive has set, connect wires to the tweeter terminals. Mark which are the positive and negative leads, and the front and rear, for future reference. The tweeters will be connected to the amplifier in parallel. The front tweeter with normal polarity; the rear with inverted polarity. The rear tweeter mount is secured to the main baffle using a small dab of panel adhesive in each corner.

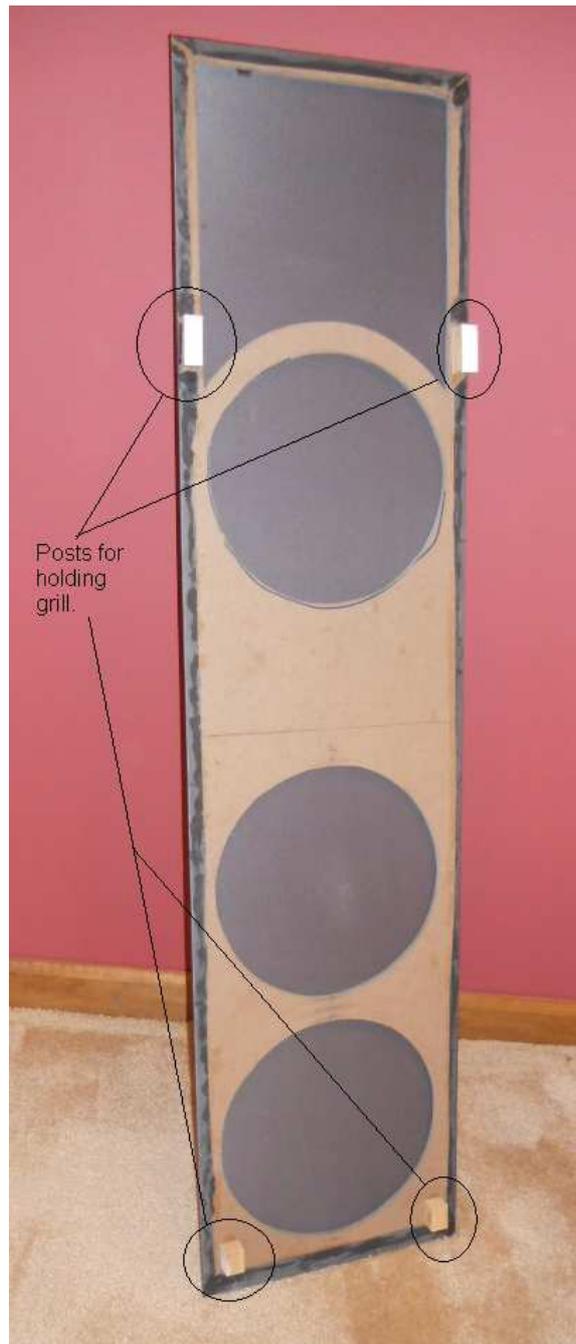
Midrange drivers

The midrange drivers are mounted to the main baffle using ½" long screws of the appropriate size. Both drivers will be connected to the amplifier with normal polarity.

Grills:

The NaO Note II RS may be listened to with the grills in place or removed. Depending on the grill cloth used the difference in response is very small. One source of grill cloth is Parts express: <http://www.parts-express.com/wizards/searchResults.cfm?srchExt=Cat&srchCat=140>.

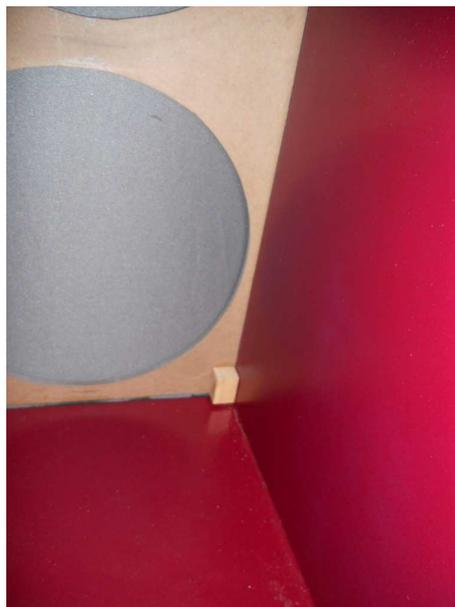
The front surface of the grill frame should be painted the same color as the grill cloth. Grill cloth should be stretched and glued to the grill frame. The grills are held in place by friction between 4 posts glued to the back of the frame and the side panels and dipole.



