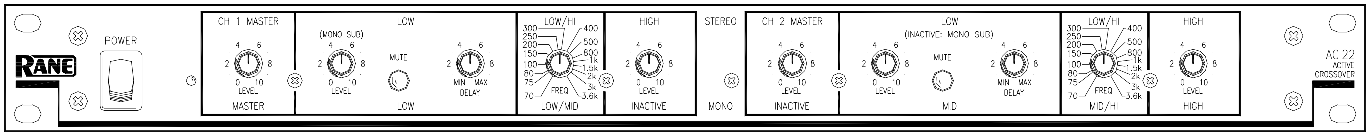
OPERATORS MANUAL AC 22

ACTIVE CROSSOVER



QUICK START

This is an automatic crossover! By automatic, we mean that the AC 22 is *smart* enough to know whether you want to run it as a two channel crossover, or as a single channel unit. It *knows* by the way the plugs are inserted how your system is to be configured. However, just because it is automatic, doesn't mean that it will not automatically confuse you when you try to connect it in a bench test situation. **NOTE: Labels *above* the controls refer to the unit being operated in the 2-Way *STEREO* mode. Labels *below* the controls refer to the unit being operated in the 3-Way *MONO* mode.**

Plugging a signal into the **CHANNEL 1 INPUT** and nothing into the **CHANNEL 2 INPUT** tells the unit that you are running a single channel system in **Mono 3-Way** mode, and therefore sets the unit up to be a single channel device. This can lead one to think that there are some dead channels in the unit when looking for output in places where there shouldn't be any.

When operating the AC 22 as a **Stereo 2-Way**, follow the diagram on page Manual-3, reading the labels *above* the jacks and controls. To drive both channels with a mono signal, connect only to the **CHANNEL 2 INPUT**. This approach is the same as if you used a wye cable to both Inputs. This is very useful in situations where only one mix exists, but two independent channels of crossover are desired, normally used for separate amplification on each side of a stage. This is a good way to test both channels of the crossover when only one signal source exists.

The **AC 22B** is available as a fully balanced output version equipped with XLR connectors (for inputs and outputs) instead of the standard ¼" TRS jacks. *If you are running balanced amplifiers from the AC 22 or are running crossover output cable lengths greater than 10 feet, we highly recommmend you purchase an AC 22B.*

Never connect ANYTHING except an RS 1 or other approved Rane AC power supply to the thing that looks like a red telephone jack. This is an AC supply and requires some special attention if you do not have an operational power supply ***EXACTLY*** like the one that was supplied with your unit. Consult the Rane factory for replacement or substitution.

AC 22 CONNECTION

Balanced/Unbalanced Inputs

The ¼" Input jacks on the AC 22 are TRS (tip-ring-sleeve). We recommend connecting the AC 22 with a balanced cable from the balanced output of a mixer or equalizer.

If a balanced output is not available, and the cable run is less than ten feet (three meters), inserting an unbalanced ¼" TS (tip-sleeve) plug works in most situations.

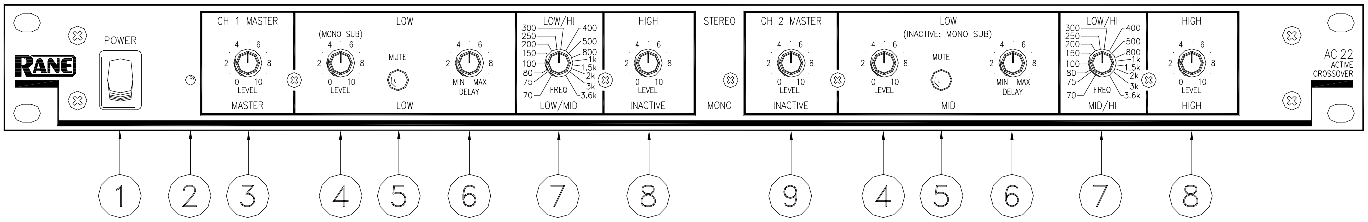
Unbalanced Outputs

The ¼" Output jacks on the AC 22 are unbalanced TS (tip-sleeve). We recommend that cables to the amplifiers be no longer than ten feet (three meters).

See the "Sound System Interconnection" RaneNote included with this manual for more information on cabling and grounding requirements.

WEAR PARTS: This product contains no wear parts.

FRONT PANEL: STEREO 2-WAY CONFIGURATION



Observe the labels ABOVE the controls for Stereo operation.

① **POWER switch:** Self-evident.

② **POWER indicator:** When this yellow LED is lit the unit is ready to operate.

③ **CH 1 MASTER LEVEL control:** sets the overall level of Channel 1 without altering the relative settings of the HI and LOW outputs. Unity gain for all level controls is at “7”.

④ **LOW frequency LEVEL control:** sets the level of signal going to the Low Output in this Channel. Refer to alignment instructions on page Manual-11. In the MONO SUB mode the Channel 1 LEVEL control sets the Level of the mono subwoofer output; Channel 2's LEVEL control is inactive.

⑤ **LOW frequency MUTE switch:** When pressed to the *in* position, all signal is removed from the Low Output in this Channel. This eases tune-up procedures as described on page Manual-6. In the MONO SUB mode, the Channel 1 LOW MUTE switch Mutes the MONO SUB Output, Channel 2's Mute is inactive.

⑥ **LOW frequency time DELAY control:** adds from 0 to 2 ms of time Delay to the Low Output only. This allows a low frequency driver to be electronically phase-aligned with a high frequency driver whose diaphragm is situated *behind* the low frequency diaphragm. *NOTE: Both DELAY controls are inactive in the MONO SUB mode.* See instructions on page Manual-6.

