The PicMix White Paper

A Surround Sound Primer

by Michael Tapes

OTARI

Acknowledgements

PicMix products are designed and manufactured by TG Systems, Inc.

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A note from the author…
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Introduction

This document is designed to provide an overview to the use of the PicMix™ Monitor and Panning systems in the audio post production environment. For the audio professional who is proficient in surround sound audio techniques and technologies, it will explain how PicMix provides cost effective solutions to the day to day problems encountered in this work. For the audio professional who is new to surround sound audio post production, it will summarize the process and provide a basic understanding of the solutions that PicMix provides.

The PicMix product line currently consists of 2 products…the PicMix Monitor and the PicMix Panner. Both are modular systems offering a variety of system configurations as well as the ability to expand the systems in the field.

With the addition of PicMix, standard multi-bus audio consoles are now able to provide the features and functionality that are necessary in order to post audio to picture in a surround sound environment. Dedicated and expensive re-recording , dubbing, or "post" style consoles are no longer necessary to provide mix-to-picture services using film style techniques. It is our sincere hope that this white paper will give you an understanding of how the PicMix products can help to integrate surround sound audio post production into your facility or working environment.

The PicMix Monitor and Panner are sold and serviced worldwide by Otari Corporation, which has served the professional audio market with exceptional and innovative products for over 25 years. They were developed and are manufactured by TG Systems, Inc., whose principals, Michael Tapes and Paul Galburt, have a long involvement with successful audio product designs including API consoles, Sound Workshop consoles, ARMS, JH-50 and DISKMIX automation systems, and Otari's CONCEPT I, Status, and Premiere audio consoles.

In this paper we will focus on the film style mixing techniques that have been developed in Hollywood studios and facilities over the last several decades. While you may not have the need to mix feature length motion pictures, these techniques are directly applicable to whatever type of surround sound work you will be doing, whether it be television, film, commercials, or multimedia.

The Surround Sound Explosion

Audio material containing surround sound channels is all around us! Virtually all US made major motion pictures are released with surround sound audio channels. Broadcast and cable television programming is loaded with surround sound from episodic drama and comedy series, to sports and special programming. The majority of home video rentals have surround encoded soundtracks. All of the future video delivery formats now under discussion include surround sound capability as a

specific part of their design specifications. Even future audio only formats (Super CD, etc.) are being discussed in terms of multiple channels (more than 2) including surround sound channels.

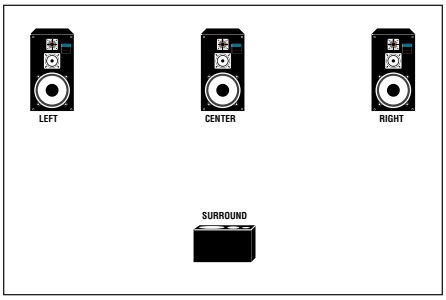
What the above paragraph points out so vividly, is that if a commercial audio facility cannot handle multi-channel multi-format audio, it will not be competitive in the marketplace. And handling these formats is not enough. They must be able to be dealt with as quickly and easily as current stereo formats are handled.

What is Multi-Channel Multi-Format Audio?

Since the 1960's, stereophonic (2 channels, Left and Right) sound has dominated the music recording industry. Television, until recently, has been monophonic. And the film industry, until the early 80's, was also primarily monophonic, except for an important distinction. Special projects were released using various multi-channel formats, breaking the monophonic barrier, as early as 1941, when Walt Disney's Fantasia was released. The film industry has been and still remains the leader in innovations in multi-channel audio formats. Even the term "stereophonic" was first used by the film industry and actually referred to multi channel audio with a surround (or effects) channel. Only years later, after the hi-fi industry, came out with it's left/right 2 channel multi-channel format did the term stereo become associated with 2 channel sound. (When I refer to "stereo" in this paper I mean the hi-fi 2 channel stereo, as commonly used. Note, however, that Dolby™ Stereo refers to the 4 channel encoded system as described below).

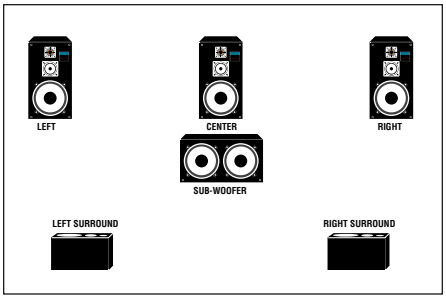
Surround Sound Formats

Over the years Hollywood studios have pioneered numerous multi-channel formats. Not all of them used the same number of audio channels and even those that did, placed the audio in different locations from each other. The listing and history of these formats are beyond the scope of this paper, but let me list the formats that are in current usage in film and television.

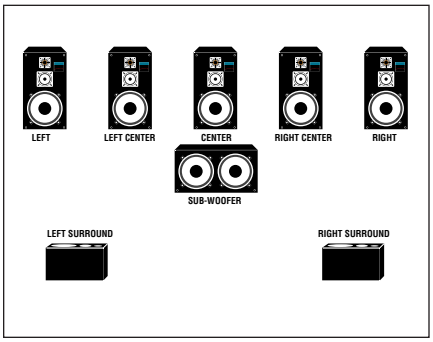


Dolby™ Stereo (also known as Dolby™ Surround)
4 channels - Left, Center, Right, Surround
This is the most common surround sound format used today. Almost all major shows and films produced for theatrical release, broadcast television, and direct to video are presented in Dolby™ Stereo audio. This system uses the Dolby process of MP (motion picture) encoding to create a stereo (2 channel) release that may be decoded into its 4 playback channels. If no decoder is used then the show will play back properly in stereo or mono. This compatibility between mono, stereo and full 4 channel playback (all on a single release print or video) is one of the main reasons for the popularity of this format. There are other encoding systems that are compatible with Dolby Stereo and maintain almost identical technical characteristics. Two of these systems are Ultra-Stereo™ and DTS™ Stereo.

Note: *Dolby Stereo format can also be decoded for television without the center speaker. This becomes a Left/Right/Surround system, having the Left and Right speakers create a phantom center channel.*



5.1 Format
6 Channels - Left, Center, Right, Left Surround, Right Surround, Sub-woofer
This is the format used in several new digital release formats for motion pictures. It was also the most common format used in recent 70mm releases. This differs from the Dolby Stereo format in that the surround channel is stereo (2 channel) rather than mono, and there is also a sub-woofer channel. The "5.1" designation is based on the fact that the 5 front and rear audio channels are full bandwidth, but the sub-woofer channel has limited bandwidth, carrying only extremely low frequencies (generally those frequencies below 80 or 120 Hertz, depending on whose delivery system is used). The two most popular motion picture systems using 5.1 are Dolby Digital (SR-D) and DTS Digital (DTS). These are both digital audio systems in which the 6 channels of audio are stored as a digital bit stream (although SR-D is stored optically on the film print, while DTS is stored on a separate "laserdisc" which is time code linked to the film print). The current proposal for HDTV (High Definition Television) includes 5.1 audio, as does DVD (Digital Versatile Disk), the new standard 5" CD size video/computer disk format.



SDDS (Sony Digital Dynamic Sound)
8 Channels - Left, Left Center, Center, Right Center, Right, Left Surround, Right Surround, Sub-woofer
This format is similar to the digital formats mentioned above except that 8 channels of audio are handled, adding the left center and right center front speaker positions. Although it is not designated as such, this system could be thought of as 7.1 with 7 channels of full band audio and 1 channel (sub-woofer) of limited bandwidth. The SDDS "player" has additional output modes so that the 8 channel format may be played back on 5.1 and other smaller format (less than 8 channels) playback systems.

What's a Mother to Do?

The reality for audio facilities is that all three of the above formats (in addition to mono, stereo, multimedia, and others) will be with us for the next several years, at which time perhaps some of the formats might drop out of usage. **In order for an audio facility to prosper, it must be able to handle surround formats of all types. Surround sound formats will be a permanent part of all future audio delivery formats.**

As you can see from the above list (which does not include stereo, multimedia, IMAX and other multi-channel formats), they all deal with multiple channels of audio yet each one has a different format. As discussed later, it is the duality of multi-channels and multi-formats that preclude a simple monitor system in a standard console from being applicable to this type of work.

Until now, in order to handle multi-channel formats properly and efficiently it was necessary to use a specialized console or to build custom monitor facilities that could be added to a standard audio console. These specialized consoles (such as Otari's Premiere™ dubbing console) are large in scope and therefore relatively extensive and expensive. While they serve the dedicated dubbing stage extremely well, they are unsuitable to the many facilities that cannot justify the expense or the dedicated features sets that these consoles embody.

Introducing the PicMix Monitor

The **PicMix Monitor** has been designed to break the big-bucks-console barrier and allow surround sound formats to be handled with ease in conjunction with almost any multi-bus audio console. For a studio first delving into the world of surround sound, this allows their existing console to be retained, or the purchase of a new, more generalized console, that can better serve the facility.

Note: The section on surround sound panning and the PicMix Panning System begins on Page 30.

The **PicMix Monitor** and its options provides the following functionality:

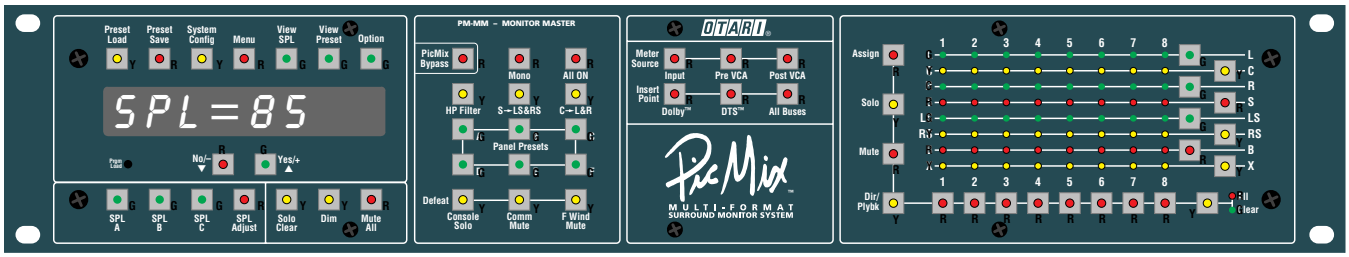
- Up to 32 dual input channels (64 audio inputs)
- Each Channel is assignable to one of 8 speaker buses
- Precision calibrated output monitor level can be set in 1 dB steps from 20 to 105 dB SPL
- Compatible with all surround sound formats including Dolby Stereo, Dolby Digital (SR-D), DTS Digital, Sony SDDS, and multimedia
- Serial and parallel machine transport control
- Serial and parallel recorder track arming
- Up to 4 monitor controller remote panels may be used
- Compatible with almost any multi-bus audio console
- All audio I/O is electronically balanced at +4 dB nominal level

- 36 presets available for instant setting of monitor formats
- Hardwire bypass for normal stereo console operation
- LED matrix display shows current speaker assignments
- Alphanumeric display shows SPL level and system messages
- Fully buffered switchable meter outputs
- GPIO connector for simple logic interface with console
- User Preference System allows user customization

PicMix Monitor Components

The PicMix Monitor is a modular system that is comprised of the following components

Monitor Master

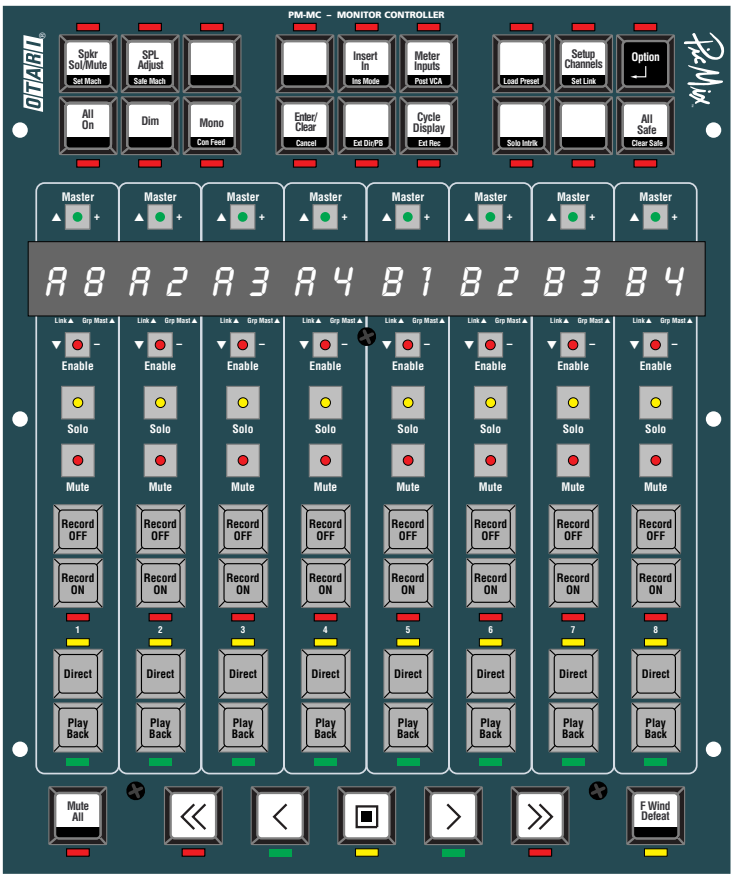


This 2U rack unit is the core of the PicMix Monitor. All basic functionality (excluding machine control) is available. All audio connections interface to the Master rack. Eight dual input channels allow for 8 tracks of audio with Direct/Playback switching, or 16 tracks without Direct/Playback switching which are each assignable to one of the 8 speaker buses available.

