

SEAS KingRO4Y MK.III Application Note & Assembly Guide

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System Outline

The KingRO4Y MK.III is a compact three-way loudspeaker kit, making use of two SEAS drive units- the **C18N002/A** and **L26RO4Y**. The amplification and DSP crossover networking are handled by the powerful Hypex Fusion FA503, a 3-channel plate amplifier boasting two 500W channels and a 100W tweeter channel.

Drivers:

The **C18N002/A** is an 18cm coaxial unit from the Excel range, a mid-frequency cone with a tweeter centred in its voice coil, the co-location of the mid drive unit and tweeter allows for co-location in time improving phase coherence and reducing effects such as vertical lobing which can occur with non-co-located units. Handily, housing mid and tweeter in the same basket also allows for a tidily compact and unobtrusive cabinet in terms of the given output. Both the tweeter dome and midrange membrane are made of an aluminium/magnesium alloy and the shape of the midrange's cone is specifically designed to optimally load the tweeters radiation.

The **L26RO4Y** is a 26cm low frequency drive unit from the SEAS Extreme range. Having a large magnet system for the size of driver it has exceptionally low Q which makes it ideal for use in compact systems with digital crossovers, such as utilised in the Fusion FA503 as part of this kit. A four-layer, high temperature voice coil means high power handling capacity and reduced thermal compression further waiting to take advantage of the improved output power of the FA503.

Cabinet:

One of the design goals of this system was to make the enclosure as small as possible. Since the target group is the DIY enthusiasts the design also required reasonable simplicity.

The subwoofer needs a 12L closed box as a minimum to have a nice response. However, the used enclosure is 15.6L. This is a slight reduction in volume compared to the MK II, a compromise to retain the same outer dimensions while providing a larger housing for the FA503 (or FA253). This compromise is fine as the reduction in box volume is rather small and we are using a more powerful amplifier which compensates for the increased air stiffness of a lower volume enclosure.

The coaxial uses a closed box of 10.4L, which was the smallest possible enclosure on top of the subwoofer and still have an easy build. That gives the midrange excellent working conditions and a nice response.

Crossover:

The crossover for this system is all handled by the Hypex plate amplifier- the design is fairly similar to the MK II version however the midrange & tweeter having a channel of equalisation each has allowed for a slightly finer tuned and more consistent frequency response and the increased power of the amplifier has allowed for extended bass response of the L26RO4Y.

Sub/Midrange:

The sub and midrange are crossed at 215Hz, the sub rolls off with a 3rd order Butterworth slope and the midrange rolls on with a 4th order Linkwitz-Riley resulting with a -6dB point for each driver at 215Hz which can be observed in the measurements section. The sub has a second order 0.7Q high-pass filter set to 17Hz, this is a protect for the driver, so it does not reach excursion limits for sub-sonic frequencies in some recordings. There is a fair amount of EQ on the sub, since the cabinet is very small for the size of driver. The most prominent EQ points are a low shelf at 53Hz and a low peak at 27Hz, these serve to maximise the frequency response in the low end, extending the low end comfortably beyond what would usually be expected for a cabinet of this size. The low Qts of the L26RO4Y and high-power amplifier are what allow for this. The rest of the EQ on the L26RO4Y is mostly to tidy up resonances.

The EQ on the midrange uses BoostCut points (points which raise or lower gain within a certain bandwidth and slope according to their Q value) to keep the frequency response as even as possible within the crossover bandwidth.

Midrange/Tweeter:

The crossover configuration between the midrange and tweeter follows the same pattern as the sub to midrange so the midrange rolls off with a 3rd order Butterworth slope and the tweeter rolls on with a 4th order Linkwitz-Riley. The filters are set to 1880Hz however this translates closer to a -6dB point of around 1600Hz in the measurements, this is because of the EQ applied to both drivers. As can be seen in the measurements, the phase coherence through the crossover region (represented by the null when the midrange is inverted) is strong between the drivers, if a little less smooth than the subwoofer/midrange cross.

Like the subwoofer the EQ on the tweeter uses shelving points to balance the frequency response and resonances are controlled with BoostCut, effort has been made to minimise the Q and gain on boosts to avoid amplifying distortion.