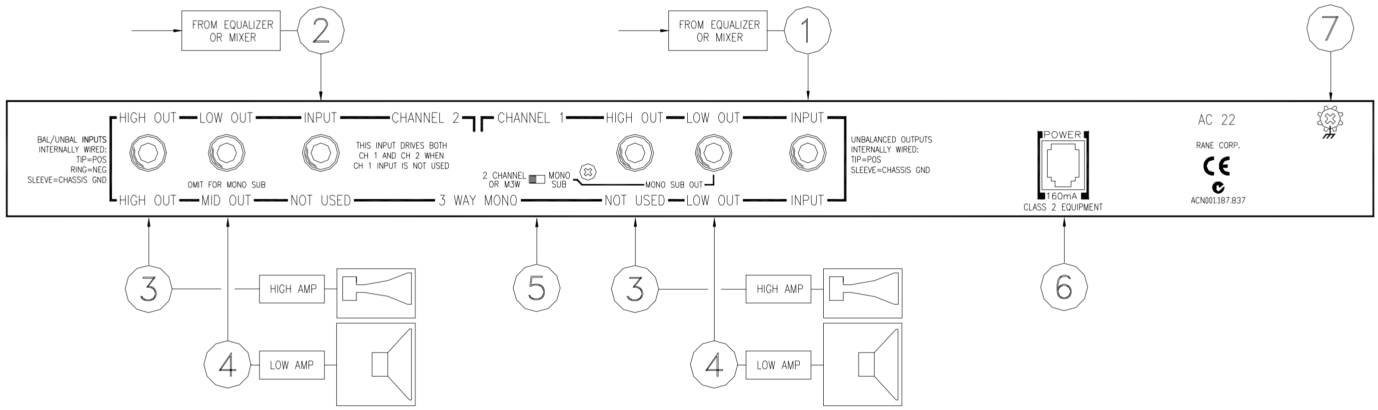
⑦ **Crossover frequency selector:** This 41-detent selector determines the crossover frequency between Low and High frequency Outputs. The detents assure maximum accuracy and consistency between channels. Refer to page Manual-6 to determine the proper crossover frequency for your particular system.

⑧ **HIGH frequency LEVEL control:** sets the Level of signal going to the High Frequency Ouput in this Channel.

⑨ **CH 2 MASTER LEVEL control:** sets the overall Level of Channel 2 without altering relative settings of the HIGH and LOW Outputs.

Observe the labels ABOVE the inputs and outputs for Stereo operation.

REAR PANEL: STEREO 2-WAY INSTALLATION



① **CHANNEL 1 INPUT:** This ¼" Input accepts either balanced TRS (tip-ring-sleeve) or unbalanced TS (tip-sleeve) plugs. Use this Input only if you are running two separate Channels. For true stereo operation, connect this Input to the left channel output of the mixer, equalizer or other signal source. If you are running two speaker systems from a single mono signal, use only the Channel 2 Input. See ② below.

② **CHANNEL 2 INPUT:** This ¼" Input accepts either balanced TRS (tip-ring-sleeve) or unbalanced TS (tip-sleeve) plugs. For true stereo operation, connect this Input to the right channel output of the mixer, equalizer or other signal source. *NOTE: Two separate speaker systems may be independently operated from a single mono source by using only the Channel 2 Input and omitting the Channel 1 Input. As long as nothing is plugged into the Channel 1 Input, Channel 2 will drive BOTH Channels of the AC 22 internally.*

③ **HIGH frequency OUTPUTS:** These are ¼" TS (tip-sleeve) unbalanced Output jacks. Connect CHANNEL 1 HIGH OUT to the left channel input of the high frequency amp, and the CHANNEL 2 HIGH OUT to the right channel input of the high frequency amp.

④ **LOW frequency OUTPUTS:** Connect the CHANNEL 1 LOW OUT to the left channel input of the low frequency amp and the CHANNEL 2 LOW OUT to the right channel input of the low frequency amp. For Mono Subwoofer applications use CHANNEL 1 LOW OUT. CHANNEL 2 LOW OUT is disconnected in MONO SUB mode. (See ⑧ below).

⑤ **MONO SUB mode switch:** This disconnects the CHANNEL 2 LOW OUT jack and sums it with CHANNEL 1 LOW OUT. The result is taken from the CHANNEL 1 LOW OUT jack.

⑥ **Power input connector:** USE ONLY AN RS 1, OR OTHER REMOTE AC POWER SUPPLY APPROVED BY RANE. This unit is supplied with a remote power supply suitable for connection to this input jack. Consult the factory for replacement or substitution. This unit's power supply input is designed for an AC supply, delivering 18-24 volts, from a center-tapped transformer capable of supplying at least the current demanded by this product. Using any other type of supply may damage the unit and void the warranty.

⑦ **Chassis ground point:** A #6-32 screw is supplied for chassis grounding purposes. Always connect crossover chassis ground to amplifier chassis ground. See the CHASSIS GROUNDING note below.

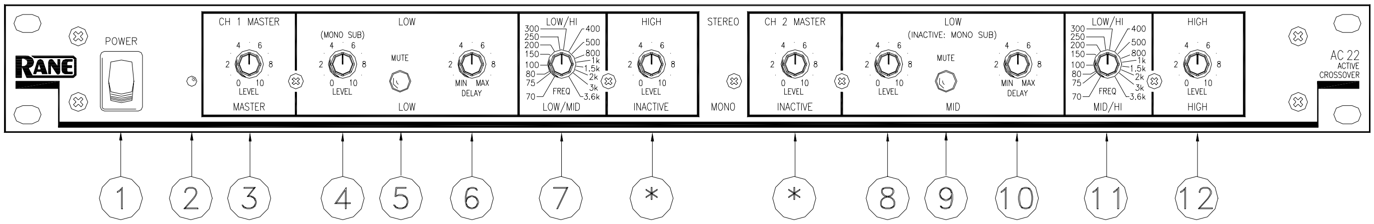
CHASSIS GROUNDING

If after hooking up your system it exhibits excessive hum or buzzing, there is an incompatibility in the grounding configuration between units somewhere. Your mission, should you accept it, is to discover how your particular system wants to be grounded. Here are some things to try:

1. Try combinations of lifting grounds on units that are supplied with ground lift switches or links.
2. If your equipment is in a rack, verify that all chassis are tied to a good earth ground, either through the line cord grounding pin or the rack screws to another grounded chassis.
3. Units with outboard power supplies do not ground the chassis through the line cord. Make sure that these units are grounded either to another chassis which is earth grounded, or directly to the grounding screw on an AC outlet cover by means of a wire connected to a screw on the chassis with a star washer to guarantee proper contact.

Please refer to the RaneNote "Sound System Interconnection" (included with this manual) for further information.

FRONT PANEL: MONO 3-WAY CONFIGURATION



Observe the labels BELOW the controls for Mono operation.

① **POWER switch:** Self-evident.

