FLEX
USERS GUIDE

RANE

PURITY BY DESIGN

Third Edition Published May, 1995

Preface to the Third Edition

We all like to have the latest revision of any software. Paper is soft, right? The second edition was from 1991. A lot has changed—then again, some things prove their worth in time. A few Flex models have been discontinued, a few new ones have taken their place, and a few more applications have been discovered by our staff and customers.

So that you don't have to examine every page to see what changed, here's the Executive Summary: The FDA 18 and FPS 28 Distribution Amps have both been discontinued and replaced by the FDA 28, which accomplishes everything these units did and more. The FPM 42 Program Mixer has been discontinued, but the FPM 44 is still around—the only difference is the FPM 44 has terminal strip connections. The FAC 24 Active Crossover is gone (24 dB/octave), but the FAC 28 is still around (at 48dB/octave). The FPL 44 Program Limiter is gone, but we added two new processors, the FSC 22 Stereo Compressor/Limiter, and the FVL 22 Stereo Remote Volume Level/Limiter. A new transformer product joins the FLT 22: the FBB 44 Balance Buddy. Other new Rane products are referenced in this guide, such as the new MA 6S Multichannel Amplifier, the SM 26B Splitter Mixer, the CP 62 Commercial Processor, and the VC 18 Voltage Converter.

Legaleze

Trademarks

Flex Contents

The Truth, the Whole Truth, and Nothing But the Truth About Flex

The modularity and variety of the Flex Series requires more than one document. In fact, just mastering one module means learning four documents:

- Flex Series General Data Sheet
- Specific Flex Module Data Sheet
- Flex Operating/Service Manual
- Flex Users Guide

Flex Series General Data Sheet

This document presents the Flex Series modular signal processing idea and shows the features and specifications common to all Flex modules. Useful block diagrams introduce the Flex Bus system. Additionally, it surveys the available Flex modules and explains the accessories. Consultants find the Architectural Specifications section useful when preparing proposals.

Use the general data sheet with the separate module data sheets to create a complete system information package. This is useful for project submittals and planning.

Specific Flex Module Data Sheets

Separate data sheets exist for each Flex module. Only specifications unique to the module appear. If certain specs are the same as all other modules (as listed on the Flex Series general data sheet) they do not appear. For example, if you want to know the input impedance and it is not on the individual data sheet, then see the Flex Series general data sheet under common specifications.

A complete Block Diagram appears with detailed drawings of the front and rear panels, along with general application information.

The individual Flex module data sheets augment the general Flex Series data sheet. They provide the specific details of the separate modules used in a system.

Flex Operating/Service Manuals

This is where you find a complete description of the controls and connectors on the module. The Operating/Service Manual contains the complete schematic and parts locator diagrams. It starts with a Quick Start section to aid those needing minimal help. Then, for the rest of us, it explains system connection and unit operation.

Flex Users Guide

What you are reading. The Flex Users Guide contains lots of application examples with a full explanation of the bus system and its uses. It includes tips on mounting, daisychaining power supplies and safety agency requirements.

Read on and discover for yourself.

To summarize: Use the general Flex Series and separate Flex module data sheets for proposals and planning. Use the Flex Users Guide for designing systems, and use the Operating/Service manuals for operation and maintenance.

Quality and Reliability: Your Job and Our Reputation

Flex represents the best we know how to do. Make no mistake about small being less. Flex offers a design and size that uniquely solves the professional's needs for flexible audio systems of the highest quality. No compromise. What is there is the best. Your job and our reputation depend on it.

Quality Components

What is there is impressive. Peek under the hood. You will see all precision parts, many mil-spec grade. You will see glass-epoxy single and double-sided printed circuit boards, 1% metal film resistors, 2% audio-grade polyfilm capacitors (various dielectrics), proven 3rd and 4th-generation audio integrated circuits featuring superior noise and distortion performance, custom hybrid circuits, and high-speed advanced CMOS control circuits.

Touch and feel the precision of the viscous-damped rotary and slide controls. See the integral dust-dams applied to each slide control for superior protection and life. And the careful location of multi-turn ferrite beads for radio interference suppression. Finally, note the use of sockets for all integrated circuits.

On the outside, feel the heft (one of our favorite specs) and sheer ruggedness of the cold-rolled steel 16 gauge (heavier than most) chassis and top cover, chosen for strength and for extra shielding against electro-magnetic interference. No wimpy aluminum here.

Quality Craftsmanship

What you cannot see is equally impressive. You cannot see all the personal extra effort that goes into the manufacturing of Flex units. You cannot see that rivets and screws secure all jacks to the printed circuit board before soldering. Electrical solder joints do not substitute for mechanical integrity. Things like every solder joint inspected for flaws and touched-up to perfection. Things like Flex units being 100% tested, then burned-in, then retested, and then undergoing a *listening* test. Imagine, actually using music to test audio products—what an innovation!

Quality you cannot see, but you can stake your career on.

And if it is a power supply, or has its own internal power supply, then it must pass a 1200 volt high-potential safety test. Plus a ground current leakage test, before we allow you to plug it in.

Safety you cannot see, but you can bet your life on.

Finally, hefty double-wall corrugated boxes and foam end-blocks protect Flex products so they arrive the same perfect way they left. No flimsy packaging here.

Flex uses only the best ingredients, combined in exactly the right manner to produce superior audio products.

Product Categories, Model Numbers, and HR Compatibility

Product Categories

Flex modules breakdown into two broad categories. Those with the Flex Bus system and all the rest. The Flex Bus system allows designing custom mixers for virtually any application. Not surprising then, the modules with busing facilities tend toward mixers of one sort or another.

The remaining modules mimic their big brothers. Available are parametric and graphic equalizers, active crossovers, dynamic processors, and remote power supplies to run them all.

Accessories make up the last product category. Flex vertical mounting racks, horizontal mounting kits, blank panels, security covers and extra cabling fill out your choices.

Product Model Numbering Convention

Flex Series model numbers mostly follow these rules:

F A B n m

where **F** = Flex Series

AB = Two letter abbreviation for product name, for example, PM stands for Program Mixer

n = number of input channels, or

= number of bands for graphic equalizers, or

= number of channels for parametric equalizers and dynamic controllers, or

= "2" = two-way configuration for crossovers, or

= unused for remote power supplies

and **m** = number of output channels, or

= number of bands, or functions for graphic or parametric equalizers and dynamic controllers, or

= order of crossovers, e.g.,"8" = 8th-order (48dB/octave), or

= number of outputs for remote power supplies

HR Compatibility

All Flex modules are HR (half-rack) compatible and designed strictly in compliance with HR1-1988, Recommended practice for applications employing half-rack (HR) size racks, panels and units—preferred dimensions and methods.

This means you can freely mix different manufacturers' HR products and Flex units with total compatibility. All HR products mount either vertically or horizontally, flush or recessed, in any location next to any other HR product. Look for the HR reference for compatibility.

Flexcessories

Depending on system requirements, you can use Flex Series modules vertically or horizontally. The special Flex silkscreen design allows mounting the same unit either vertically or horizontally. Either position gives equal readability of graphics (or equal *unreadability* of graphics—depending on whether you like what we did or not). This means a unit initially mounted horizontally, can change to vertical mounting as the system grows, without a front panel or nameplate change. Flexible.

The Flex accessories required for the various mounting options follow:

Mounting Ears
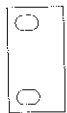
All Flex units come with mounting ears. For rack mounting applications attach the ears to the rear holes for flush mounting, or to the front holes for recessed mounting. Use only the screws provided, or exact replacements, when attaching the ears. Longer screws may damage the circuit boards.

Vertical Mounting

When mounted vertically, ten Flex (or HR compatible) modules occupy 10.5" (6U) of space in a standard EIA 19" wide rack. Vertical mounting of Flex units requires ordering the **FVR 10 Vertical Rack.** This 12 gauge steel frame is extremely rugged and road worthy. The FVR 10 comes complete with all mounting hardware.
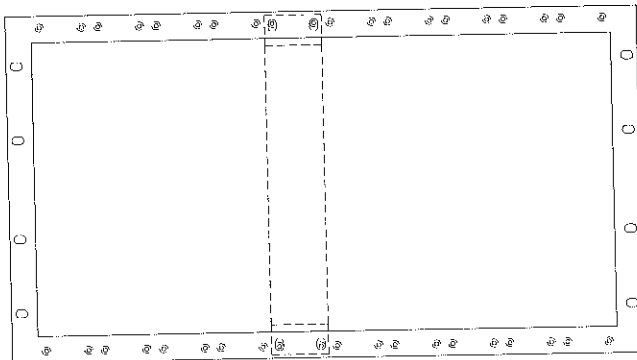
Vertical Mounting Blank Panels

Blank panels exist for single-space vertical mounting. No other widths are available. For example, if you have three spaces to close, you need three blank panels. Order the **FSB 1 Security Cover/ Blank Panel** (shown to the right).
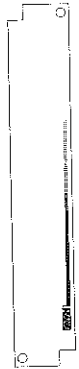
Vertical Security Covers

Three vertical security covers exist:

The first measures 10" x 19" and completely encloses the *FVR 10 vertical rack,* providing complete security for all modules. Specify model **FSC 10 Security Cover** when ordering. Use of the FSC 10 requires recessed mounting of all modules. This makes for a low profile, minimum extrusion security cover, demanding less than 3/8" (1 cm) in front of the rack.

The second cover is a dual purpose accessory. The blank panel doubles as a security cover for single-space vertically mounted Flex units. As before, order the **FSB 1 Security Cover/Blank Panel.** Again, no other widths exist.

Like its big cousin, the FSB 1 requires a recessed mounted module. This time the cover fits flush with the rack. This allows a trick to further fool knob twiddlers:

Flex Tip: Recess mount only the units with security covers. This makes the other units easier to operate, and the secured units look like blank panels. They just disappear into the front panel.

FVR 10 Vertical Rack
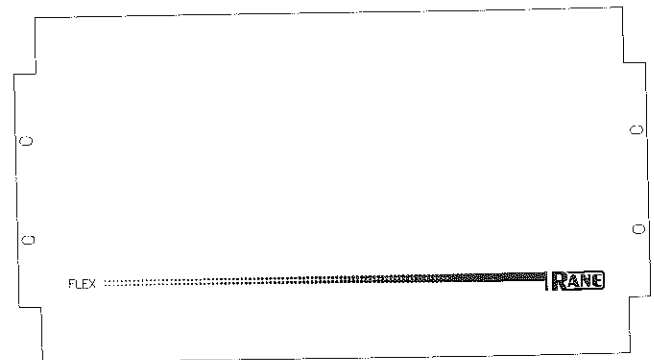
FSC 10 Security Cover

The third option is to security cover *individual controls!* All Rane rotary controls that are not dual concentric may have an individual hole cap replace the front panel knob. This means that controls may be pre-set to guard valuable settings as well as make an installation more user-friendly by removing unnecessary knobs. These caps may be optained from your dealer or the factory.

Horizontal Mounting Two Units

Mounting two Flex Series modules, or one Flex unit and one HR compatible unit, side-by-side in a standard 19" rack requires ordering one of the following:

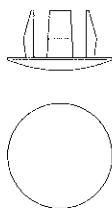The **FHL 2 Horizontal Linking Kit** contains all necessary hardware to securely attach two modules together and provide appropriate three axes support. Primarily recommended for permanent installations.

The **FHT 2 Horizontal Tray** is a 1U rack space 19" wide mounting tray for one or two Rane Flex units. The FHT 2 provides a rugged mounting method designed for touring and other portable systems. Flex units are normally fastened by screws from the top and hung. The FHA 19 can fill up the empty space when mounting just one Flex unit.

Flex Tip: An FHT 2 also mounts any combination of (3) MS 1 Mic Stage preamps, VC 18 Voltage Converters, PS 1 Phono Stages, or RPS 4 Remote Program Selectors.

Horizontal Mounting One Unit

Mounting one Flex unit horizontally requires the **FHA 19 Horizontal Adaptor**. This provides a solid extention to one of the rack ears. It can be mounted on either side for the Flex unit, and gives you that special place to put your custom switches, pots, pushbuttons, lights, etc. The FHA 19 can be used on its own, or with the FHT 2 Horizontal tray when extra roadworthiness is required.

Horizontal Security Covers

To discourage, but not prevent an operator from fiddling with a horzontal unit, is to recess mount one or both of the units using either the FHL 2 Link Kit or the FHT 2 Tray. To securitize both units, use the **SC 1.7**, the standard security cover for our 19" wide equipment. It is not necessary to recess mount the modules in order to use this security cover.

The other option is to security cover *individual controls* with hole caps as outlined in the upper left corner of this page.
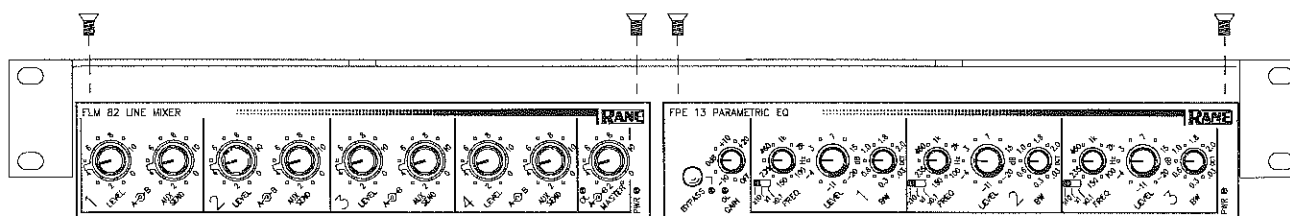
FHT 2 Horizontal Tray
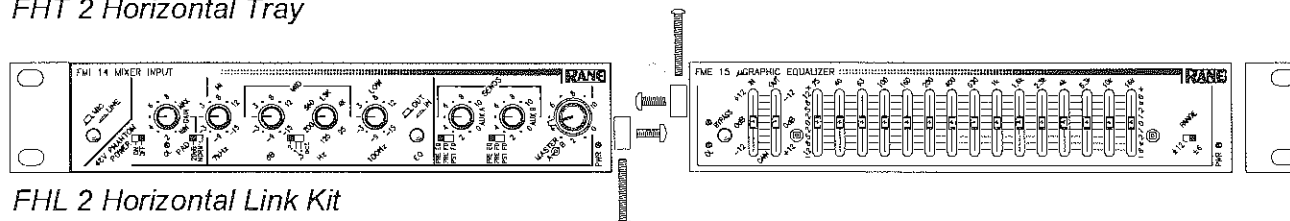
FHL 2 Horizontal Link Kit
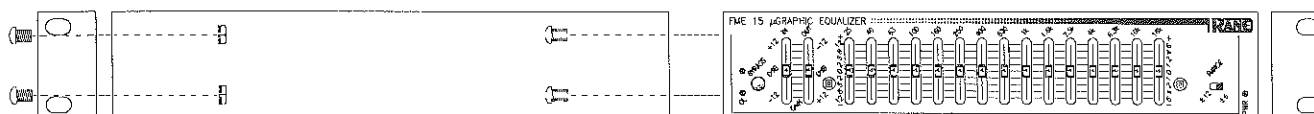
FHA 19 Horizontal Adaptor

Remote Power Supplies

Why Remote Power?

A remote supply powers each Flex unit. This does two wonderful things: First, it removes the transformer and its associated hum field from the unit for quieter performance. Second, it allows the unit to be exempt from most safety agency requirements worldwide.

Safety Agency Exemption

All Flex units ship with our Model **RS 1 Remote Power Supply**. UL and TUV listed, the RS 1 supplies the low AC voltage required to run Flex modules. The export version meets IEC 65 and VDE 0860 European safety regulations and qualifies all powered units as SELV (Safety Extra-Low Voltage) for agency exemption. This applies worldwide. In general, most countries consider any unit operating from less than 42.4 volts peak (30 volts RMS) inherently safe and not subject to approval procedures. All Flex units powered by Rane remote power supplies qualify for this exemption. (See Rane Note 121 for more information on this.)

Alternatives to Separate Power Supplies

Within the Flex Series, Rane offers the *vertical (only)* **FRS 8 Remote Power Supply**. The FRS 8 features *eight* isolated outputs, each supplying 650mA of current, and requires two spaces to mount. The FRS 8 also provides an overall system power switch.

In a standard 2U rack space 19" wide format is the **RAP 10 Remote AC Power** unit. It expands the FRS 8 concept to provide *ten* (10) outputs and normal rack mounting.

Consider the FRS 8 or RAP 10 as an alternative in systems where several RS 1 units become a mounting problem. Using an FRS 8 or RAP 10 and customizing power supply cable lengths makes for a neat, compact and convenient installation.

On the horizon exist other alternatives. Third-parties manufacture general purpose remote power supplies to run a cross-section of audio products. Power supply products are showing up as alternatives to coping with individual adapters.

Flex Tip: Third-party power supplies must have output voltage levels between 18 to 24 volts AC with center-taps. The connectors must be 6-pin modular plugs wired per Rane standards and must have enough AC current to run the Flex product(s) desired. Juice Goose™ makes a compatible supply.