Measurement:

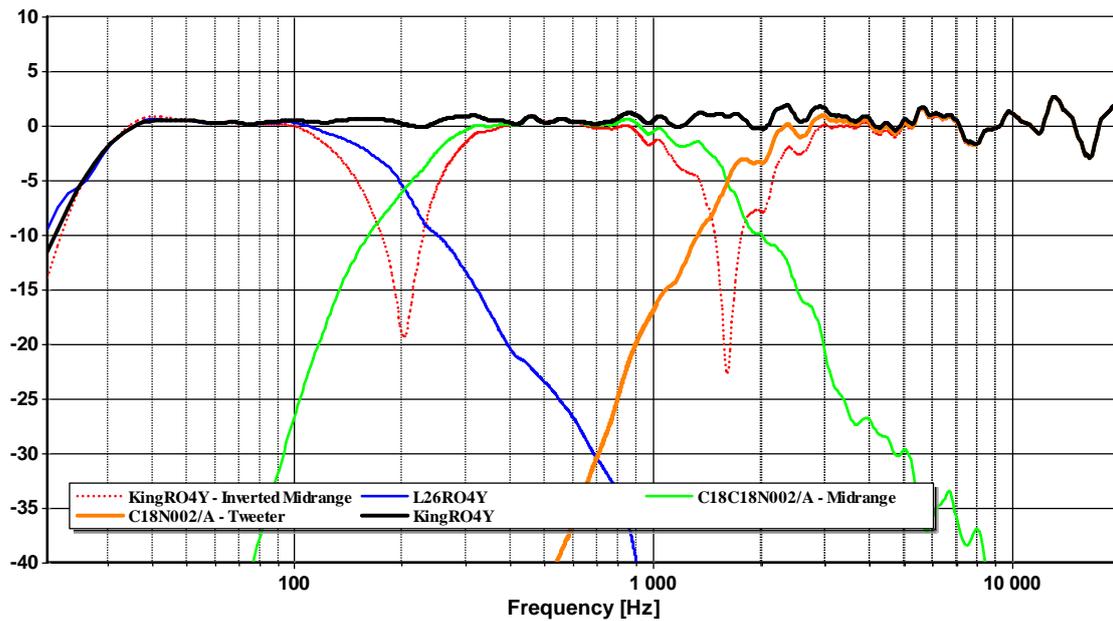


Fig 1: the above figure shows the on-axis measurements of preset-1, as can be viewed the low end is extended rolling off nicely to a -12dB point at around 20Hz. The dotted red line shows the system with the midrange inverted, displaying deep notches around each crossover point which indicates good phase coherence between the drivers. 1/12th Octave smoothing.

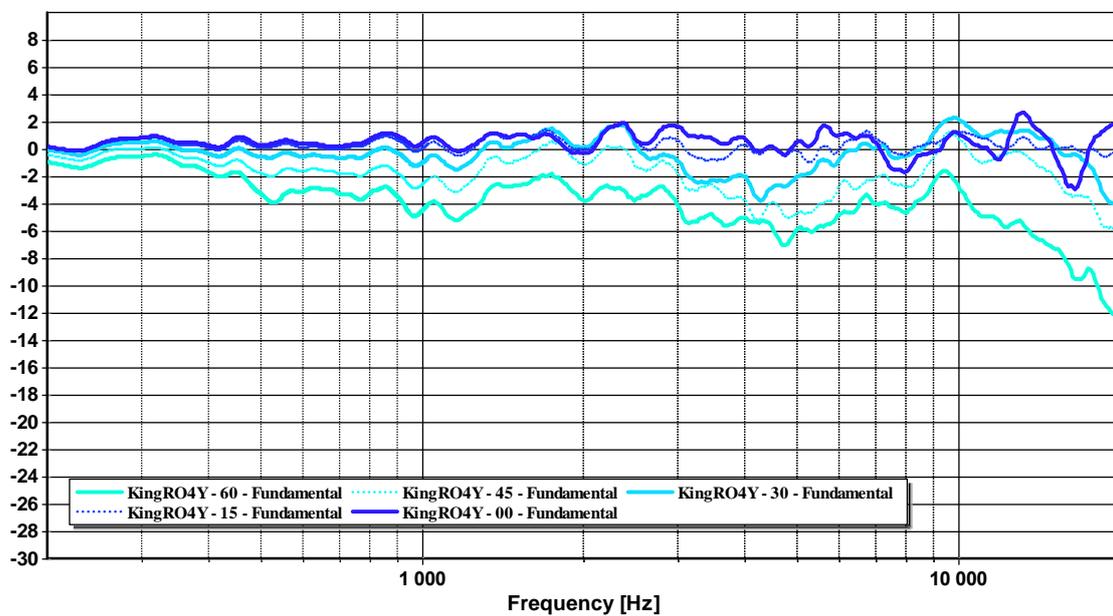


Fig 2: This figure shows the off-axis response of preset-1 in 15 degree increments, effort has been made in the EQ stage and with the crossover tuning to try and make sure that the off-axis effects of the coaxial loading are minimised, this can be seen by the minimal crossing of the data series in this graph. As can be seen in the figure somewhere around 15 degrees gives the smoothest response, this can be considered when placing the speakers in room.