② **POWER indicator:** When this yellow LED is lit, the unit is ready to operate.

③ **CH 1 MASTER LEVEL control:** sets the overall level without altering the relative settings of the HIGH, MID and LOW Outputs. Unity gain for all LEVEL controls is at “7”. See the instructions on page Manual-11.

④ **LOW frequency LEVEL control:** sets the Level of signal going to the Low Output.

⑤ **LOW frequency MUTE switch:** When pressed to the *in* position, all signal is removed from the Low Output. This eases tune-up procedure, as described on page Manual-6.

⑥ **LOW frequency time DELAY control:** adds from 0 to 2 ms of time Delay to the Low Output only. This allows a low frequency driver to be electronically phase-aligned with a high frequency driver whose diaphragm is situated *behind* the low frequency diaphragm. Refer to page Manual-6 for alignment procedure.

⑦ **CROSSOVER frequency selector:** This 41-detent selector determines the Crossover Frequency between Low and Mid Outputs. The detents will assure maximum accuracy and consistency between Channels. Refer to page Manual-6 to determine proper Crossover Frequency for your particular system.

⑧ **MID frequency LEVEL control:** sets the Level of signal going to the Mid Output.

** NOTE: The Channel 1 HIGH LEVEL control and the Channel 2 MASTER LEVEL control are automatically bypassed internally when the AC 22 is connected as shown by the diagram on the facing page. Adjusting these controls will have no effect in the MONO mode.*

⑨ **MID frequency MUTE switch:** When pressed to the *in* position, all signal is removed from the Mid Output.

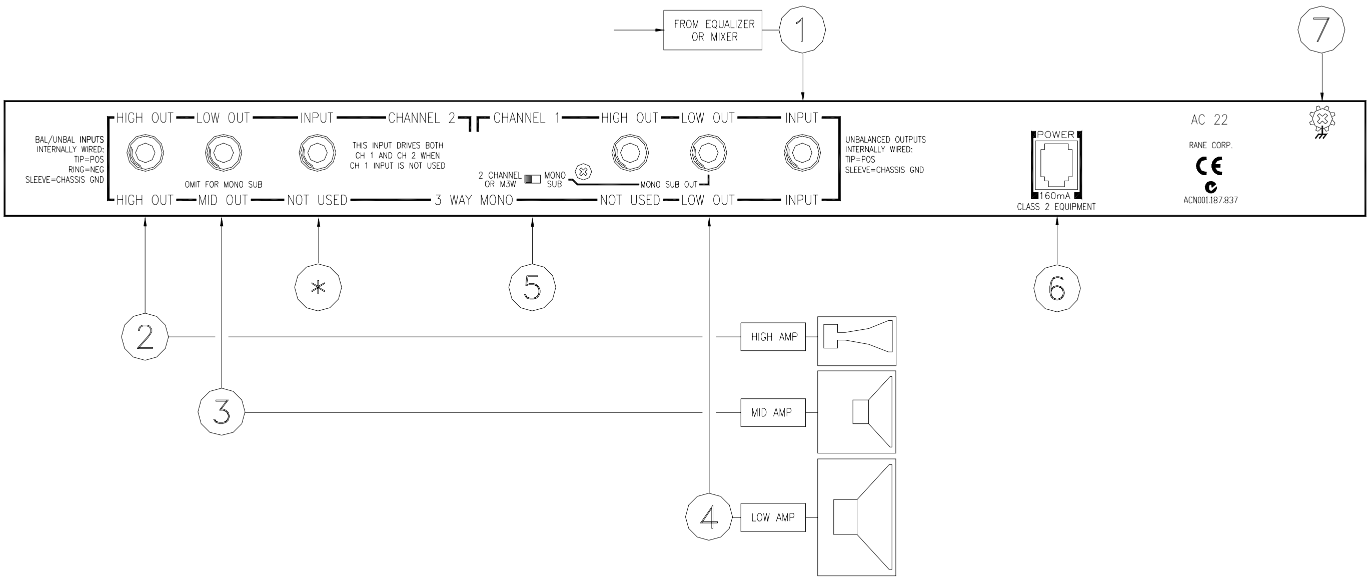
⑩ **MID frequency time DELAY control:** adds from 0 to 2 ms of time Delay to the Mid Output only. This allows a mid frequency driver to be electronically phase-aligned with a high frequency driver whose diaphragm is situated *behind* the mid frequency diaphragm.

⑪ **CROSSOVER frequency selector:** sets the Crossover Frequency between the Mid and High Outputs.

⑫ **HIGH frequency LEVEL control:** sets the Level of signal going to the High Output.

Observe the labels BELOW the Inputs and Outputs for Mono operation.

REAR PANEL: MONO 3-WAY INSTALLATION



CAUTION: MONO SUB SWITCH MUST BE IN 2-CHANNEL OR M3W MODE!

① **Mono (CHANNEL 1) INPUT:** This ¼" Input accepts either balanced TRS (tip-ring-sleeve) or unbalanced TS (tip-sleeve) plugs. Plug the output of the mixer, equalizer or other signal source to this Input for mono operation. *DO NOT PLUG INTO THE CHANNEL 2 INPUT: THAT INPUT IS USED TO DRIVE TWO CHANNELS WITH THE SAME MONO INPUT.* Refer to “Stereo 2-Way Installation” on page Manual-3.

* *NOTE: Do not use this input for 3-Way Mono operation. Use the Channel 1 Input only.*

② **HIGH frequency OUTPUT:** These are ¼" TS (tip-sleeve) unbalanced Output jacks. Connect this Output to the input of the high frequency amp.

③ **MID frequency OUTPUT:** Connect this Output to the input of the mid frequency amp.

④ **LOW frequency OUTPUT:** Connect this Output to the input of the low frequency amp.

⑤ **MONO SUB mode switch:** must be in the M3W position for Mono 3-Way operation.

⑥ **Power input connector:** This unit is supplied with a Rane RS 1 remote power supply suitable for connection to this input jack. This unit’s power supply input is designed for an AC supply, delivering 18-24 volts, from a center-tapped transformer capable of supplying at least the current demanded by this product. Using any other type of supply may damage the unit and void the warranty. Consult the factory for replacement.