The AC current requirements of all Rane products appear beneath their red power connectors, as well as on the product data sheets.
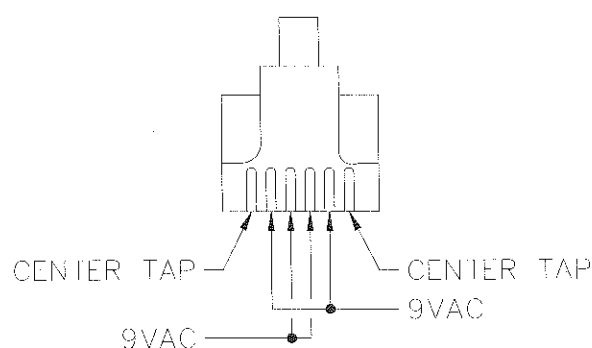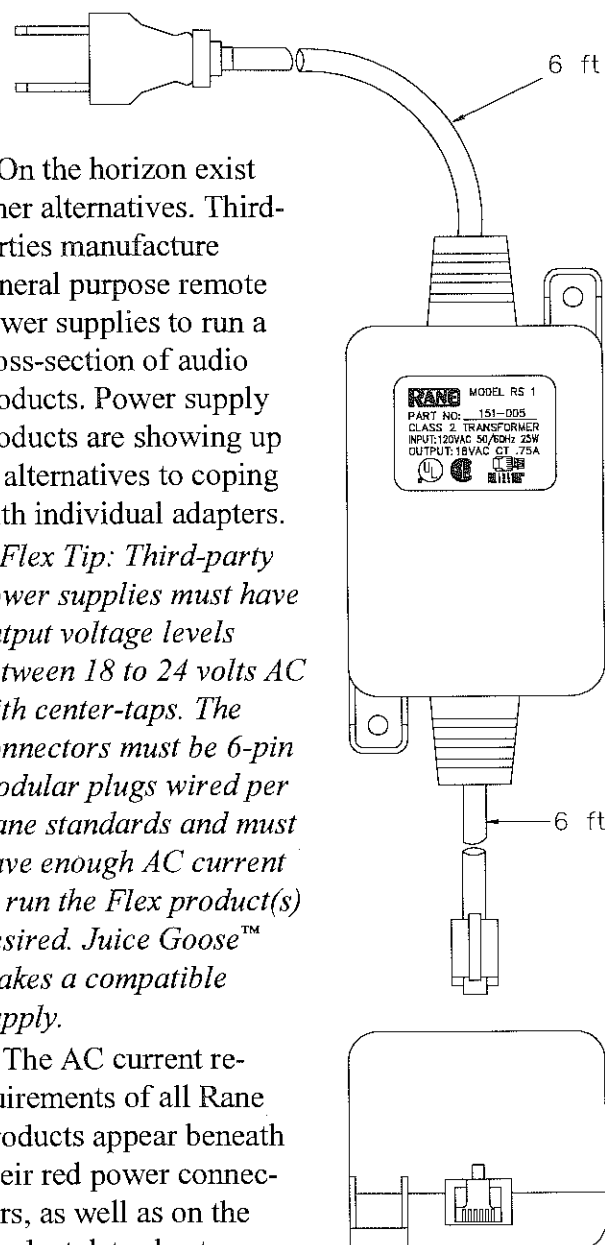
RS 1 Power Supply

Mounting Remote Power Supplies

Common sense dictates the mounting location of whatever power supply you use. The RS 1 comes with a long input AC power cord and a long output power cable. This allows mounting the RS 1 far away from high gain audio stages, such as microphone inputs. The RS 1 often mounts along the side-rear of the equipment rack. Securely mount it as distant as possible from all high-gain inputs.

When using the FRS 8 power supply mount it to the far right-hand side of the Flex rack. Locate all high-gain microphone input modules (FMI 14, FPM 44, etc.) to the far left-hand side of the rack, and all other modules between.

A RAP 10, when used, should be mounted at the extreme top of the rack.

When using third-party power supplies try to locate them at least 2 rack spaces away from all Flex modules. Mount other low-gain equipment, such as crossovers, compressor/limiters, etc., between the power supply and the Flex units. This assures a minimum of airborne hum pick-up from the power supply.

Customizing Power Supply Cables

Special 6-wire flat cable interconnects the remote power supplies and the Flex units. Customizing cable lengths requires using the tool and modular connectors found in the low cost **Mod Cable Connector Kit**. Whether it's the 6 foot cable on the RS 1, or the 24 inch cables from the FRS 8 or RAP 10, this kit contains everything necessary to shorten the wiring.

Daisychaining Power

The RS 1, FRS 8 and RAP 10 remote power supplies put out more power than required by any one Flex unit. At first this may seem wasteful, but we can explain. It is due to our one-size-fits-all philosophy of offering only one outboard power supply, big enough to run any Rane product. (Rane offers many full-size products powered from remote supplies.) We buy large quantities of one supply, get the best price, and pass the savings on to you.

Since you have more power than you need (electrically speaking), the issue of running more than one unit from one power supply comes up. This parallel connecting (daisychaining) of power is not as easy as first imagined.

You may think, what's the big deal? Just run power into one unit, then on to another unit, and so on. As long as you pay attention to the total current demand, what's to worry? Ground loops are to worry—big, ugly, loud, obnoxious, unbreakable ground loops.

Flex Tip: Daisychain power only between modules interconnected with balanced wiring.

This means isolated wiring *between* daisychained units (unbalanced connections are okay
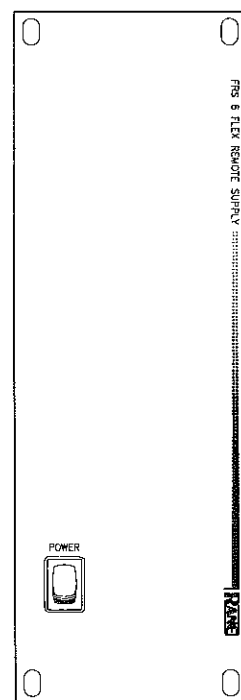
FRS 8 Remote AC Power Supply
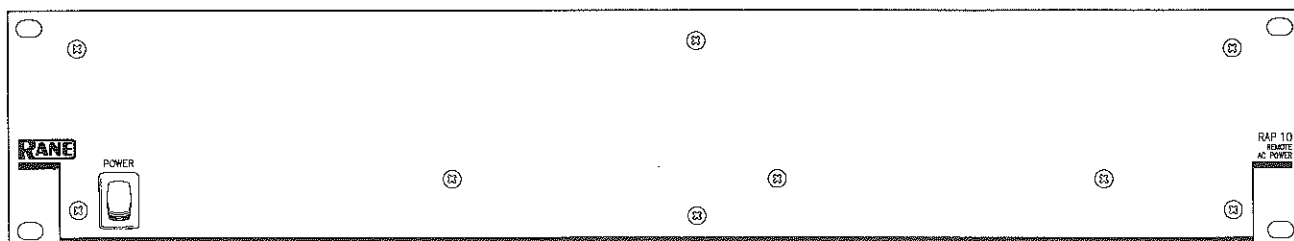
RAP 10 Remote AC Power Supply

between units *not* on the same power supply). Use true balanced wiring techniques where system ground does not connect between units, i.e., signal passes differentially between pins 2 & 3 of 3-pin (XLR) connectors (or tip and ring for ¼" TRS, or + and − for terminal strips). Do not use pin 1 for 3-pin (XLR) systems. Use signal or chassis ground *only* for shield grounding, and *only terminate at one end.*

Daisychained power allows no exceptions. Use no unbalanced connections between units powered from the same supply. To the casual observer this may seem easy, but, then again, casual observers usually err. Flex Series design features true differentially balanced main inputs and outputs. Besides these, there are expand jacks, effects loops, auxiliary ins and outs, and the Flex Bus system—all unbalanced. If you use any of these between two units, they cannot share the same power supply.

There is one exception (you knew it, didn't you?) to the above balanced-daisychaining rule: These are products specifically designed to allow unbalanced use and daisychaining. For example, Rane's MS 1 Mic Stage preamp designed for remote power, allows unbalanced use (though it has a balanced output), and daisychaining of power.

The MS 1 isolates the internal signal ground from the remote power supply, i.e., the circuitry floats relative to the supply ground. Signal ground gets tied back to supply ground only through the unit it drives. This is the key to breaking ground loops when daisychaining power between units using unbalanced interconnections. *Allow only one connection between the power supply ground and all the different signal grounds.* This actually sounds easier than it is.

To make this clearer, think about several units daisychained together by a common power supply. Internally each unit ties its signal ground back to its power supply. Daisychaining of the power supplies ties all these grounds together. That creates the ground loop. The only way to stop it is to break all but one of these paths. *It is important to recognize that no manipulation of*

connector grounds solves the problem. Floating the signal ground inside the unit is the only way to solve the problem. It cannot be done externally through cable grounding means, or ground lift switches. Ground lift switches only control tying signal and chassis grounds together.

DC Powering Flex Modules

Applications exist where Flex modules must run from DC or battery power. The most common being automotive, aircraft and marine uses. Although another rapidly growing area is battery operated emergency paging systems.

The addition of what we call "DC diodes" gives all remotely powered Rane units the ability to run from either AC or DC power. Check with the factory for applicable starting serial numbers.

The VC 18 Voltage Converter allows powering Flex units from a DC source, such as a car battery. The VC 18 also may be used to provide emergency back-up power, automatically switching from AC to DC when the AC supply fails. One VC 18 will supply voltage to at least one Flex unit. A model VC 18-2 will supply voltage to at least two units. Consult the VC 18 Data Sheet for more information, or Rane Note 133, "DC Powering RAP Units".
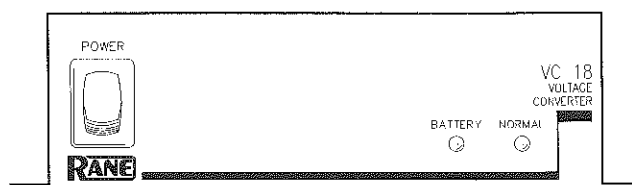
VC 18 Voltage Converter

The Ins And Outs Of Flex

International Wiring Standards

Rane wires all Flex module 3-pin connectors (XLR, the original model number of this type connector, is a registered trademark of ITT Cannon and cannot legally describe other manufacturer's versions; therefore the use of the term 3-pin) per the American, British and International standards of *pin 2 positive, and pin 3 negative*. These standards are ANSI PH7.102-1983, AES 14-1991, BSI BS 5428, Part 5, Section 3, 1980/81, and IEC 268, Part 11, 1975 respectively. Of particular interest, is IEC 268-11, *issued in 1975*, and signed by 17 countries, *including the UK and the USA*. The result of this agreement caused the individual national standards by Great Britain (in 1980) and America (in 1983).

There is one standard, not two as popularly believed. The standard was agreed on in the seventies; it is now the nineties. You'd think everyone would have the message by now.

Hardware

Flex modules come with all popular types of connectors. The specific application of certain modules dictates input/output hardware. Always limited space is a determining factor. Some modules have 3-pin, ¼" and terminal strips, while others have only terminal strips, or just ¼" connectors. Flex modules find use in all segments of the professional audio industry. This creates great variety and value. If certain module hardware seems wrong for your application, it's because its primary use requires different connectors.

Space problems usually require all secondary functions be ¼". These include Auxiliary In/Outs, Effect Loops and patch points. Occasionally, these may be terminal strips. Usually, main signals connect to the Flex system using balanced 3-pin connectors for the inputs and outputs, and all secondary connectors use unbalanced ¼" connectors.

Scribble Strips

All Flex units come with scribble strips. Scribble strips are adhesive backed labels used for custom labelling. You scribble notes on them.

The ones Rane supplies have a gloss surface easily marked with a Sharpie®, wax pencil, or equivalent permanent ink marker. They are not easily marked by any other means.

You get two sizes: The bigger ones (about ½" x ¾") fit between the mounting screws on the mounting ears, and allow marking of the entire unit. The smaller ones (about ¼" x ½") fit in various places along the front panel edges for marking specific controls. Additional scribble strips are available directly from Rane.

Clutch Washers

Various Flex modules use concentric controls. These allow two functions to take up the space of one. Commonly, these are Level controls (e.g., Master A/B, Aux A/B, etc.). Concentric controls let you set independent levels for each. As an example, signal splitting and zoning wants this type of control.

Concentric controls differ from ganged controls. Ganged controls use one shaft (and knob) to control two functions together. A common use for ganged controls is changing levels for stereo signals. Both left and right channels change simultaneously without disturbing their relative differences (if any).

Naturally the question comes up of how to turn Flex concentric controls into ganged controls? The answer is to use a thin clutch washer. These look like the hole reinforcement rings you bought as a student to protect 3-hole punched papers, only made from sheet rubber.

These washers cause a friction fit between the two concentric knobs. Turning one knob automatically turns the other; yet, they can be positioned to separate locations if necessary, and the whole thing moves together after that.

Installation is easy. Remove the small inner knob. Drop the clutch washer over the shaft and

position on top of the large outer knob. Then put the small knob back on and push down to seat inside the large knob as before. Only this time press the clutch washer down to fill the gap between the two knobs. This causes both knobs to operate as one.

Clutch washers are available free from the Rane factory.

Electrical Design

Inputs. All main line level inputs feature true differential instrumentation amplifier balanced designs with high common-mode rejection and RFI traps (Fig. 1). This means equal common-mode and differential-mode impedances, and superior noise immunity. These inputs easily handle +20dBu levels, with standardized input impedances of 20k ohms (each input to ground, i.e., 40k ohms balanced).
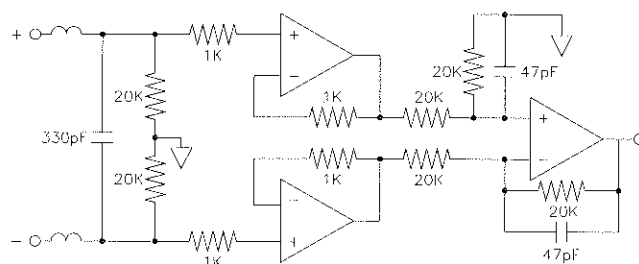

Fig. 1 Flex Series Balanced Input Stage

Outputs. Most main outputs feature high-current active differential balanced line drivers (Fig. 2). Special compensating techniques optimize Flex output stages for driving long reactive lines. Standardized output impedances equal 100 ohms (200 ohms balanced).

Recently Analog Devices designed an integrated circuit solution to the matching problems of "cross-coupled" output stages. (So-called since the output of each driver feeds back, or "crosses over" to the other side. Others call this a "servo-loop" driver.) The main advantages are no gain change between balanced and unbalanced operation, very low output impedance, and good common-mode rejection; thus it mimics an output transformer. Rane has begun incorporat-
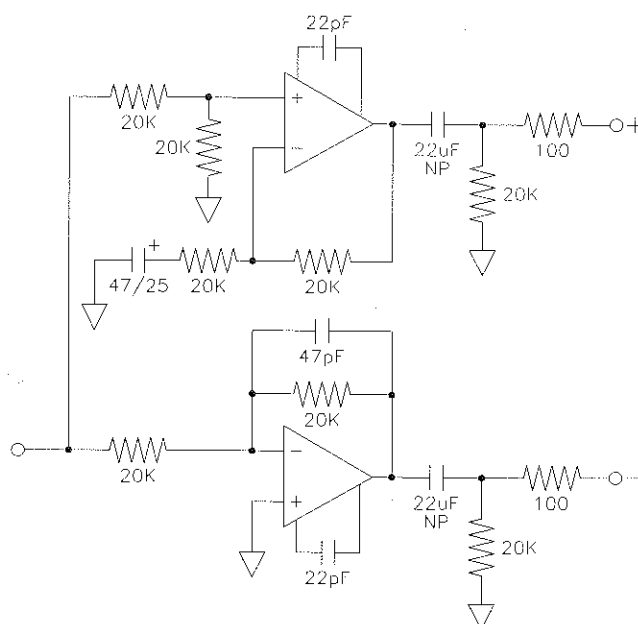
Fig. 2 Flex Series Balanced Line Drivers

ing this part into certain Flex units (FDA 28 Distribution Amplifier), and will use it in other Flex units as the need arises.

All unbalanced outputs use standard tip=positive, sleeve=signal ground wiring convention and feature buffered line amplifiers, with 100 ohms driving impedance.

Low Filters. Some Flex units have infrasonic filters built-in. Mostly these are crossover and EQ modules (e.g., FAC 28, FPE 13 and FME 15). The corner frequency of each equals 15Hz (-3dB point). The slopes equal either 18dB/octave (FPE 13 & FME 15), or 24dB/octave (FAC 28).

Each unit offers simple internal provisions for defeating the low filter. Do this by removing the top/rear cover. *CAUTION: Be sure to unlock the 3-pin (XLR) connectors before trying to slide the top/rear cover back. Turn the small locking screw CCW ¼ turn. If you need help, please call the Rane Technical Service Department.* After removing the cover, find the jumper block marked LO FILT. Using needle nose pliers, lift the header assembly up, move it over one pin and push back down again. Check the silkscreened labels on the PCB to insure correct positioning. Replace the cover, lock the 3-pin connectors, and take a nap.

Number of Cascaded Units	−3dB Corner Frequency	
	18dB/Octave Modules (FME 15, FPE 13)	24dB/Octave Modules (FAC 28)
1	15Hz	15Hz
2	17.5Hz	17Hz
3	19Hz	18Hz
4	20Hz	18.5Hz

Table 1 Cascading Flex Units

When cascading units, such as an equalizer driving a crossover, for instance, it is appropriate to consider the resulting combined responses of the low filters. If one unit is −3dB at 15Hz, then two cascaded units are −6dB at 15Hz. If they are −6dB at 15Hz, then where are they −3dB? Table 1-1 gives the answer. This shows you why we picked 15Hz for the low filter. This allows cascading as many as four 18dB/oct units before the response is −3dB at 20Hz. Using 24dB/oct modules allow even more units. A combination of both falls somewhere between the two.

Usually this means you don't have to worry about losing any low-end when cascading Flex units (the high-end is even less of a problem). It is only the extreme case where cascading results in a problem. If necessary the internal defeating option allows you to bypass any low filter for whatever reason.

Levels—Professional, or What?

Portable recording, the misnomered "semi-professional" tape recorders (Tascam, Fostex, etc.), and consumer audio products use −10dBV levels (0dBV = 1 volt, so −10dBV = .316 volts). Broadcast, sound reinforcement, recording studios, post-production, and installed sound systems use +4dBu (0dBu = 0.775 volts, so +4dBu = 1.23 volts) levels. Flex modules perform equally well with either −10dBV or +4dBu levels. They also allow transitions between the two in either direction, i.e., amplify −10dBV to

+4dBu, or attenuate +4dBu to −10dBV. (Although not obvious, this requires approximately 12dB gain. Calculations go like this: changing −10dBV to +4dBu means amplifying .316V up to 1.23V, or increasing by a factor of 3.89, which equals 11.8dB.)

These level mismatches are not a problem for Flex users. Most applications go together without worrying about levels. Just hook it up, and you will have all the gain, attenuation, headroom and silence you require.

The only levels of concern are mic levels. Connect microphones to mic level inputs only. If you are out of mic inputs, try this:

Flex Tip: Use a Rane MS 1 Mic Stage preamp at the microphone to amplify the mic output to line level before running long lines. You are then free to use any available line level input for mixing and processing.

Phantom Power

All Flex modules with mic-level inputs offer switchable phantom power (also known as *simplex* power—an old telephone term). On some modules, space limitations required locating this switch internally, or on the side of the unit, so please look carefully before deciding that we forgot it.

Flex products use two phantom power voltages. The FMI 14 Mixer Input module (and the MS 1 Mic Stage) use +48 VDC based on the

international standards: DIN 45 596 and IEC 268-15. All other modules use +15 VDC as described next.

The built-in phantom power level is tightly regulated and extremely quiet. Fig. 1-3 shows a typical Flex module +15 VDC phantom power circuit. The precision matched (typically ±0.4%) phantom power resistors are 750 ohms each. This value is an interpolation based on the recommendations of the international standards cited above. All Flex phantom power circuits are high-current designs, able to supply the 10-15 mA sometimes required for modern condenser designs.