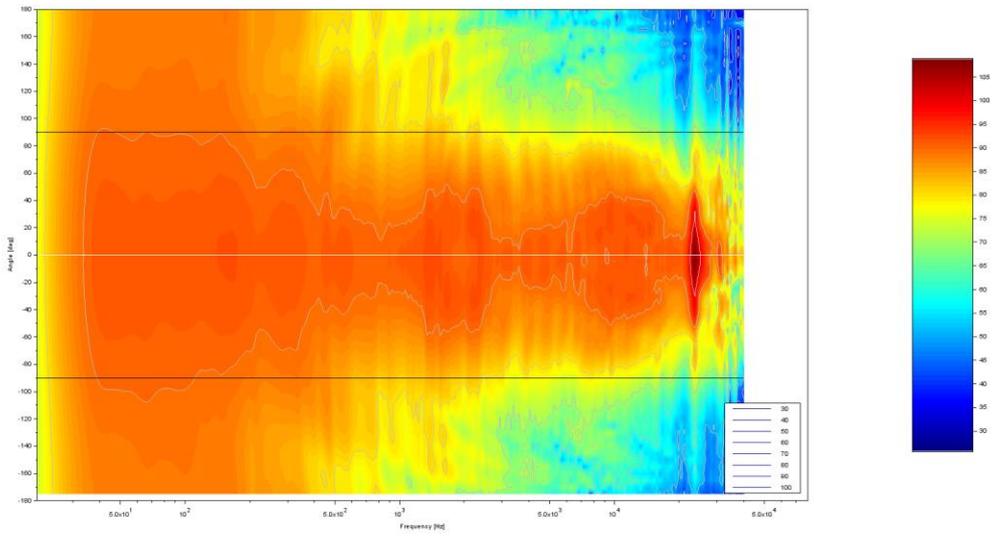
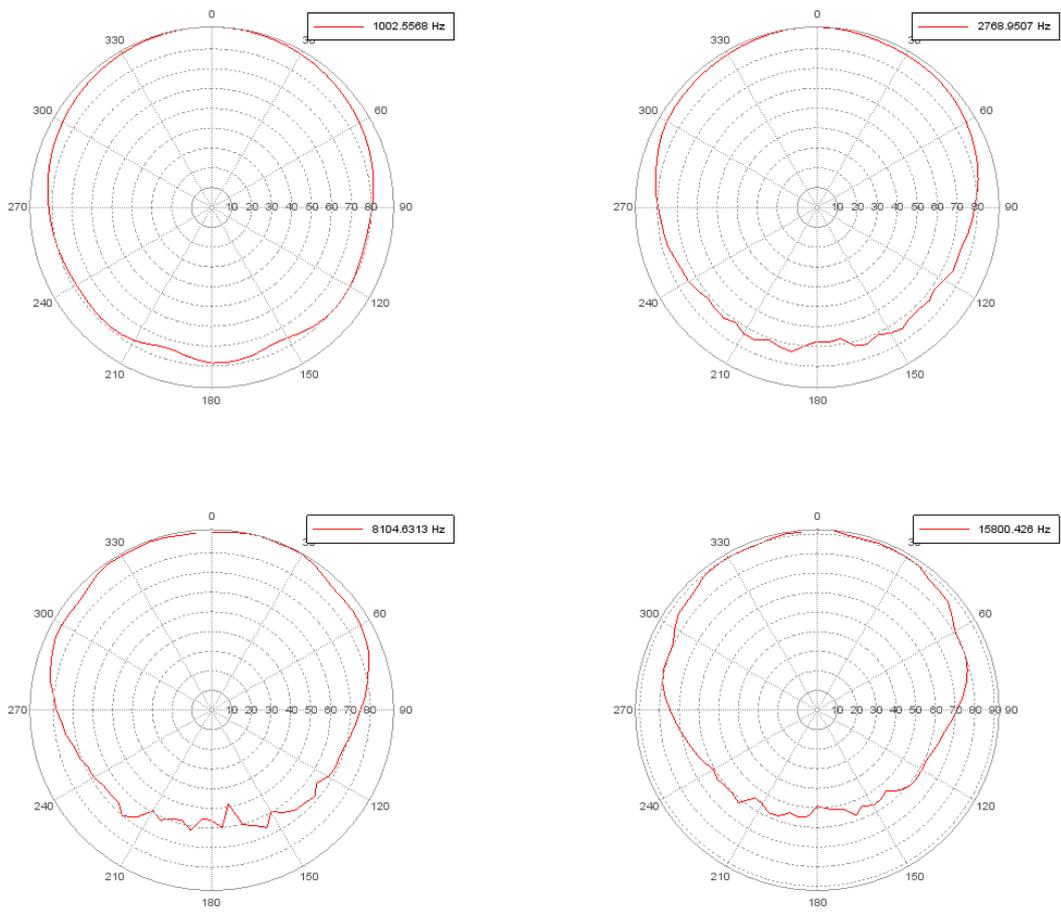