⑦ **Chassis ground point:** A #6-32 screw is supplied for chassis grounding purposes. Always connect crossover chassis ground to amplifier chassis ground. See the CHASSIS GROUNDING note on page Manual-3.

OPERATING INSTRUCTIONS

Selecting Crossover Frequencies

Most speaker manufacturers supply low and/or high frequency cut-off points for each driver, especially if these are supplied in a system. These cut-off frequencies are based on each driver's performance at and beyond this point, with a certain safety margin to accommodate more gentle filter roll-offs and resultant higher output beyond the recommended performance range.

The AC 22 utilizes 41-detent crossover frequency selectors which are precision potentiometers. The detents assure consistent accuracy from channel to channel and unit to unit. This is a distinct advantage over the continuously variable designs using low-tolerance parts, possible knob misalignment and panel screening variations. Even with 41 choices it is possible that the exact recommended crossover frequency may not fall on one of the detents on the selector. Not to panic, for these sound reasons:

1. The AC 22 possesses 24dB/octave roll-off, so the crossover points may be set to the nearest detent above or below the recommended limit with virtually no hazard to the driver or degradation in sound quality. If extremely high power levels are expected, it is safer to defer to the high frequency drivers and shift the crossover point *up* in frequency rather than down.

2. Detents do not rely on knob alignment, silk-screen accuracy, parallax and other variables which erode the accuracy of continuously variable designs. Chances are that even careful visual alignment on these will often yield a frequency error greater than a full detent on the AC 22 .

3. If it is absolutely critical to obtain the exact crossover frequency (Mil Spec., P.A., etc.), the selector *can be positioned between detents* if necessary. This of course will require the aid of a precision signal generator and other equipment to verify the exact setting.

For best overall system results, try to choose the speaker components so that each operates well within its recommended limits. This will provide valuable leeway so that you may move crossover points in order to fine-tune the system, and will also yield higher system reliability. If at all possible, beg, borrow or best yet always use some kind of realtime analyzer to tune your crossover and fine-tune the system for each different location with an equalizer.

Time Delay Adjustment Procedure

Before jumping feet first into the realm of time delay and how to adjust it, it might help to spend a moment to re-affirm why on earth this delay is really necessary. For a detailed and enjoyable short course on time delay, Linkwitz-Riley and other mouth-watering details, we urge you to pick up free copies of the RaneNotes "Linkwitz-Riley Crossovers" and "Linkwitz-Riley Crossovers up to 8th Order". Ask your dealer or write to us here at the factory. In the way of summary, a few words are in order here to outline the basic effects of time delay in crossovers.

Problems pop up when two different speakers emit the same frequency as occurs in the crossover regions of two, three, four and five way systems. Because the two drivers are displaced vertically, cancellation occurs somewhere off-axis because the sound waves have to travel different distances from the two speakers and hence, will arrive shifted in phase. This forms a "lobe" or radiation pattern, bounded on either side by cancellation lines or axes, which narrow the dispersion pattern or listening area of the speaker.

Fine. So we put up with it. But to make matters worse, when two drivers are horizontally displaced—that is, one is in the front of or behind the other, this "lobe" or dispersion pattern gets *tilted* (usually upward) toward the driver that is further behind. This gets hard to put up with, because the end result is that your speaker system will have two, three, four or more tilted radiation patterns and only two or three people in the house will have decent seats. And we're not talking trivial pursuits here—this rampant lobing error can make a sound system a real headache, to listener and operator alike.

The idea, then, is to be sure that all drivers are vertically aligned and that all components are always in phase. Then all the main lobes are on-axis, well behaved, and the system enjoys the widest possible dispersion pattern so that everyone gets good sound. The one catch is that in many cases it is physically or otherwise impossible to get all the drivers vertically lined up at the sound source. *This* is where time delay comes in.

By electronically delaying the signal going to the front driver, enough time allows the sound from the rear driver to literally catch up to the forward driver's voice coil, so that signal from both drivers is emitted in phase—and it works! Time delay makes an appreciable improvement in overall sound. The trick is finding the proper time delay amount: hence the rest of this section.

Unfortunately the amount of time delay is a function of *two* factors (life ceased to be simple after age 9, right?): the amount of horizontal displacement between driver voice coils, *and* the actual crossover frequency involved. Setting delay controls by ear is supposedly possible, but *very* tricky and unreliable. The following methods are a couple of (but by no means all) means of setting time delay.

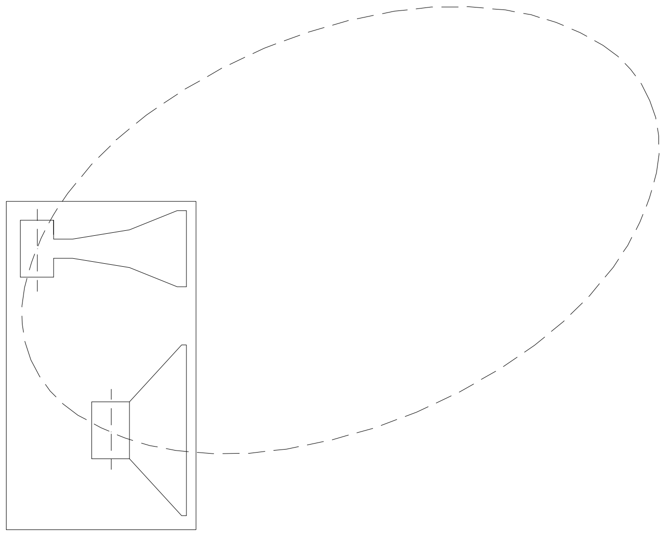


Fig. 1 In-Phase Axis Response Without Time Delay

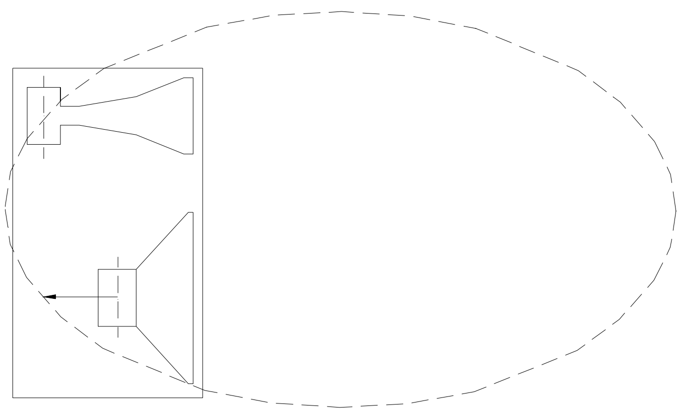


Fig. 2 Corrected In-Phase Axis Response With Electronic Time Delay on Low Frequency Driver

Time Delay Adjustment Using Realtime Analyzer & Pink Noise

This method outlines the use of a realtime analyzer, pink noise generator and flat response microphone to set crossover time delay. Some references will be made to the Rane model RA 27 analyzer for those with the intelligence and good taste to use one regularly. The procedure applies to virtually any analyzer system. We recommend using a one-third or two-thirds octave analyzer as either of these is more likely to match your specific crossover points than a one-octave analyzer. And it *is* important to match the analyzer to the crossover point as closely as possible for proper phase alignment, otherwise the analyzer readings may be misleading.