Monitor Slave

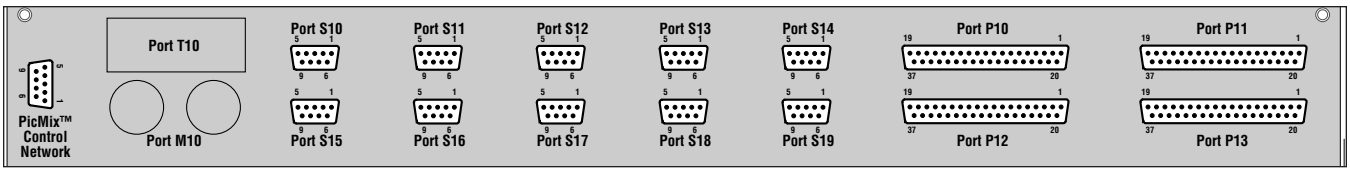
This 2U rack unit serves to expand the input capability of the Monitor system. Each Slave provides an additional 8 dual input channels to the system. Up to 3 Slaves may be added for a total of 32 dual input channels (64 audio inputs).

Monitor Controller



This 8.8w X 10.5h (inches) panel is designed to mount in or on your console in a blank panel or in an available desktop box. The Monitor Controller adds extensive remote control capability to the PicMix Monitor. Multiple Controllers may be utilized for multi-section console operation. Each Controller has 8 control strips that can be assigned in a virtual fashion to any of the (up to 32) input channels in the system.

Machine Control Interface (MCI)



The MCI is a hardware/software "black box" (it's actually silver in color) that allows the PicMix Monitor to control track arming (record enable) and basic motion control for a variety of recorder models. The

MCI is able to control up to 4 serially controlled machines and up to 2 parallel controlled machines. (At least 1 Monitor Controller must be installed in the system in order to use the MCI).

Note: *More detailed information about all of the components that make up the PicMix Monitor can be found in the Color Brochure and Technical Information Foldout Sheet, both available from Otari or your Otari dealer.*

Information about surround sound panning and the PicMix Panning System can be found in this paper starting on Page 30.

Mix to Picture and Film Style Mixing

The PicMix Systems are designed to facilitate fast, efficient, and creative audio post production that is or will be associated with a moving picture, whether that be film, video, or multi-media. PicMix draws from a long tradition in the Hollywood film community of how this audio post production process is accomplished. Even if your work does not involve film, or is small in scope, there is much to learn from these pioneers.

The film studios have always been the leaders in sound production. They have always been faced with the most difficult tasks due to the sheer number of audio tracks that have been associated with large budget movies, as well as the desire to draw people into theaters with larger than life sound and picture. While the Hollywood studios are still faced with the largest projects, shows produced for television are and have been catching up.

Movies of the week have become more ambitious and are really mini theatrical release features. Even episodic television dramas have taken on the aura of weekly mini-features. As the track count and demand for sophisticated television audio have increased, so have the demands placed on the sound editors and mixers. Over time they have looked to the people who have done this before, the Hollywood editors and mixers. Whether a show is being produced for television or the movies, more and more audio post production for picture is being done using the *film style mixing* techniques that have been developed and perfected in Hollywood.

Film Style Mixing is a generic term that has come about to describe the process that these Hollywood mixers and editors go through in the process of creating and molding the sound for a motion picture destined for theatrical release. This process can be thought of as an assembly process. The following is a rough summary of the process…

Location Sound Acquisition

Production dialog and some production location sounds are recorded during the picture shoot.

Dialog Editing

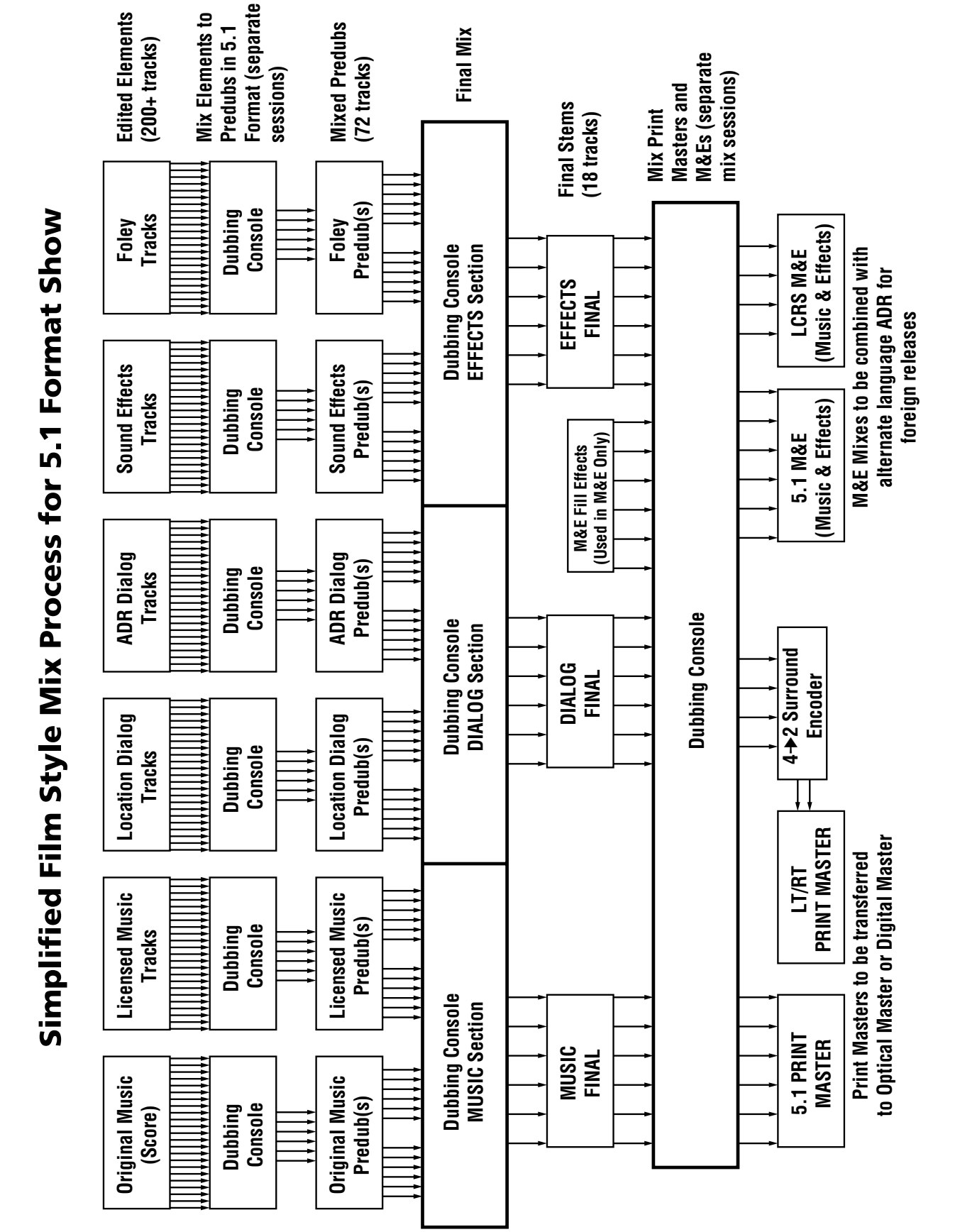
Production dialog is edited, matched, and tied to selected picture takes.

Automatic Dialog Replacement Recording

ADR is a post production process (formerly known as looping), that records the actors and actresses performing dialog while they are watching themselves on screen. They perform their lines, attempting to match their on-screen lip movements, so that better performances can be obtained, script changes can be inserted, or sections can be replaced that were poorly recorded due to equipment failure or location noises.

Sound Effects Design

Sounds from live recordings, sound effects libraries, and electronic synthesis are edited, layered and mixed to create sound effects elements that match on screen events.


Simplified Film Style Mix Process for 5.1 Format Show
Original Music (Score)
Licensed Music Tracks
Location Dialog Tracks
ADR Dialog Tracks
Sound Effects Tracks
Foley Tracks
Edited Elements (200+ tracks)
Dubbing Console
Mix Elements to Predubs in 5.1 Format (separate sessions)
Original Music Predub(s)
Licensed Music Predub(s)
Location Dialog Predub(s)
ADR Dialog Predub(s)
Sound Effects Predub(s)
Foley Predub(s)
Mixed Predubs (72 tracks)
Dubbing Console MUSIC Section
Dubbing Console DIALOG Section
Dubbing Console EFFECTS Section
Final Mix
MUSIC FINAL
DIALOG FINAL
EFFECTS FINAL
Final Stems (18 tracks)
M&E Fill Effects (Used in M&E Only)
Dubbing Console
Mix Print Masters and M&Es (separate mix sessions)
5.1 PRINT MASTER
LT/RT PRINT MASTER
4→2 Surround Encoder
5.1 M&E (Music & Effects)
LCRS M&E (Music & Effects)
Print Masters to be transferred to Optical Master or Digital Master
M&E Mixes to be combined with alternate language ADR for foreign releases

What is a stem?…
A final mix for film or video may consist of more then 1 "item". For an LCRS show, their might be an LCRS music mix, plus an LCRS effects mix, and perhaps 4 tracks of dialog meant for the center speaker. Each of these components of the final mix is known as a stem. When these stems are mixed together at unity gain, this represents the complete final mix. These stems may exist on separate tapes (or disks) or may exist as separate tracks within a multitrack tape or disk. Some people would also refer to any Predub (group of similar type pre-mixed tracks) as a stem.

Foley Recording
Foley artists perform using props, in a specially designed Foley pit (recording area with different floor surfaces) to create sounds which are recorded live to picture. These sounds include footsteps, clothing noises, paper noises, fight noises, leaf rustles, water noises, etc.

Original Music Recording
The original music score is recorded. Some or all may be recorded against edited sections of the picture.

Sound Editing
All of the above types of audio tracks (plus others such as source music, licensed music, etc.) are edited and timed so that they match the picture edits.

Predub Recording
Groups of audio tracks of similar type (music, effect, dialog, Foley, ADR, etc.) are mixed on the dubbing stage (mix theater) into sub or pre mixes known as Predubs. There may be several predubs mixed for each type (Music A, B & C, Effects A-F, etc.).

Final Mix
All of the predubs are mixed on the dubbing stage to form the final mix which is broken down into the final music, dialog, and effects mixes which are referred to as stems.

Print Master
The final stems are mixed at unity gain to create the actual physical tape, film or disk that will be transferred to the picture master.

The above list is a generalized and simplified summary and takes license with the various processes. In some cases there may be many more steps that have not been listed, and in other cases many steps may be merged into one. The above procedures are not necessarily done sequentially because some of the processes can be worked in parallel.

While many of the early procedures can occur without regard to surround sound, proper surround sound monitoring is essential during the the predub, final and print master mixes. In some circumstances sound effects design and music scoring may also be done with full surround monitoring to better prepare for the work that will eventually be done on the dubbing stage.

Note: *The final mix, which theoretically is a unity gain mix of the predubs, is actually a very complex mix where all of the audio elements (as well as all of the picture elements) are brought together for the first time. This is also the first time that the show's director hears the audio in context, which may cause many changes to be made. It is the last time for the director to make audio choices, such as which music to use, or which ADR lines to use, or even if there should be music or effects in this scene or that. And this does not take into account any last minute picture changes that might send all of the sound editors scrambling and get all of the mixers growling.*

What About Me?

Many of you reading this may never be involved in a big budget theatrical release, but I guarantee that if you are ever involved in any part of the mix to picture process, these techniques (or modifications of them) will be part of your audio toolkit. That is why it is so important to have a firm understanding of the large scale film style mixing procedures.

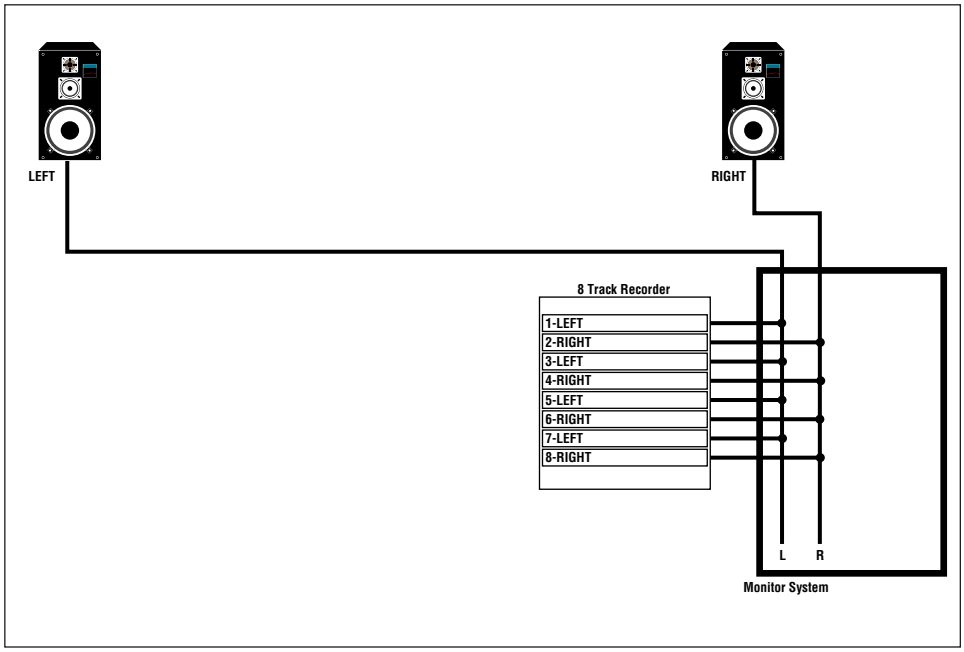
Now that PicMix is available, it is possible for many more audio facilities to become proficient at mix-to-picture audio post production for surround sound formats. Of course, any professional will understand that like a microphone or a console, PicMix is just a tool. In the proper hands it can help to create artistic audio that will enhance the story being told by the picture, and in the wrong, inexperienced hands it can help in producing distracting noise. The purpose of this paper is to inform you of the availability of an incredible new audio tool, PicMix…and to hopefully wet your appetite to pursue the proper education and people that will allow you to become proficient and profitable in this exciting area of audio.