A fair question for those of you familiar with DIN 45 596 is why did we pick +15 VDC as opposed to +12 VDC—the recommended DIN value? The answer is simple, really. Our positive power supply is +15 VDC, so that was the easiest value to route to the mic input lines. Lastly, most all modern condenser mics work from a wide range of phantom power voltages (typically 9-52VDC), not just the three values (12, 24, & 48 volts) specified by the standards.

Note the use of large DC blocking capacitors in Fig. 3. This allows you the option of turning off the internal phantom power supply and substituting a +48 VDC external unit when

necessary, or preferred. Their oversized value prevents inadvertent loss of low frequency response.

Flex Tip: Connect the shield at both ends of microphone cables using phantom power. Otherwise the phantom power ground return path is an incomplete circuit and will not work.

Most condenser mics rate phantom power requirements at 9-52 VDC. This includes all new AKG, Audio-Technica, Beyer Dynamic, Crown, and Shure brands. (Some discontinued AKG and Beyer Dynamic models must use 48 volts.) Most phantom powered microphones work with 15 volts, but some do not. For example, the MKE series from Sennheiser does; the MKH series does not. (Check with the factory for other models.) Even Schoeps offers a line of 12 VDC models (which work from 15 volts).

Some microphones need at least 18 or 24 volts. Many Electro-Voice and Telex models fall into this group. Only a few microphones, some costing as much as a Lamborghini, work *only* from 48VDC. These are mostly Neumanns, standard line Schoeps, some discontinued AKG models, and top-of-the-line Sennheisers. Some B&K models work only from +130 VDC!
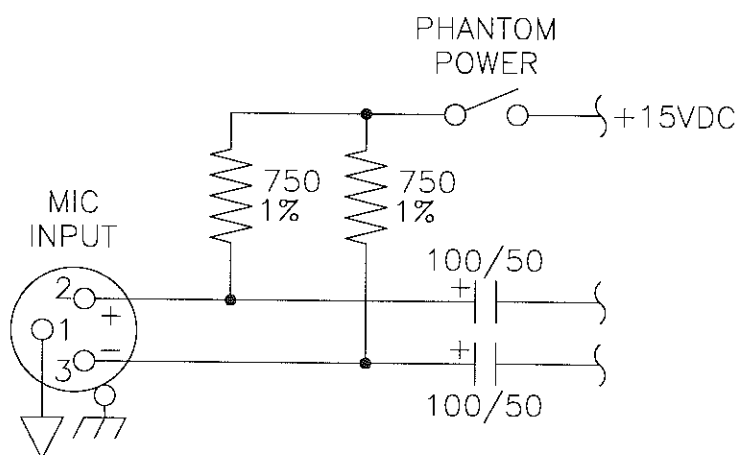

Fig. 3 Flex 15VDC Phantom Power Circuit

The Flex Bus System

Introduction

The most misused word-of-the-month in audio literature is "buss." To buss someone is to kiss them. Look it up. Our concern is routing, not kissing; so we sing thee praises of bus, buses, and busing—not buss, busses, and bussing.

Definition and Wiring

Certain Flex modules offer a Bus system for added interconnect flexibility. This Flex Bus system operates similarly to the mixing buses found in standard size consoles. The system adopted for Flex modules features six audio lines interconnected through 7-pin, 270° DIN connectors and cable. As much as possible the wiring convention agrees with IEC and ANSI specs for DIN audio connectors, shown in Fig. 4.
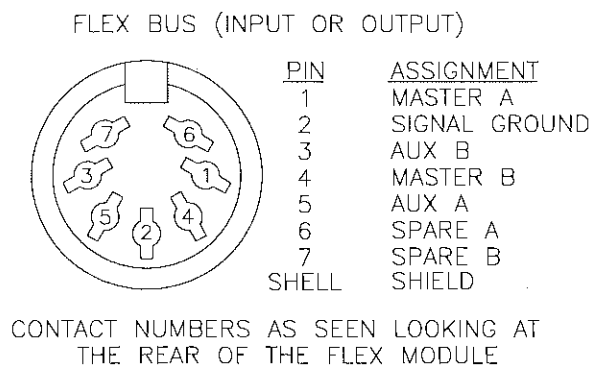
FLEX BUS (INPUT OR OUTPUT)

PIN	ASSIGNMENT
1	MASTER A
2	SIGNAL GROUND
3	AUX B
4	MASTER B
5	AUX A
6	SPARE A
7	SPARE B
SHELL	SHIELD

CONTACT NUMBERS AS SEEN LOOKING AT THE REAR OF THE FLEX MODULE

Fig. 4 Flex Bus System Wiring

Two Master, two Auxiliary, two spare and one ground, make up the Flex Bus system. Agreement with International and American wiring standards comes in using pin 2 as ground, pins 1 & 4 as one audio pair, pins 3 & 5 as another audio pair, and pins 6 & 7 as the last pair—either control or audio, depending on future needs. The shield ties to the shell only.

The spare pair was included, with the knowledge that no matter how carefully we planned the Bus system, someone would come along and say, "This is great, but…"

Impedances

Intended as a design reference, Fig. 5 shows a block diagram of the Flex Bus system. The 2k ohms input impedance is lower than other Flex inputs, but is nothing to worry about. This reduces noise pick-up when using the Bus. There is no headroom penalty since the Flex Bus buffers drive 2k ohms to the full supply limits of at least +20dBu. When driving the Flex Bus system from anything other than Flex modules, or any Rane product, be sure the outputs can drive 2k ohms to full supply limits. All modern op amps do this with ease.

The output impedance of 300 ohms stabilizes the buffer amplifier when driving reactive loads, yet is low enough not to cause significant signal loss. To demonstrate the extent of the careful attention to detail in Flex module design, the slight loss attributed to 300 ohms output driving 2k ohms input (−1.2dB) is corrected within each unit. The careful reader need worry no more.

Putting on the Flex

Fig. 5 shows where audio leaves and adds to the Flex Bus. Each Bus-equipped Flex unit provides separate summing amplifiers for all signals. Audio enters, sums with new internal signals and then redrives the Bus lines. This deviates from the standard mixing board practice of running a common summing-node junction throughout all modules. Superior noise performance and increased flexibility results from using separate summing amplifiers at each unit. The added improvements and benefits easily outweigh the additional cost.

Different Flex units do different things with the Flex Bus. Some do both, take from and add to the Bus; others only take from the Bus, and others still only add to the Bus. All combinations are possible, with applications for each.

Note the careful use of terminology in Fig. 5. Three types of Bus connections exist: IN, OUT and THRU. The first two are self-evident. The BUS THRU jacks are for daisychaining purposes. They exist solely to save you a wye-cord.

They are parallel-wired to the BUS IN jacks, with nothing between. *Use the BUS THRU jacks only for daisychaining; they will not sum two Bus Inputs.*

Hook-up rules are simple:

* Drive BUS IN jacks only from BUS OUT, or BUS THRU jacks.

* BUS OUT jacks drive only BUS IN jacks.

* BUS THRU jacks drive only BUS IN jacks.

Don't Drive; Take the Bus

Creative uses for the Flex Bus abound. These can save money, space and time. Most of these fall into the category of using the Bus when you think you don't need it.

Flex Tip: Use the Bus for extra inputs or outputs.

By wiring your DIN cable (using Fig. 1-4), you can add extra inputs to FPM 44, FLM 82 and FMM 42 modules. The Master A/B Bus inputs (pins 1 & 4) give you an extra line-level input pair that sums with all other inputs for these modules. You can use the Aux A/B inputs (pins 3 & 5) to add an extra line-level pair to the Aux mixes. Or split your extra input to drive and mix into both.

Extra outputs exist on all the Bus modules, except the FMM 42, when using either or both of the Master and Aux Bus Outputs.

Flex Tip: Use the Bus to expand modules.

Tying the same modules together with the Bus cables expands them. For example, using four FPM 44's Bused with the supplied DIN cables, creates a 16-to-4 mixer. Or four FLM 82's Bused together creates a 16-to-1 STEREO (32 input) line-level mixer.
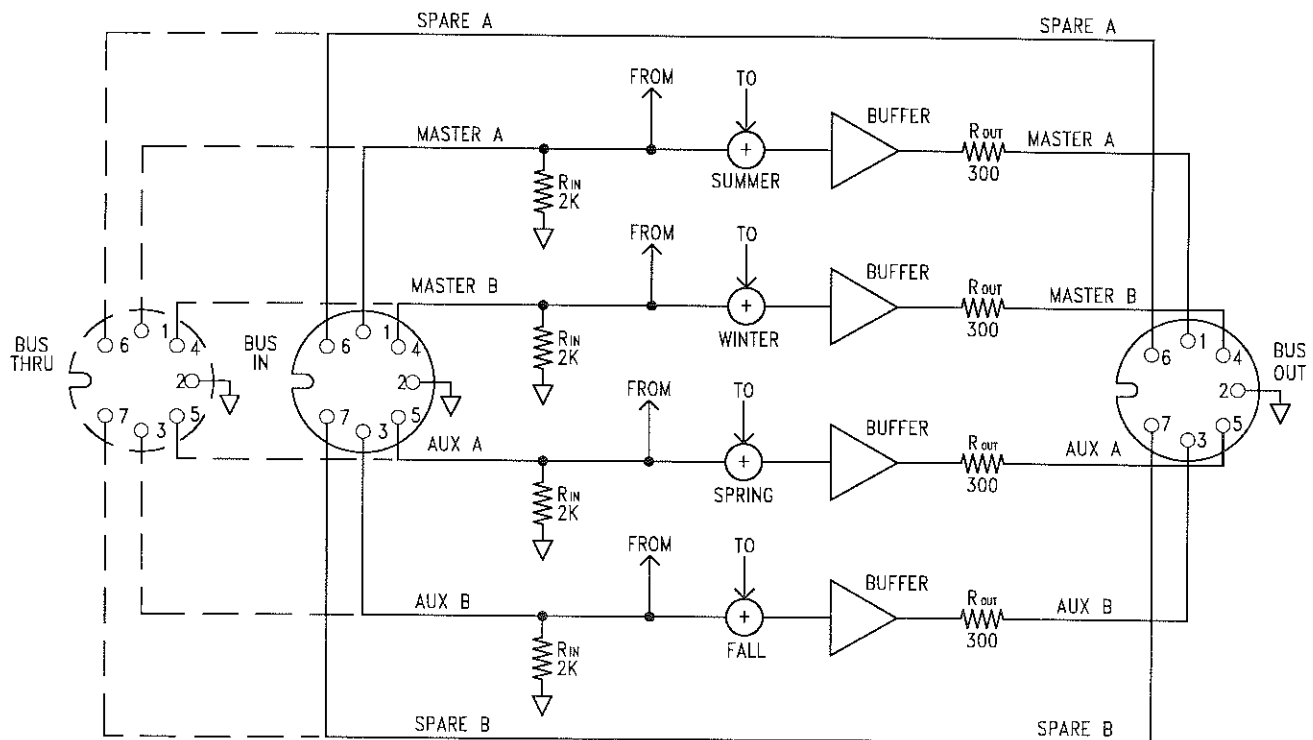

Fig. 5 Flex Bus Block Diagram

Bus Modules

Flex modules using the Bus system generally fall into the preamp/mixer category. The Flex Bus allows modular design of small custom mixers for sound contracting applications (churches, restaurants, schools, etc.), performing artists (keyboard mixers, guitar racks, personal monitor systems, etc.), recording studios (monitoring, equalization, dynamic control, etc.), broadcast (dynamic processing, talk-overs, commercial control, etc.), and post-production work (sweetening, dynamics, monitoring, etc.).

We now turn our discussion to the Bus facilities of each module. Since the data sheets contain complete block diagrams, you may find them helpful as we proceed.

FMI 14 Mixer Input

The FMI 14 is a complete single mic input stage, with functions identical to a standard mic channel on a large mixing board. Fig. 6 shows the Bus diagram. The FMI 14 is an example of a Bus module that only adds to the Bus—it does not take from it. It takes the amplified, processed mic input signal and adds it to the Buses. Which Buses and how much is up to the user.

Control of how much signal adds to the Master A/B Buses is done via the concentric MASTER level pots at the bottom of the module (mounted vertically).

The range is from none to all. Full clockwise (CW) rotation of the *inner* knob adds all the signal to the Master A Bus. Full CW rotation of
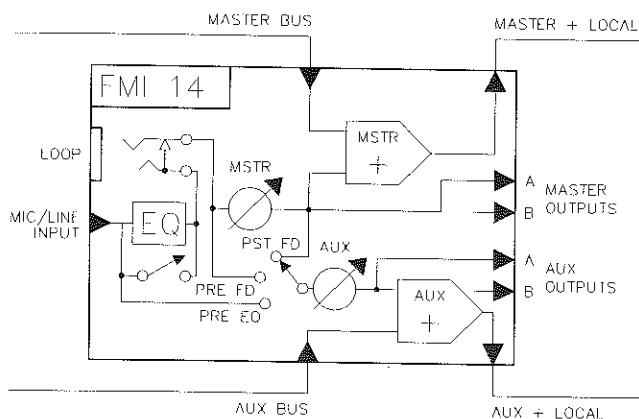

Fig. 6 FMI 14 Bus Diagram

the *outer* knob adds all the signal to the Master B Bus. Full CW rotation of both knobs routes all the signal to both Master A and B Buses. Rotating both knobs together controls the signal level added to both Master Buses simultaneously.

Flex Tip: Use the concentric controls to double as Panning Controls.

Turning MASTER A up, while leaving MASTER B down, pans the signal to the MASTER A Output. Doing the opposite, pans the signal to the MASTER B Output. Rotating both controls together places the signal equally into both channels, i.e., pans center. ("Pan" may not be the term you use. One person's "pan" is another persons's "assign," "route," "send," or whatever. Pan means to send different amounts of the same signal to different places.)

Optional use of the individual AUX SEND controls routes the processed mic signal to either, or both, of the Aux A and B Buses. These independent controls operate identically, with a range of no output (full CCW rotation), to full output (full CW rotation). For all settings described below, the AUX SEND controls determine the output level added to the Aux A and B Buses, and the output level present at the AUX A/B OUTPUTS (different levels, same knob).

The individual assign switches separately control the AUX SEND pick-off points. Choose between PRE EQ, PRE FD and PST FD.

PRE EQ stands for pre-equalization. This position taps the signal after the mic preamplifier, but before the equalizer, insert loop and output sections. Use this for an amplified (line level) signal unaffected by insert effects, equalizer or the MASTER output level controls.

PRE FD stands for pre-fader. "Fader" refers to the concentric MASTER Level controls. This position taps the signal after the preamp, equalizer stages, and insert loop, but before the Master Output Level controls. Use this for an amplified, equalized and/or looped signal, but whose level is independent from the MASTER Outputs.

Changing equalizer settings affect this signal; changing the MASTER Level control does not.

PST FD stands for post-fader. This position taps the signal off after the MASTER Level (fader) control. Use this to control (slave) the Aux Buses signal levels with the MASTER Level controls, such as for effect sends to reverbs, etc.

FPM 44 Program Mixer

The FPM 44 trades off the EQ and effects loop features of the FMI 14 for multiple inputs. Four mic/line inputs exist on the FPM 44, with the Aux sends assignable pre- or post-fader. All connections are through a terminal strip. This makes the FPM 44 most desirable for permanent installations.

The Flex Bus diagram appears as Fig. 7 and shows that the FPM 44 does both: it takes from the Bus and adds to the Bus.

The four mic/line inputs (called local) sum with the Master Bus. The new results (Master + Local) drive the Master Bus, and the MASTER A/B outputs. To repeat (a little redundancy at this point may be useful), the MASTER A/B outputs are the sum of the four inputs channels plus everything that preceded on the Bus. The concentric MASTER level controls determine the relative levels of the MASTER A/B outputs.

The four concentric input LEVEL controls set the respective amount of that input mixed into the MASTER A and/or B Buses and outputs. Use these controls to pan or assign outputs.
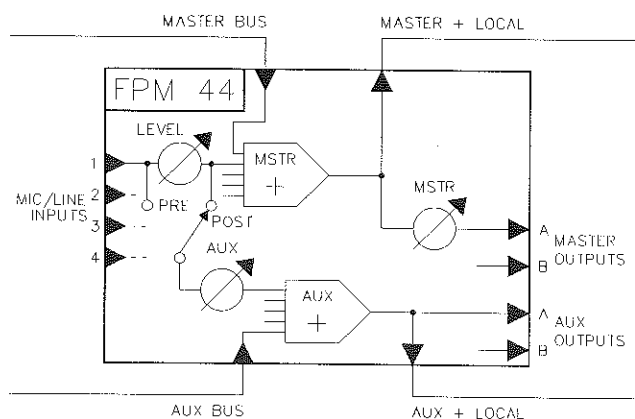
The Aux Bus situation is similar. Use the assign switches to select between PRE (before), or POST (after), the channel level controls. (These switches are internal.) The four AUX SEND level controls are ganged (as opposed to concentric, i.e., these only have one shaft) controls. They simultaneously control the amount of each input added into Aux A and Aux B Buses and outputs. For example, this means you cannot send an input only to Aux A; it always goes to Aux A and Aux B. Like the Master Buses, the four local inputs sum with what is on the Aux Buses and then redrive the Buses and the Aux outputs.

FLM 82 Line Mixer

Better get your block diagram. You're gonna need it for this one.

The FLM 82 trades off the mic level capability of the FPM 44 for extra line-level (only) inputs. Think of the FLM 82 as a stereo mixer. It mixes 4 stereo (or 8 mono) inputs down to 1 stereo (or 2 mono) output(s). The architecture for doing this is important in understanding the Flex Bus system. See Fig. 8 and the block diagram on the data sheet.

The FLM 82 sets up and processes four input pairs (call them stereo if you like), labeled INPUTS 1A & 1B, 2A & 2B, 3A & 3B, and 4A & 4B. Each ¼" TRS input uses the tip=A, ring=B wiring convention. There is a MASTER
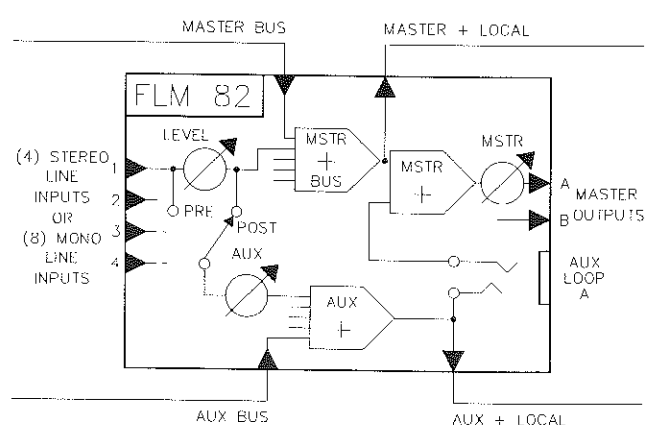

Fig. 7 FPM 44 Bus Diagram

Fig. 8 FLM 82 Bus Diagram

A/B output pair, AUX LOOPS A & B, and the Flex Bus connectors. Note there are no direct AUX Outputs—the Aux sends go only to the Bus system. See Fig. 8 for reference.