The upper posts are positioned to rest against the main baffle to hold the grill at the proper height:



The lower posts are positioned so that they sit in the corners of the woofer enclosure:



If the post do not fit tight enough to hold the grill a small piece of grill cloth can be glued to the outside surface to tighten the fit.

Setting up the miniDSP crossover:

The speaker system uses the miniDSP 2x8 or 4x10 dsp crossover. Four configuration files are supplied with the plan set. These configuration files are used to setup the dsp crossover. Three are

basically identical except for the crossover between the upper and lower midrange. The 4th file is slightly different in design. Configurations 1 through 3 use a 4th order acoustic crossover between woofer and lower midrange and a 4th order electrical crossover between upper midrange and tweeter. These configuration differ in their treatment of the crossover between upper and lower midrange (coupling crossover) as follows:

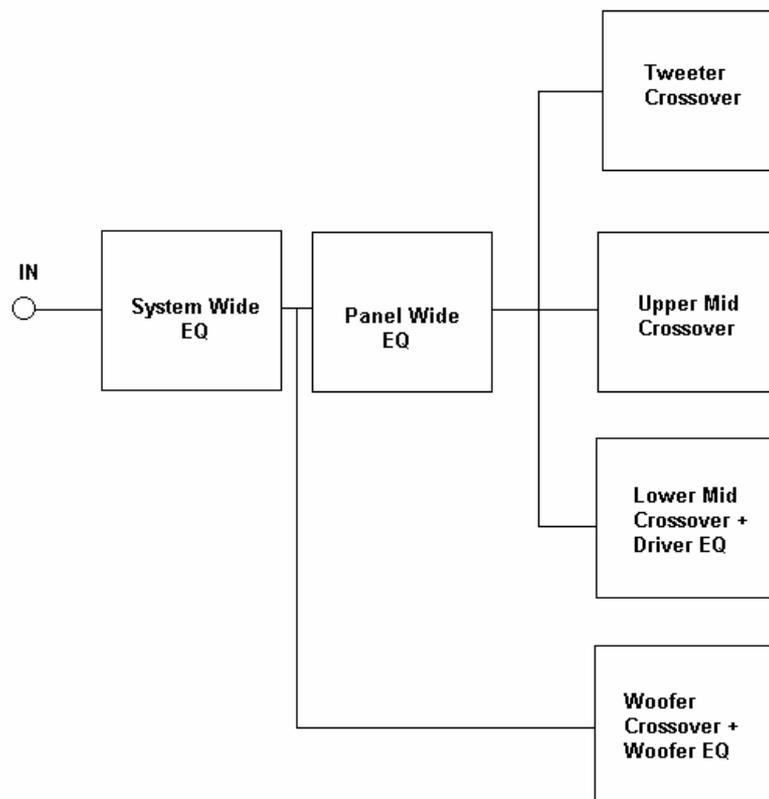
Configuration 1: 4th order electrical coupling crossover. (File name: **4th order.xml**)

Configuration 2: 2nd order electrical coupling crossover. (File name: **2nd order.xml**)

Configuration 3: 1st order electrical coupling crossover. (File name: **1st order.xml**)