Fig 3: Horizontal Dispersion Sonogram and select polar plots



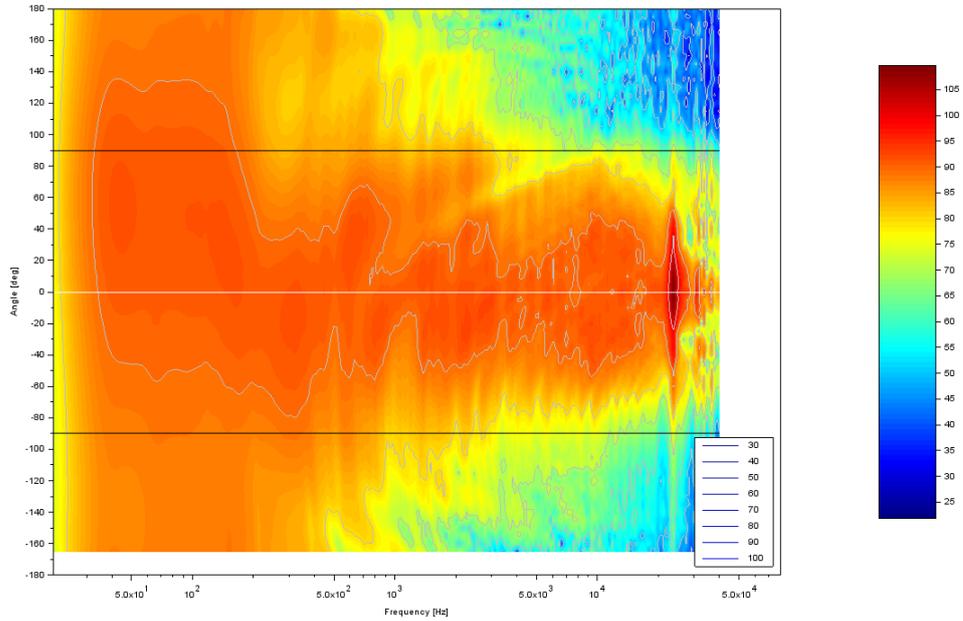
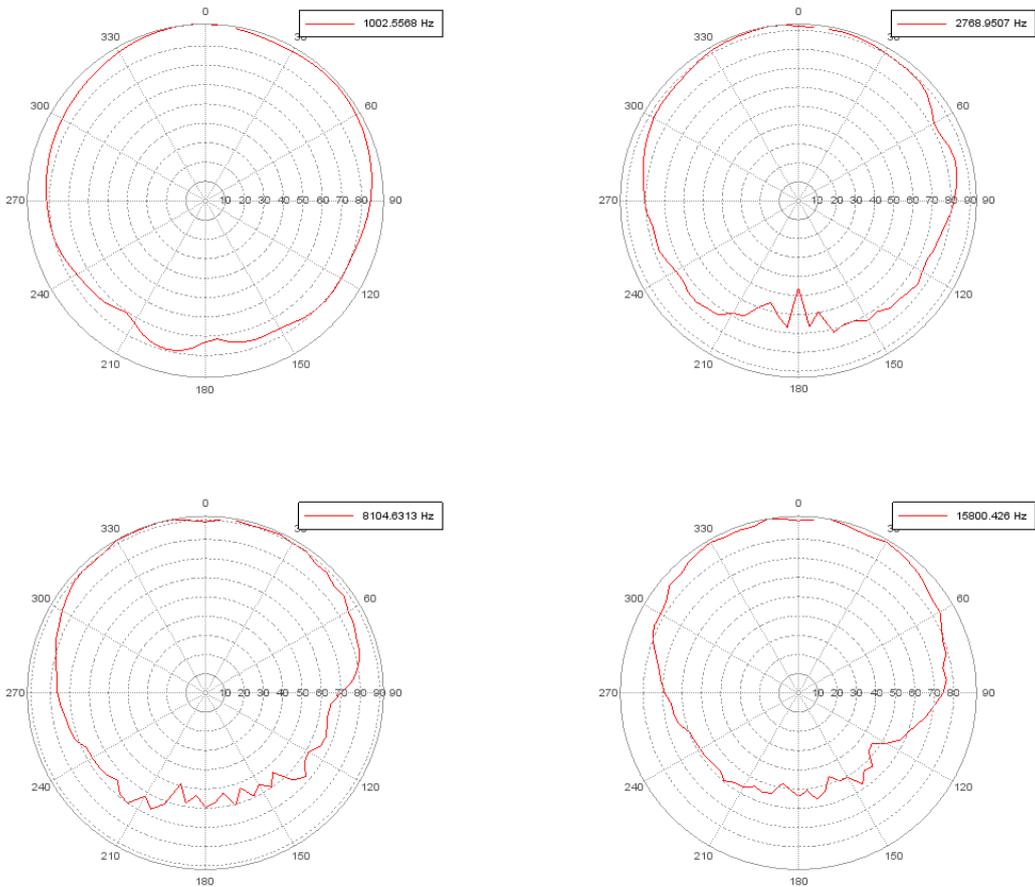