Flex Tip: If you need an Aux Output, use a Mono ¼" jack plugged into the AUX LOOP. Use standard mono ¼" plugs on both ends.

The internal architecture sums the four A inputs and the four B inputs separately for the Master Buses/outputs and the Aux Buses. That is, there are four independent summing networks: one each for Master A & B outputs (and Buses), and one each for Aux A & B Bus use.

Mixing 4 stereo inputs to a Master A/B stereo output and a separate mix to the Aux A/B stereo Buses is the natural order for this arrangement. So how do you mix 8 inputs together? Simple; did we mention the MONO switch?

Mixing 8 mono inputs together uses the MONO switch to combine the Master A and B outputs (but not the Buses—no Flex module monos the Bus). Now each Master output is the mix of all 8 mono inputs. For zoning or other purposes, set separate output levels using the concentric MASTER level controls.

The same 8-to-1 mix therefore is possible for each Master output, but not on the Bus. The best you can do is a 4-to-1 mix on Master A Bus and a different 4-to-1 mix on Master B Bus. You can do the same thing for the Aux A & B Bus outputs, but you cannot get an 8-to-1 mix onto any of the Buses. (If this need is critical, you have to do another 2-to-1 mix on the previous 4-to-1 mixes using another module.)

Flex Tip: The Aux Bus does not automatically combine with the FLM 82 Master direct outputs. Normally this happens through an external effects unit plugged into the Aux loop jacks. A dummy plug works as well. Simply insert a shorting ¼" plug with tip wired to ring. This allows the Aux Buses to sum with the Master outputs.

Bus-wise, the FLM 82 is the same as the FPM 44. All FPM 44 Bus comments apply equally here. If you are reading this straight through, you may skip to the FMM 42 discussion.

The four stereo inputs (called local) sum with what is on the Master Bus. The new results (Master + Local) drive the Master Bus, and the MASTER A/B outputs. The MASTER A/B outputs are the sum of the four stereo input channels plus everything that preceded on the Bus. The concentric MASTER level controls determine the relative levels of the MASTER A/B outputs.

The four concentric input LEVEL controls set the respective amount of that input mixed into the MASTER A and/or B outputs. Pan or assign with these controls.

The Aux Bus situation is similar. Assign each input PRE (before), or POST (after), the channel level controls. (To the very careful reader, we respond, "Yes, this means there are 8 assign switches." Each side of each stereo input, e.g., 1A & 1B, have their Aux assign switch. These switches are internal.) Differing from the FPM 44, the FLM 82 features concentric AUX SEND controls. This allows individual levels for each Aux Bus.

Flex Tip: To operate the FLM 82 as a 4-to-1 mono mixer with 2 Aux sends for each input, use a mono cable with a ¼" mono connector on one end and a stereo ¼" TRS with tip and ring shorted on the other end. This arrangement drives both channels with the mono signal, allowing use of each Aux send control.

Like the Master Buses, the four local stereo Aux sends sum with what is already on the Aux Buses, then redrive the Aux Buses and outputs.

FMM 42 Master Module

This is it: the granddaddy of the line, the end of the river, the top of the mountain, the buck-stops-here finale, the big Kahuna of Flex. (Okay, I know, but it's really a great module.)

With the FMM 42, we examine the other Bus extreme. Here is a module that only takes from the Bus; it does not add to it. This means the FMM 42 (Fig. 9) usually terminates the Bus system. The Bus-thru feature allows continuation of the Flex Bus to other modules when required.

The FMM 42's main functions are summing the returning Aux Buses with the Master Buses, displaying the results on the output meters, and driving the main outputs. The FMM 42 allows the Aux Buses to pass through an outboard signal processing device (usually a reverb) using the AUX BUS OUTS/LOOPS, and then return and sum with the Master signals. The AUX BUS level controls set how much of each goes to the outboard processor. For stereo applications, position both knobs to the same spot and rotate together. Mono applications should set the DUAL-MIX switch to the MIX position. This combines the returning Aux signals before summing them with the Master signals.

Flex Tip: If you want to use the Aux Buses separately without mixing into the master, you must turn the Aux Bus controls fully ccw to their "0" positions. If you want to make this fool-proof, insert dummy plugs (mono or stereo) into the Aux Bus outs/loops jacks. Do not wire the dummy plugs; leave all connections open. This breaks the return signal paths.

But wait, there's more.

Besides the above, the FMM 42 provides two extra inputs that sum with the returning Bus signals. One is an additional stereo line-level input with concentric level controls. The other is a mono (mic or line-level) input that triggers a powerful priority ducking system (if engaged).

Talk-over or paging applications normally use this input. Either plug a microphone directly into this jack (offering phantom power and gain trim controls), or use line-level signals. Often these are direct paging outputs available from the telephone equipment. This input is assignable to either Master A, or Master B, or both outputs. It ducks only the channel assigned.

Whenever the audio signal present at the MIC/LINE 1 input exceeds the DUCKER SENSITIV-ITY setting (lighting the LED), all audio except this input attenuates (ducks) by the amount set on the DUCKER DEPTH control. This includes signals coming in on the Master and Aux Buses as well as the LINE 2 inputs.

The Ducker is so handy that many applications exist without using the Bus. Simply bring a stereo source into LINE 2 and plug a paging mic into the MIC/LINE 1 input. Just like that, you have designed a background music system, with paging, using one Flex module.

Flex Tip: If you need another line level input pair, and you are not using the Aux Buses to sum with the Master Buses, you can use the AUX A/B BUS OUTS/LOOPS jacks as inputs. Use a stereo ¼" TRS plug wired with the tip open and the ring hot. Use a standard mono ¼" connector on the driving end. This breaks the Aux Bus return path and drives the ring=return input.

Non-Bus Modules

The rest of the Flex line includes the non-mixers, the problem solvers, the audio tools. These modules do not use the Flex Bus, and are provided to round out a complete system. These are powerful devices, and these little packages contain some amazing circuitry found nowhere else on the planet (at least for such a reasonable price). A general run-down of each module is given here—for more info, please see the respective Data Sheet.
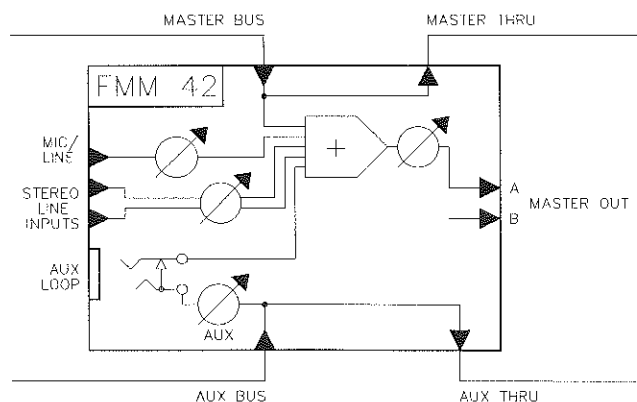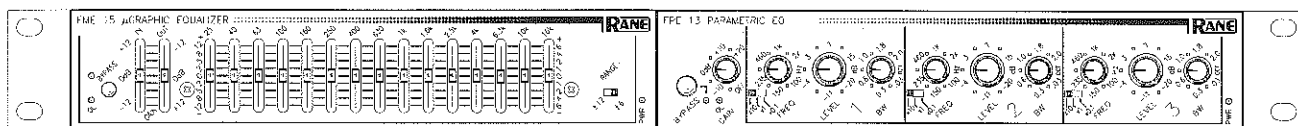

Fig. 9 FMM 42 Bus Diagram

FME 15 Graphic Equalizer

FPE 13 Parametric Equalizer

Equalizers—The FME 15 & FPE 13

Both the FME 15 and the FPE 13 furnish a ¼" TRS PATCH I/O jack on the rear, allowing easy patching to any Insert jack on any mixer input module, giving extensive EQ to any input (FMI 14) or master outputs (CP 62, FLM 82, FMM 42). Balanced Inputs and Outputs include 3-pin, ¼" TRS and #6 strip terminals.

The **FME 15** microGraphic Equalizer is a 2/3-octave, 15 band, interpolating constant-Q graphic equalizer. The interpolating filters in the FME 15 are the same as in the much coveted GE 30 graphic used in the finest installations in the world. Interpolating means the FME 15 produces ripple-free combining of adjacent response curves, while constant-Q produces constant bandwidth curves for all slider positions. See Rane Notes 101 "Constant-Q Graphic Equalizers" and Note 117 "The Rane GE 30 Interpolating Constant-Q Equalizer" for further discussion on why these things are so great. The FME 15 features include a ±6/±12dB RANGE switch, separate Input and Output GAIN controls, Overload indicator and passive BYPASS switch.

The **FPE 13** Parametric Equalizer is a 3 band version of the PE 17 Parametric Equalizer. Each of the 3 filters cover the entire audio spectrum by means of Frequency Range switches on the front panel. Each filter can be adjusted from –20dB cut to +15dB boost, and the Bandwidth in continuously variable from .03 to 2 octaves. Overload and BYPASS switch are included.

Compressor/Limiter—The FSC 22

The FSC 22 is a Stereo Compressor based on the popular DC 24 Dynamic Controller, with a few enhancements. In addition to the RATIO and THRESHOLD controls, a SYSTEM RESPONSE pushbutton allows selection of Fast/Slow program dependent attack/release times. A METER MODE switch allows the GAIN REDUCTION meters to double as OUTPUT LEVEL indicators, helpful during setup. A DUAL/SLAVE switch allows operation as a dual mono unit, or slaved in stereo. In Slave mode, if either channel exceeds the Threshold setting, both channels compress equally preserving stereo imaging. Balanced Inputs and Outputs include both 3-pin and ¼" TRS connectors. See Rane Note 130, "The DC 24 Users Guide" to understand compressor operation.

Limiter/Remote Level Controller—The FVL 22

Sometimes you may need to control volume from a remote location. The FVL sports a ¼" TRS PATCH I/O jack for connection to any Insert jack on a mixer to enable an input or output to be remotely controlled by a potentiometer or switch containing only DC voltage. The FVL 22 allows you to connect almost any potentiometer to a +5 to +24VDC source (the FVL includes a +10VDC source) to control VCAs. Calibration is easy. Additionally, LIMITER circuits are added, preventing system overdrive. The Limiters can be set INDEPEN-
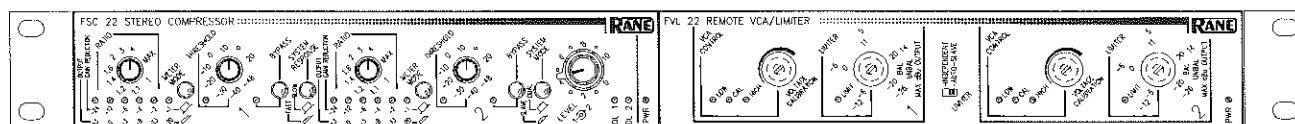
FSC 22 Compressor/Limiter

FVL 22 Remote VCA/Limiter
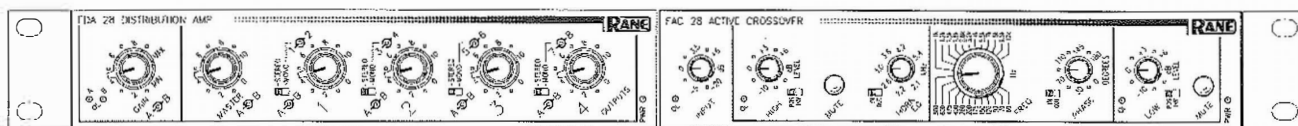
FDA 28 Distribution Amplifier

FAC 28 Active Crossover

DENT (for dual mono) or AUTO-SLAVE (for stereo material). Balanced Inputs and Outputs are on #6 terminal strips.

Signal Splitter—The FDA 28

The FDA 28 is a 2 Input, 8 Output splitter/DA. Each Input is Mic/Line switchable, with GAIN and MASTER Level controls, and Phantom Power switches. Each line level Output has its own Level control, and each pair of Outputs has it's own STEREO/MONO switch, allowing a mixture of stereo and mono feeds. All connections are on convenient Euroblock connectors.

Crossover—The FAC 28

The FAC 28 is the world's first commercially available 8th-order Linkwitz-Riley circuit, in other words, a 48dB per octave filter slope! A 2-Way crossover in the Flex series makes a lot of sense—like building blocks, you build whatever size crossover needed for the number of channels and frequency divisions by daisy chaining. This is Rane's finest crossover to date.

Each HIGH and LOW section has its own LEVEL control, INVERT and MUTE switch, and Overload LED. Variable constant-directivity horn EQ is built-in if required, and variable PHASE correction between outputs, from 0 to 180 degrees, is front panel adjustable. A LOW SUM INPUT jack is provided on the rear panel for Mono Subwoofer applications. Balanced Inputs and Outputs include both 3-pin and ¼" TRS connectors.

Transformer Options—The FLT 22, FBB 44 and Option 44

Transformers are great problem solving devices—they isolate (eliminate ground loops), perform balanced to unbalanced conversion, and match levels. What's more, they require no power supply and add no noise to the signal. Flex packaging makes transformers easy to add into a system without soldering and "where do I stick this thing?"

The **FBB 44 Balance Buddy** is a 4-in, 4-out tranformer balancer/isolator/level converter designed to convert between −10dBV and +4dBu signals. Two 3-pin inputs unbalance to two RCA outputs, and two more RCA inputs balance to two 3-pin outputs. Transformers translate signal either direction, so inputs can be turned to outputs (or vice versa) to enable 4-same-way level matching within one FBB 44. The FBB 44 solves the integration of +4dBu balanced and -10dBV non-balanced units.

The **FLT 22 Line Transformers** are simple line level balancing/isolation tranformers in Flex packaging with #6 terminal strips. Each FLT 22 contains two transformers, and has room to install two more with the **Option 44** kit. The Option 44 is two transformers with terminal

strips, converting the FLT 22 into 4-in, 4-out. The Option 44 can also be mounted anywhere using screws and standoffs when rack space is limited.
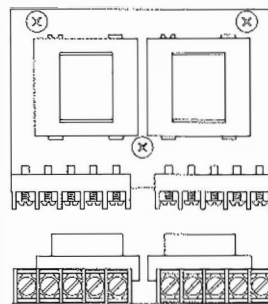
Option 44 Transformers (top and rear)
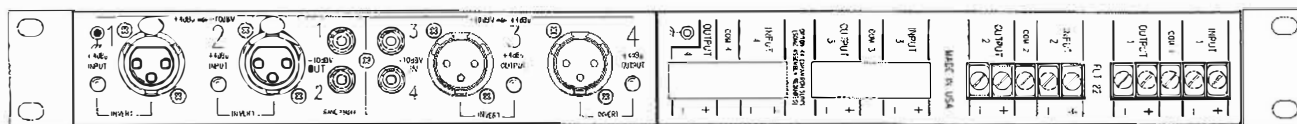
FBB 44 Balance Buddy (rear panel)

FLT 22 Line Transformers (rear panel)

Clever Bus Tips

Now let's actually do something with these modules. The Flex system can solve just about any audio need; yet no amount of effort would allow us to produce a complete application section. All we can do is whet your appetite. This we intend to do with idea teasers, tips and other bits of bizarre cleverness.

Combine Flex With Other Rane Products

As obvious as this may sound, sometimes we get into a half-rack rut. This is where you feel you must solve everything with just Flex products. Not true. The best solutions often are the ones that combine Flex with our full-size products. Check all products before committing your final design.

Use the Bus

If you jumped to this section without reading Part 1, please go back and read the chapter on the Flex Bus System. Using the Bus is the key to compact cost-effective designs. Cost savings come from reduced interconnect time and materials. The Bus allows direct expansion and interconnect between mixing modules. Further, it allows extra inputs and outputs for certain kinds of applications. This alone can save you the expense of adding unnecessary modules.

Front-End Substitution

Tom Jung, of DMP (Digital Music Products) fame, now uses FMI 14's as the main mic preamps for his newest digital recordings. (How's that for name dropping?) He does this because he prefers them to his main recording console.

The idea is to up-grade your present console by using FMI 14's. Add as few or many as needed, whenever you want. To paraphrase a TV commercial: use all you want; we'll make more.
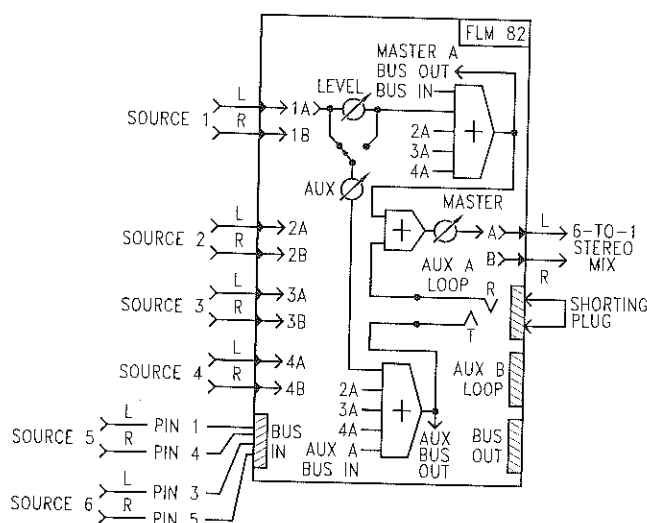

Fig. 10 Using an FLM 82 for a 6 to 1 Stereo Mix

Turning an FLM 82 into an FLM 122

For example, Fig. 10 shows how to add two extra stereo inputs to the FLM 82 Line Mixer. Ordinarily, for stereo line-level input signals, the FLM 82 mixes 4 stereo sources to 1 stereo output. However, if 2 of the input pairs do not require level controls then the trickery displayed in Fig. 10 allows a mix of 6 stereo sources to 1 stereo output (hence, 12 in and 2 out, or an FLM 122).

All you do is wire the 2 extra stereo input pairs (unbalanced) to a DIN connector as shown. Next, connect a shorting plug into each AUX LOOP jacks. This allows summing the signals coming in on the Aux Buses with all the other signals. Make the shorting plug from a stereo ¼" TRS connector with the tip and ring wired together. Leave the sleeve open. Do not short the tip and ring to the sleeve.