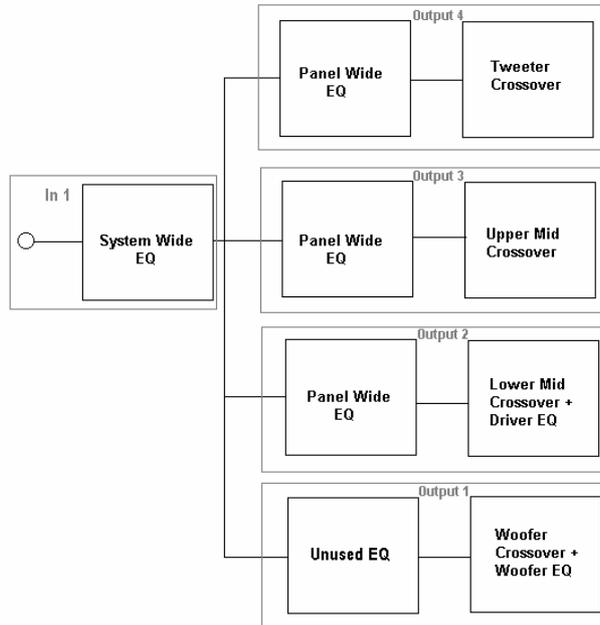
These three configurations also have system wide equalization applied to correct for dipole roll off and additional response anomalies. If implemented in the analog domain the signal path would follow the block diagram shown below.

Analog block Diagram of active crossover.



When emulated digitally using the miniDSP 2x8 the panel wide equalization lumped with the output for each channel. This is necessary because of the miniDSP routing. This is shown in the block diagram below.

miniDSP Digital implementation of crossover.
Single Channel Shown

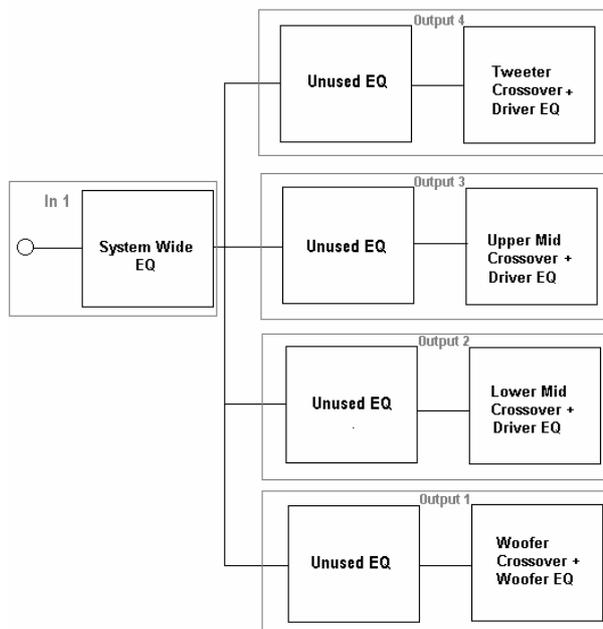


Configuration 4 differs from 1 through 3 in that all crossovers are 4th order acoustic.

(File name: 4th Acoustic.xml)

With equalization applied on a driver by driver basis. The block diagram corresponding to the miniDSP emulation of this configuration is show in the figure below.

miniDSP Digital implementation of crossover.
Single Channel Shown



The preferred/recommended configuration is configuration 2 with the 2nd order coupling crossover.