STEP BY STEP PROCEDURE

A 3-Way mode consisting of High, Mid and Low drivers is used here as an example. For 2-Way systems, use the same procedure by replacing LOW for MID and following steps 2 through 5. *NOTE: If you are running two separate channels on the crossover, tune up only* ***one*** *channel at a time, using the same procedure for both.*

1. Place the analyzer microphone about 15 feet in front of the speaker stack and at a height about midway between the high and mid drivers. *Turn all crossover LEVEL controls fully down.*

2. Connect the pink noise source to the INPUT of the crossover (or mixer or wherever is convenient). Turn up the crossover MASTER LEVEL control and the MID OUT control until noise is heard from *only* the mid driver at a comfortable volume.

3. With a healthy but not uncomfortable volume of noise from the mid driver, set the analyzer DISPLAY LEVEL control so the LED's corresponding to the high crossover frequency are reading 0 dB (this would be a green LED at the crossover frequency with the Rane analyzer set in the ±1 dB mode.) For example, if your high crossover frequency is 2 kHz, set the RA 27 in the ±1 dB mode and then adjust the RTA LEVEL control until the green LED is lit in the 2 kHz band. There... easy.

4. Now press in the MID MUTE switch on the crossover so that the tone is removed from the mid driver. *Without re-adjusting either the meter or the crossover input or MID LEVEL controls,* turn up the HIGH LEVEL control until the tone coming from only the high driver reads 0 dB (a green LED at the crossover frequency).

5. Now release the MID MUTE switch on the crossover so that pink noise is heard from *both* the high and mid drivers. Switch the display sensitivity to ±3 dB on the Rane analyzer (not necessary with full scale analyzers) and observe the display reading at the crossover frequency:

   i. If the display shows a +3 dB reading (red LED on with the Rane analyzer in the +3 dB mode), then the drivers are properly phase aligned and no delay is necessary; leave the MID DELAY control at minimum.

   ii. If the display shows *less* than +3 dB reading (still in green or in yellow on the Rane analyzer), slowing turn up the MID DELAY control on the crossover until the display shows +3 dB (Red LED just on with Rane analyzers). Now the drivers are electronically phase aligned and the DELAY control should be left in this position at all times unless the speaker system is physically altered.

iii. If you have turned the MID DELAY control all the way up and still do not have a +3 dB (red) reading, you will have to physically move the high driver farther *forward* until the display shows +3 dB (red). The amount of displacement correction available from the delay depends on the actual crossover frequency: the higher the frequency, the less amount of correction capability. If the drivers are built into a single cabinet and/or it is impossible to change relative positions, then you will have to obtain additional external delay to achieve proper phase alignment.

iv. If turning the MID DELAY control *up* makes the display reading *decrease* instead of increase, this means that the high driver is actually in *front* of the mid driver; adding delay to the mid driver then only worsens the situation. There are a couple of ways to deal with this:

a. Try to move the high driver back as far as possible without losing stability in balancing the speaker stack. You may want to raise it up as well to restore dispersion close to the stack. If you cannot move the high driver, then you will have to obtain an additional delay source to align the high and mid drivers. The built-in delay system in the AC 22 is designed to accommodate the majority of common speaker configurations; if you encounter confusion or difficulty with your particular system, it is best to consult your dealer or the Rane factory for assistance.

b. If this decrease in the display due to the DELAY control occurs at a low frequency crossover point below about 150 Hz, set the DELAY to minimum and leave it there. Frequencies below 150 Hz are actually omnidirectional, so that phase misalignment is virtually inaudible below this point. Subwoofers will often possess long folded or straight horns, resulting in the diaphragm being well behind the rest of the stack. Most authorities agree that phase alignment of subwoofers is unnecessary. Otherwise you will have to obtain additional delay equipment to align these to the rest of the system.

6. Lower the microphone until it is vertically midway between the mid and low drivers. Repeat steps 2 through 5, using the crossover LEVEL control, MUTE switch and next DELAY control. You may start each series of steps 2 through 5 at a different volume as necessary—but once the levels are set in step 3 do not alter these until step 5 is completed. Once all of the crossover delay controls are set, then set the output level controls as outlined on page 11.

Time Delay Adjustment Using SPL Meter and Tone Generator

Now that good quality realtime analyzers are becoming more affordable and easier to use, there are few reasons why one of these would not be regularly used in any sound system. If an analyzer is simply not available or for some reason inappropriate, an accurate delay setting can be obtained by using a straightforward SPL meter (obtainable at most local electronics and some hi-fi stores) and some kind of variable tone generator.

In order to exclude the effect of room acoustics and imperfect driver response, only the crossover frequencies are to be emitted (one at a time) by the tone generator. First the highest crossover frequency is run through the crossover and each of the two speakers sharing the crossover point is set *separately* to an arbitrary 0 dB level on the SPL meter. When both drivers emit the crossover tone simultaneously, the combined response should read +3 dB higher on the meter. If the drivers are not phase aligned, some cancellation will occur on-axis, resulting in a combined response *less* than +3 dB. Turning the DELAY control up causes the lower frequency driver to electronically move backward until the SPL meter reads +3 dB; then the two drivers are electronically aligned and the on-axis cancellation is eliminated. This procedure is then repeated for the next lower crossover point(s).