Variations of this trick work wonders with other Bus-equipped modules. Remember the Bus whenever you need an extra input or output. It can save you gobs of grief, not to mention tons of cash.
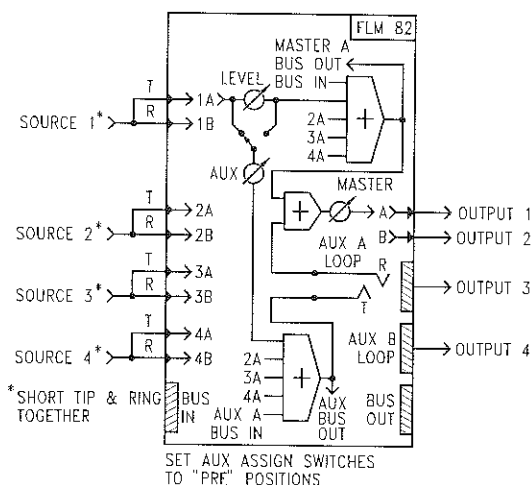
Fig. 11 FLM 82 4x4 Matrix Mixer

FLM 82 4x4 Matrix Mixer

Perry Lengyel of Ouzunoff Associates, a New England rep firm, is the first guy who figured out how to use an FLM 82 as a 4x4 matrix mixer. Imagine, a true 4x4 matrix mixer in a single half-rack package—man are we ever clever! (Of course, someone else had to point it out to us, but that's beside the point.)

Fig. 11 illustrates all the necessary tricks: 1) Use stereo ¼" TRS plugs for each input, and short the rings and tips together so that each input drives both A and B sides; 2) Set all AUX SEND assign switches (internal) to PRE positions. Now each input signal drives four controls in parallel: LEVEL A/B & AUX SEND A/B. Each of these is individually summed to four outputs: MASTER OUTPUTS A/B & AUX LOOPS A/B. The final trick is to take the AUX outputs from the AUX LOOP jacks using a standard mono ¼" plug.

The only compromises are overall level controls on the MASTER OUTPUTS, but not on the AUX LOOP outs; and balanced outputs for the MASTERS but not the AUX's. Not bad.

Any Size Matrix

Expansion to any size matrix is straightforward: Additional inputs result from Busing FLM 82's together using the supplied Bus cables. Two Bused FLM 82's produce an 8x4 matrix; three yield an 12x4 matrix, and so on. Add outputs by paralleling inputs; thus if each input drives two

FLM 82's you get a 4x8 matrix; three gives you a 4x12 matrix, etc. And, of course, doing both creates an size matrix (in multiples of four), e.g., 8x8 or 12x16, or whatever.

Mic or Line-Level 4x3 Matrix Mixer

Consider using FPM 44's when you need to create a 4x3 matrix mixer with mic and/or line-level inputs. Use the four inputs, set the internal ASSIGN SWITCHES to their PRE positions, and take your three outputs from MASTER A, MASTER B and either AUX A or AUX B jacks (the same mix appears at both AUX outputs with the ganged control). Slick.

You can use the FPM 44 Level controls to judiciously assign inputs. The problem is to mix one input separately with each of three individual inputs, to produce three 1 + 1 mixes.

Use Channel 4 for the common source, and turn all of its knobs up full, i.e., the concentric LEVEL A/B and the AUX SEND knobs. This routes this source equally to all outputs. Next bring the individual inputs into Channels 1, 2 and 3 respectively. With all other controls off (fully CCW), turn Channel 1 LEVEL A maximum. Turn Channel 2 LEVEL B maximum. Lastly, turn Channel 3 AUX SEND maximum.

The result is to combine and send Channels 1 + 4 to MASTER A output only; Channels 2 + 4 to MASTER B output only; and Channels 3 + 4 to AUX A output (and B, but we don't care). So there you have it: an economical, simple and small way to provide three 1 + 1 mixes.
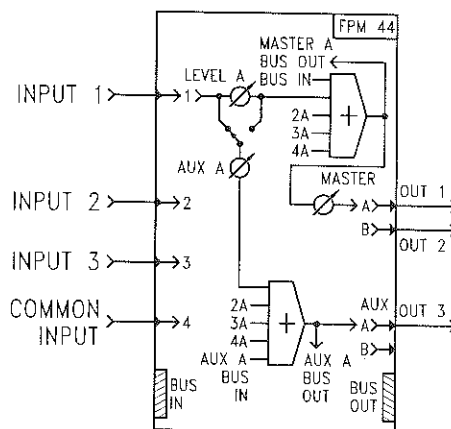

Fig.12 Three 1 + 1 Mixes

Mic or Line-Level 4x4 Mic Preamp

Sometimes a 4in-4out mic preamp is needed. For instance, 2 FPM 44's could be used as eight super-clean balanced mic/line inputs in a single rack space for digital eight track machines. Other applications use the FPM 44 where a full 4x4 matrix is not necessary for all mic inputs. The FPM 44, as it exists, has four Inputs and four Outputs, Master A/B and Aux A/B. However, the AUX SEND controls both the A and B Aux's simultaneously, making it impossible to route to Aux A or B independently. Because of the GAIN dB switches, there isn't enough room on the front panel to make the AUX SEND control a dual concentric like the FLM 82's. Solution: There is an easy mod which will assign any inputs Aux to either Aux A or Aux B without affecting the Masters, creating 4 in, 4 out.

1. There is a pre-post switch located on the pc board near the front of each section. These need to be in the PRE position on any channel you wish to send to an Aux Output only.

2. There are resistors that connect each input to the Aux A or B Outputs. R31 connects to the Aux A Output, and R34 connects to the Aux B Output. So to make any input send only to Aux A, disconnect 1R34 for input 1, 2R34 for input 2, etc. To make any input send only to Aux B, disconnect 1R31 for input 1, 2R31 for input 2, etc. To keep it simple, you might want to just modify input #3 by disconnecting 3R34 to send to Aux A, and 4R31 in input #4 to send to Aux B. Any input will send to Master A or Master B Outputs by turning one of the dual concentric (A/B) LEVEL controls up. You can also send each of the modified channels to their respective Aux Output with the AUX SEND control.

Using the simple mod described above, you can use input #1 to go to Master A, #2 to go to Master B, #3 to go to Aux A, and #4 to go to Aux B. Remember, LEVEL controls should be turned all the way down on any channels which you only want to send to an Aux Output. To insure the warranty, this mod should be done by any factory authorized warranty station.

Mixing Mic, Line and Phantom Power

Thanks go to "Santez" of Chicago fame for this one. The FPM 44 design now allows simultaneous use of phantom powered mics, non-phantom powered mics, and line level signals. Santez came up with the clever idea of having the GAIN switch *automatically defeat phantom power when placed in the lowest gain setting.* The rationale being that you would only use the lowest GAIN setting for line-level signals (I told you this was clever.) Next, for absolute flexibility, he suggested we try to put individual phantom switches *internally.* That way, they at least exist if needed. We took these suggestions to heart and managed to do it all. So now, thanks to Santez, you can mix and match phantom power mics with non-phantom powered mics and line level signals, all in the same half-rack unit.

Fig. 13 shows the details for a system comprised of one phantom powered mic, one non-phantom powered mic, and two line-level signals. You must remember to do three things: 1) Turn on the Phantom Power switch located on the side of the unit; 2) Remove the top cover and move the Channel 2 internal PHANTOM POWER jumper block to "OFF"; and 3) Position the Channel 3 & Channel 4 GAIN switches to the "+10dB" settings. Now phantom power appears only on Channel 1 for this unit.
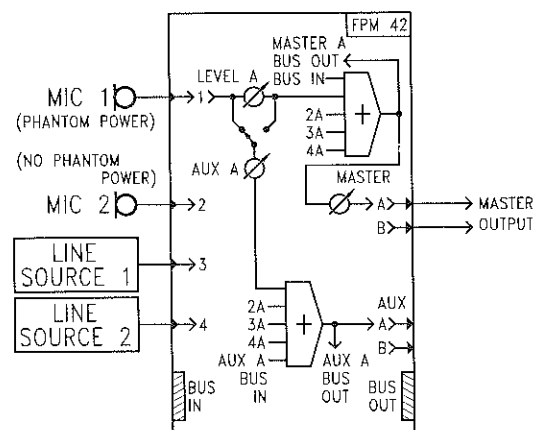

Fig.13 Mixing Mic, Line and Phantom Power

Paging Systems

Distributed Sound System

This application is similar to Rane Corporation's factory sound system. Fig. 14 shows how Flex provides an efficient solution to factory and office distributed sound systems.

Twelve zones divide into two paging areas: office and factory. Two FMM 42's provide the ducking facilities for the telephone paging signals and the main sound source (a tuner in Rane's case). The combined signals distribute through separate level controls (using the FDA 28's). Three FME 15's allow equalization of troublesome factory zones.

Lastly, two MA 6S's drive two MT 6's, providing 70.7V or 25V drive to the ceiling speaker arrays. The complete system fits into just 31.5"
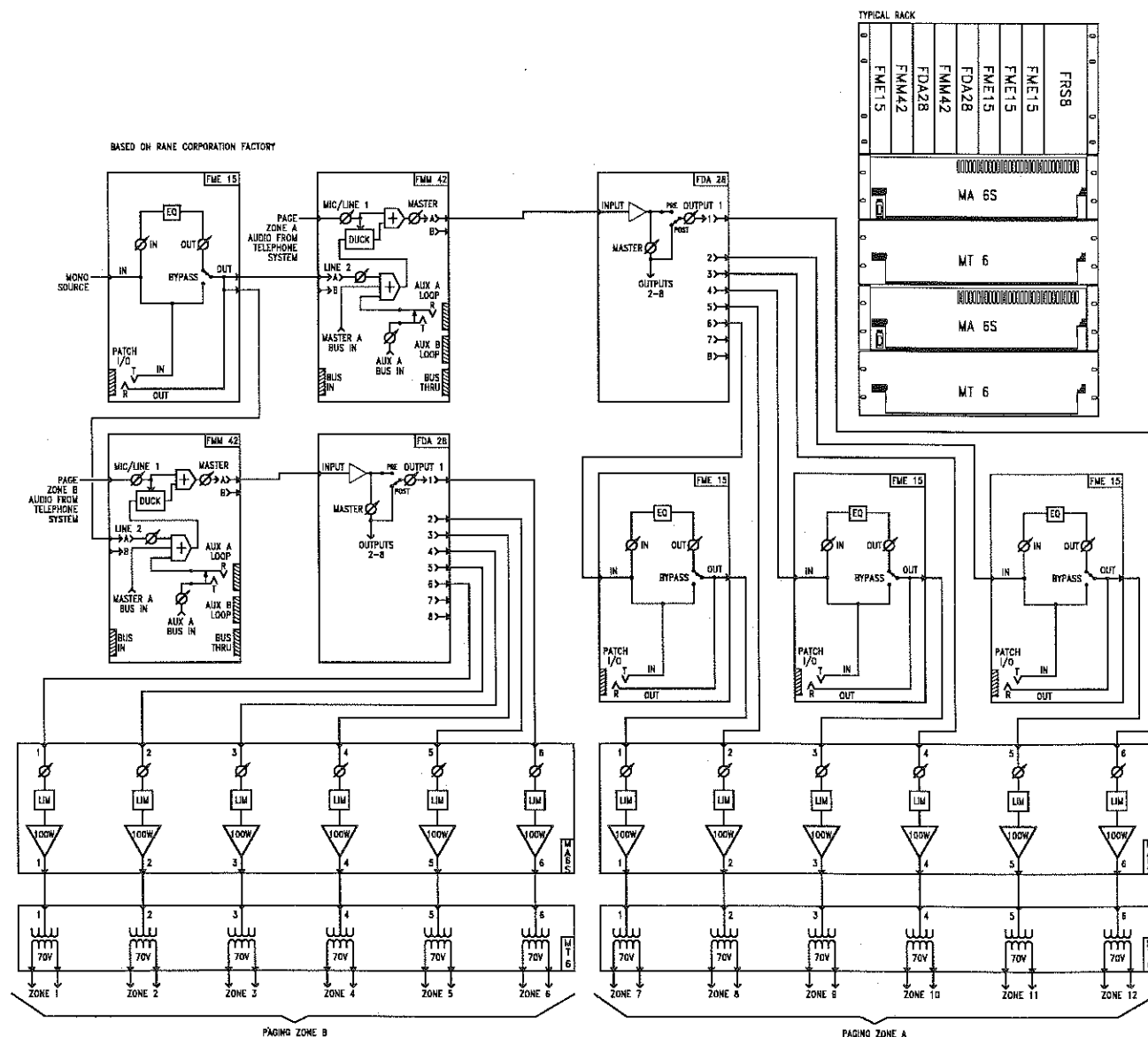
Fig. 14 Distributed Sound System

Multi-Mic Paging System

This application neatly solves the problem of mixing several microphones together for paging the same areas. Fig. 15 shows how one FPM 44 amplifies and mixes four paging mics to one output signal. This signal passes through an FPE 13 for equalization before going to the FMM 42.

The FMM 42 gives the ducking function necessary to mute the mono source while paging. The output of the FMM 42 drives the FDA 28, splitting the signal into six lines. These go to the MA 6S/MT 6 combo to provide 70.7V or 25V power for the zones.

It all fits into a very compact 14" (8U) rack.
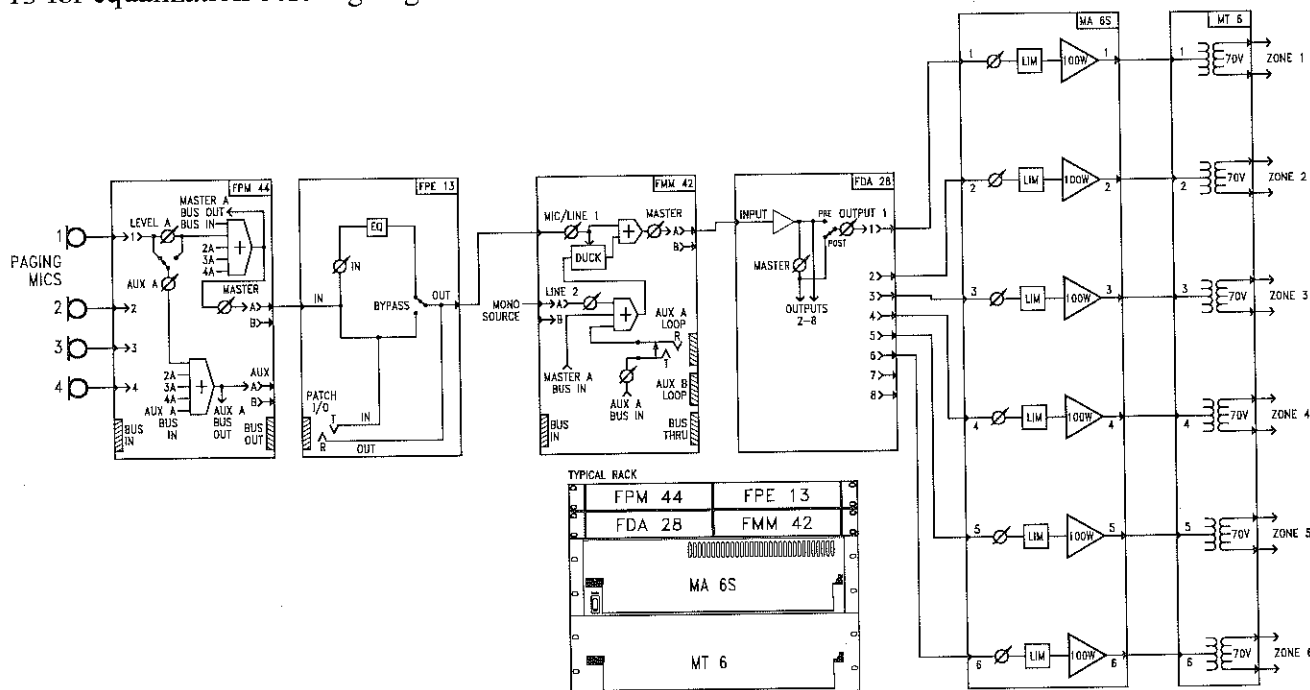
Fig. 15 Multi-Mic Paging Systems

Four Zone Mixer with Paging

Figure 16 shows a little system that can handle four sources, each assignable to any zone, and a mic that ducks all zones for a page.

Use a dynamic mic with an on/off switch for the paging mic. Run it's output to a simple wye splitter cable to both mic inputs on the FMMs.

The FLM 82 TRS inputs should have their tip and rings shorted together to allow routing to any output (see the FLM 82 Matrix Mixer on page 23). Optionally, these could be wired as four stereo sources and the output would be two stereo zones—the choice is yours. Refer to Rane Note 109, Wye Not Wye, to correctly convert stereo sources to mono.

To send an input to Zone 1, turn up its Master A on the FLM 82. Zone 2 comes from Master B. Zone 3 from Aux A, and Zone 4 from Aux B.
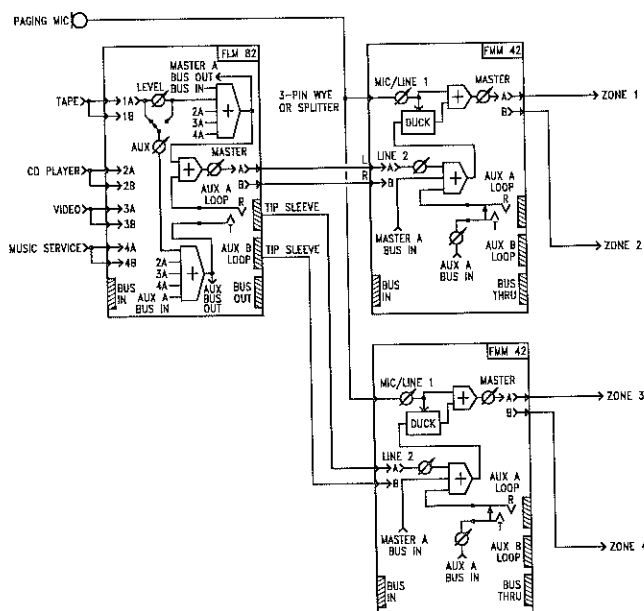

Fig. 16 Four Zone Mixing and Paging

Separate Paging Zones

Fig. 17 addresses the case where you have the same stereo program source going to eight zones, with four of them having separate paging microphones. First, the FDA 28 splits the input stereo source into four distributed sources. Then it provides convenient expand out points to drive another FDA 28, used to drive the four unpaged zones.