Why is PicMix Needed for Multi-Channel Multi-Format Audio?

In order to understand the need for specialized monitoring facilities when dealing with surround sound, please compare the following drawings in which an 8-track tape in various formats needs to be played back through the console monitor system. Unlike a stereo tape in which track 1 always represents the left channel audio and track 2 always represents the right channel audio, you can see that each of the following tapes have different playback channels (speakers) associated with each track. **The monitor system must be able to feed each track of each tape into any one of the 4, 6, or 8 playback speakers.**

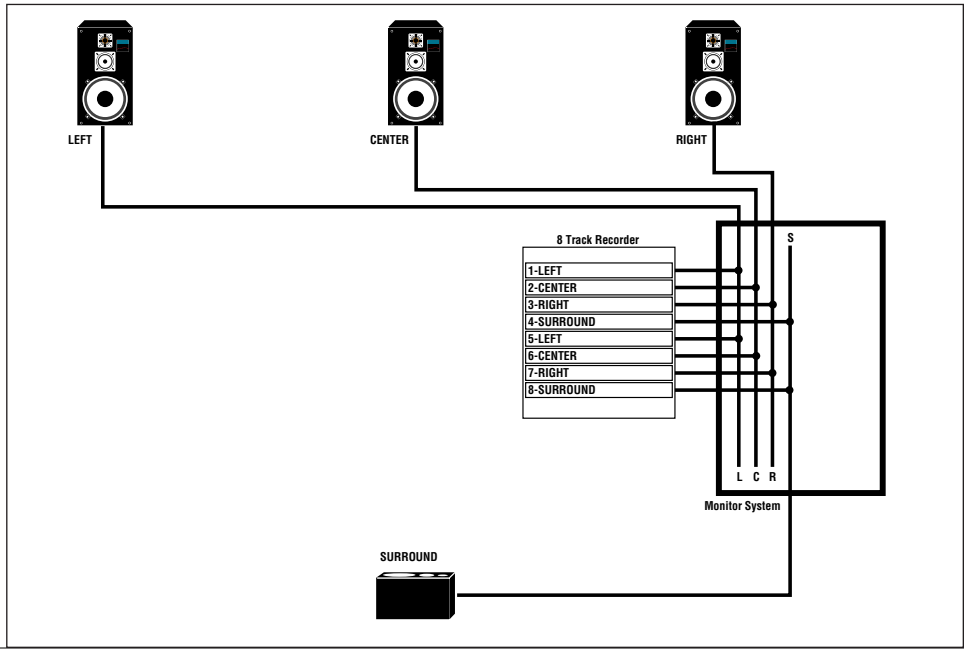
Stereo Format

A basic stereo console monitoring system is all that is needed to play back this 8 track tape which consists of 4 stereo stems.



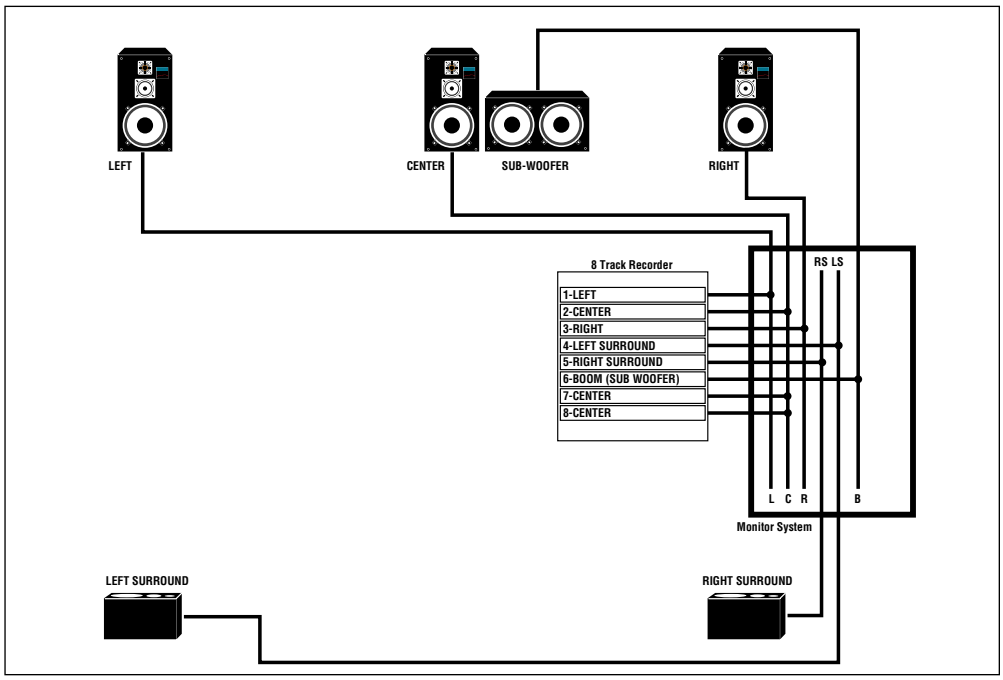
Dolby Stereo (LCRS)

Here the monitor section must be able to route these two 4 track stems into the LCRS speakers. This is beyond the scope of standard audio console monitor sections.



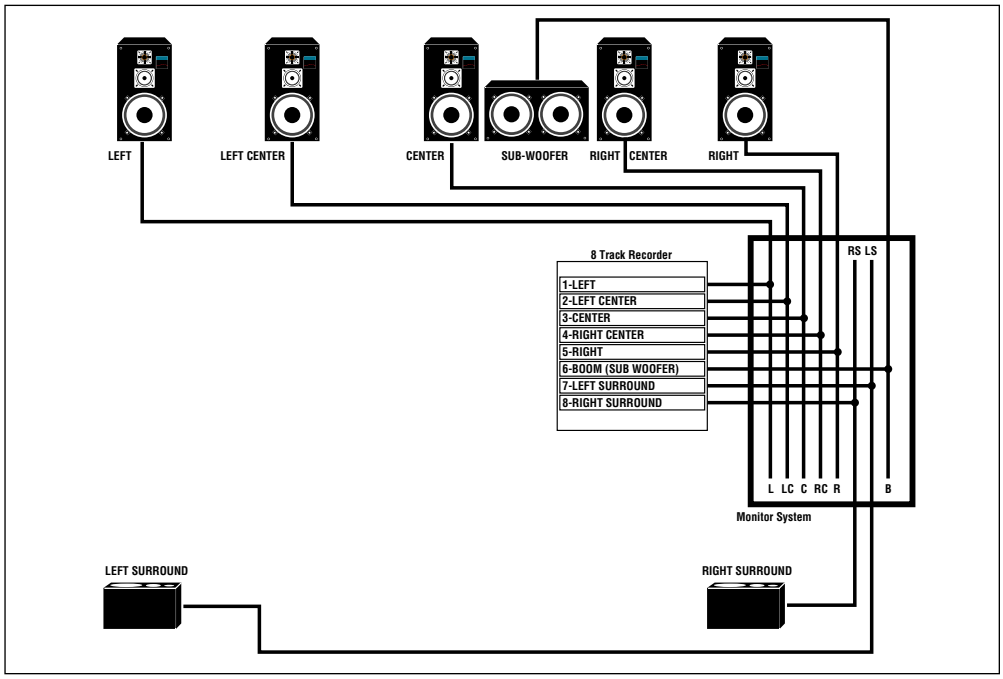
5.1 Format

This 8 track tape consists of a 6 track stem (5.1), plus two additional tracks of material that were kept separate so they could be handled separately in the final mix. Only a dedicated dubbing console would be able to handle this without PicMix.



SDDS Format

This 8 track tape consists of an 8 track SDDS stem. Only some dedicated dubbing consoles would be able to handle this without PicMix.



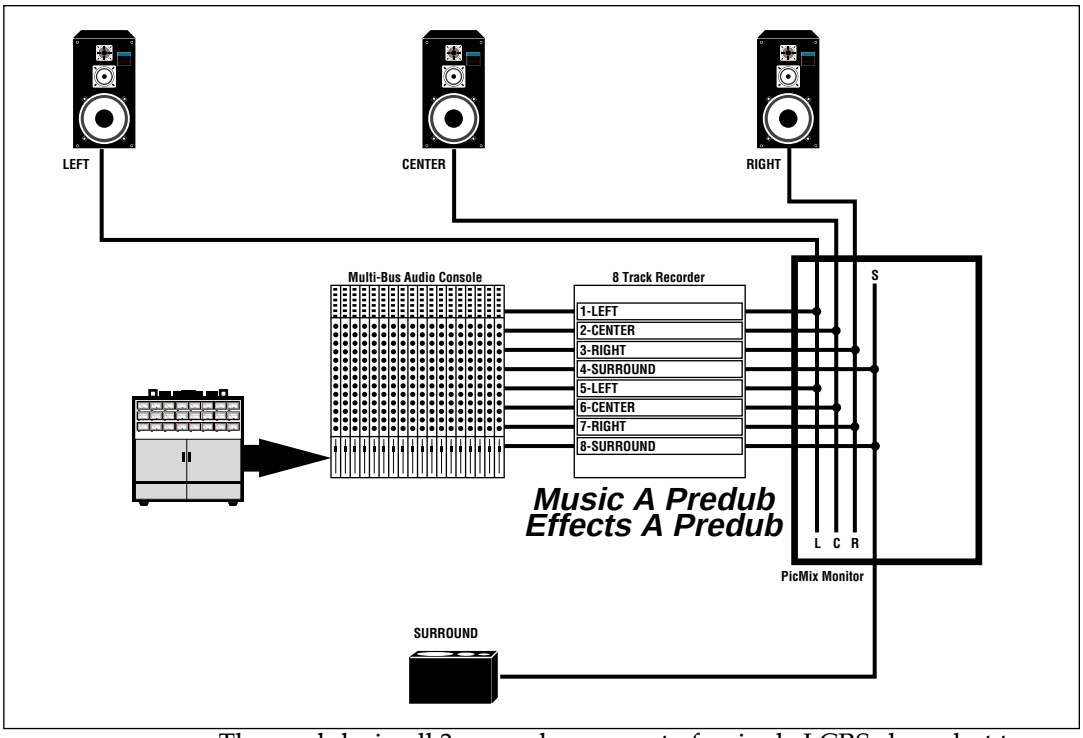
Even Within One Format, Monitor Requirements Vary

It is easy to see from the above drawings that working in different formats will require different monitor setups. However, even within a specific format (let's say LCRS to keep this example simple), a series of 8-track predubs will usually contain several combinations of track layouts. Each of these will therefore require a different monitor setup

The 3 examples on these 2 pages show the mixing of a set of Predubs that might be used in one Dolby Stereo (LCRS) format show…

Example 1

This monitor setup of 2 LCRS stems might be used to create music and effects predubs where all of the surround components are in place. These types of predubs would be directly routed to their respective LCRS tracks during the Final Mix.



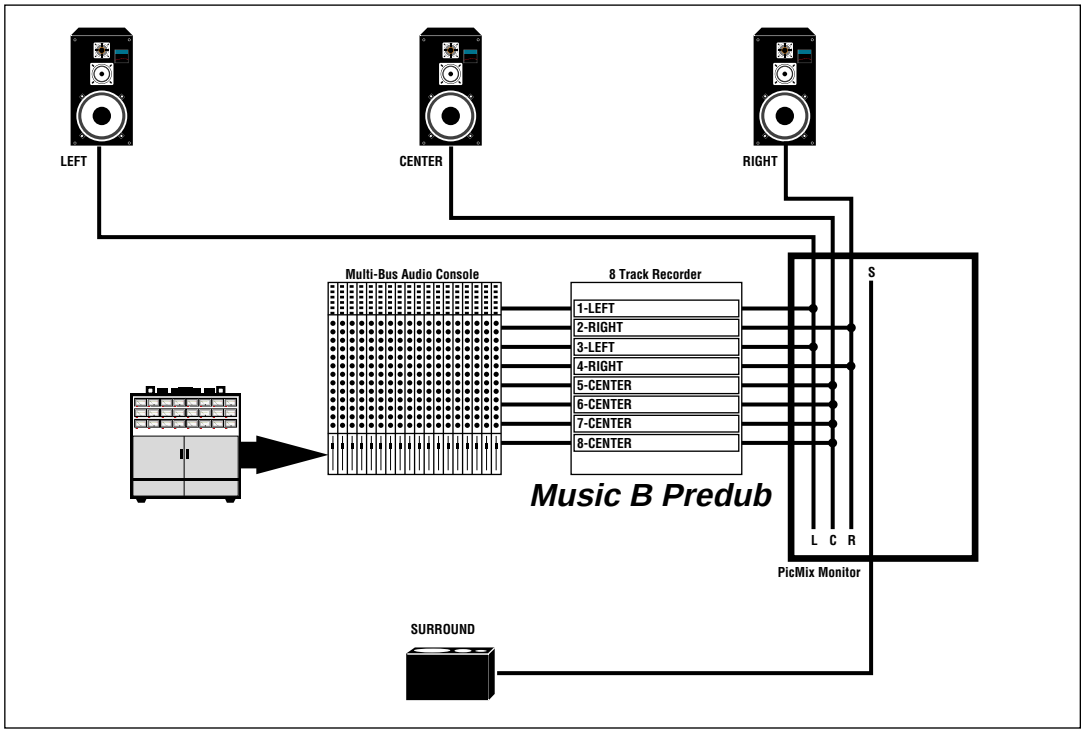
The predubs in all 3 examples are part of a single LCRS show, but to create any of them requires a monitor system that can be completely re-assigned at any time.