STEP BY STEP PROCEDURE

A 3-Way mode consisting of high, mid and low drivers is used here as an example. For other configurations, use the same procedure starting with the highest crossover point and repeating steps 2 through 5 for each lower crossover point.

1. Set the tone generator to the highest crossover frequency and plug it into the Input of the crossover. Turn all crossover LEVEL controls fully down.

2. Position the SPL meter (microphone) about 15 feet in front of the speakers and at a height about midway between the high and mid drivers. It is very important that the meter remain in exactly the same position throughout the test, so affix it to a mic stand, small tree or other stable object. Set the switches on the SPL meter to C-weighting, Slow. Be sure to minimize background noise (air conditioners, fans, traffic, wild animals, etc.) as these will effect the meter reading.

3. Slowly turn up both the crossover INPUT control and the MID LEVEL control until the tone is heard through the mid driver. Adjust the SPL meter control and/or the crossover LEVEL controls until you obtain a 0dB reading on the meter. Verify that no sound is coming from any other speakers except the mid driver.

4. Now press in the MID MUTE switch on the crossover so that the tone is removed from the mid driver. *Without re-adjusting either the meter or the crossover input or mid frequency level controls,* turn up the HIGH LEVEL control until the tone coming from only the high driver reads 0 dB on the SPL meter.

5. Now release the MID MUTE switch so that the tone is emitted from *both* the high and mid drivers. Check the reading on the SPL meter:

   i. If the meter reads +3 dB, then the drivers are properly phase aligned and no delay is necessary; leave the MID DELAY control at full minimum.

   ii. If the meter reads *less* than +3 dB, slowly turn up the MID DELAY control until the meter just reads +3 dB. Now the drivers are electronically phase aligned and the DELAY control should be left in this position at all times, unless the speaker system is physically altered.

   iii. If you have turned the MID DELAY control all the way up and still do not obtain a +3 dB reading, you will have to physically move the high driver farther forward until the SPL meter reads +3 dB. The amount of displacement corrections available from the delay depends on the actual crossover frequency: the higher the frequency the less amount of correction capability. If the drivers are built into a single cabinet and/or it is impossible to change relative positions, then you will have to obtain additional delay to achieve proper phase alignment.

   iv. If turning the MID DELAY control up makes the SPL reading *decrease* instead of increase, this means that the high driver is actually in *front* of the mid driver; adding delay to the mid driver then only worsens the situation. There are a couple of ways to deal with this:

      a. Try to move the high driver back as far as possible without losing stability in balancing the speaker stack. You may want to raise it up as well to restore dispersion close to the stack. If you cannot move the high driver, then you will have to obtain an additional external delay source to align the high and mid drivers. The built-in delay system in the AC 22 is designed to accommodate the majority of common speaker configurations; if you encounter confusion or difficulty with your particular system, it is best to consult your dealer or the Rane factory for assistance.

      b. If this decrease in the display due to the LOW DELAY control occurs at a low frequency crossover point below about 150 Hz, set the DELAY control to minimum and leave it there. Frequencies below 150 Hz are actually omnidirectional, so that phase misalignment is virtually inaudible below this point. Subwoofers will often possess long folded or straight horns, resulting in the diaphragm being well behind the rest of the stack. Most authorities agree that phase alignment of subwoofers is unnecessary. Otherwise you will have to obtain additional delay equipment to align these to the rest of the system.

6. Tune the tone generator to the next lower crossover frequency and then repeat steps 2 through 5, using the appropriate level and delay controls. Once the DELAY control is set, you may re-adjust any of the crossover LEVEL controls at the beginning of each alignment procedure. Once all of the DELAY controls are set, then re-adjust the output LEVEL controls as outlined on page Manual-11.

Delay vs. Frequency Table

If you do not have the equipment necessary to electronically align the system as described previously, you may use the table below to obtain a *rough and approximate* phase alignment of your drivers. Measure the horizontal displacement between the voice coils of the two adjacent drivers sharing the same crossover point, then find the column in the table nearest your actual displacement. Move down this column to the proper crossover frequency as indicated on the left of the table: the corresponding DELAY control setting will then be the closest for your system. For example, if you have a two-way system crossed over at 800 Hz with the compression driver voice coil located about 9" behind the woofer voice coil, the DELAY control setting corresponding to a 9" displacement at 800 Hz on the table would be “5” as indicated on the front panel.

In order to phase-align two drivers you must observe only the crossover frequency, which is common to both drivers. Pink noise can be used if all other frequencies are disregarded, since room acoustics and imperfect driver response will cause erroneous alignment attempts. Using pink noise as a source, each driver is individually tuned to an arbitrary 0 dB level on the analyzer display *only at the crossover frequency*. When both are turned on simultaneously, the combined response of the two drivers should read +3 dB higher at the crossover frequency on the display. If the drivers are not phase-aligned, some cancellation will occur on-axis, resulting in a combined response less than +3 dB. Turning up the DELAY control causes the lower driver to electronically move backward until the analyzer reads +3 dB; then the two drivers are electronically aligned and the on-axis cancellation is eliminated.

Voice Coil Displacement (Inches)

(Hz)	.75"	1.5"	3"	6"	9"	12"	15"	18"	21"	24"	
70		1	1.5	2	2.5	3.5	5	6	7	8	MAX
80		1	1.5	2	2.5	3.5	5	6	7	8	MAX
100		1	1.5	2	2.5	3.5	5	6	7	8	MAX
150		1	1.5	2	2.5	3.5	5	6	7	MAX	
200		1	1.5	2	2.5	3.5	5	6	7	MAX	
250		1	1.5	2	2.5	3.5	5	7	8	MAX	
300		1	1.5	2	2.5	3.5	5.5	7	MAX		
400		1	1.5	2	2.5	4	6	8	MAX		
450		1	1.5	2	2.5	4	6	8	MAX		
500		1	1.5	2	2.5	4	6	8	MAX		
800		1	1.5	2	3	5	7	MAX			
lk		1	1.5	2.2	3	6	MAX				
1.2k		1	1.5	2.2	3.5	MAX					
1.5k		1	1.5	2.3	3.5	MAX					
2k		1	1.5	2.3	MAX						
2.5k		1	1.5	2.3	MAX						
3k		1	1.7	2.4	MAX						
3.6k		1	1.7	MAX							
4k		1	1.8	MAX							
6k		1	2	MAX							
7k		1.2	MAX								

