

### QUICK START

No one likes to read manuals. Everyone likes to plug in and turn on. That's usually OK and with only a very few exceptions, damage is unlikely to result from such procedures when initiating the use of a FAC 24/28.

It is a good idea to begin with all level controls set to their full counterclockwise position. Unless you are certain that there is an electrical inversion in one of your amplifiers or drivers, set both "POS INV" switches to their "POS" positions. Both mute switches should be "out". If you are using a constant-directivity horn, set the "HORN EQ IN OUT" switch to the "IN" position and adjust the frequency control per the recommendations of the horn's manufacturer. Set the "PHASE IN OUT" switch to the "OUT" position. Set the crossover frequency selector to the frequency recommended by the speaker manufacturer. Power up the system and set the input and output levels for appropriate performance.

**NEVER CONNECT ANYTHING EXCEPT AN APPROVED RANE POWER SUPPLY TO THE THING THAT LOOKS LIKE A TELEPHONE JACK ON THE REAR OF THE FAC 24/28.** This is an AC input and requires special attention if you do not have an operational power supply EXACTLY like the one that was originally packed with your unit. See the full explanation of the power supply requirements elsewhere in this manual.

### SYSTEM CONNECTION

When connecting the FAC 24/28 to other components in your system for the first time, LEAVE THE POWER SUPPLY FOR LAST. This will give you a chance to make mistakes and correct them before any damage is done to your fragile speakers, ears and nerves.

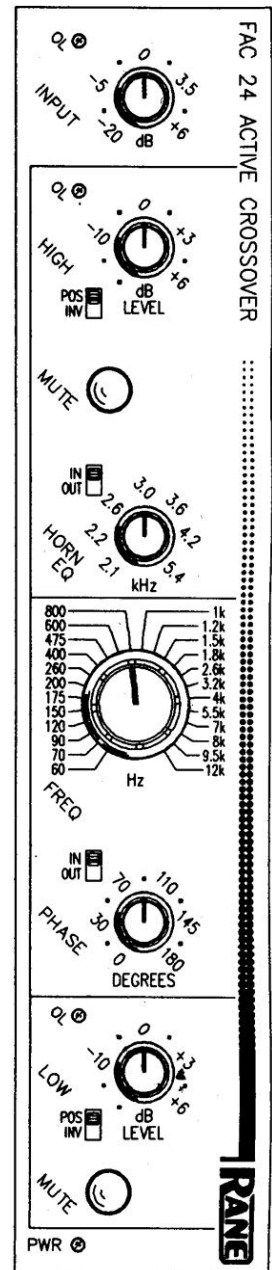
**INPUTS** on the FAC 24/28 are balanced. The 3-pin (XLR) uses pin 2 as "hot" or "+" signal polarity, pin 3 is "return" or "-" and pin 1 is signal ground. If unbalanced operation is required, drive pin 2 as hot and pin 1 as ground. The 1/4" input is a tip-ring-sleeve connector. Tip is (+), ring is (-), and sleeve is ground. Unbalanced 1/4" inputs should drive tip as hot and sleeve as ground and may be either a "mono" 1/4" or TRS 1/4" with the ring left open or tied to sleeve, your choice. See Rane Note 110 for further information on this subject.

**OUTPUTS.** The FAC 24/28's outputs are balanced as well. As with the 3-pin input, pin 2 is hot and pin 3 is not. Pin 1 is signal ground. True balanced operation requires only the use of pins 2 and 3 for signal and either cast ground (chassis) or pin 1 signal ground for shielding. If unbalanced output is your preference, use pin 2 as signal and pin 1 as return. Use case ground for shield. The 1/4" output is a tip-ring-sleeve character whose polarities match the input connector. Again, have a look at Rane Note 110 for more detail.