While each of the above predubs was being mixed, the monitor system was configured to match the recorder track layout which matched the console record bus track assignments. The monitor system is in effect a mini-console used for listening which establishes the relationship of monitor speakers→recorder tracks→console buses.

Of course to produce the final mix, the above predubs are fed into a large mixing console during the Final Mix. The monitor would then be configured to match the final recorder track layouts as required, which in this case would be LCRS. However, if the final mix created 3 LCRS stems (music, effect, and dialog), those might be recorded to 2 or three 8-track tapes, or 12 tracks of a 24-track tape recorder, or three 4-track film recorders, or two 6 track film recorders, or 12 tracks of a hard disk recorder. So, here too, the monitor must be flexible enough to handle any of these possibilities.

Example 2

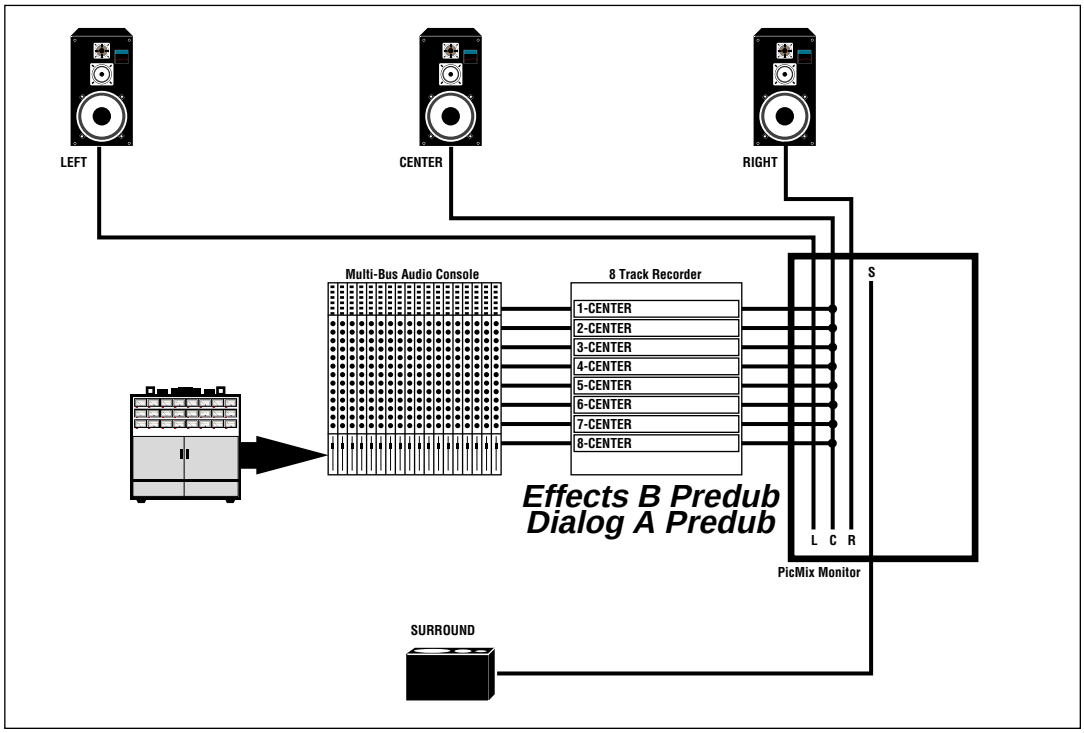
This monitor configuration allows the creation of an additional music predub B, which contains 2 stereo stems and four mono tracks. These might be solo instruments or sections that could be used to segment the basic LCRS mixes in Music Predub A. Alternately, they might represent submixes of the complete score which would allow the LCRS mix to be established on the dubbing stage.



Example 3

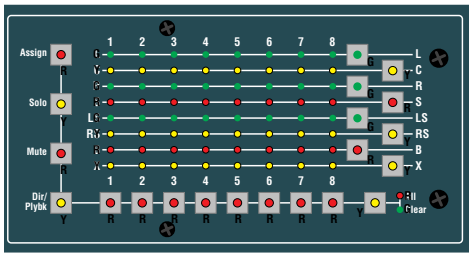
Dialog consists of mono tracks. This predub configuration would allow different characters to be split onto individual tracks, as well as some tracks having alternate production or ADR tracks for the director to choose from during the final mix.

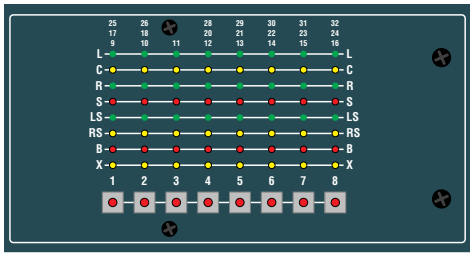
A mono Effects B predub might contain effects that the Supervising Sound Editor was not sure the director would like. Because they are not "married" (mixed into) to the Effects A LCRS predub, decisions of whether or not to use them can be made later on the dubbing stage.



The PicMix Monitor is, in fact, a mini-console that is able to assign each of its inputs to one of the 4, 6 or 8 speaker outputs. When a set of assignments is created, as in any of the examples above, it can be saved as one of 36 Presets within PicMix. When this format is later needed again, the Preset is simply recalled, eliminating the need to assign all of the inputs individually.

From the Assign Matrix section of the PicMix Master (left) and Slave (right), inputs can be assigned to speakers. Assignments are always displayed on the LED assignment grid.

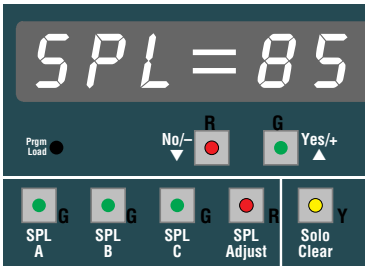




More than Just Assigning Speakers

The ability to assign inputs to speaker buses is the most obvious and critical aspect of a surround sound monitor system. But the needs go much further. PicMix has a host of additional features that are critical to the efficient implementation of surround sound mixing techniques. Some of these facilities are listed below.

Precision Calibrated Level Adjustment



The absolute monitor level is always displayed on the PicMix Monitor Master. Using the SPL Adjust, A, B, and C buttons, monitor levels can be instantly set to 1 of 3 stored levels, or adjusted in 1dB increments. These same adjustments are also available on all Monitor Controllers.

In a stereo console, a very important specification is the tracking precision of Control Room Level Control. The Left and Right channels must be maintained in perfect balance throughout the range of the control. If the control is out of spec, the mix engineer will compensate which will produce an out of balance mix. (The out of spec pot can be corrected by changing the relative power amplifier input gain settings, but this will not work if the control varies it balance at different level settings).

In a multi-channel monitoring environment this problem is further complicated because there are 4, 6 or 8 channels to keep in perfect balance. This cannot easily be accomplished with a conventional level control.

The PicMix Monitor has a sophisticated digitally controlled, calibrated level control system. This assures that all 8 speaker outputs (actually amplifier feeds) track accurately. In addition, once the system is calibrated to your amplifiers and speakers, absolute SPL levels can be set from the Master panel or from any Controller. This is important because when mixing shows for theatrical release, Dolby specifications require that they be mixed at specific Sound Pressure Levels (usually 85 dB SPL at each speaker). The PicMix Monitor allows SPL levels to be adjusted in 1 dB increments and also has 3 user stored SPL presets that can be recalled to instantly set a specific SPL level. A rotary monitor level control can also be optionally added.

What is a Surround Encoder?

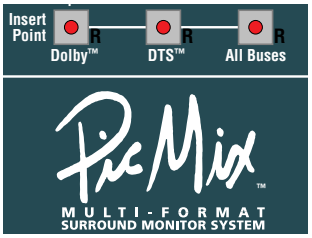
When a show is done in the Dolby Stereo format (or compatible format such as DTS Stereo or Ultra-Stereo) the final mix is made up of 4 discrete LCRS tracks or several sets of LCRS tracks (stems for music, dialog, and effects, for example). However, the delivery medium, in almost all cases has only a stereo (left/right) pair of tracks. The beauty of the Dolby Stereo format is that the discrete 4 channel LCRS mix can be "encoded" into just 2 tracks which can be "decoded" or expanded into the original 4 LCRS channels upon playback (and the stereo tracks can be played in "stereo" without decoding, as well). In a theater, a professional Dolby decoder system is used, while in a home theater a Dolby Pro Logic decoder is used. In either case the original 4 tracks of the final studio mix are extracted from the stereo (LT/RT, or Left Total/Right Total) tracks that exist as a stereo optical soundtrack on a movie or a stereo magnetic soundtrack on a video. However, the 4→2→4 encode/decode process is

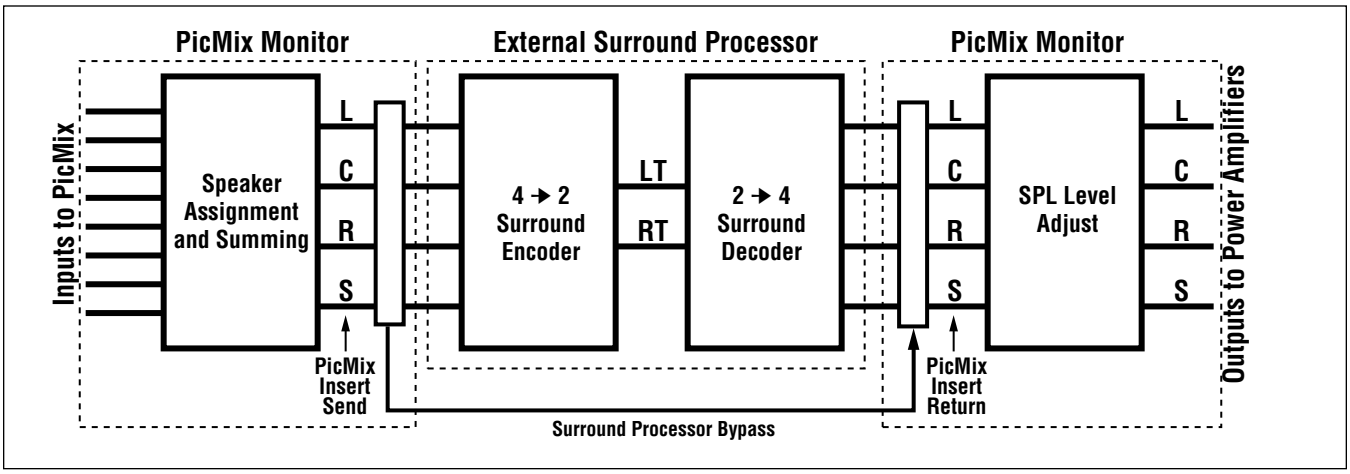
not perfect. In order to make the stereo tracks compatible with playback in stereo or mono (with no decoder), compromises were made in the design of the encode/decode process.

When producing the original 4-track mixes in the studio, it is misleading to monitor them discretely because this will not take into account the changes that will occur due to the encode/decode process. It is therefore desirable to monitor through an encoder plugged into a decoder so that the anomalies of the encode/decode process can be heard while mixing. In this way the mix engineer can preview what the viewer will hear when the Dolby Stereo mix is decoded back into 4 channels of sound during viewing. Adjustments in placement and level can be made during the mixing process to minimize any undesirable effects of the encode/decode process, so that the desired sonic results can be achieved.

The PicMix Monitor allows you to insert a Dolby DS-4 encode/decode processor (or similar device) into the monitor loop at precisely the correct point in the signal path, so that the processor receives the exact calibrated levels that it requires. The processor device may be taken in or out of the signal path at the push of a button on either the Master Rack or the Controller Panel. You do not need to listen through a surround processor if the format maintains true discrete tracks upon playback, as it is the case with SDDS and most 5.1 formats.

Surround encode/decode processors (such as the Dolby DS-4) can be punched in and out of the monitor signal path from the Monitor Master (shown) or the Monitor Controller.





Simplified (and partial) PicMix Monitor Block Diagram shows monitoring through a surround encode/decode processor.

So What is PEC/Direct, Anyway?

Whenever surround monitoring is discussed, the term "PEC/Direct" switching comes up. While the actual definition is now outdated, its function is not. Allow me to explain some more of the film style mix process which will lead us to a complete understanding of the mysterious PEC/Direct.

Because of the complexity of mixing to picture, the mix proceeds in a 3 steps forward, 1 step backward kind of way. In many cases each picture cut on the screen represents a new sound perspective, so the mixer needs to change the settings of the EQs, reverbs, and faders for each change in perspective. Tie this in with the large number of inputs involved with mix to picture projects and you end up with a very complex mix that has many starts and stops. Of course these starts and stops mean that the recorder must be punched in and out repeatedly during the course of a mix.

This constant punching in and out puts great demands on the recorder being used. It (or they) must be able to seamlessly punch in and out quickly and with no audible artifacts. The other great demand is put on the mix engineer. He or she must ensure that at the time of the punch in, the signal coming from the console exactly matches (in every way) what is already on the recorder. If the punch represents an audio insert, the punch out must also be matched perfectly or else the viewer (or on the dub stage, the director!) will hear the punch.

In order to facilitate the perfect matching before a punch, surround monitor systems have provisions to listen to the output of the console *or* the playback of the recorder. This creates an additional great demand. The monitor must be able to switch between these 2 input sources with no audible glitch. While the glitch would not be recorded (since this is just a monitor function), it would distract the mix engineer from discerning whether or not the console output perfectly matched the audio already on the recorder. Since this matching process occurs hundreds of time during a mix, the crossover between console and recorder must be smooth and perfectly timed so that there is no click, no gap, and no audio buildup during the switch.