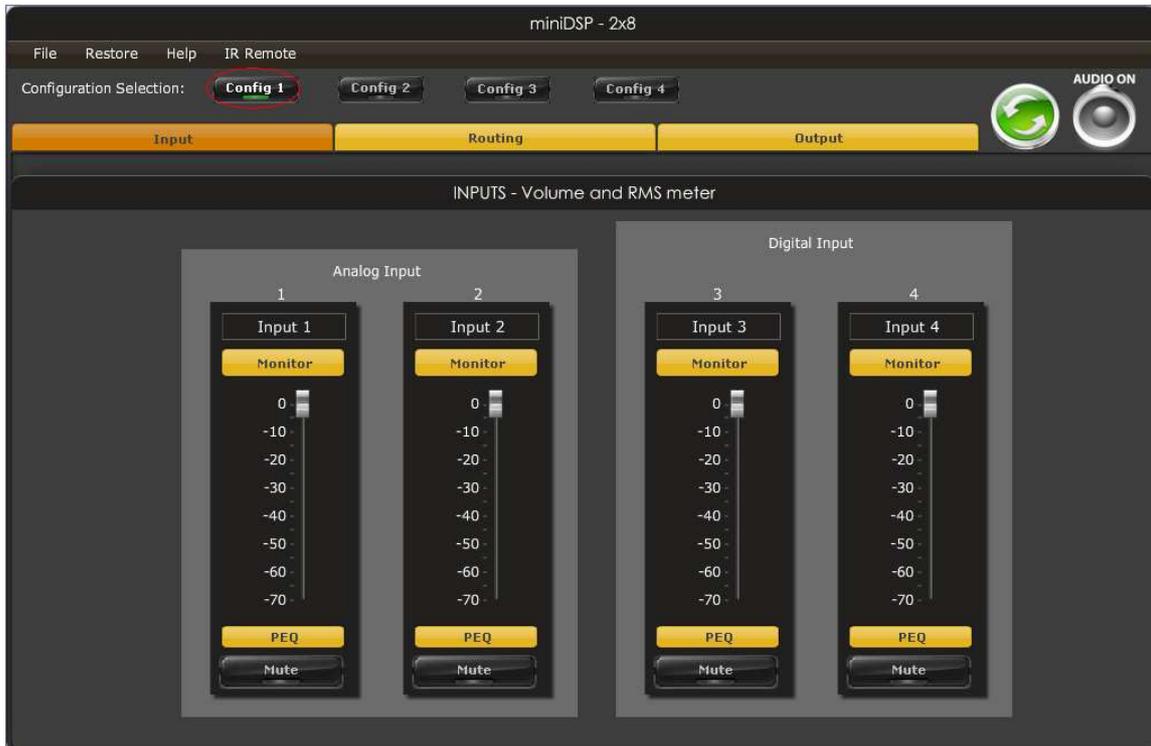
The miniDSP allows you to load all four configurations on the dsp board and switch between them on the fly with only a brief period of silence while switching. In this way you are free to evaluate the different configuration to see if you prefer one over the other. Additionally, the 5 channels of equalization associated with inputs are left unused to allow you to adjust the system to your needs.

When the miniDSP crossover is configured the inputs and outputs are as indicated in Table I.

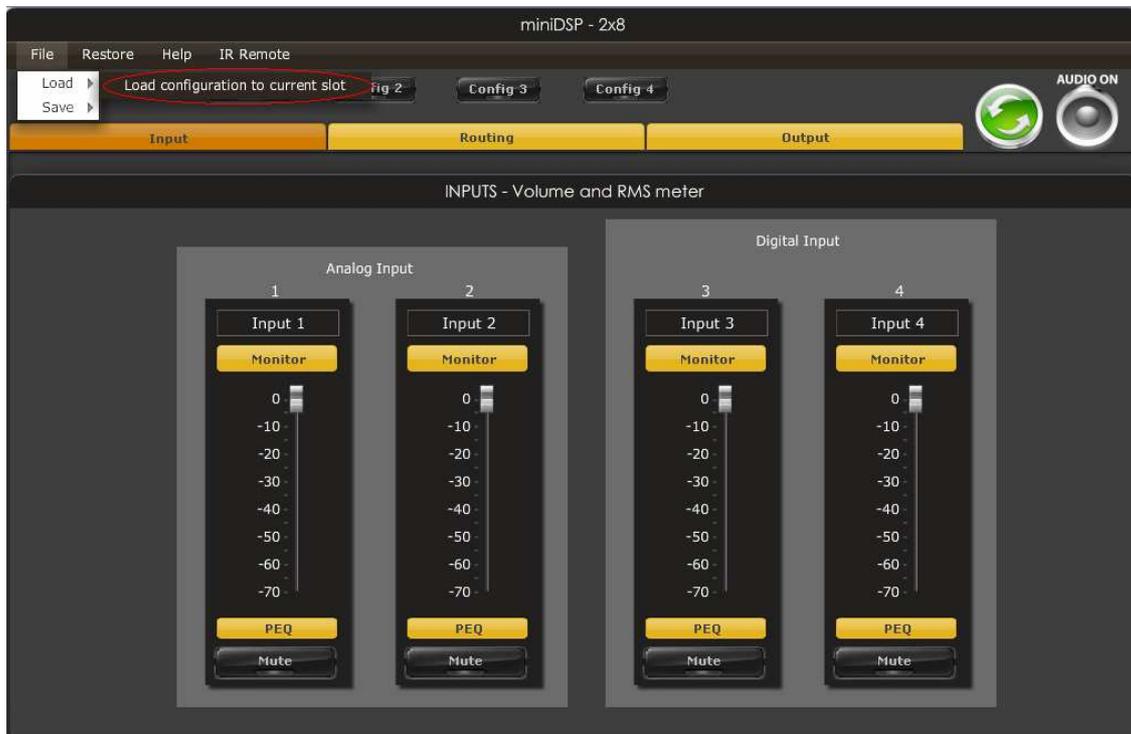
Input	Woofers	Lower midrange	Upper midrange	Tweeters
Analog Input 1	Analog Output 1	Analog Output 3	Analog Output 5	Analog Output 7
Analog Input 2	Analog Output 2	Analog Output 4	Analog Output 6	Analog Output 8