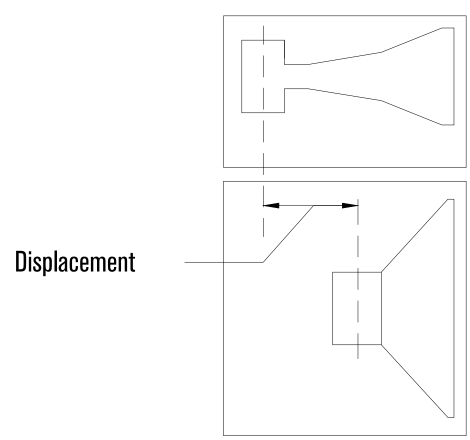


Figure 3. Vertical Driver Displacement

Setting the Output Level Controls

Choosing the crossover frequencies was the easy part. Now it gets real fun. The idea is to set the output LEVEL controls on the crossover so that the entire speaker system has a uniform, flat response. Unfortunately, the *room* in which the speakers are placed has a habit of always getting into the act, so things get messy. As a result there seems to be two schools of thought regarding the use of active crossovers.

The Set-It-Once-And-Glue-It School

The philosophy here is to use the crossover to flatten system response as much as possible *without* room acoustics involved. This means setting up the system outside (unless you happen to have a *very* large anechoic chamber handy) and with the aid of a realtime analyzer and pink noise source (ala Rane RA 27), adjust all of the crossover outputs so that the system is as flat as possible. Once the system is tuned, the crossover is then locked behind a security cover (posted guard is optional) and never again touched. It is then the job of the system *equalizer(s)* to normalize or flatten the system to each different room.

The Fix-It-With-The-Crossover School

Here the crossover knobs get a good workout, for the crossover is used at each location to help flatten the system along with the equalizer. Some even maintain that a good active crossover can work alone like a parametric equalizer in the hands of an expert. This does require experience, skill, and the right equipment to back it up (not to mention a licensed set of ears).

Regardless of which school you profess, the absolute importance and effectiveness of some kind of realtime analyzer in your system cannot be overstressed! No, this is not a callous plug for our other products; analyzers in general have come a long way. They're out of the lab (i.e. closet) and into the hands of every smart working musician and sound technician. An analyzer will save tremendous amounts of time and provide the absolute consistency, accuracy, and plain old good sound that very few ears on this earth can deliver. They are affordable, easy to use and amazingly effective. You owe it to yourself and your audience to at least look into one of these analyzers—you'll wonder how you managed at all without one.

Whether by analyzer or by ear, here are a few recommended methods of setting crossover output Levels.

Setting Levels Using a Realtime Analyzer

NOTE: If you are running ***two*** *channels, tune up only* ***one*** *channel at a time.*

1. Set all LEVEL controls on the crossover to minimum; leave Delay and Frequency controls as set previously.

2. Place the analyzer microphone at least 15 feet away from the speaker stack, on axis (dead ahead) and about chest level. Minimize any background noise (fans, air conditioners, traffic, etc.) that could affect the readings.

3. Run pink noise through the system, either through a mixer channel or directly into the crossover. Turn all amplifier controls at least half way up.

4. We will use the 3-Way mode here as an example: the procedure applies to all configurations. Turn up the INPUT LEVEL control(s) on the crossover half way.

5. Slowly turn up the LOW LEVEL control on the crossover, until you hear a healthy level of noise through the low frequency drivers (it should sound like rumble at this point).

6. Adjust the display controls on the analyzer so that it shows the greatest number of 0dB LED's (green on Rane equipment) below the crossover point.

7. Now slowly turn up the MID LEVEL on the crossover until the display shows the same output level average as the low frequency section.

8. Repeat this procedure for all crossover frequency sections, so that the end result is as flat as possible a response on the analyzer display.

IMPORTANT: Compression driver or horn roll-off, bass roll-off, and room acoustic usually cannot be corrected by the crossover. If you are using constant directivity horns, see page 13. If, for example, you are adjusting the High Frequency control and observe a decline in frequency response somewhat above the crossover point, then set the crossover level control for equal display level near the crossover point and leave it there. Then use an equalizer or bank of tweeters to correct the roll-off problem. If you are tuning the system in a room, the room acoustics will greatly influence the system response, as shown by the analyzer.

Check the system response on an analyzer at several other locations and adjust the crossover as necessary to reach a fixed compromise setting if desired. If you plan to use the analyzer only once to set the crossover, set up the speaker system in a quiet place *outside* or in a very large concert theater, and run pink noise at low levels with closer microphone placement to keep the room acoustics out of the picture as much as possible.

Setting Levels Using an SPL Meter & Pink Noise Generator

The MUTE switches on the AC 22 make using an SPL meter an easy and relatively accurate means of tuning a system. First, obtain a good SPL meter from a local electronics store. Second, and perhaps a little trickier, get a hold of a pink noise generator—again try electronics stores. You may also use a sweep or tone generator in place of a pink noise source. If so, be sure to look at several different tones within each crossover section to get a good average driver response.

1. Run pink noise into the crossover inputs (through the mixer or directly, as is convenient).

2. Make sure all crossover output LEVELs are turned all the way down and all amplifier level controls are at least half way up to start with.

3. Turn the crossover input(s) half way up. Place the SPL meter at least 15 feet from the speaker stack and about chest high. Once positioned, make sure that the SPL meter remains in the *exact* same location for the rest of the procedure. Minimize all background noise (fans, air conditioners, traffic, wild animals, etc.) to get accurate readings. Set the SPL meter to “C-weighting, Slow” if those switches are present.

4. Slowly turn the LOW LEVEL of the crossover up until there is a healthy rumble coming from the bass speakers (For this example the 3-way configuration is used—the same procedure applies to all configurations, starting with the lowest frequency and ending with the highest). Adjust the SPL meter and/or crossover output until you get a 0dB reading on the meter. *After this point do not change the controls on the SPL meter.*

5. While leaving the LOW LEVELcontrol at the 0dB adjustment just obtained, press the LOW MUTE switch on the crossover so that the pink noise disappears from the bass speakers (revel in the silence...).