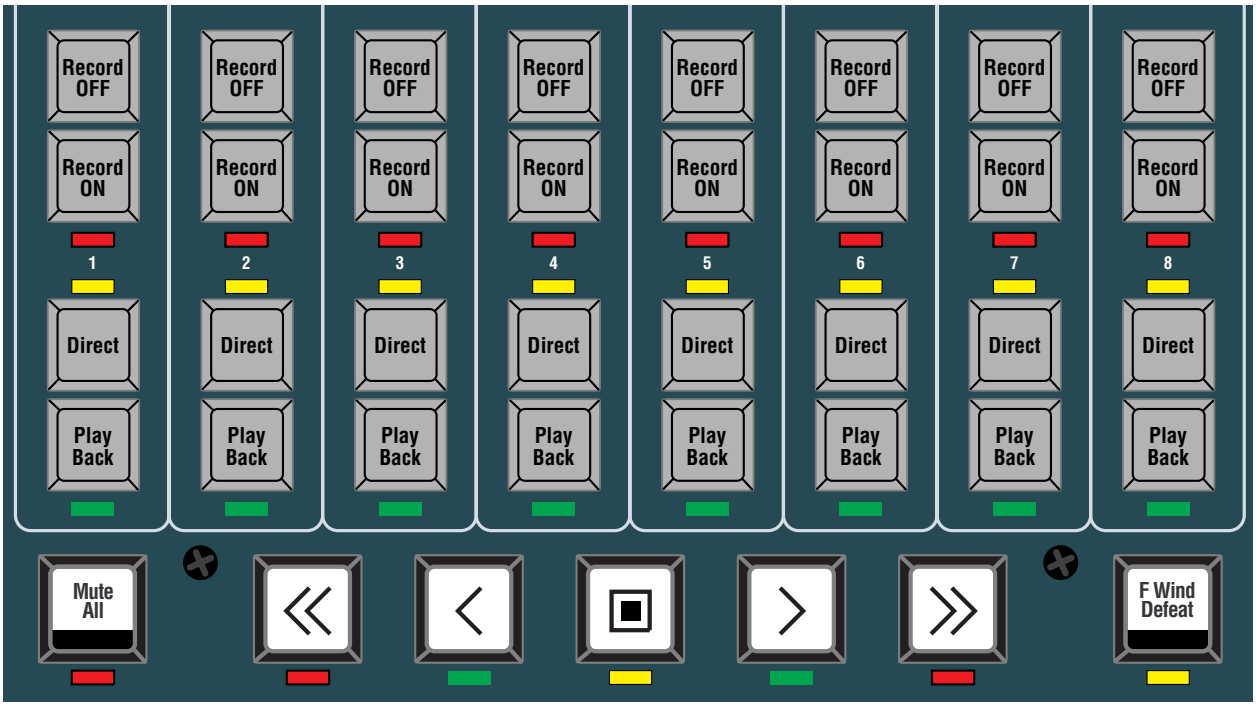
So what *does* PEC/Direct switching mean, anyway? When the recorders used on the dub stage were optical recorders (before my time), listening to a playback meant listening to the output of the **P**hoto **E**lectric **C**ell, or the PEC input to the monitor. Listening to the console *directly* meant listening to the DIRECT input to the monitor. Switching between them came to be called PEC/Direct switching. Now it is referred to as Direct/Playback switching.

PicMix has superb facilities for handling Direct/Playback switching. Of course each input channel of the PicMix monitor has two audio inputs…1 for the console output and 1 for the playback output of the recorder. Proprietary circuitry has been developed to ensure a smooth, click free, gapless crossover during switching with minimal audio buildup and optimal timing. Each channel is factory calibrated for glitch free switching. While each input can be switched at the Monitor Master, in practice this occurs from 1 or more of the monitor controllers which are mounted in or on the console.

The purpose for all of this matching between the console and the previously recorded mix, is to allow seamless punch ins and outs. PicMix has full provisions for actually performing the punches on a variety of audio recorders. When the PicMix Machine Control Interface (MCI) is installed, the monitor controller Record On and Record Off buttons now

"speak" directly to your recorder. Since the Direct/Playback buttons are adjacent to the Record On/Off buttons this allows the mix engineer to punch as soon as possible after the audio match is confirmed.

The MCI can control up to 4 serially controlled machines and 2 parallel controlled machines at one time. One of these ports can also be set up to perform basic motion control functions (Play, Stop, Fast Forward, Fast Rewind, and Reverse Play on some machines) from the motion control buttons which are also located on the Monitor Controller panel.



The PicMix Monitor Controller has complete facilities for seamlessly switching between console outputs (Direct) and the recorder outputs (Playback). When used in conjunction with the PicMix Machine Control Interface, recorder punch ins and outs as well as basic transport functions are also available.

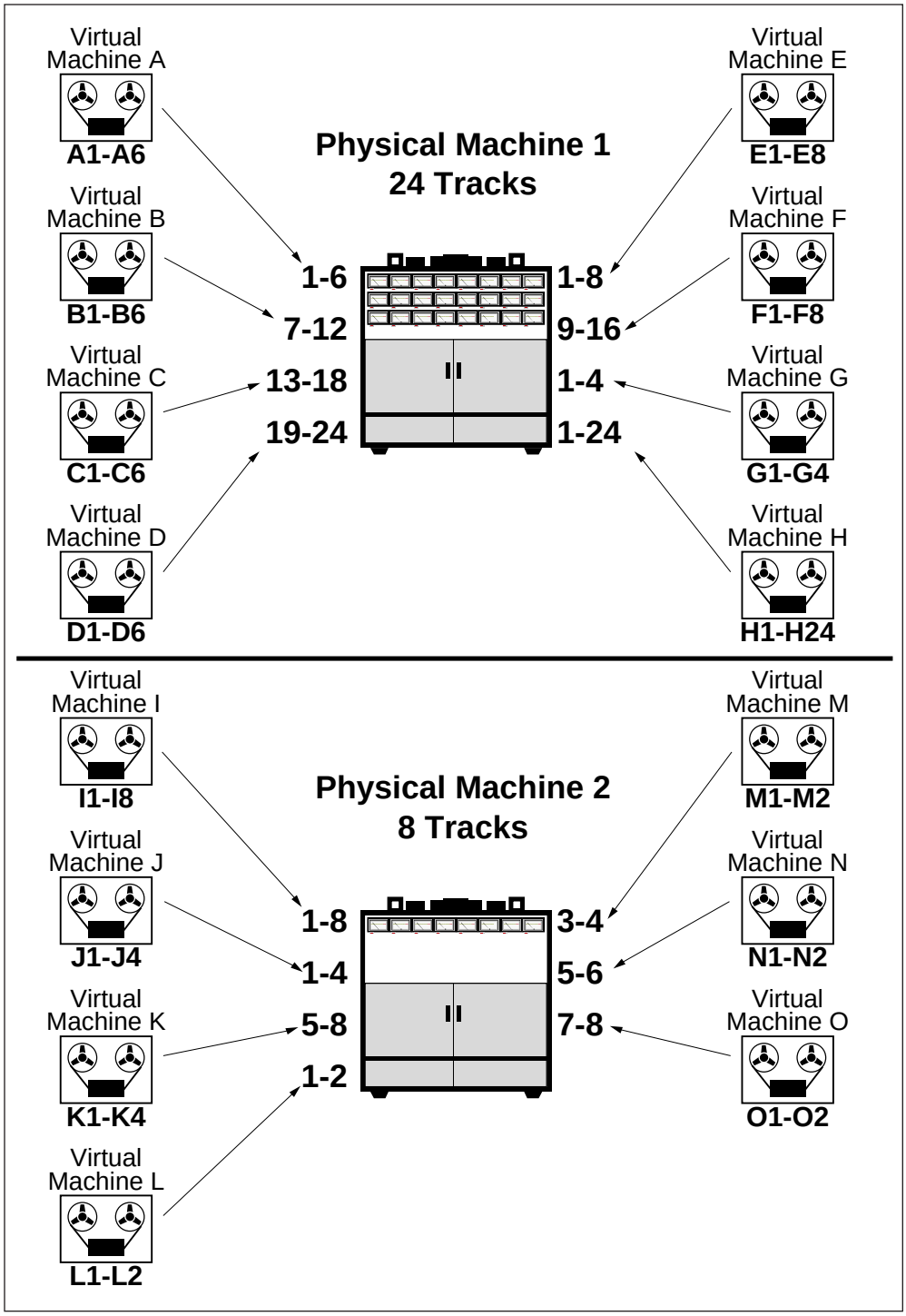
Physical and Virtual Machines

When mixing to a predub or final, it is essential that the mix engineer has complete control of the recorder where the stem or predub resides. But many times the recorder is a multi-track that is being shared. Two or more stems might be recorded onto a 24-track machine, for example. And perhaps each stem "belongs" to a different engineer.

In order to allow control of smaller parts of larger recorders, PicMix allows you to you define Physical Machines and Virtual Machines. The physical machines are the actual recorders that reside in your system. The Virtual Machines are subsets of the Physical Machines, so that you can have complete control of a smaller number of tracks and

treat them as if they were part of a completely separate recorder. These Virtual Machines, of course, do not really exist, but merely point to the actual tracks of the Physical Machines. PicMix can define up to 8 Physical Machines numbered 1 through 8, and 26 Virtual Machines called A through Z.

Through the use of Virtual Machines, the mix engineer does not have to have knowledge of where the actual tracks are being recorded. Up to 26 Virtual Machines can be set up to point to any contiguous range of tracks on any 1 of the 8 Physical Machines.

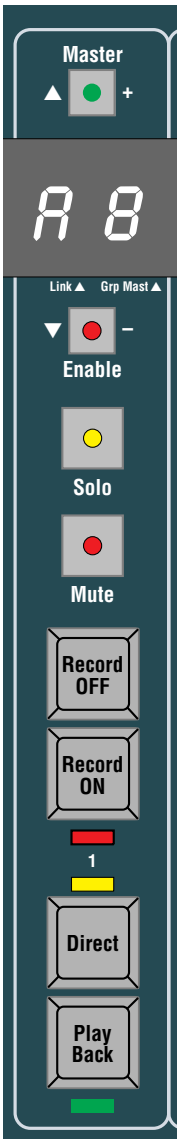


Controlling Tracks

Once the Virtual Machines are set up for the system, they can be assigned to Monitor Controller strips. Any strip can dial up any track of a Virtual Machine. Each Virtual Machine Track (VMT) points to a track of a Physical Machine and to a PicMix input channel. Any Controller strip or strips that are assigned to a VMT will control the physical track and input associated with it. This allows different mix engineers to be able to control the same tracks by dialing up the same VMTs on multiple Monitor Controllers. The Controllers are completely virtual and set no limits as to which tracks can be controlled from which controllers. Anything goes.

A Controller strip allows control of the following functions…

- Mute of the PicMix input
- Solo of the PicMix input
- Switch the PicMix input between Direct (console output) and Playback (Recorder output)
- Punch in or Out of the Recorder Track
- Safe the strip to prevent switching and punches
- Make the strip a Machine Master or a Global Master



The PicMix Monitor Controller has 8 strips that can be assigned to any Virtual Machine Tracks. Any strip can become a Machine Master or a Global Master by using the Master button.

Grouping Tracks

When recording a stem (let's use LCRS for this example) there are many times that you will want to control all 4 tracks at once, but there are also times when controlling the Center track alone or the Surround track alone is more appropriate. PicMix makes it easy to do both. (By control I mean do any of the functions listed above…Mute, Solo, Direct/Playback switching, Punch In or Out).

Normally all tracks work independently. Pushing the Master button above any Controller strip, however, makes that strip become a Machine Master. Asserting a function on a Machine Master activates that function on all tracks that belong to that same Virtual Machine. By "safeing" some strips using the enable button (set enable to off), Machine Masters can control subsets of Virtual Machines.

By pushing the Master button above a strip a second time (so that the LED flashes) that strip becomes a Global Master that will control all enabled strips in the system.

Linking Tracks

To allow the control of more than 8 tracks on each Monitor Controller, PicMix permits the Linking of multiple tracks "beneath" each control strip. By using the Setup Link function, up to 8 Virtual Machine Tracks may be assigned to each Controller strip. That strip then controls all VMTs that are linked to it. A VMT that is linked to a Controller strip can still be assigned to other Controller strips in the system.

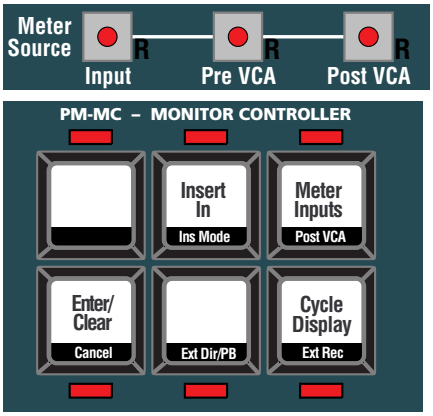
PicMix Metering

The PicMix Monitor Master has 8 buffered meter outputs along with a 3 input switching network. From either the Master panel or the Controller panel one of the 3 meter modes can be selected.

- **Input Metering** - The meter feeds read the PicMix input signals just post the Direct/Playback switching. This allows the viewing of the console outputs or the recorder outputs. (Each Monitor Slave also has 8 buffered meter feeds that allow the viewing of it's 8 audio inputs).
- **Pre VCA Metering** - The meter feeds read the calibrated signal levels on the internal speaker buses. This metering point is critical because it allows the checking of the signal levels that are fed to the surround processor if it is used. An internal jumper selects whether this meter feed comes before or after the insert return. If it is set before, then the meters always read the signal going to the processor. If it is set after, then the input or output of the processor can be read by switching it in or out of the circuit.
- **Post VCA Metering** - The meter feeds read the signal after the VCAs, which control the monitoring output level. This position allows the viewing of the signals being fed to the monitor power amplifiers. Since in a film style mix environment the entire monitor system (including power amplifiers and speakers) have been calibrated, these levels are relevant.

Note: *The meters that you use with PicMix should be set at unity gain (+4dBu in = 0 Vu reading).*

PicMix has 3 metering points within the system. The currently selected point can be selected from either the Monitor Master panel (top) or the Monitor Controller (bottom).