Fig 4: Vertical Dispersion Sonogram and select polar plots



Listening Room & Placement:

High quality stands should be used to bring the tweeter approximately to ear level or slightly above. Even in the best listening room, it is important to determine the positions where the loudspeakers will perform optimally. Placing the cabinets too close to the walls or corners will result in more powerful bass but may also cause response irregularities in the bass/midrange area. Some experimentation is recommended in order to find cabinet positions that result in a good tonal balance and freedom from coloration.

After finding a good placement of the speaker, then there are almost endless possibilities to fine tune the sound balance with the Hypex DSP.

DSP Presets:

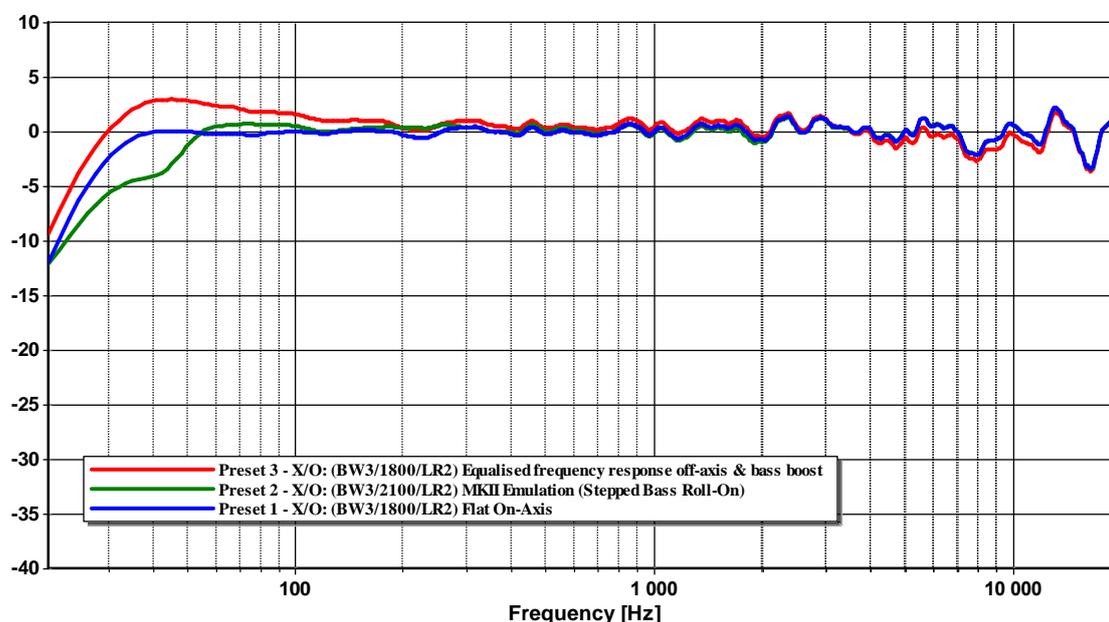


Fig 5: The measurements shown in this figure show the frequency response of the different presets included with the kit, details can be seen in the legend. These presets can provide a starting point for adventurous DIY'ers or can be used as supplied with careful placement of the cabinets.

Tips and alternatives:

- If tweaking with DSP, stay under 9dB gain in the DSP filters to avoid digital clipping.
- For even more low end-output, the system can be made into a floor standing speaker by extending the subwoofer enclosure height with 50cm and adding two SEAS SL26R passive radiators. The subwoofer DSP-filters then needs to be recalculated.

Assembly Guide

Cabinet:

The construction of the KingRO4Y kit is fairly open ended, it could be entirely completed with some basic tools such as a router, plunge saw and drill with some additional accessories or completed using CNC which a CAD file is included for on the website. The construction uses two standard (1220*2440) sheets of 18mm Birch Ply (as many layers of laminate as possible) or MDF.

If using MDF it is recommended to paint with a reasonably thick drying paint or line with a veneer as MDF is very susceptible to moisture damage and is not very aesthetic.

The schematic plans include suggestion of rebates, these improve the overall integrity of the cabinet and reduce the chance of air leakage between the low and mid rear chambers and the amplifier chamber, so are advised. The prototype cabinets used a rebate depth of 8mm.