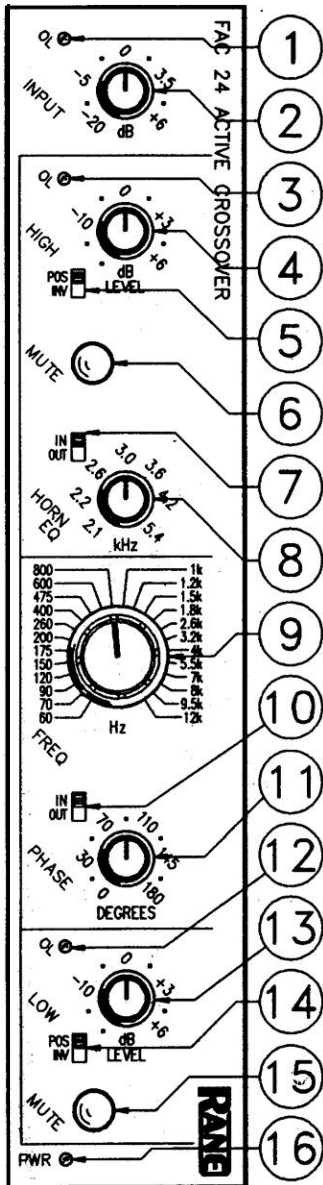
**THE LOW SUM INPUT** is used to combine the low frequency outputs of two crossover modules (mono sub bass in stereo applications). To take advantage of this feature, the low frequency output of one crossover module connects to this input (unbalanced only). The sum of both modules low frequency sections then appears at the low frequency output of the module whose low sum input is being driven.

**3-WAY, 4-WAY etc.** Two or more FAC crossovers may be used together to produce 3, 4 and 5-way systems. To accomplish this, the first unit is driven with full range audio. The Sub bass output is taken from the low out of the first module, the high out of the first module then drives the main input of the second. For 3-way applications, mid and high are taken from the low and high outs of the second module, respectively. If a four way system is being constructed, the high out of the second module drives the third, the low out of the second module becomes the low-mid, the low out of the third module is the 3rd frequency range, the high out of the third module becomes the 4th. See the diagram on the back page of this document as well as the Flex User's Guide for more details.

**CHOICES** need to be made regarding which input and output connectors to use. Generally, the 1/4" ins and outs work well enough and are definitely cheaper to use in terms of the labor required to terminate cables with 1/4" plugs and the material cost. The 3-pins do, however, provide a locking mechanism for situations where physical abuse can be a problem. The 3-pin also provides a tighter connection and can be more impervious to corrosion and stresses of time and environment.



## FRONT PANEL DESCRIPTION



**1. INPUT OVERLOAD INDICATOR.** This red LED will illuminate any time the input stage is driven to within 4 dB of clipping. This level is a function of both input signal level and the position of the input gain control.

**2. INPUT LEVEL CONTROL.** This rotary control determines the input gain of the crossover. Its range is from -20 dB to +6 dB. The majority of applications should find this control set at 0 dB for unity gain.

**3. HIGH OUTPUT OVERLOAD INDICATOR.** This red LED will illuminate anytime the high frequency output of the crossover is driven to within 4 dB of clipping. This level is a function of both the input level and the high frequency output level control.

**4. HIGH OUTPUT LEVEL CONTROL.** This rotary control determines the amount of gain to follow the high frequency output of the crossover's frequency dividing network. Its range covers Off to +6 dB.

**5. HIGH FREQUENCY INVERT SWITCH.** This two position slide switch electrically inverts the high output in the INV position. This may be necessary where drivers or amplifiers are tied incorrectly or when the crossover's phase control lacks sufficient range (more than 180 degrees becomes necessary).

**6. HIGH FREQUENCY MUTE SWITCH.** In its in position, all output signal from the high output of the crossover will be totally muted. This is to be used when initially setting levels of the low output and during the phase alignment process.

**7. HORN EQ DEFEAT SWITCH.** If a constant-directivity horn is to be used on the high output, set this switch to the IN position.

**8. HORN EQ FREQUENCY CONTROL.** This rotary control allow a continuously variable adjustment of the frequency at which boost begins to occur. This should be set based on the horn manufacturer's recommendation.

**9. CROSSOVER FREQUENCY SELECTOR.** This rotary control offers 24 precise frequencies at which the crossover makes the divide between the high and low outputs. It is a binary encoding switch which sets up the digital control of the filter's frequency dividing circuits for very high precision.

**10. PHASE CONTROL BYPASS SWITCH.** In its "OUT" position, the phase control has no effect on the low frequency output.

**11. PHASE ANGLE CONTROL.** This rotary control provides a constantly variable 0 to 180 degree phase shift between the low and high outputs.

**13. LOW FREQUENCY OVERLOAD INDICATOR.** This red LED illuminates any time the Low Output comes within 4 dB of clipping. This level is a function of input level as well as low frequency output level.

**13. LOW FREQUENCY LEVEL CONTROL.** This rotary control wits the output gain of the low frequency section from Off to +6 dB.