A separate FMM 42 amplifies and controls the ducking circuitry for the microphone used to page each zone. The outputs go to an MA 6S or any other appropriate multichannel power amplifier used to drive the zone loudspeaker arrays.
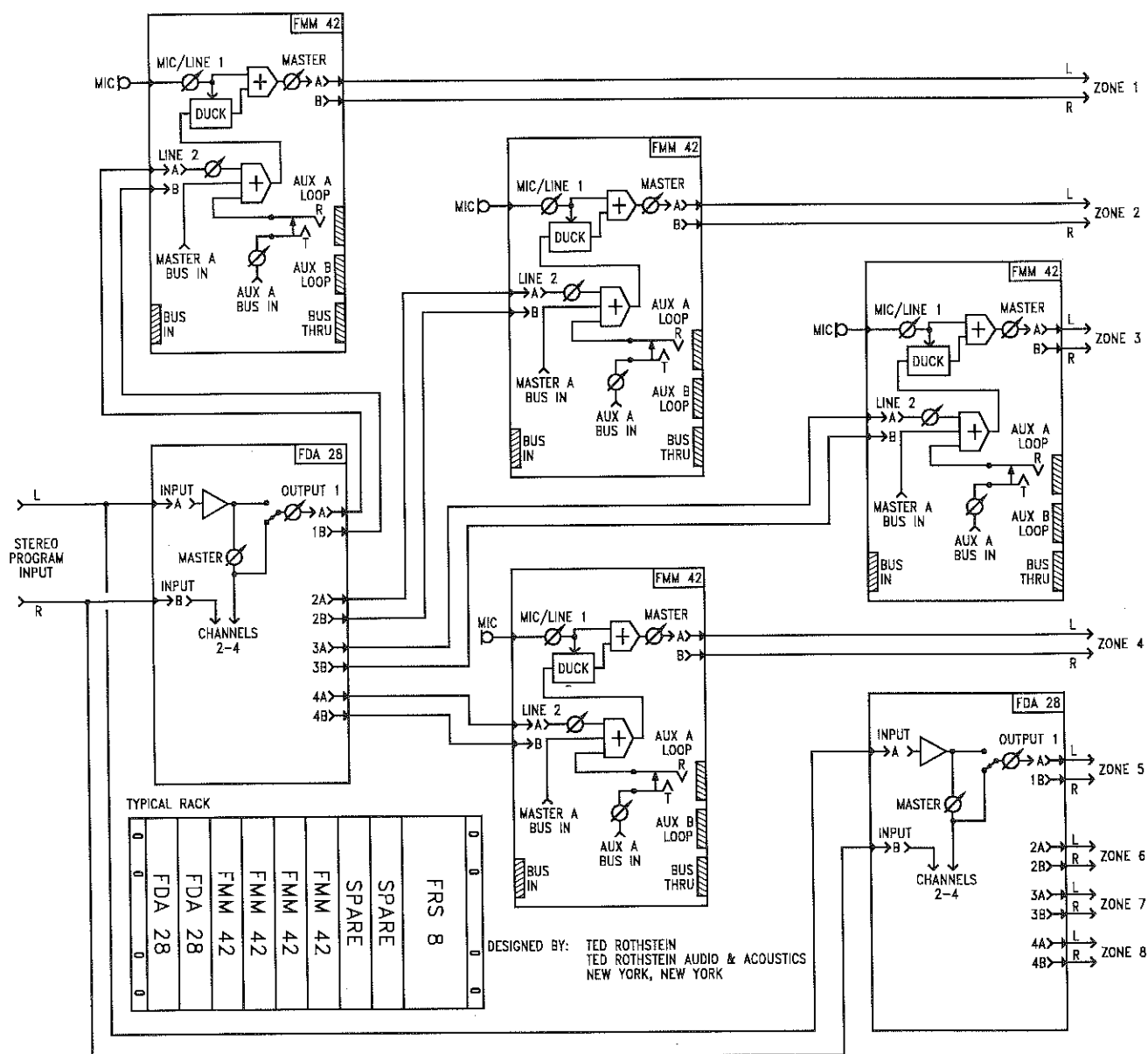
Fig. 17 Separate Paging Zones

Priority Paging System

Ted Rothstein, Ted Rothstein Audio & Acoustics, New York, designed the system shown in Fig. 18. Here he expands the previous application to allow each of the four mics to page any of the four zones.

Individual MS 1 mic preamps amplify each paging microphone locally before going to the selector switch. Each switch allows the user to select which zone they page. The switch outputs go to the four FMM 42's to control the ducking circuitry. Note the use of two FLT 22's (with Option-44's) to provide transformer isolation.

Here's the clever part: The stereo program source goes to the AUX A/B LOOP jacks (using a ¼" TRS plug with the tip and ring shorted together) instead of the LINE 2 inputs. This backfeeds through the AUX LEVEL pot (positioned fully CW and welded) to drive the Aux A/B bus lines. Now expansion is done by connecting the FMM 42's together using the DIN cables supplied with each unit.

To complete the circle, the AUX A/B LOOP jacks on the last FMM 42 provide the exit to the stereo source (again using a ¼" TRS plug shorted tip to ring). This signal feeds the inputs of the FDA 28 for the final four zone split.
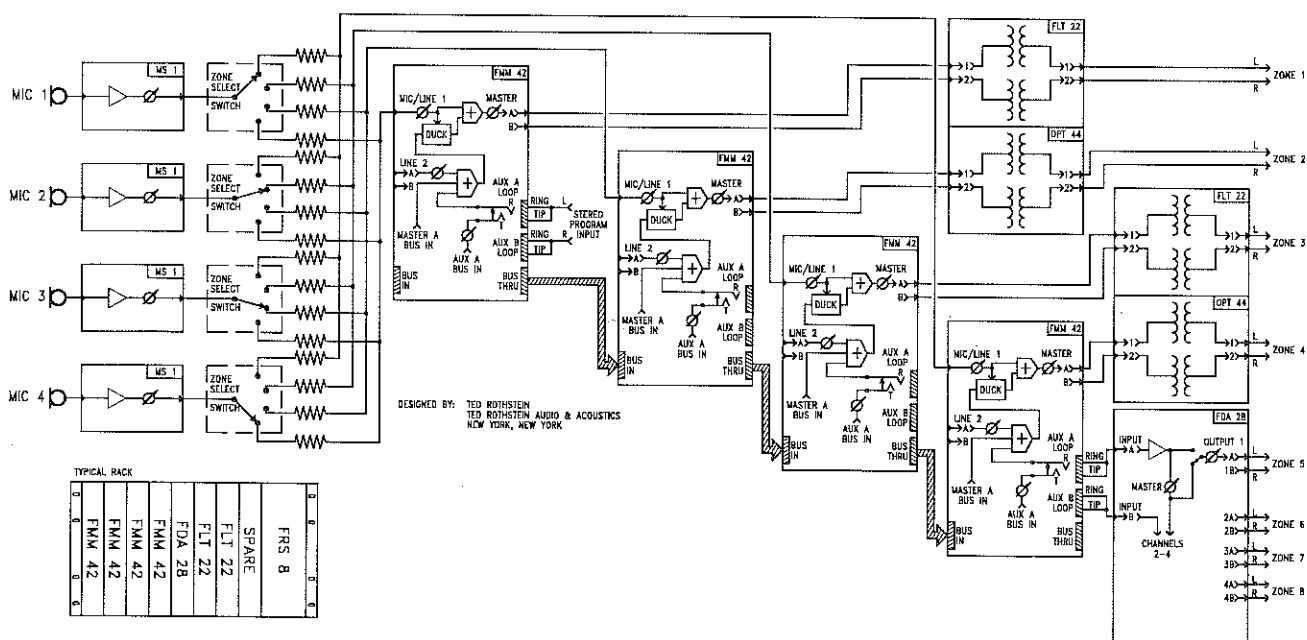
Paging With Separate Stereo Sources

Fig. 19 shows how to solve the problem of having one paging mic and the need to page five different zones, each with its own stereo background source.

An FMI 14 conditions the mic's output and drives an FDA 28 Program Splitter, used to distribute the signal to the MIC-LINE 1 input on each of the five FMM 42's. Position each FDA 28 internal assign switch to POST. This way, turning down the FDA 28's MASTER level control affects all paging zones equally. Use the individual FDA 28 OUTPUT level controls to set the desired paging level for each zone.

Route each of the music sources to the LINE 2 inputs on the FMM 42's. Be sure and select LINE mode for the paging input going to MIC-LINE 1 input, and set the ASSIGN switch to AB.

Bicycle Shop Sound

Larry O'Neill of Dobbs Stanford, a Texas rep firm, solved a tricky routing request using the single FMM 42 scheme shown in Fig. 20. The problem involved a bicycle shop and the desire to add audio background music-on-hold to their telephone system, and to sometimes route an

Fig. 18 Priority Paging System

Fig. 19 Paging with Separate Stereo Sources

audio-from-video (TV) feed through their (normal) FM tuner sales floor sound system.

Referring to Fig. 4-7 we see the following: the telephone page signal is brought into the FMM 42 MIC-LINE 1 input, selected for Line mode. The ASSIGN switch is set for "A" only. This way only the "A" channel is ducked and paged.

The FM tuner is set for Mono mode and connected to the LINE 2 inputs. This is the music-on-hold signal as well as the normal background sound source. The 70 volt ceiling system is fed from the OUTPUT A jack. The OUTPUT B signal (FM tuner only, since LINE 1 input is assigned only to "A") is used to drive the music-on-hold input on the telephone panel. This interconnection is balanced or unbalanced as required.

Next the TV audio feed enters the FMM 42 using the AUX A input (pin 5) on the FLEX BUS IN jack. (Note: the AUX BUS OUT/LOOP jack is not used since it would bypass the Aux level control.) By selecting the DUAL mode for the AUX BUS, the TV sound is available upon demand as a background source instead of the FM signal. This is used during the televising of important bicycle events (Tour de France, etc.), or for running similar video tapes. For TV sound

the shop owner turns LINE 2 "A" (FM tuner) down and AUX "A" up. This way, TV sound is broadcast throughout the ceiling system, while FM is still heard as the music-on-hold signal.

If TV sound is desired as the music-on-hold signal then MIX mode is selected and both LINE 2 "A" and "B" are turned down, while both AUX "A" and "B" are turned up.

Obviously this system adapts easily to all store types and TV broadcasts.

Fig. 20 Bicycle Shop Sound

Specific Systems

Lecture Lab Audio System

Joe Baron, AV Associates, Inc., Connecticut, designed the Lecture Lab Audio System shown in Fig. 21. This voice reinforcement and play-back system uses Flex modules to create a set-and-forget mixer, secured with an FSC 10 security cover. For this college environment application a full-sized mixing console was too bulky and hard to enforce security.

Located in the main student seating area are eight mic plates. These receptacles are always hot, allowing moving microphones at will. Two FPM 44's amplify and mix these mic signals for driving the distributed speaker system power amplifier.

Two FLM 82's mix the various signal sources with the feed from the distributed power amp used for the seating area mic plates. Two FME 15's equalize the Master A/B signals from the FLM 82 before sending them to the FVL 22 Remote Volume Control (VCA) for the main speakers. The FLM 82 Bus Out signals (Master A/B) drive an FDA 28 for splitting the main mix into one mono and two stereo signals. The mono signal drives the tape recorder patch bay, while the two stereo signals go to the Distribution Panels for remote location use.

Lastly, the first FLM 82 feeds an FMM 42 via the Flex Bus System. The FMM 42 adds a stereo Monitor Audio source from the video rack to the sources on the bus. This signal feeds the powered monitor speakers in the control booth.

All done with one Flex rack full of Rane gear.
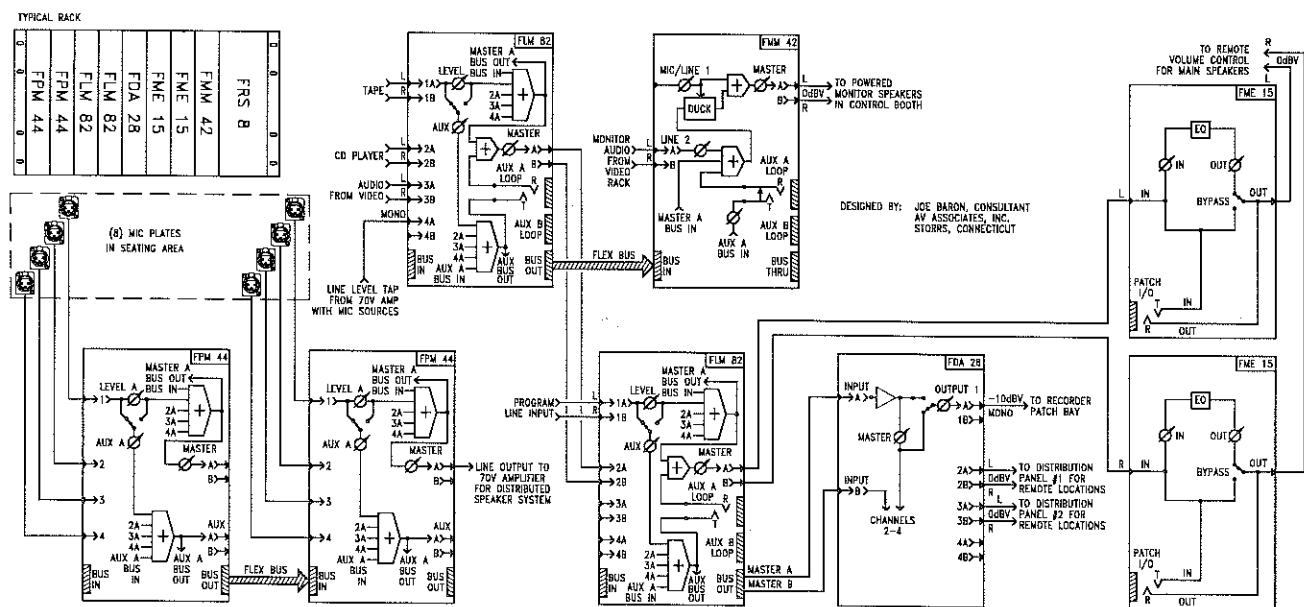
Fig. 21 Lecture Lab Audio System

Hypnotherapy Doctor/Patient Offices

This one comes to us from Charlie Brewer, of World of Music in Joliet, Illinois. The problem involves three doctors, five patients, and two-way headset communication between any doctor and any patient. Patients and doctors must be able to hear themselves in their own headphones. Normally involving only one doctor and one patient at a time, the patient sits in a reclining chair with a sleep-mask and headsets. The headsets provide soft stereo background sounds, while screening out the extraneous outside noise. Over the background sound comes the soothing voice of the doctor. At the same time, other doctors may listen in for learning experience or as consultants. And the whole thing is video taped and monitored by a nurse in a central viewing room.

The system must be simple, intuitive and unobtrusive. It must allow a doctor to enter the room, put on headsets, plug into the desired patient room, press the corresponding TALK switch, and begin therapy. The patient only has a headset. No controls, no choices. All done with no noise (for distraction reasons) and absolutely no crosstalk (for confidentiality reasons).

The solution appears as Fig. 22. Each doctor room uses an MS 1 Mic Preamp to amplify the mic to line level. The MS 1 output routes through a switch bank to one of the five patient TALK buses. An HC 6 Headphone Console receives each of the five stereo LISTEN buses, and provides the headphone drive while maintaining excellent channel separation. Another HC 6 drives the five patient headphones.

Using a variation of the trick shown in Fig. 10, an FLM 82 (for each patient, five total) mixes the three doctor TALK inputs (shorting input tip to ring to drive both A and B channels), the cassette deck, and the patient mic (amplified by a local MS 1 driving pins 1 & 4 of the BUS IN jack). Alternatively, substitution of an SM 26B for the FLM 82 works just as well. The trade-off being cost versus space. While costing slightly less, the five SM 26B's occupy five rack spaces to the FLM 82's three.

Another requirement for this system was to allow right-brain/left-brain experiments. Either the FLM 82 or the SM 26B provides this capability by allowing panning of all signals to either the left or the right.

In practice the system proved so quiet that only the patient's amplified breathing sounds revealed it was even on.
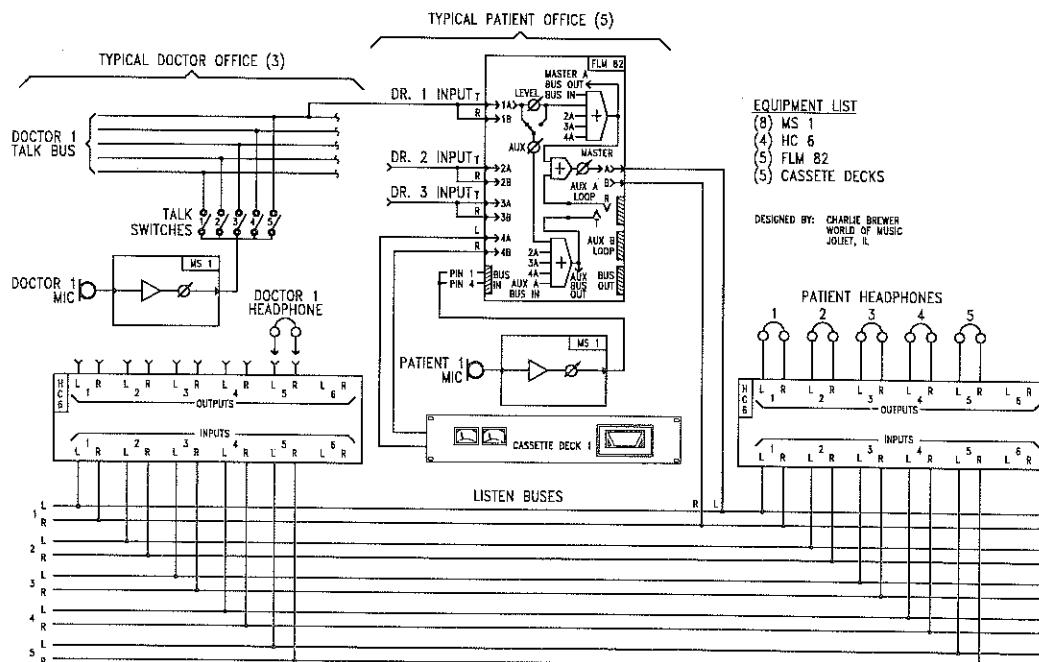
Fig. 22 Hypnotherapy Offices

Hotel 3-Way Conference Room

Fig. 23 shows how to apply Flex modules to create a 3-way conference room sound system. This is the situation where one day you want three individual rooms. The next day you need two of them combined with one solo; and the day after that you want all three connected. A small version of the classic room-combining problem. Here's a very affordable solution. Nothing fancy, just functional.