Rebates can be done with fairly simple tools so if you don't have access to a router then you can still use a plunge saw or table saw if you can set the depth of the blade. By carefully completing multiple passes the size of thickness of the saw blade then cleaning up afterwards with a chisel, file and sandpaper you can achieve the same effect as using a router with jig or guide. When rebating, it is advisable to leave between 0.5mm and 1mm over the thickness of the board used to allow for glue expansion and irregularities in the thickness of the board.

**NB: It is important to remember that when rebating, all the internal bracing must be adjusted in size wherever it is to be inserted into a rebate joint, leaving again between 0.5mm and 1mm for glue.*

To recess the drive units and amplifier plate a minimum of a router is required (otherwise a jigsaw can be used to cut the basic mounting hole). When routing the cut-out's inner and outer diameters it is necessary to route the outer diameter first- otherwise you lose your fixed centre point.

If rebating the internal bracing it is not necessary to use screws or fixtures for the cabinet, if rebates are not used then it is advised to clamp or vice panels in place and pilot drill through the first panel into the connecting join before gluing and screwing in place to ensure minimal movement in the panels when screwing.

**NB: Dry assembly, i.e. without glue, is always advised regardless of build method. If you are not using screws or fixtures this can be done with Sellotape or masking tape without tarnishing the material.*

Amplifier set-up and driver mounting:

Once the loudspeaker cabinet structure is complete it comes to assembling the amplifier plate, Hypex have very informative documentation on all their products available online so do not be afraid to check that out when preparing the FA503 for mounting.

The way the presets are set-up is specific so,

Channel 1 – Low Frequency - **L26RO4Y**

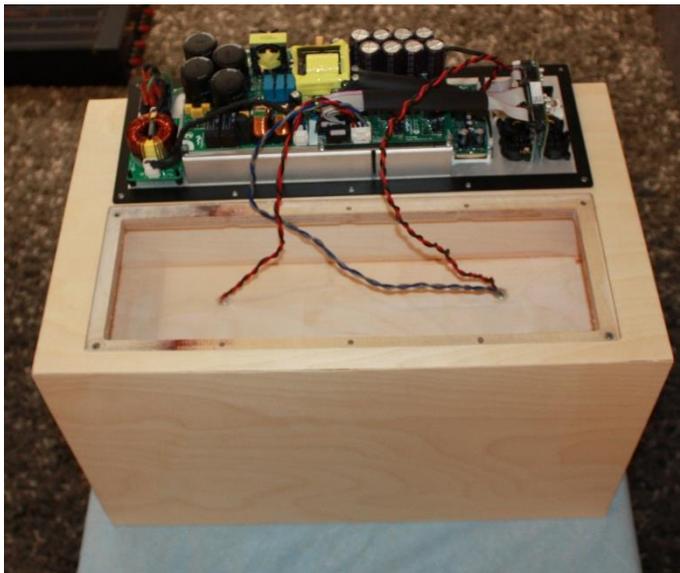
Channel 2 – Mid Frequency - **C18EN002/A** - Midrange
(terminals attached to the basket of the driver; you should be able to see the lead-outs from the terminal attach to the outer voice coil)

Channel 3 – High Frequency - **C18EN002/A** - Tweeter

(terminals attached to the plastic plate at rear of the magnet)

Hypex have some safety guidance on installation of their Fusion amps on page 13 of their FusionAmp User Guide (available here: <https://www.hypex.nl/product/fusionamp-fa503/160>) and it is strongly recommended to follow these guidelines as these plate amplifiers can get very hot despite excellent temperature control systems.

Once the FA503 is set up, the cables should be braided and fed through the holes to the appropriate rear chambers. A good rule for how much cable is good to run through is to place the speaker face down and ensure there is enough cable in the amplifier chamber to allow for the Fusion amp to be placed on the back of the cabinet, as shown below.



As seen in the picture above, the four pin socket on the larger section of the amplifier is the 2x500W output, red(+) & black(-) is channel one and blue(+) & grey(-) is channel two. The tweeter output (100W) is the two pin slot on the smaller PCB towards the top of the amplifier plate, red(+) & black(-) which is channel three.

Once you are confident that the cable lengths for the amplifiers and drivers are sufficient it is necessary to seal the cabling hole, it is advisable to use a soft-setting but acoustically opaque (meaning sound cannot travel through it easily) glue for this- a hot glue gun is a good choice as the pump action can force the glue into the opening, filling any space between the panel material and the cable.

When mounting the drivers, you can either use quick-connects or solder, quick connects are recommended for the **C18EN002/A** however the terminals of the **L26RO4Y** are much larger so have a nice surface area for soldering. 6.3mm quick connects can also be used.