To load the configuration files into the miniDSP you will require the 4x10 Crossover plug-in.

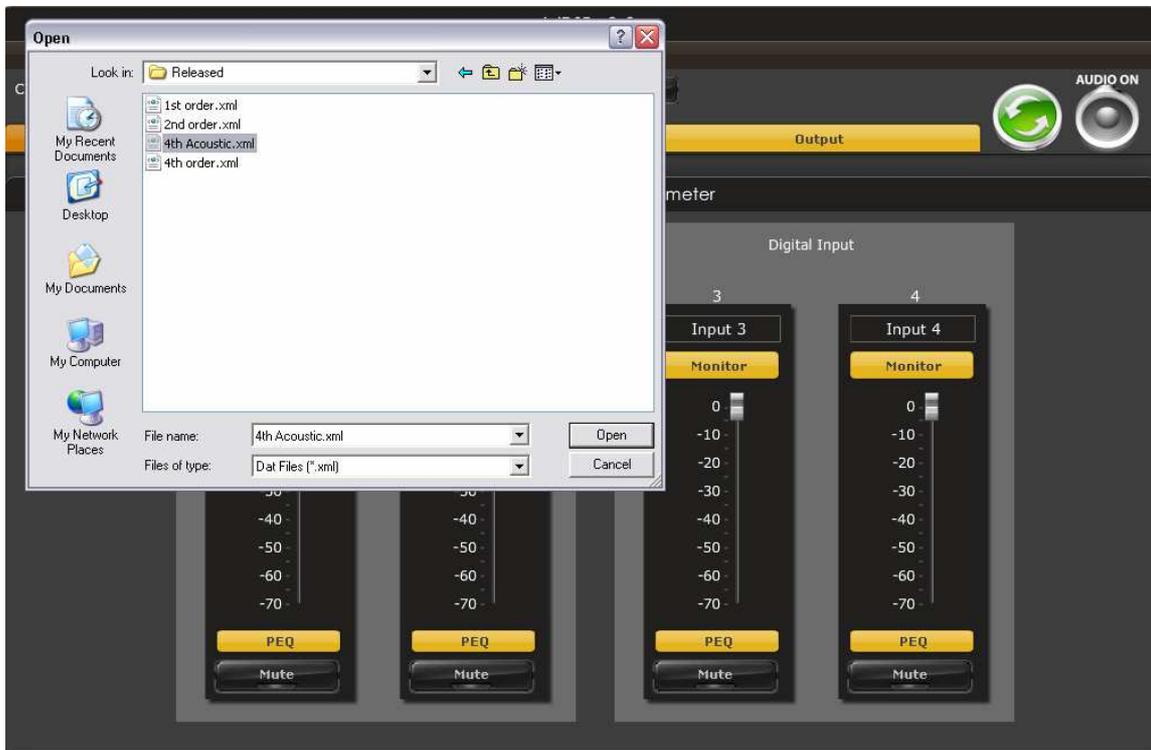
Open the plug-in and select the configuration number to be loaded (1 through 4):



From the File menu select **Load**, then **Load configuration into current slot**.