6. Now slowly turn up the MID LEVEL control so that pink noise is heard from the mid frequency speakers. Without changing any settings on the SPL meter, adjust the crossover MID LEVEL control until you obtain a 0dB reading on the SPL meter. Now the low and mid speakers are set at the same level.

7. Now press the MID MUTE switch on the crossover so that the pink noise again disappears.

8. Repeat this process for each frequency section of the crossover, ending with the highest frequency. *NOTE: It is possible that you may turn one of the frequency section output LEVEL controls all the way up and still not have enough volume for a 0dB reading (as determined by previous section levels). This is probably due to different sensitivities of amps, speakers and other level controls in the system. When this happens, re-set the SPL meter so that it reads 0dB on this frequency section (you may have to “down range” the meter and re-adjust the crossover LEVEL control). Now go back and re-adjust the previous crossover LEVEL controls, turning these down to get a 0dB reading on the meter.*

9. Once the HIGH LEVEL control is set for 0dB on the meter, disengage all of the MUTE switches on the crossover, and check that noise is emitting from all the speaker components. The crossover should now be aligned. Make any overall level adjustments with the input MASTER LEVEL controls and leave the output level controls unchanged.

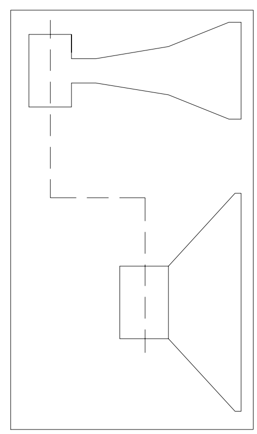


Fig. 4 Normal Configuration with Long Throw Horn

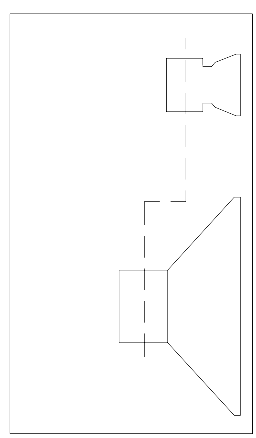


Fig. 5 Configuration with Constant Directivity Horn

Time Delay Transplant Modification

We have added modification jumpers to the AC 22. These jumpers permit the transplanting of the Delay circuits from one output to another. As the units are shipped, the Delay circuit is not installed on the High Frequency Outputs. When the AC 22 was first designed, long throw horns were more common than Constant Directivity horns (CD horns). The long throw horn's diaphragm was the farthest sound emitter from the front of the speaker enclosure, (*see Fig. 4*) so no delay was needed. The mid frequency and low frequency drivers were always in front of the high frequency drivers, therefore, the mid and low frequency drivers needed the Delay circuits for proper time alignment.

Now, with the use of CD horns becoming more common, occasionally there is a need to delay the CD horn as its diaphragm is usually in front of the other drivers in the enclosure (*see Fig. 5*). If you are using CD horns, you should also read the CD horn EQ modification as described in the next column.

STEP BY STEP PROCEDURE

CHANNEL ONE:

1. Refer to the board layout on page 15.
2. On the board layout locate W5 next to the CH 1 DELAY pot, and W4 behind the CH 1 MUTE switch.
3. To remove the Delay 1 circuit from the Low Frequency output, remove both the W5 and W4 jumpers.
4. To get the Low Frequency output to work again, place a long jumper from W5, Pin 1 to W4 Pin 2.
5. The Delay 1 circuit is now removed from all circuits.
6. To install the Delay 1 circuit into Channel 1’s, High Frequency output, find jumper W7 near the CH 1 INPUT and remove it.
7. Install a long jumper from W5, Pin 2 to W7, Pin 1.
8. Install a long jumper from W4, Pin 1 to W7, Pin 2.

The Delay 1 circuit is now installed into Channel 1’s High Frequency Output.

CHANNEL TWO:

1. Refer to the board layout on page 15.
2. On the board layout locate W22 next to the DELAY pot and W20 behind the CH 2 MUTE switch.
3. To remove the Delay 2 circuit from the Low Frequency output, remove both the W22 and W20 jumpers.
4. To get the Low Frequency output to work again, place a long jumper from W22, Pin 1 to W20 Pin 2.
5. The Delay 2 circuit is now removed from all circuits.
6. To install the Delay 2 circuit into Channel 2’s High Frequency output, find jumper W25 and remove it.
7. Install a long jumper from W22, Pin 2 to W25, Pin 1.
8. Install a long jumper from W20, Pin 1 to W25, Pin 2.

The Delay 2 circuit is now installed into Channel 2 High Frequency Output.

Constant Directivity Horn Equalization Modification

Constant Directivity (or CD) horns need additional equalization to help cover the same area a long throw horn can cover. Additional circuitry has been added to the AC 22 and AC 23 layouts for the additional equalization of the High Frequency outputs for the CD Horns. This modification should only be attempted by an experienced technician who is adept at soldering.

It is important to know the 3 dB down point of the CD driver's frequency response. The manufacturer of your driver should be able to supply you with a chart showing a frequency response curve. Find the point where the high end *starts* to roll off, and look for the point on the chart that is 3dB down from *that* point (toward the right, as the higher frequencies roll off). Find the frequency at the bottom of the chart of this point—an approximate is fine, you don't have to be exact. Find the closest frequency in the table below to determine the correct value capacitor to install in the AC 22 to correct for this high frequency roll off.

STEP BY STEP PROCEDURE

The following procedure is for Stereo 2-Way. For a Mono 3-Way system with a CD horn on the high output, only place C16 in Channel 2.

1. Remove the top and bottom covers of the AC 22.
2. Locate the positions for C15 and C16 on page 15 and on the circuit board. C15 (for Channel 1) is located near the CH 1 LOW OUT jack toward the middle of the board. C16 (for Channel 2) is located near the CH 2 HIGH OUT jack toward the middle and edge of the board.
3. Clean the solder pad on the underside of the board so that the appropriate capacitor can be inserted. Install the capacitor, and solder the leads from the underside using fresh solder. Clip the excess leads.
4. Replace the top and bottom covers.

3 dB Down Frequency	Capacitor
2.2 kHz	.0027 μf
2.5 kHz	.0024 μf
2.7 kHz	.0022 μf
3.3 kHz	.0018 μf
4.0 kHz	.0015 μf
5.0 kHz	.0012 μf
6.0 kHz	.001 μf