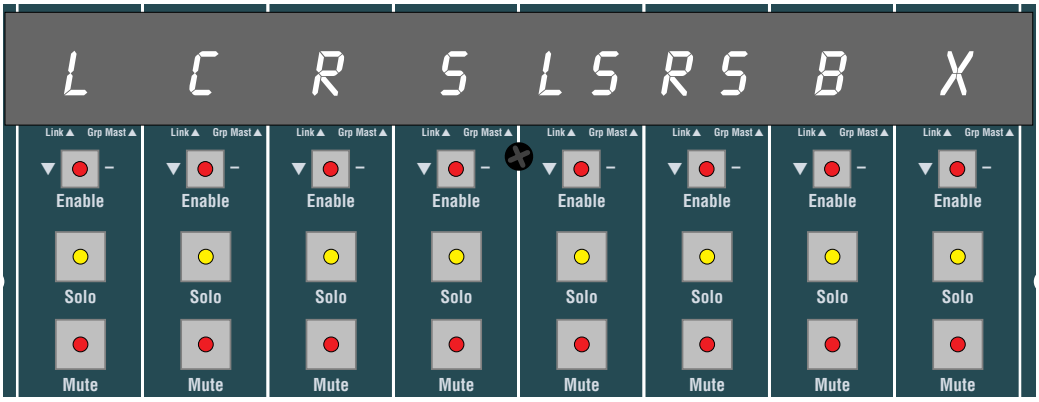


Speaker Solo and Mutes

While mixing to picture, it is often necessary to listen to only the signals that are assigned to a specific speaker…or to mute all signals being fed to a specific speaker. For example, to check if the proper signals are being routed to the surround speaker, you would want to mute all of the audio assigned elsewhere. The problem is that in muting these signals, it is extremely easy to make a mistake and mute a wrong signal or miss one.

PicMix eliminates this drudgery by offering complete solo and mute facilities for the speaker signals. On the Master panel, the speaker assignment buttons can mute or solo speakers when the panel is in these special modes. On any Monitor Controller, the panel can be set to Speaker Solo/Mute mode. In this mode the 8 Controller strips represent the 8 speaker buses, and the Solo and Mute buttons act on the speaker buses instead of the VMTs that the strips is assigned to. All other buttons continue to act on the VMTs.

When the PicMix Monitor Controller is set to Speaker Solo/Mute mode, the top half of the panel changes to allow the soloing and muting of the 8 speaker buses. The alphanumeric displays change to label the 8 strips with the speaker bus names.



Using PicMix with Standard Multi-Bus Consoles

PicMix is a monitoring system. It does not have any direct effect on the record chain. As such, it can work with just about any standard multi-bus console. However, special provisions have been made within PicMix so that normal console operation can occur unimpeded whenever surround sound functionality is not needed.

Because PicMix is the final device (except for room EQs, if used) in the monitoring chain, all power amplifiers must be connected to PicMix. The console Control Room outputs that would normally feed the left and right amplifiers are connected to PicMix. When PicMix is not turned on, or is in the PicMix Bypass mode, the console Control Room outputs are routed, through relays, directly to the left and right power amplifier inputs. This is a true hardwire bypass because the signal does not go through any active circuitry. In addition, to ensure that there is absolutely no affect on the console's sonic integrity, the internal PicMix cir-

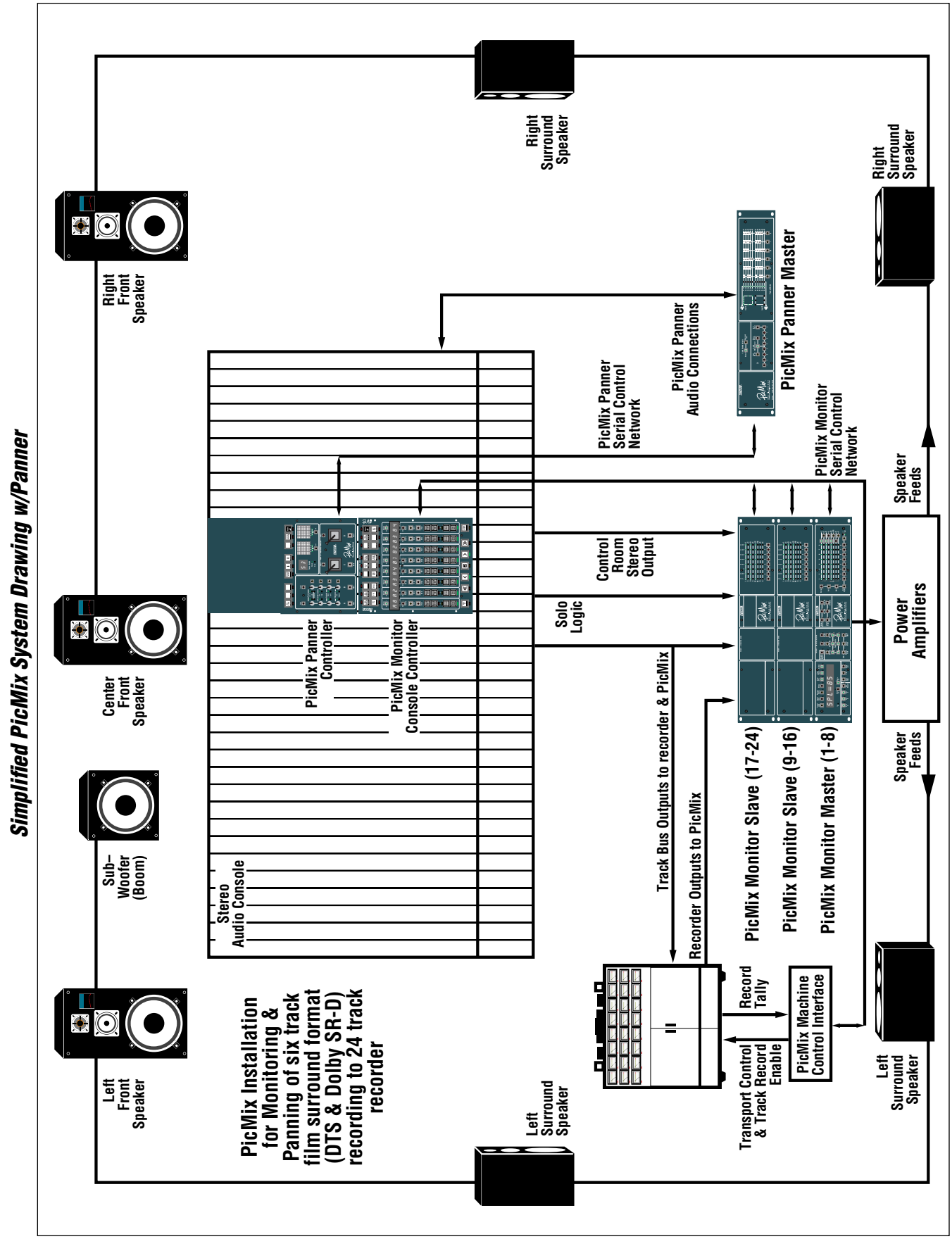
cuitry that the Control Room signals also feed (for console solo operation through PicMix), are totally lifted via additional relay contacts. All of the other power amplifier inputs are also shorted to ground during these bypass modes, preventing any signal leakage from appearing at those speakers.

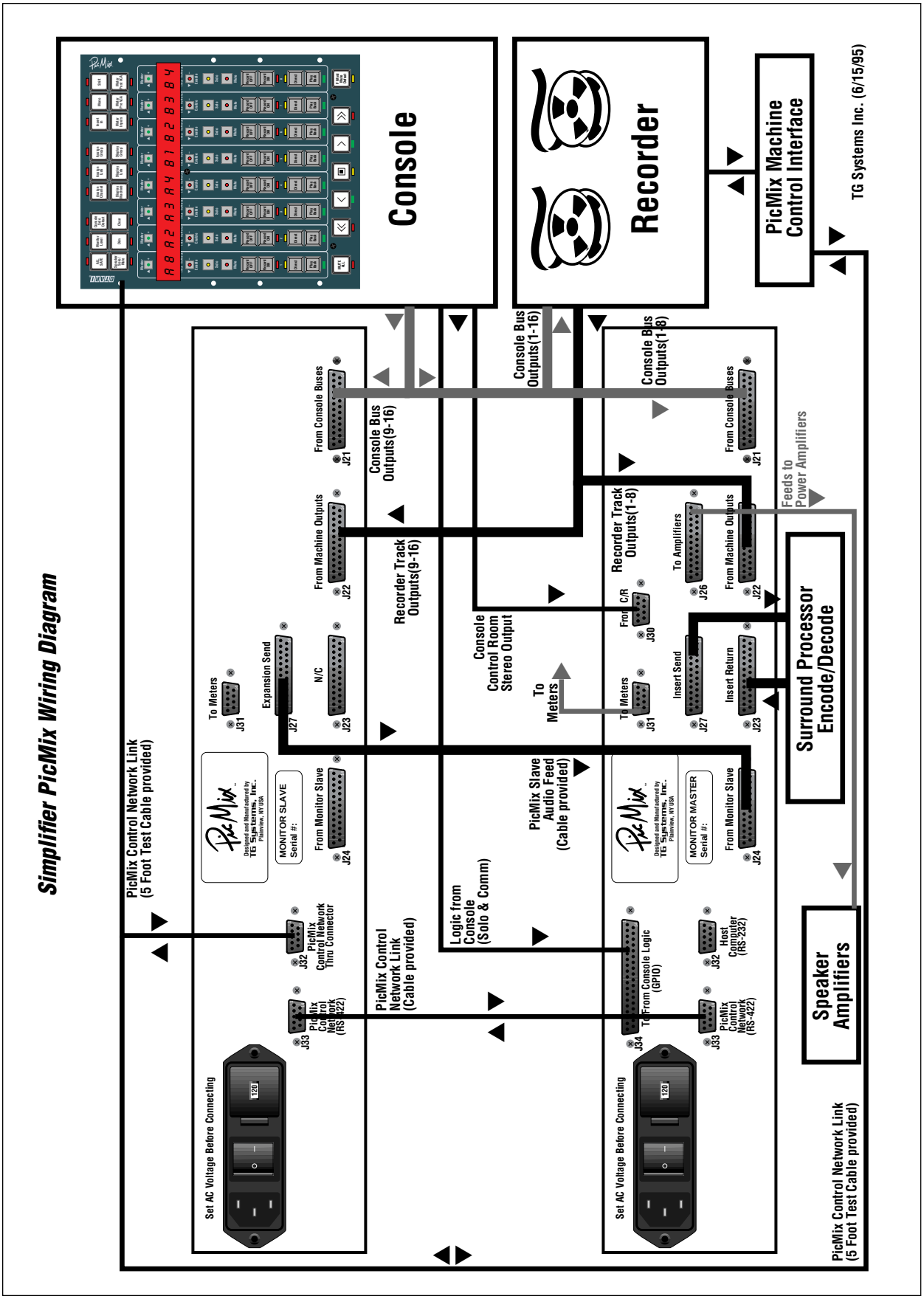
So that PicMix may fully integrate with the console's solo and communications functions, provisions are made for connection of logic lines from the console to the GPIO (General Purpose Input and Output) connector on the rear of the PicMix Master. When the console drives the solo logic line low (indicating that the console is in AFL or PFL solo mode), PicMix mutes all normal inputs, and feeds the console's Control Room outputs to the left and right speakers. When the console drives the communications logic line low (indicating that the console is in slate, comm, or talkback mode), PicMix mutes or dims the monitor level (depending on a setting in the User Preference System). PicMix has several additional logic inputs and outputs that allow even tighter integration with the host console system.

In addition to the console Control Room output connections and logic lines, this list summarizes the wiring of a large scale PicMix system…