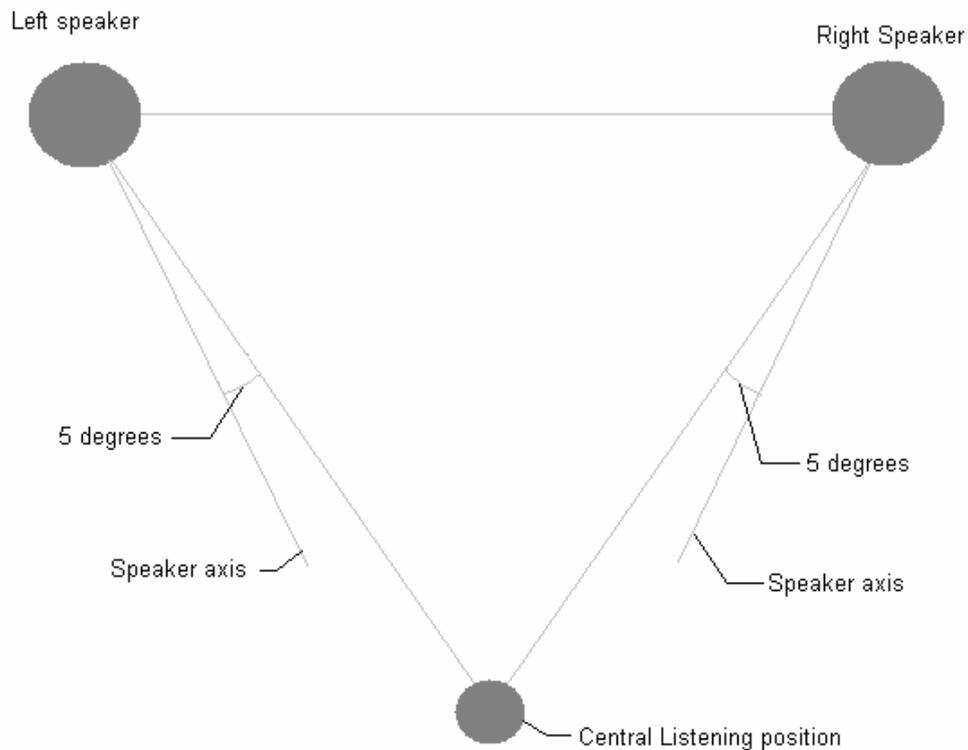


When the dialog opens search for and select the configuration file to be loaded:



Then click Open and the configuration will be loaded into the plug-in. From there follow the instructions in the miniDSP User's Manual to synchronize the crossover settings to the miniDSP crossover board. Note that all four configurations supplied with the plan set can be loaded into the software under the different configuration slots and synchronized to the miniDSP crossover board. Then, with only a slight delay, you can switch between configuration on the fly and decide for yourself which configuration you prefer.

Speaker Set Up:

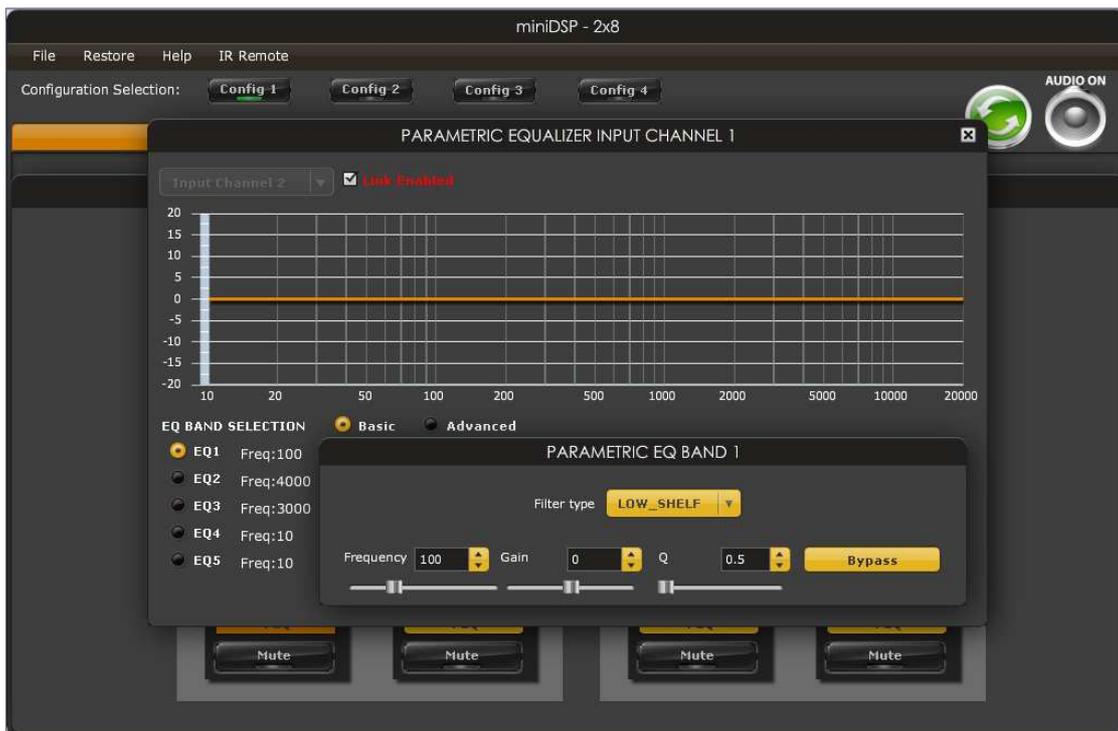


The NaO Note II RS should be set up as any conventional speaker with a few exceptions.

- 1) The miniDSP crossover should remain **powered on** at all time to avoid turn on/off transients. If you must turn it off and on, please make sure the power amplifiers are off and their power supplies are discharged before turning the crossover on or off.
- 2) The speakers should be angled so that each speaker is towed out approximately 5 degrees relative the axis between the speaker and the central listening position.
- 3) The speaker should be 2 to 3 feet from a side wall.
- 4) The speaker should be positioned 4 to 5 feet from the wall behind the speaker. If the speaker must be placed closer it may be advantageous to apply some type of damping material to the wall directly behind the speaker. Bass response may suffer if the speaker is close to the wall.

Audio Adjustments:

The NaO Note II RS was designed to have flat on axis response with a low frequency -3dB point of 30 Hz in an anechoic environment. This is intended to be a reference level about which the user may choose to make adjustment to suit his taste and/or environment. However, before making such adjustments it is suggested that you spend some time listening to the system and experiment with speaker placement to obtain the best sound stage and image. After you are familiar with the sound of the system on a variety of you favorite recording you may wish to may make additional audio adjustments. To make such adjustments the miniDSP 4x10 plug-in must be opened and the miniDSP crossover board connected to your computer. Make sure you have the proper crossover configuration file loaded. Then, under the Input tab, open the parametric equalizer screen (PEQ) as shown below:



You will note that the first three equalizer bands are set as follows:

EQ1: 100 Hz, Low Shelf, Gain = 0, Q = 0.5

EQ2: 4000 Hz, High Shelf, Gain = 0 Q = 0.5

EQ3: 3000 Hz, Peak, Gain = -3dB, Q = 1.0, Bypassed

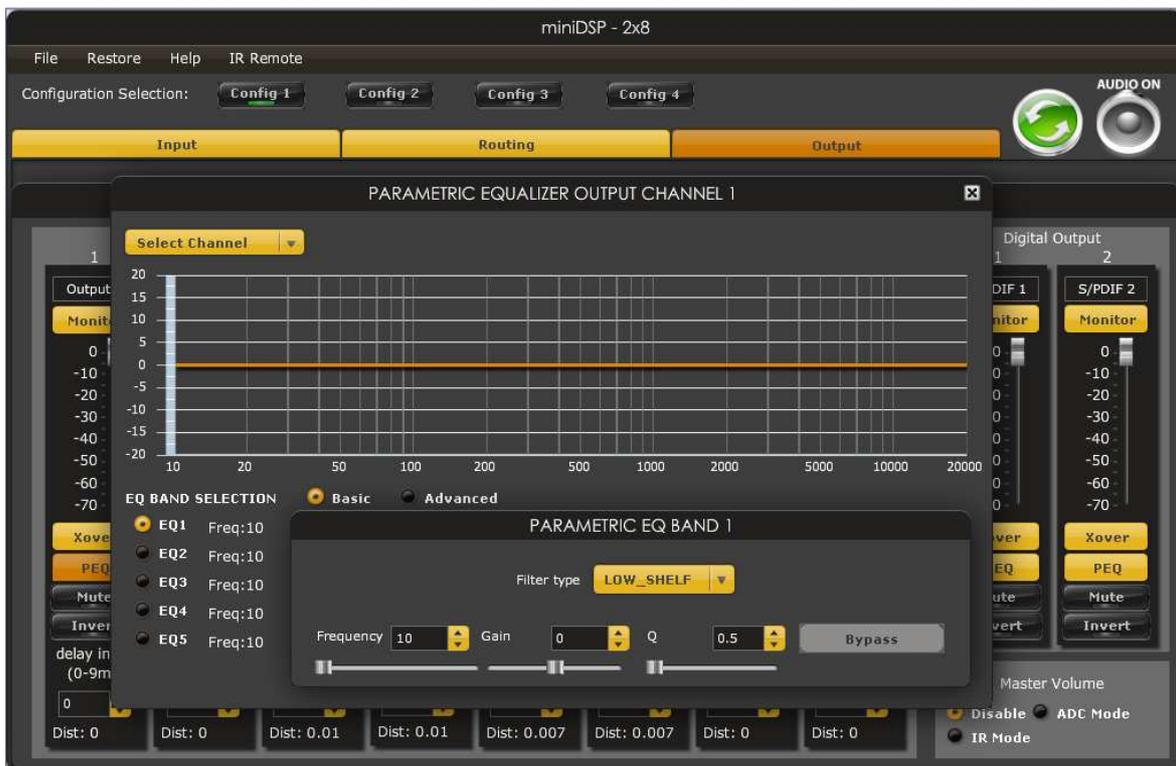
EQ1 may be used to increase or decrease the bass level. It is suggested that any adjustment be limited to +/-3dB.

EQ2 may be used to cut the treble level. It is suggested that this be limited to -3dB.

EQ3 may be used to apply a “BBC dip” by turning off the bypass setting.

If you do not require using any of these adjustments, EQ1 through 3 can be used as desired, along with EQ4 and 5, to correct for other room related response problems.

In addition to the 5 bands of system wide equalization available under the Input tab there are an additional 5 band of equalization available to adjust for low frequency response problems under the woofer crossover channels. To access these, select the Output tab and open the Channel 1 parametric equalizer (PEQ), as shown below. You will find 5 unused equalization bands which you may adjust as desired. Please note that the PEQ for Channel 1 should be linked to the second woofer channel, Channel 2, if the same woofer equalization settings are to be used for both the left and right woofers.



The adjustments to your system will not take affect until the miniDSP board is synchronized. Once synchronized the setting may be adjusted in real time. The equalization bans under channels 3-8 should not be used or altered.

When you have made all the necessary adjustments it is recommended that you save the configuration to a file with a unique name so as not to overwrite the configuration files supplied with the plan set.

The NaO Note II RS should provide you with many hours of enjoyable listen.