**14. LOW FREQUENCY INVERT SWITCH.** This switch electrically inverts the polarity of the low output in the "INV" position. This may be necessary for many of the same reasons cited in #5, above.

**15. LOW FREQUENCY MUTE SWITCH.** Identical to #6, above with the exception that it mutes the low output.

**16. POWER INDICATOR.** Illuminates whenever the correct AC power is applied to the unit from a remote power supply.

## REAR PANEL DESCRIPTION

**1. 1/4" INPUT CONNECTOR** A balanced/unbalanced input, the tip is positive, ring is negative and sleeve is ground. For unbalanced operation, drive the tip as hot and the sleeve as ground. You may use a TRS or "mono" connector. If the former is used, the ring may be left open or shorted to sleeve.

**2. 3-PIN INPUT CONNECTOR** Pin 2 is positive, pin 3 is negative and pin 1 is signal ground. For unbalanced operation, drive pin 2 as hot and 1 as ground.

**3. 1/4" HIGH FREQUENCY OUTPUT CONNECTOR** This 1/4" TRS connector parallels the 3-pin connector featured in item #4. Tip is positive, Ring is negative and Sleeve is signal ground

**4. 3-PIN HIGH FREQUENCY OUTPUT CONNECTOR.** Pin 2 is positive, pin 3 is negative and pin 1 is signal ground. For unbalanced operation, DO NOT SHORT ANY PINS TO ANY OTHERS. Active balanced outputs operated in the unbalanced mode should only consist of pin 2 driving the line and pin 1 acting as the return. Pin 3 should be left disconnected.

**5. 1/4" LOW FREQUENCY OUTPUT CONNECTOR** This 1/4" TRS connector parallels the pin connector featured in item #6. Tip is positive, Ring is negative and Sleeve is signal ground.

**6. 3-PIN LOW FREQUENCY OUTPUT CONNECTOR.** Identical to item #4 above except this one sings the low parts.

**7. Low SUM INPUT CONNECTOR** This unbalanced input consists of only a tip and sleeve contact. The tip is positive and the sleeve is ground. It is to be used to connect the low frequency output of another crossover module so that the Low Out of the driven unit consists of a mono sum of both low frequency sections. This is useful for mono sub woofer applications in a two channel (dare we we the word stereo) system.

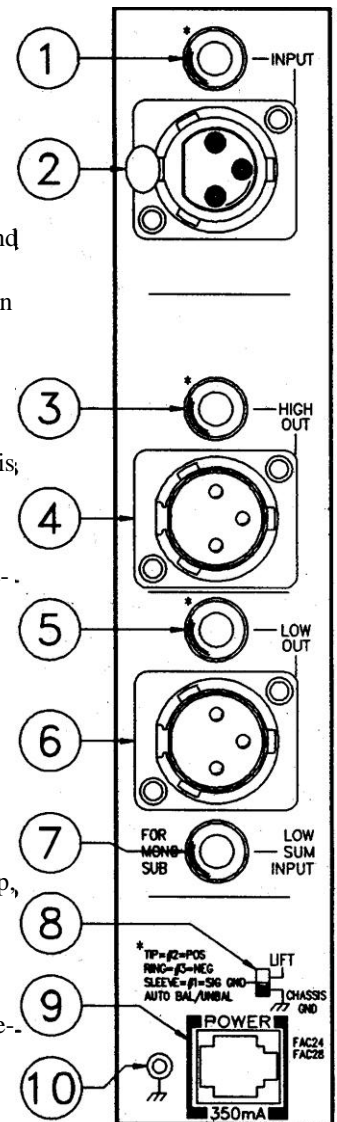
**8. GROUND LIFT SWITCH.** This switch provides the ability to separate chassis ground and signal ground. Normally, this switch should be in the LIFT position. In some circumstances it maybe necessary to move it to the opposite position to elite stubborn hum and buzz problems. We realize a scientific explanation of this switch would be helpful, unfortunately science doesn't seem to have much to do with it.

If you are tempted to try moving this switch with your power amplifiers turned on or turned up, DON'T BE. ALWAYS TURN YOUR AMPLIFIER LEVELS DOWN BEFORE CHANGING YOUR GROUNDS AROUND and then bring them up slowly.