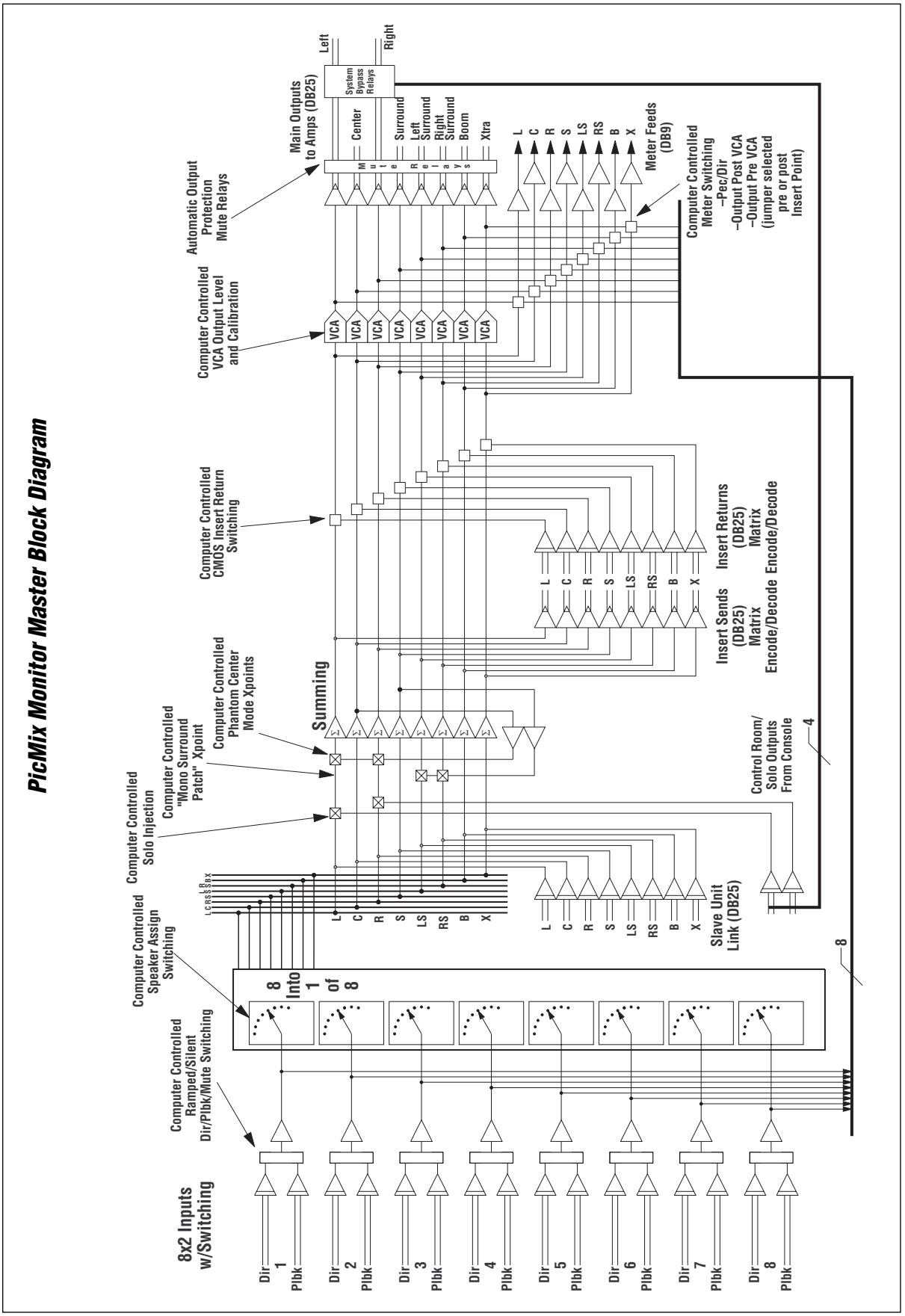
- The console record bus outputs must be wired to the recorder and also wired to the Direct inputs on the PicMix Master and Slaves (if any)
- The outputs of the recorder(s) must be connected to the Playback inputs on the PicMix Master and Slaves (if any)
- The surround processor (if used) must be connected to the insert send and returns on the PicMix Master
- The power amplifiers that drive the speakers must be connected to the main outputs on the PicMix Master
- The audio outputs of the PicMix Slaves (if used) must be connected to the previous Slave or Master rack (cables provided)
- All components of the PicMix Monitor system being installed should have their Control Network (PCN) connectors wired in parallel and connected to the PCN connector on the PicMix Master. This includes Slaves, Controllers, and the Machine Control Interface.
- If meters are used, they should be connected to the PicMix Master. If full input metering is desired the additional meters (beyond the first 8) should be connected to the PicMix Slave(s).

The drawings on the next two pages outline the interconnections involved in a complete PicMix Monitor System. They are meant as an overview. For details regarding installation, please consult the PicMix Operations Manual and your PicMix dealer.


Simplified PicMix System Drawing w/Panner
PicMix Installation for Monitoring & Panning of six track film surround format (DTS & Dolby SR-D) recording to 24 track recorder
Left Front Speaker
Sub-Woofer (Boom)
Center Front Speaker
Right Front Speaker
Left Surround Speaker
Right Surround Speaker
Stereo Audio Console
PicMix Panner Controller
PicMix Monitor Console Controller
PicMix Panner Serial Control Network
PicMix Panner Audio Connections
PicMix Panner Master
PicMix Monitor Serial Control Network
Control Room Stereo Output
Solo Logic
Track Bus Outputs to recorder & PicMix
Recorder Outputs to PicMix
PicMix Monitor Slave (17-24)
PicMix Monitor Slave (9-16)
PicMix Monitor Master (1-8)
Power Amplifiers
Speaker Feeds
Speaker Feeds
Record Tally
PicMix Machine Control Interface
Transport Control & Track Record Enable
Left Surround Speaker
Right Surround Speaker


Simplifier PicMix Wiring Diagram
Console
Recorder
PicMix Machine Control Interface
TG Systems Inc. (6/15/95)
PicMix Control Network Link (5 Foot Test Cable provided)
Console Bus Outputs(1-16)
Console Bus Outputs(9-16)
Console Bus Outputs(1-8)
From Console Buses
J21
From Machine Outputs
J22
Recorder Track Outputs(9-16)
Recorder Track Outputs(1-8)
To Amplifiers
J26
Expansion Send
J27
N/C
J23
Console Control Room Stereo Output
To Meters
J31
Front C/R
J30
Insert Send
Insert Return
Feeds to Power Amplifiers
Surround Processor Encode/Decode
PicMix Slave Audio Feed (Cable provided)
From Monitor Slave
J24
MONITOR SLAVE Serial #:
MONITOR MASTER Serial #:
Logic from Console (Solo & Comm)
PicMix Control Network Link (Cable provided)
PicMix Control Network Thru Connector
J32
PicMix Control Network (RS-422)
J33
To From Console Logic (GPIO)
J34
Host Computer (RS-232)
Set AC Voltage Before Connecting
120
Speaker Amplifiers
PicMix Control Network Link (5 Foot Test Cable provided)

PicMix Monitor Master Block Diagram



I Don't Mix Film. What's In It For Me?

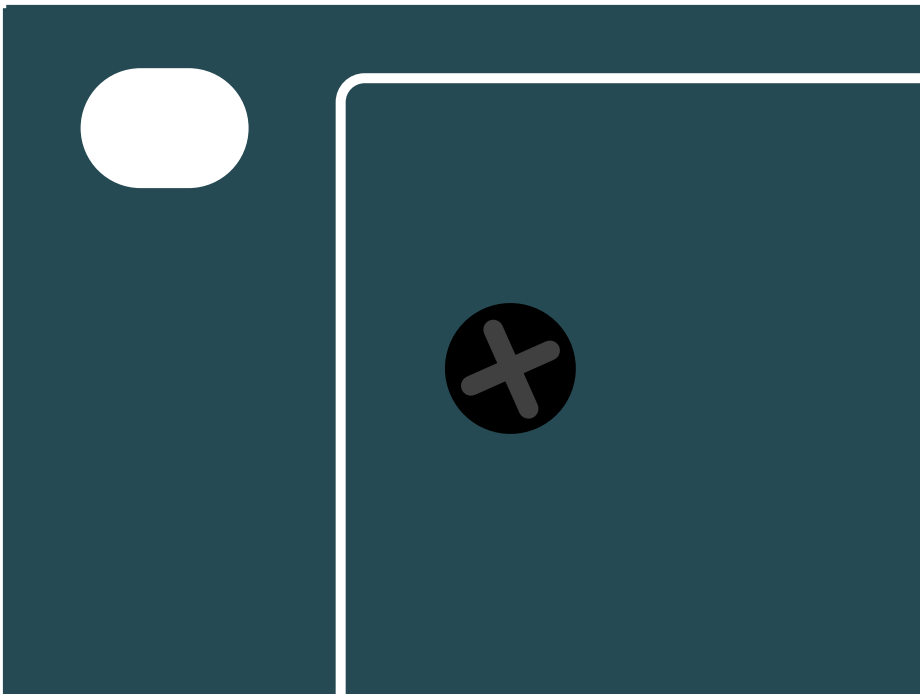
I have spent a lot of pages outlining the film style mixing process in the course of this paper, yet I have also stated that most of you will probably never mix a big budget motion picture. The reason for this is simple. Our talented friends in Hollywood have been dealing with the complex issues of posting sound to picture longer than anyone else has. All those that start to work in surround sound audio eventually come to find that these film style techniques or modifications of these techniques, eventually find their way into the process. My hope is that by looking at the most complex applications of PicMix in surround sound posting, it will be easier to identify the portion or portions that might be applicable to you and your work.

PicMix was designed not only to handle large scale film dubbing jobs, but also to handle the smaller tasks, down to and including the simple (now that PicMix exists) task of just listening to a surround sound tape or disk. The modular design of PicMix allows you to create the exact size system that is required for your work. The system can grow as your needs expand by simply adding additional components. This is an extremely cost effective and practical way to adapt your business to surround sound mix to picture.

The following is a brief list of some of the places and applications where PicMix can help ease the burden of dealing with surround sound…

- Music Mixing Rooms
- Film and Video Multi-Format Screening Rooms
- Edit Suites
- Sound Design
- Television Broadcast Facilities
- Ad Agencies
- Jingle Houses
- Multimedia Production
- Dubbing Stages
- Remote Recording Trucks
- Remote Broadcast Trucks

The next section of this paper will present a basic explination of the nature of surround sound panning and the PicMix Panning System.



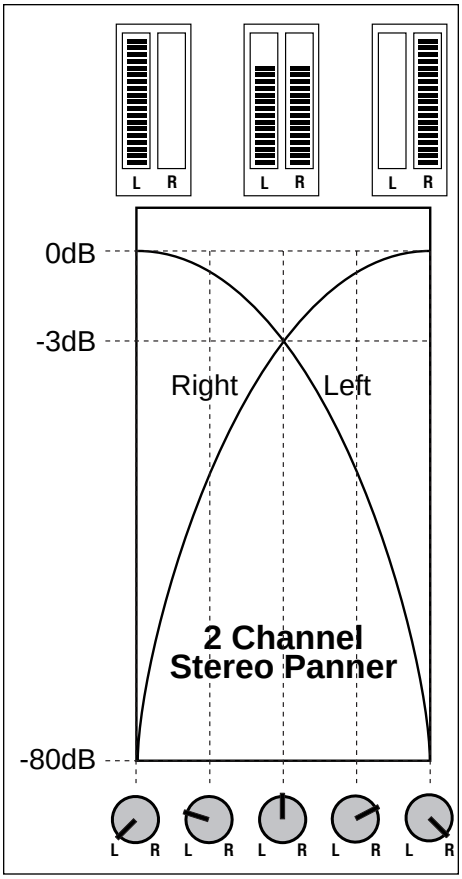
Surround Sound Panning Basics

The previous section of this paper focused on the general aspects of surround sound formats, the complexities involved in monitoring them and how the PicMix Monitor System simplifies these complexities.

In this section we will explore the basics of surround sound panning and the extraordinary functionality of the PicMix Panning System. While the PicMix Panner is fully compatible with the PicMix Monitor, please note that it can also be used with almost any multi-bus console and does not need to be used in conjunction with the PicMix Monitor.

In order to understand the need for panning in the surround sound environment, we will first take a look at the purpose of panning while recording or mixing for the standard 2 channel stereo format.

Panning for Stereo



Panning curve for standard 2 channel stereo panner.

A stereo mix is ultimately played back through 2 speakers, left and right. By assigning audio elements during the mix, to either the left speaker, the right speaker or to both speakers, the listener is led to believe that the sounds are emanating from the left speaker, the right speaker, or from a phantom center speaker that is located directly between the left and right speakers. (We are assuming that the room acoustics and the position of the listener allow this phenomenom to occur. In other words the listener is in the sweet spot of a good room).

Since music and sounds that occur in nature do not emanate from only 3 point sources, a recording with only left, right, and center (phantom) placements would sound unnatural. We need to be able to spread our sounds across the entire listening *pan*orama. For this we use the aptly named *pan* pot or *pan*ner. The pan pot not only allows us to assign our audio elements fully to each speaker, but also to assign them to both speakers in *unequal* amounts. By varying the amount of signals fed to each of the 2 speakers, we can place the sound sources at any location between the speakers.

Note: *Since I mentioned music and sounds that occur in nature, I should be clear that the use of a multiple pan pots, feeding multiple* ***mono*** *sound sources, to multiple places in the sound field pananora, does* ***not*** *equal great reproduction of natural sounds. Panned mono sources are a way of life in the studio of today, and I could write 30 pages on that topic but I won't (at least not here). Let's assume that we all understand that panning is used to* ***simulate*** *the actual, natural stereo recording that we all wish we could be doing.*

So the main thing that a pan pot allows us to do is to place a mono sound source at any location between 2 speakers. The other thing that a pan pot can do is to move that signal smoothly over time. A sound source can be moved in space by operating the pan pot while mixing or recording. This can be used to provide special effects in a music recording (number 9...number 9...number 9) or to match the movement that occurs on screen when mixing to picture.

Panning for Surround Sound Formats

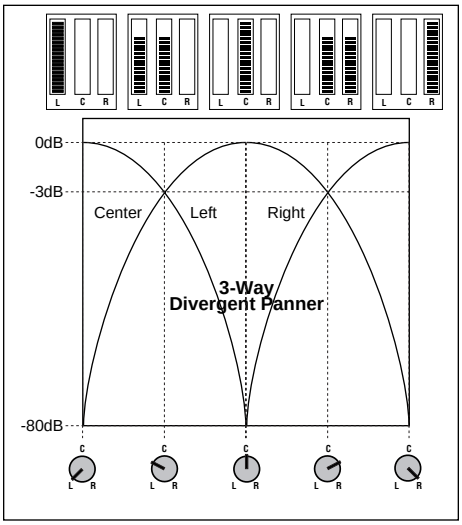
The reasons to use a panpot when mixing for surround sound are the same as when mixing for 2 channel stereo…to precisely place a sound source within the sound field (created by multiple speakers) or to dynamically move a sound source within the sound field. However, the conventional stereo pan pot is not up to the task. Surround sound formats present a host of barriers that must be overcome.

First of all, as we have seen in the previous sections of this paper, there are several surround sound formats that must be accommodated.

To simplify our discussion I will use just the 5.1 (LCRISrS) format, realizing that this discussion should be applied to all surround sound formats, either present or future.

It is difficult (if not impossible) for analog controls to create the audio curves necessary for panning into the various surround sound formats. Therefore, it is only practical to implement a multi-channel multi-format panner using digital control of the audio electronics. With this approach the panner is able to accommodate all formats and do tricks that were not possible in previous generation all analog designs.