DSP:

The Hypex software used for the DSP is Hypex Filter Designer, which can be found here:

<https://www.hypex.nl/product/hypex-filter-design/17>

The latest firmware for the plate amplifier you are using should also be downloaded, for the Fusion FA503 this can be found here, in the “downloads” section:

<https://www.hypex.nl/product/fusionamp-fa503/160>

For the Fusion FA253, here:

<https://www.hypex.nl/product/fusionamp-fa253/157>

Once Hypex Filter Designer (HFD) is installed, connect the amplifier to your speaker via USB and run HFD. The program should automatically recognise the amplifier, before going any further press the “Firmware Update” box and a browser window should appear- from here locate the firmware file you downloaded and select. Note you will have to update the firmware on both amplifiers.

The presets can be downloaded from:

http://www.seas.no/images/stories/diykits/KingRO4Y_MK.III/KingRO4Y_MKIII_Presets.zip

Once the presets are downloaded they can be uploaded to each amplifier individually. In HFD, click the “Filter Design” button, this will open a new HUD display for the DSP processing. To load the presets into the software, click “File” -> “Open”. In the new dialogue window this opens you will see a file path, move the preset file to this destination then select it in the dialogue window and click “OK”.

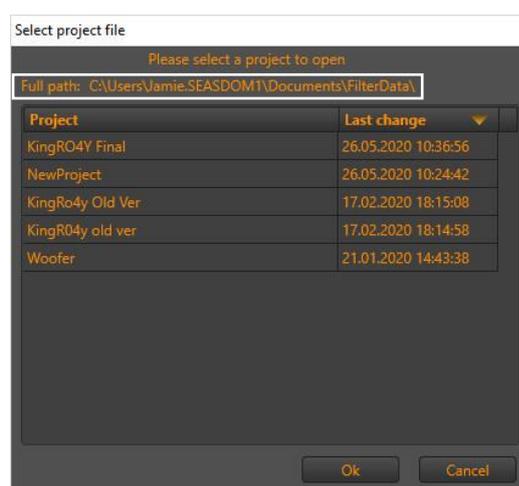


Fig 6: Highlighted white is the path to move the downloaded preset

Once opened you can view the different preset settings by selecting “PRESET 1/2/3”, from these pages the presets can be edited if desired. The HFD documentation provides ample description on how to do this.