**9. REMOTE POWER SUPPLY INPUT.** The FAC 24/28's are supplied from the factory with a Model RS 1 Remote Power Supply suitable for connection to this input jack. The power requirements of the FAC 24/28 call for a 18-24 volt AC center-tapped transformer only. THIS IS NOT A DC INPUT. IT IS NOT A TELEPHONE JACK.

NEVER USE A POWER SUPPLY WITH YOUR CROSSOVER OTHER THAN THE ONE SUPPLIED OR AN EXACT REPLACEMENT OBTAINED FROM RANE CORPORATION. Using any other type of supply may damage the unit and void the warranty. Two years parts and labor is worth safeguarding, don't you think?

**10. EXTERNAL GROUND ATTACH POINT.** This threaded hole is to be used to attach an external earth ground to the system. This may be necessary in situations where no other earth ground reaches the chassis of the processing components due to the fact that the third pin earth ground of the line cord does not pass through the external power supply. If the rack rails are not earth grounded by some other means, one of the FLEX components in your system may require that this connection be made for safety purposes and noise performance.



## OPERATING INSTRUCTIONS

Before attempting a complete run-down of operating guidelines for the FAC crossovers, a few words about state-variable Linkwitz-Riley filters are in order. Rane implements this alignment using two cascaded two pole butterworth filters in the FAC 24 to produce the fourth order characteristic. The FAC 28 simply multiplies the circuitry of the FAC 24 times two and produces an 8th-order

crossover. The fourth order version exhibits rolloffs of 24 dB per octave the FAC 28 a steeper 48 dB per octave. In both cases, at the crossover frequency the high and low outputs are 6 dB down from unity and in phase with each other. The result is a combined output which is completely flat from one end of the audio spectrum to the other. See Rane Note 119 for greater detail. The important element here is that

the outputs be in phase. This is relatively easy to accomplish electrically, and much more difficult acoustically where it really counts. Therein lies the reason for the phase correction capabilities of the crossovers. They are able to alter their phase response to compensate for phase problems in drivers and their cabinetry.

**CROSSOVER FREQUENCY** should be set primarily based on the driver manufacturer's recommendations. Some fine tuning may be necessary depending on the specifics of the system. Caution should be used when straying too far away from factory guidelines. Crossing over a horn or other high frequency component too low may result in permanent damage. Low frequency drivers generally can be driven with hi frequencies with no ill results other than poor sound. It is better to err on the high side than the low.

**INPUT AND OUTPUT LEVELS** should generally be set at or near the unity gain marks. There should be no reason to take gain in a crossover other than to make up for efficiency differences between the high and low drivers. Taking too much gain or loss in a crossover usually indicates inappropriate gain structure elsewhere in the system. For best noise performance, system gain should be accomplished at the mixer or source. Taking gain in components throughout the system usually yields poor noise performance. We recommend that a realtime analyzer or other measurement system be used to set the relative levels between the low and high outputs. Most speaker systems can be made relatively flat using only the level and phase controls on the crossover before equalization is applied.

**PHASE CONTROLS** as well as the polarity switches on the outputs of the crossover may be adjusted using the aforementioned test equipment. Starting with the invert switches in their "POS" position and the Phase control full CCW, look at the crossover frequency area with your test equipment. If you are using pink noise as a source, be sure to observe only the crossover region. Room acoustics and imperfect driver response can throw off everything else to the point of total frustration. Mute the high end and set the high level control for a 0 dB indication on the test equipment at the crossover frequency. Now mute the low and unmute the high. Set the high out for 0 dB at crossover. Release the mute on the low and you should see a + MB indication at crossover. If you do not, first try to achieve it by setting the Phase in-out switch to the in position and slowly rotate the phase control clockwise. If unable to achieve +3 dB at the crossover frequency, return the phase control to its full CCW position and change only one of the invert switches to its "IN" position. again rotate the phase control slowly clockwise. With one of these combinations you should be able to optimize the combining of the two drivers.

**3-WAY AND BEYOND.** The FAC 24/28 modules may be combined to produce 3, 4, and 5- way systems. Have a

look at the diagram below for a typical application and consult the Flex User's Guide.

### IMPORTANT NOTE

#### CHASSIS GROUNDING

Rane Flex Series modules are supplied with a rear-mounted ground-lift switch. The unit is shipped with this switch in the "grounded" position, tying circuit ground to chassis ground. 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 the cord grounding pin or the rack screw 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 Rane Note 110 (supplied with your product and available on request at no charge if you lost your first one) for further information on system grounding

#### Application Diagram (3, 4-way system)