FMI 14's amplify and EQ the three public address microphones. The Master A Outputs of the FMI 14's go to a custom built switching box

as shown, and they interconnect using the Bus In/Out jacks. These connections create the following distribution as a function of selector switch setting:

Switch Position	Zone 1	Zone 2	Zone 3
Left	1	2	3
Middle	1+2	1+2	3
Right	1+2+3	1+2+3	1+2+3

The outputs of the switch box feed FME 15's (or FPE 13's, or whatever) to add EQ before passing on to the MA 6S/MT 6 combo for powering the 70.7V or 25V ceiling speaker arrays.
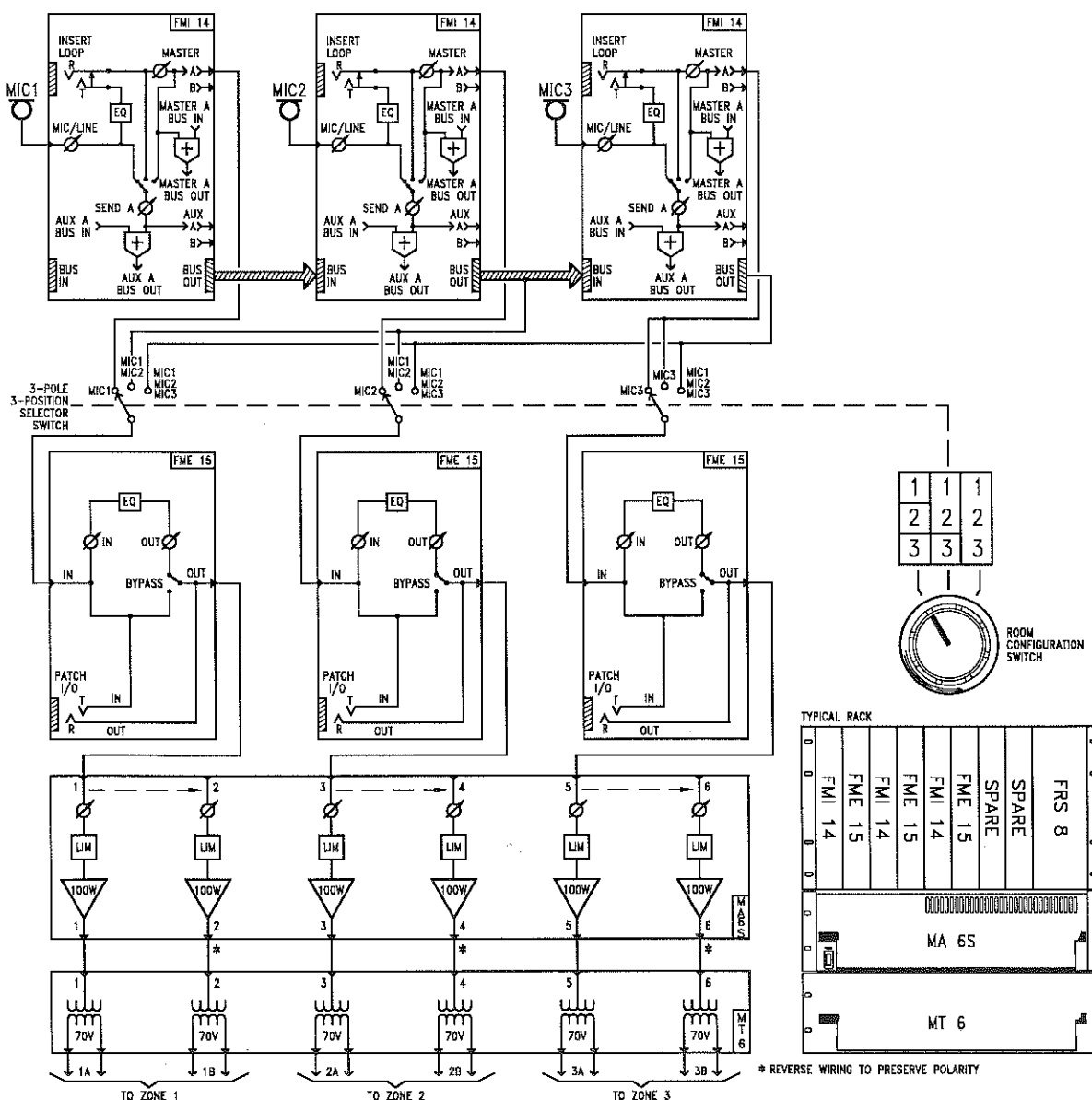
Fig. 23 Hotel 3-Way Conference System

Four Room Combining System

Here's a Flex system in Figure 24 we came up with for a midwestern hotel, solving the classic room combining problem. Here is an affordable solution to combining four rooms in eight different combinations. A RAP 10 power supply delivers power with one switch. Add EQ, amplification and 70 volt line transformers as required.

A FSC 10 vertical security cover houses a four pole, eight throw switch wired per Figure 4-11. Each position taps a different point in the Flex bus chain, or sum from the FLM 82. Refer to the FLM 82 4x4 Matrix Mixer on page 24 for details on matrixing. Though we've drawn the system "maxed out", some switch positions could be eliminated for simplification.
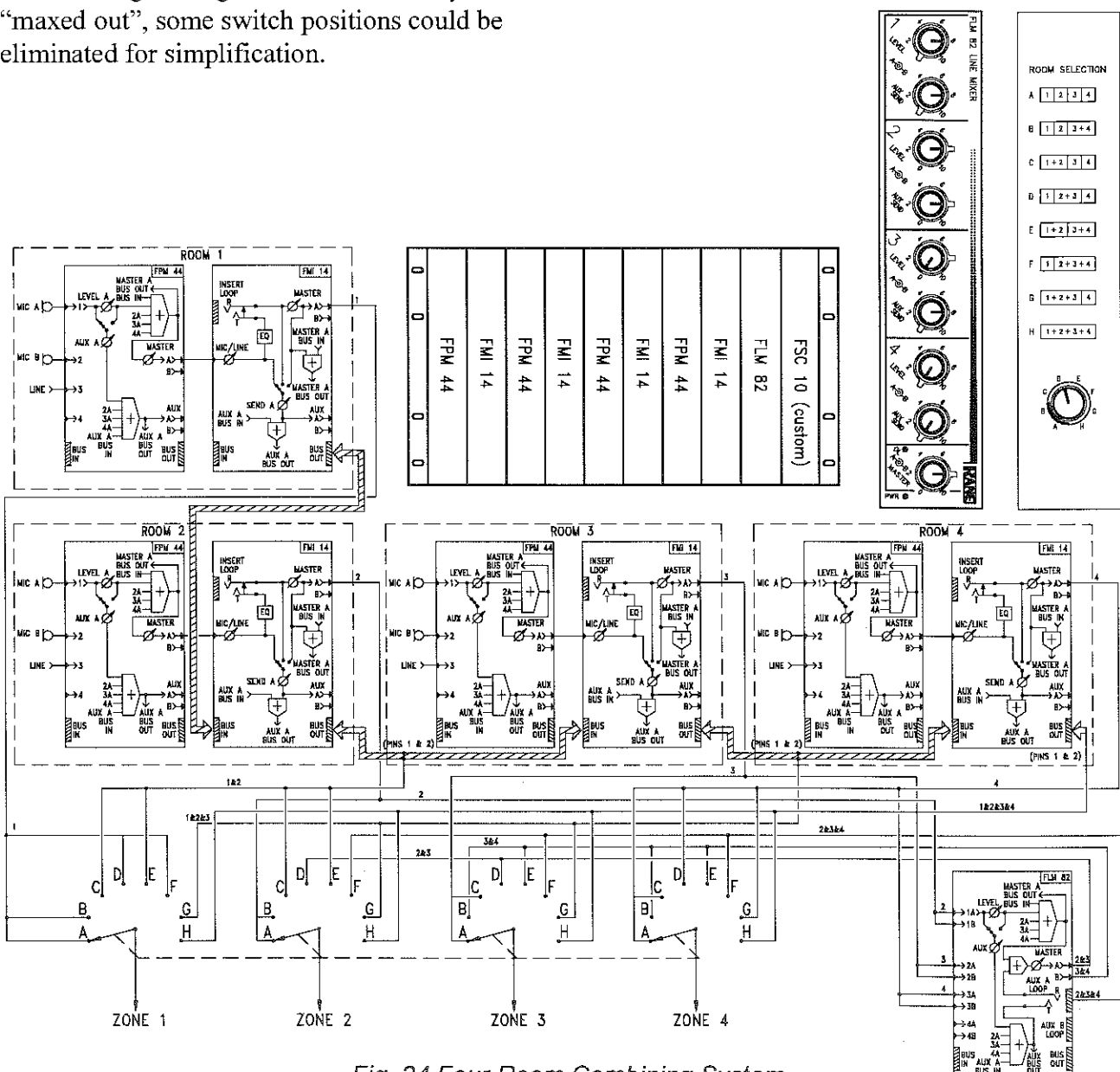
Fig. 24 Four Room Combining System

Ballroom Combining System

Fred Piotrowicz of MKE, a Michigan based professional sound contracting firm, designed the system shown in Figure 25 for the Kalamazoo Center Hotel. The problem solved here is the common one of how to provide flexible, yet simple and cost-effective, room combining capabilities.

Designed around room combining panels made by Communications Company of San Diego, Flex products provide the required mixing and EQ, while one MA 6S powers all six rooms. An FPM 44 mixes two mics and the FVL 22 VCA controlled Aux source together to drive an FME 15 graphic equalizer. This signal is then routed by the room combining panel to the MA 6S, which drives the ceiling speakers.

Fig. 25 Ballroom Combining System

Noise Masking System

Simple noise masking systems use one equalized noise generator, distributing the shaped noise throughout the ceiling array. Rane Note 116 gives the details. While cost effective, these simple systems too often are, themselves, a distraction. When this happens, the system gets switched off and the customer feels noise masking doesn't work and they wasted their money.

The evolution of successful noise masking produced the following guidelines (from "Acoustics of Open Plan Rooms," by Rollins Brook and "Sound System Design," by Chris Foreman in Glen Ballou, Ed., *Handbook For Sound Engineers* [Howard W. Sams & Co, Indianapolis, 1987]) for creating unnoticeable, yet very effective systems:

• Use three carefully equalized noise sources
• Interlace noise sources driving speaker arrays
• Disperse noise evenly in all areas (±2dB)
• Use adequate amplification to avoid clipping
• Use separate EQ for the paging source
• Do not attenuate noise during paging

These guidelines result in a fairly complex and expensive system. Luckily, Flex modules can help reduce both. Fig. 26 outlines the basis for a system meeting the above criteria.

The most random signal results from the use of exactly three noise sources (more do not add more). This way, no two adjacent speakers emit the same sound. Each neighbor produces a randomly different sound. Experience has shown this approach creates the least distracting and most effective masking.

A nonirritating and successful noise source mimics the shape and range of normal speech. This means a maximum frequency range of about 200Hz to 5kHz, with an overall rolloff of 5-6dB/octave beginning at 200Hz and extending to around 5kHz. With perfect speakers and no room interference, this can be done with a single capacitor. With actual speakers and normal rooms, this takes a 1/3-octave equalizer. Such is the cost of living in the real world.

The equalizer locations are arbitrary. Placing them between the FPM 44 and the MA 6S works just as well (shown dotted in Fig. 26). Some (extreme) situations use equalizers in both spots.

The FPM 44 mixes the page signal with each noise source, keeping the sources independent. You do this by rotating one output fully CW while leaving all others positioned fully CCW. Turning up Channel 1 adds the page signal.

An MA 6S/MT 6 combination drives the ceiling array. Channels 1, 3 & 5 of the MA 6S automatically feed the inputs of Channels 2, 4 & 6 with an inverted signal when the Bridge switch is engaged. Reverse wiring their speaker outputs brings everything back into proper polarity.

The outputs drive the loudspeakers in an interlaced array as shown by the detail drawing. No two adjacent speakers receive the same source. This is not the wiring nightmare it first appears. Notice that the speakers still wire daisychained, just diagonal instead of straight.

The noise must be as uniform as possible throughout the office environment. This demands lots of speakers. The most successful systems extend the noise signal into ancillary areas (storage rooms, copying/FAX centers, closets, etc.) adding even more speakers.

Extension of the basic design given in Fig. 4-13 is straightforward. Using additional MA 6S/MT 6 combos allow easy affordable expansion.
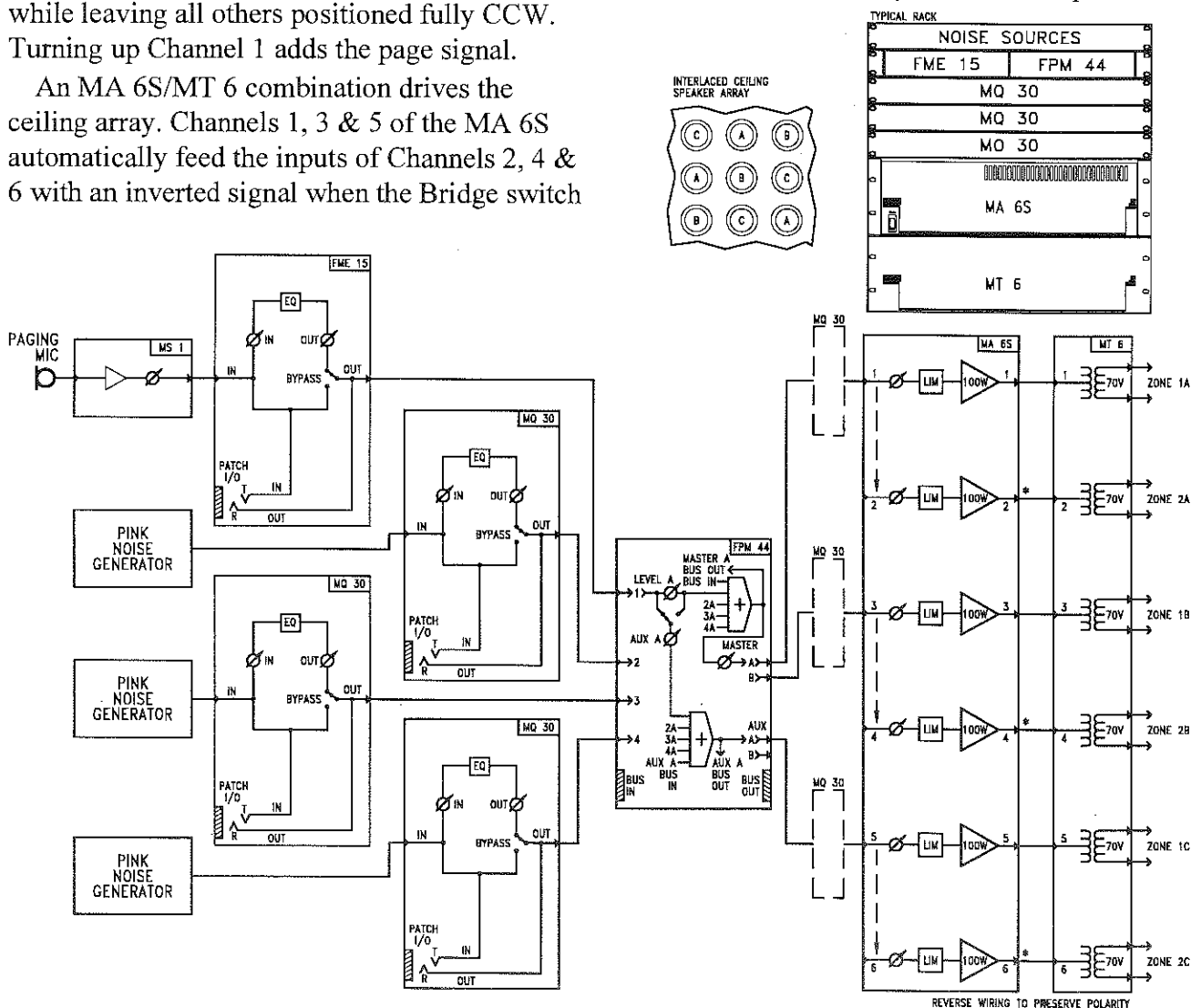
Fig. 26 Noise Masking System

Small Church System

Fig. 27 shows a compact church system with good versatility. An FMI 14 selects between a pulpit and/or a wireless mic (the MIC/LINE switch doubles as a selector switch when needed). The FME 15 provides graphic equalization to the main signal driving the power amplifier. This amp powers the sanctuary speakers.

The Master B output drives a second power amplifier used to run the loudspeakers located in the Cry Room/Sunday School/Overflow areas. Finally, the Aux A/B outputs feed a cassette deck.
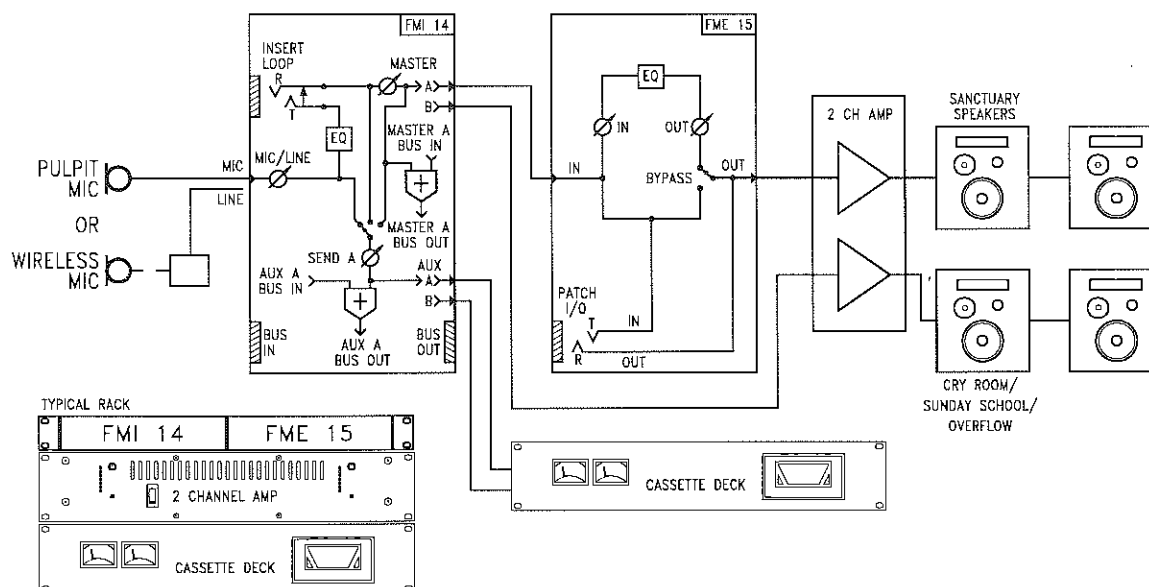
Mid-Size Church System

The scheme shown in Fig. 28 expands upon the small system. An FPM 44 allows adding four microphones for larger coverage. The FMM 42 adds a paging mic with a background source.