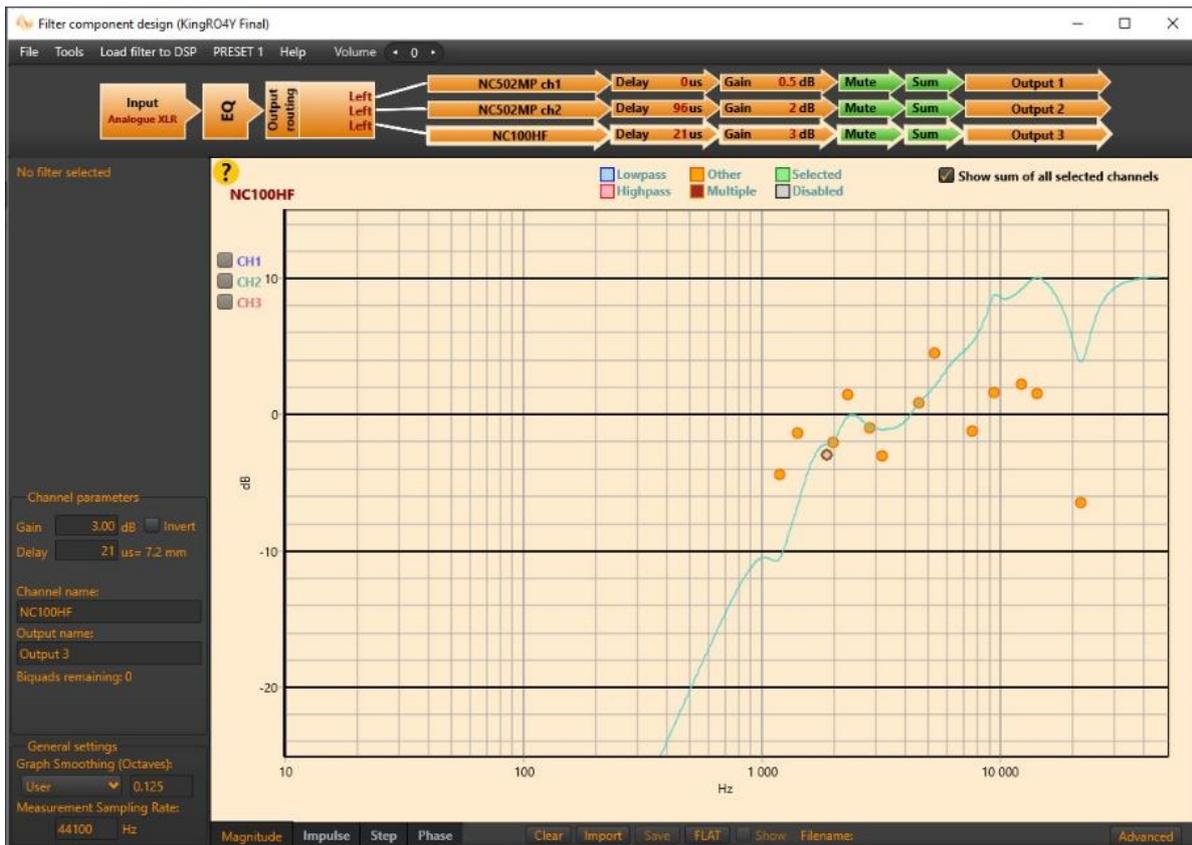


Fig 7: This is the main filter design window where the user can load presets, edit them and upload them to the Hypex hardware for reference.

Once you have loaded the presets in the software you will then need to upload the presets to the amplifier, to do this click “Load filter to DSP” then select “Upload all presets”. Once this is done you can close the filter component design window and click on the “Device settings” button in the main HFD window.

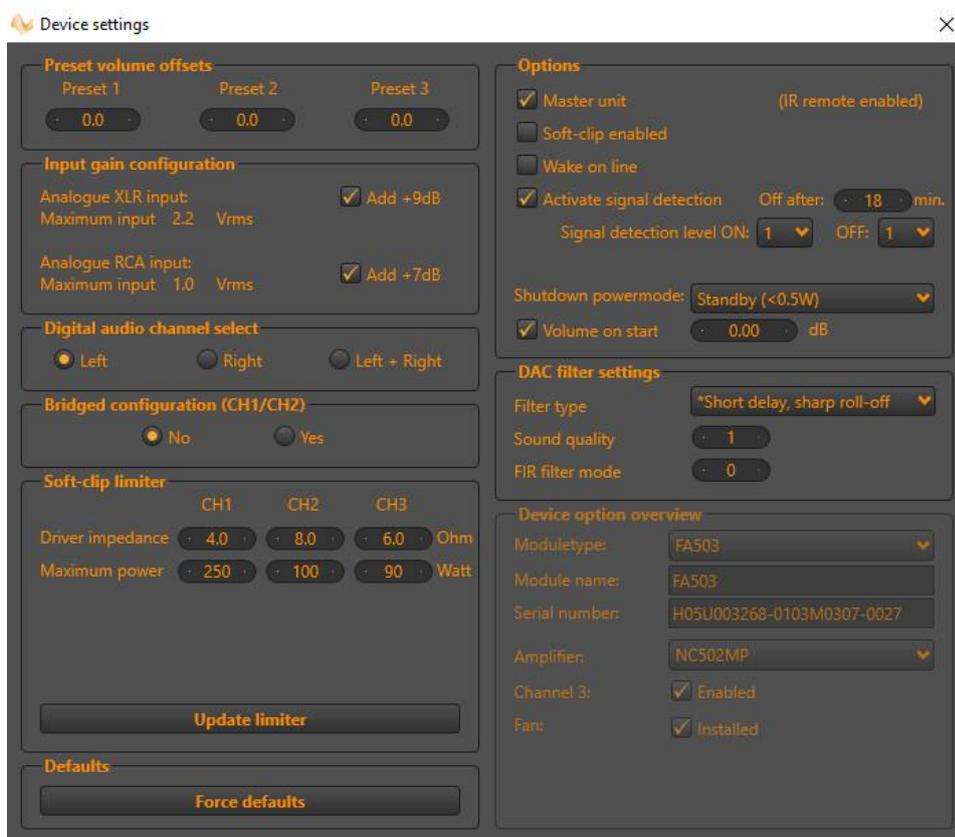


Once the presets are loaded, in the “**Preset Settings**” section of the main dialogue box click the “**EQ**” button and a screen will load like above, here it is necessary to add a ShelfLo- the details can be copied from the image above. These need to be uploaded to the DSP and this process repeated for each preset.

Lastly there are the “**Device Settings**”, where there are options for adding a limiter, input gain settings, amplifier configuration etc.

The settings in the figure below can be copied for ease but you may want to customise some of the power settings. Please note that you should select “**left**” or “**right**” for the corresponding speaker in “**Digital Audio Channel Select**” of this window.

There is a limiter in place which can be seen in the figure below, to activate this, please ensure you check “**soft-clip enabled**” in the “**Options**” section of this window.



After this you should be all set to test out your newly build speakers.