A FAC 28 splits the main signal for bi-amped speaker use. Another FME 15 adds EQ to the auxiliary zones.

Using only six modules and three rack spaces, Flex adds a lot of versatility and features while staying within tight budgets.

Fig. 27 Small Church System
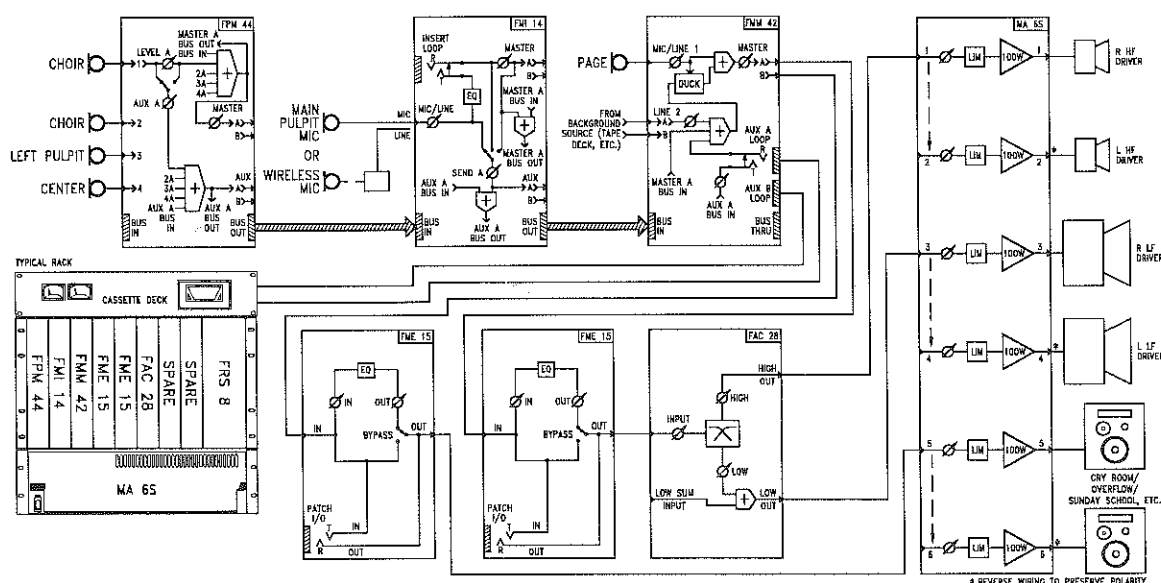
Fig. 28 Mid-Size Church System

Large Church System

Today there is no limit to large church systems. Their size, cost and complexity rival sound systems anywhere. Understanding that, Figure 29 presents a modest system for illustration and beginning purposes.

Two FMI 14's allow stereo micing of the pulpit, including wireless options. Two FPM 44's add to this for the sanctuary and choir mics. Just four Flex modules handle a dozen mics, with full EQ and effect loop options on the main pulpit mics.

The Flex Bus System ties everything together to an FMM 42, which adds inputs for a background music source and a paging mic. By assigning the paging mic to the Master B output,

you get two isolated main outputs—one with paging. The AUX BUS OUTS provide a stereo mix (without the paging and background sources) for the cassette recorder.

From here, an FDA 28 splits the main signals into four paged and four unpaged zones. The FME 15 and FAC 28 add EQ and crossover capabilities for the main sanctuary signals. Balcony fill signals get optional equalization (of choice) and time delay as required.

MA 6S power amplifiers and MT 6 transformers satisfy powering of the zones as required. Bigger budget systems allow further bi-amping of the loudspeakers. Expansion of the system is possible in all areas, but this shows what can be done with just one Flex rack full of modules.
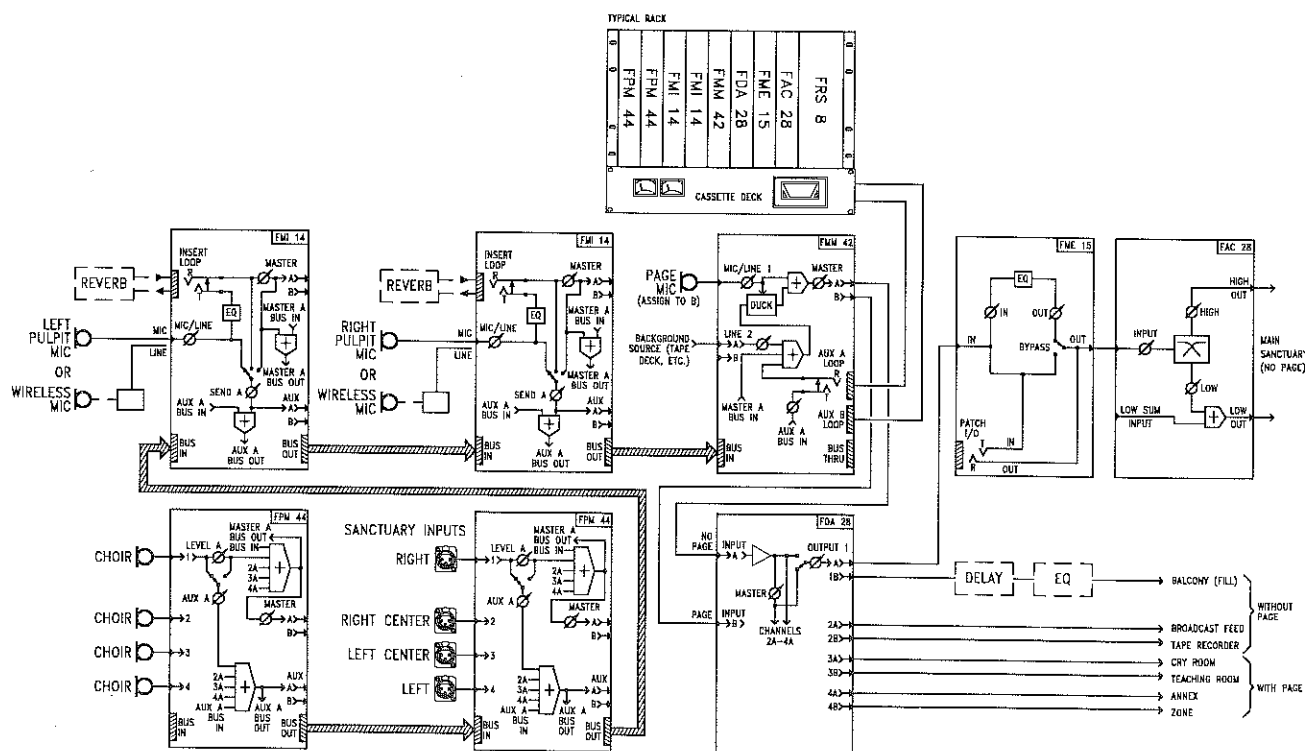
Fig. 29 Large Church System

Stereo & Mono Mic Mixer

Mark Strong of Strong Communications, in Wayne, Pennsylvania suggested the deceptively elegant solution shown in Fig. 30. This small church problem involved how to combine 10-12 microphones from the choir and pulpit to produce a mono house mix, plus send a stereo feed to a tape recorder. The budget, of course, was small.

Three FPM 44's solved the problem nicely. The Master A/B outputs provided the stereo tape feed, while the mono house mix used the Aux A output. The system expands by interconnecting the bus system (using the supplied DIN cables). This 12-to-2-to-1 mixer takes only three inexpensive modules to replace a 12-channel mixing console—in 1½ rack spaces. No EQ, but there are times when you don't need, or cannot afford EQ. When used, the EQ appears dashed in Figure 30.
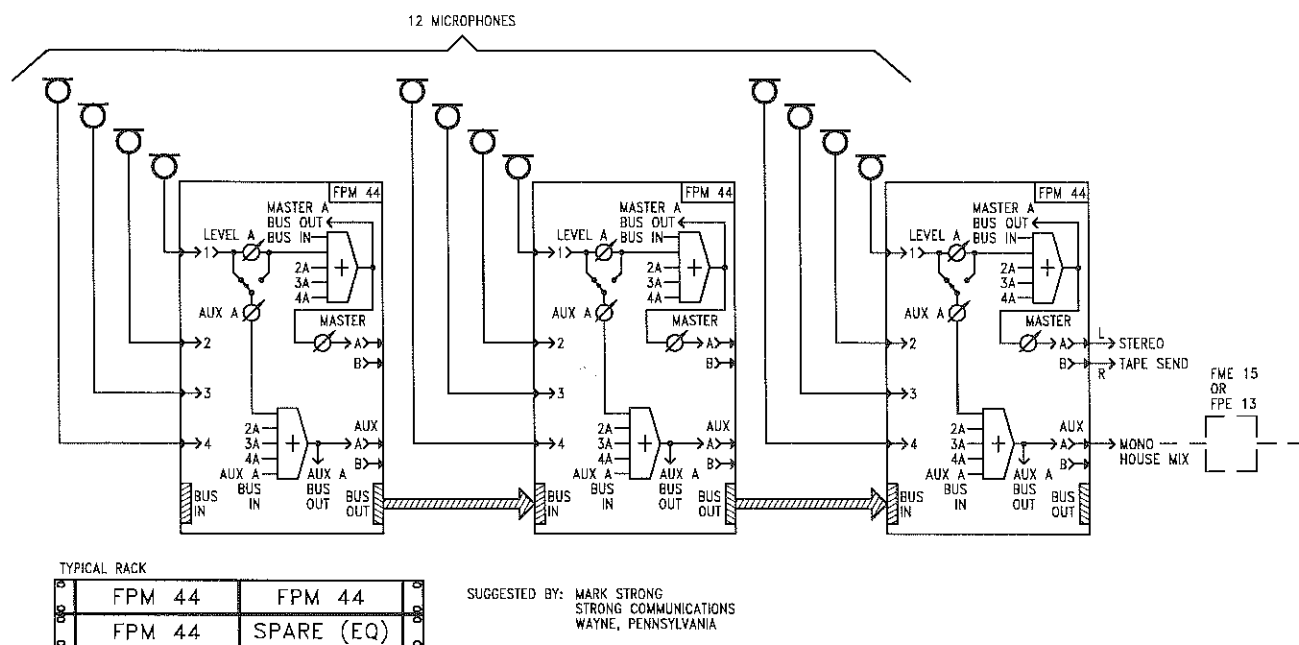
Fig. 30 Stereo and Mono Mic Mixer

Appendix A: Flexcessory Installation Details

FVR 10 Vertical Mounting and Security Covers

6-32 x 3/8"
SCREW

NYLON
SHOULDER
WASHER
(#6 ID
.25 OD)

MODULE
MOUNTING EAR

FVR 10

FSB 1
SECURITY COVER/
BLANK PANEL
WHEN USED AS SECURITY COVER
UNIT MUST BE RECESS MOUNTED

FSC 10
SECURITY COVER
WHEN USED, UNITS MUST
BE RECESS MOUNTED

FVR 10
VERTICAL RACK
(FRAME)
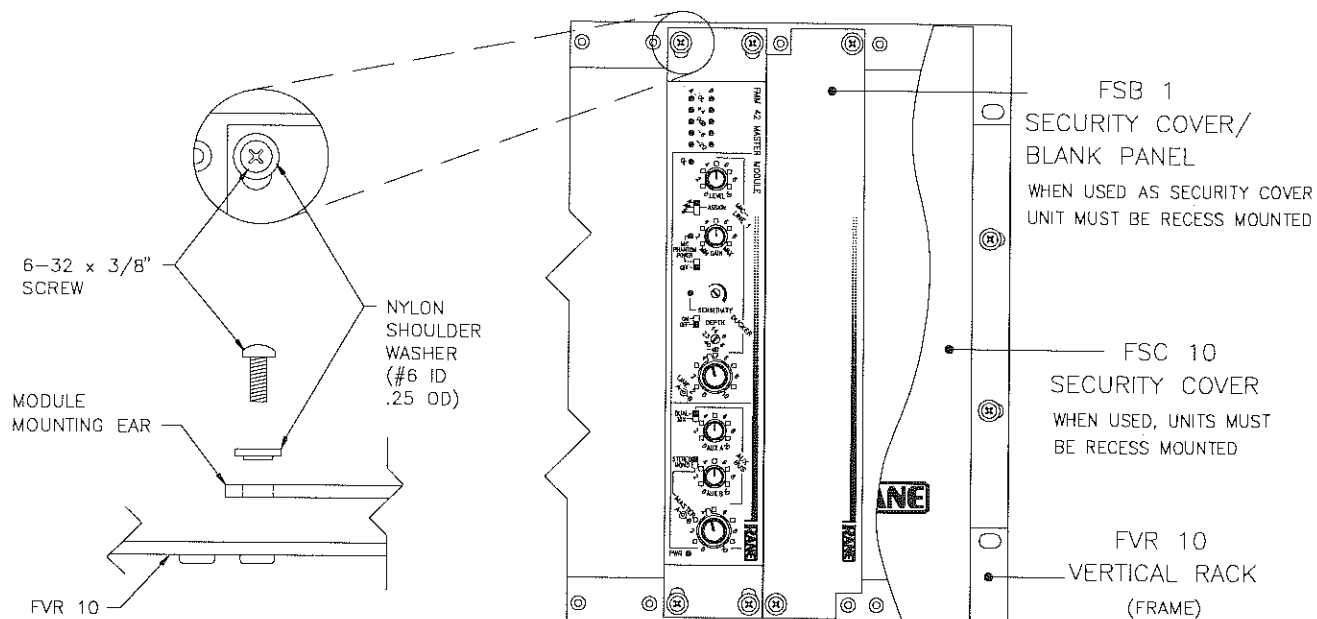
FHL 2 Flex Horizontal Linking Bars

NOTE: Install linking bars so that the clear
hole in one bar is next to the threaded
hole in the other.

FHL 2 HORIZONTAL LINKING BARS

6-32 x 1/4" SCREWS

MOUNTING EAR

CAUTION:
Do not use screws longer than
1/4" to secure ears. Longer screws
WILL damage internal parts!!!!

OPTIONAL 1.05" SETBACK
(FOR RECESS MOUNTING)

4-40 x 1" SCREW REAR

4-40 x 1" SCREW FRONT

6-32 x 3/8" SCREW (4 PLACES)

FHA 19 Horizontal Adaptor

FHT 2 MAY BE USED
WITH THE FHA 19 WHEN
MOUNTING ONE UNIT
FOR EXTRA SUPPORT

6-32 x 1/4" SCREW AND KEP NUT (2 PLACES)

MOUNTING EAR

CAUTION:
Do not use screws longer than
1/4" to secure ears. Longer screws
WILL damage internal parts!!!!

FHA 19
HORIZONTAL ADAPTOR

6-32 x 1/4" SCREWS (2 PLACES)

FME 15 µGRAPHIC EQUALIZER — RANE

FHT 2 Horizontal Tray

REMOVE 4 TOP COVER SCREWS
FROM FLEX UNIT AND SECURE
IT TO THE FHT 2 WITH
4 ea. 6-32 x 1/4" FLATHEAD
SCREWS (PROVIDED)

FHT 2
HORIZONTAL TRAY

HOLES FOR MOUNTING
UP TO 3 MS 1, PS 1, RPS 4 OR VC 18 UNITS

(THIS SIDE SHOWN
IN RECESSED POSITION)

(THIS SIDE SHOWN
IN FLUSH POSITION)

ORIGINAL FLEX UNIT TOP SCREW

OPTIONAL 1.05" SETBACK
(FOR RECESS MOUNTING)

6-32 x 1/4" FLATHEAD SCREWS
(4 PER FLEX UNIT)

FLM #2 LINE MIXER — RANE   FPE 13 PARAMETRIC EQ — RANE

FHA 19 MAY BE USED
WITH THE FHT 2 WHEN
MOUNTING ONE UNIT
TO FILL BLANK SIDE

Appendix B: Summing Networks

This appendix abridges Rane Note 109, "Why Not Wye," giving you the bare details on building summing networks. For all the details, please request a complete copy of Note 109.

Unbalanced Summing Box

Fig. B-1 shows the details for an unbalanced summing box. The resistor values can vary over a wide range without disturbing basic performance. As designed, the input impedance is about 1k ohms and the output impedance is around 250 ohms. The output impedance is small enough that long lines may still be driven, even though this is a passive box. The input impedance is pretty low and does require 600 ohm line-driving capability from the sources, but good line drivers are normal for most professional audio products.

Note that the rings are tied to each other, the sleeves are tied to each other; however, the rings and sleeves are not tied together. Floating the output in this manner makes the box compatible with either balanced or unbalanced systems. (Please see Rane Note 102, "Analog I/O Standards," for additional details regarding floating outputs.) It also makes the box ambidextrous: It is now compatible with either unbalanced (mono, 1-wire) or balanced (stereo, 2-wire) ¼" cables. Using mono cables shorts the ring to the sleeve and the box acts as a normal unbalanced system; while using stereo cables takes full advantage of the floating benefits.
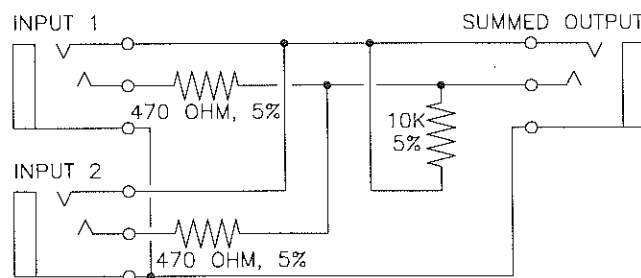
Fig. B-1 Unbalanced Summing Box

Balanced Summing Box

Fig. B-2 shows the wiring for a balanced summing box. It is just a logical extension of the above with 3-pin (XLR) connectors. Here both the tip (pin 2, positive) and the ring (pin 3, negative) sum together through the resistive networks shown. Use 1% matched resistors. Any mismatch between like-valued resistors degrades the common-mode rejection capability of the system.
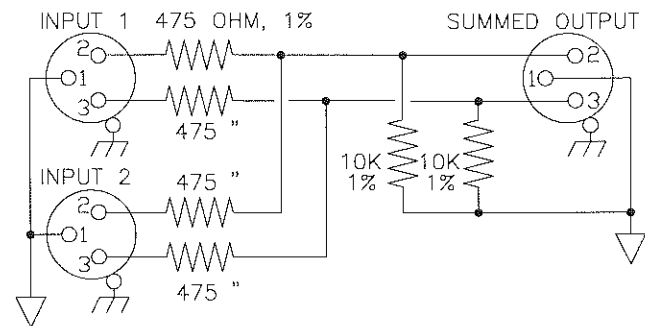
Fig. B-2 Balanced Summing Box

Flex Index

Symbols

A

B

C

D

E

F

G

H

I