Full Divergence



Panning curves for 3-way fully divergent panner. This panner is used for the front speakers in Dolby Stereo (LCRS) and 5.1 (LCRISrS) formats.

Most of the major surround formats have 3 speakers in the front of the sound field. This fact is what makes the standard "stereo" pan pot inadequate for the job of surround format panning. When an audio element is panned across the front (as in our 5.1 example) the signal must appear only in the left speaker when it is panned to the left, only in the center speaker when panned to the center, and only in the right speaker when panned to the right. The fact that the sound moves to each speaker separately in the course of the pan, is known as divergence. The panner is said to be a *divergent* panner or to have *full divergence.*

In order to understand why this necessary, let's diverge for a moment to discuss the center channel speaker.

Why a Center Channel Speaker?

In a home hi-fidelity music reproduction system there are only 2 speakers, left and right. What is different about film that made "them" add a center channel speaker? There are several differences. The first is that in a theater, most of the viewers are not sitting in the "sweet spot", so their brains are unable to form a focused center image. Secondly, these same people would be distracted if they were sitting near the right speaker, for example, because their eyes are looking to the center of the screen, but their ears are being drawn to the right speaker. In addition, before multi-channel film sound was introduced there was *only* a center channel speaker, so in truth, the left and right (and surround) were added, not the center speaker.

While a home theater system is not the size of a commercial theater (unless you go to a newly constructed multiplex!), the reality of the small sweet spot is actually worse than in a large commercial theater. It can only serve 1 or 2 people at most. Anyone who has made the transition from an original home Dolby Surround (LRS) system to the 4-channel Dolby Pro Logic system (LCRS), with the center channel speaker, can attest to the dramatic improvement this seemingly subtle change makes.

It is also important to remember that the usual purpose of a film (or film on video) is to convey a story and the most important aspect of telling the story is usually the dialog. Having a center speaker helps ensure that the dialog (which resides in the center speaker 99% of the time) can be as intelligible and localized as possible.

Back to Divergence

Let's remember that person sitting on the right side of the theater and suppose that a car is about to drive across the screen (in the movie) from the left to the right. The sound first appears in the left speaker exclusively. When the car is center screen, the sound emanates from the center speaker only (because the panner is fully divergent). If the sound came from the left and right speakers (forming a phantom center image), or even from all three speakers, the right sitting person would perceive the sound as coming from the right speaker and the effect of the smooth pan would be destroyed. Since we also defined the job of the panner to statically place sound elements, it is clear that when an element is panned (or positioned) for placement in the center, it must *also* come only from the center speaker. But there are exceptions…

A Little Less Divergence

Let's talk about the person sitting over by the right speaker once again. If a sound element is panned (positioned) full left, then there is a chance that this person will not hear the element clearly or at all, because it is coming from only the left speaker. To remedy this, the sound can be panned slightly to the right so that it appears left of center (to someone sitting in the sweet spot). This will be a perfect solution in many cases. The right sitting person will hear the sound better because some of its energy is now also coming from the center speaker which is closer to their viewing position.

Another remedy would be to keep the element panned full left, but reduce the divergence of the panner. When the divergence of the panner is reduced (making it less divergent) some of the energy of the sound is fed to the other speakers, allowing the sound to have a presence throughout the sound field, while still being predominant in a specific speaker.

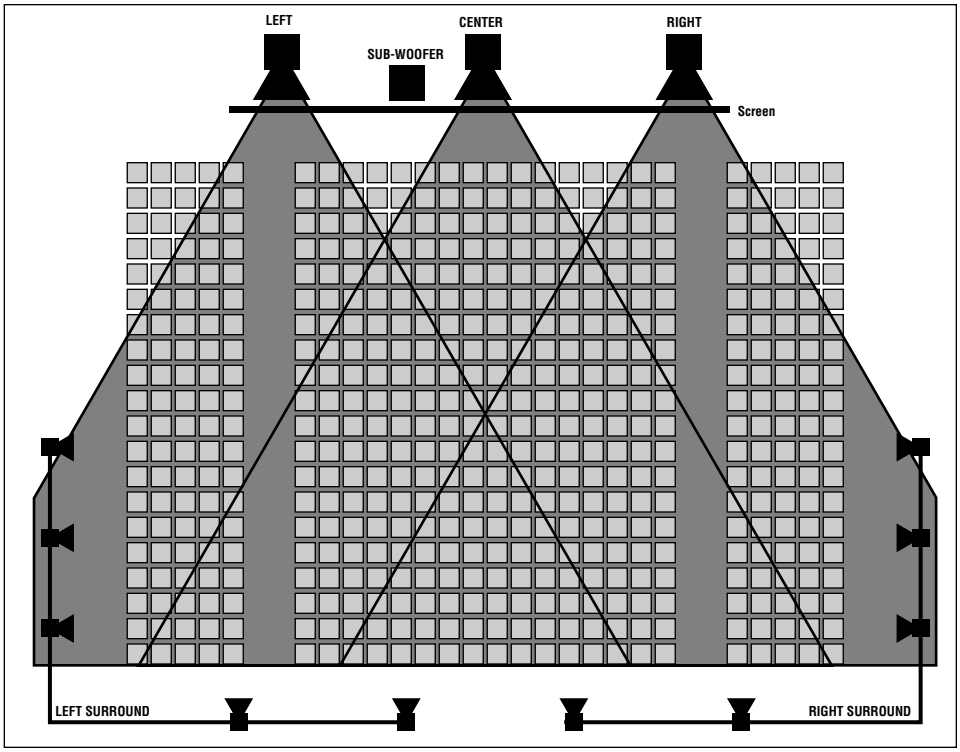
In a dynamically panned element, the pan will be smoother, because the sound never completely disappears from the alternate (not panned to) speakers. Rather than jump from speaker to speaker during a fast pan, it will glide smoothly.

Decreasing the divergence of a panner also acts to limit the spread of the pan. Instead of panning from full left (of the sound stage) to full right as the knob (or joystick) goes through its full range, the sound will appear to pan from left-center to right-center. The spread can be varied by changing the amount of divergence that is applied to the panner.

The drawings later in this section should serve to show the technical effects of varying the divergence of a full 5.1 panner (LCRlSrS) and of just the front speakers of a 5.1 or Dolby Stereo (LCRS) panner. By studying these drawings you should get an understanding of how divergence affects the action of a panner.

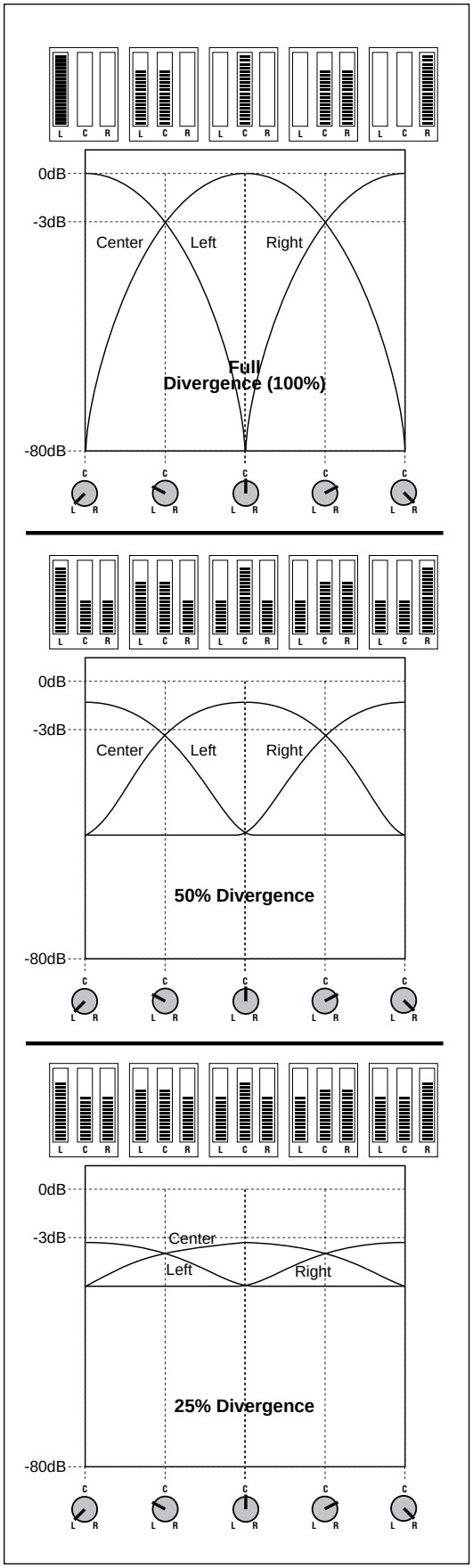
But the technical information does not get to the root of the divergence debate…yes, debate! Many mix-to-picture mixers will tell you that they have never touched a divergence control, (ever!), and many mixers will not use a panner unless it has complete control of its divergence characteristics. I will not enter the debate, but will only say that having variable divergence in a panner extends the creative capabilities of that panner. It can be left in the "full" mode all of the time, or can be played like a violin by those mixers that take the time to explore the possibilities.

As you can gather through the above discussion, panning and positioning sound for picture is a giant compromise because the listening (viewing) environment can vary so much, and within a given environment, someone can have a great seat, or be stuck up close to the screen and over to the right. The dynamic panning of audio as a special effect, or the passive panning of sound for sonic positioning, requires artistic compromise. Keeping everything in the center, can be boring and uninspired, while spreading things out and dynamically panning lots of elements can be distracting to what is happening on the screen. This is why the sought after mix-to-picture mixers get the big bucks.

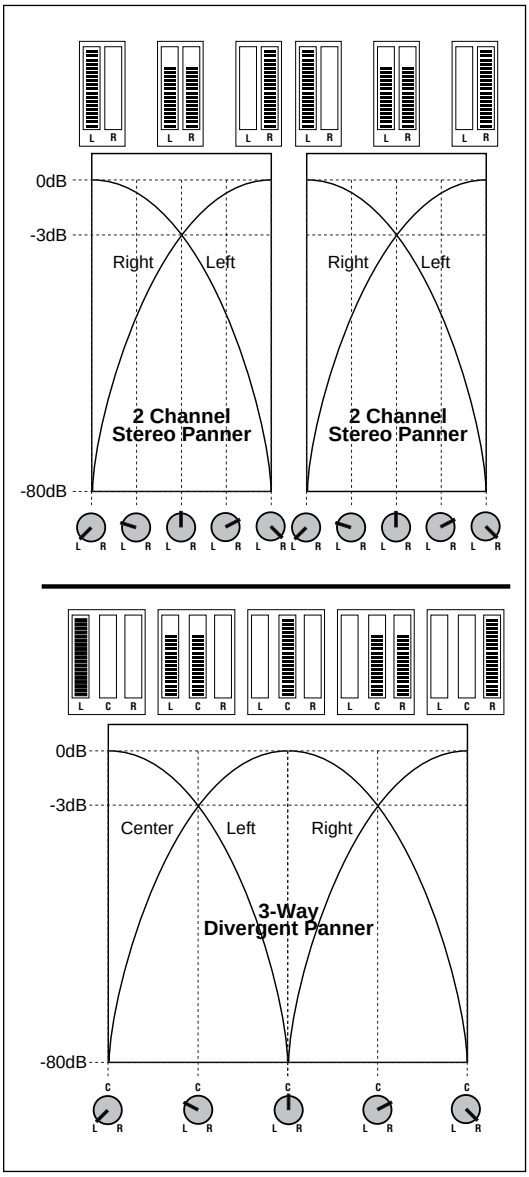


Simplified drawing of a 5.1 theater shows that many seats do not get on axis coverage from all of the speakers. Reducing the divergence of the panner can help this situation by leaking some signal into the alternate speakers while still maintaining the signal dominance in the panned to speaker.

These 3 graphs compare the panning characteristics of a 3-way divergent panner, with the divergence set to full (top), 50% (middle), and 25% (bottom). In all cases the total power distributed is the same.



The 3-way divergent panner (bottom) acts as if it is two stereo panners attached in the middle (top). Notice in the divergent panner that at no time is there ever sound in the left and right speakers simultaneously!



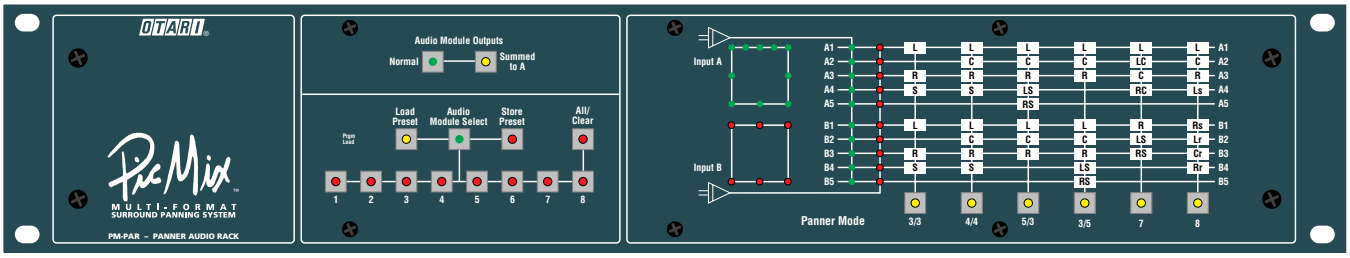
Introducing the PicMix Panner

The PicMix Panner is extremely versatile in that it provides a variety of panning modes for the various surround sound formats. It can be set to pan into all current formats including Dolby Surround, 5.1, SDDS, and 8-channel multi-media. Future formats can be accommodated via software updates. Two independent sets of buses (5 each) are provided so that one panner rack can service two separate stems (or just feed 1 stem). The PicMix Panner consists of the Panner Audio Rack and the Panner Controller.

The **PicMix Panner** and its options provides the following functionality…

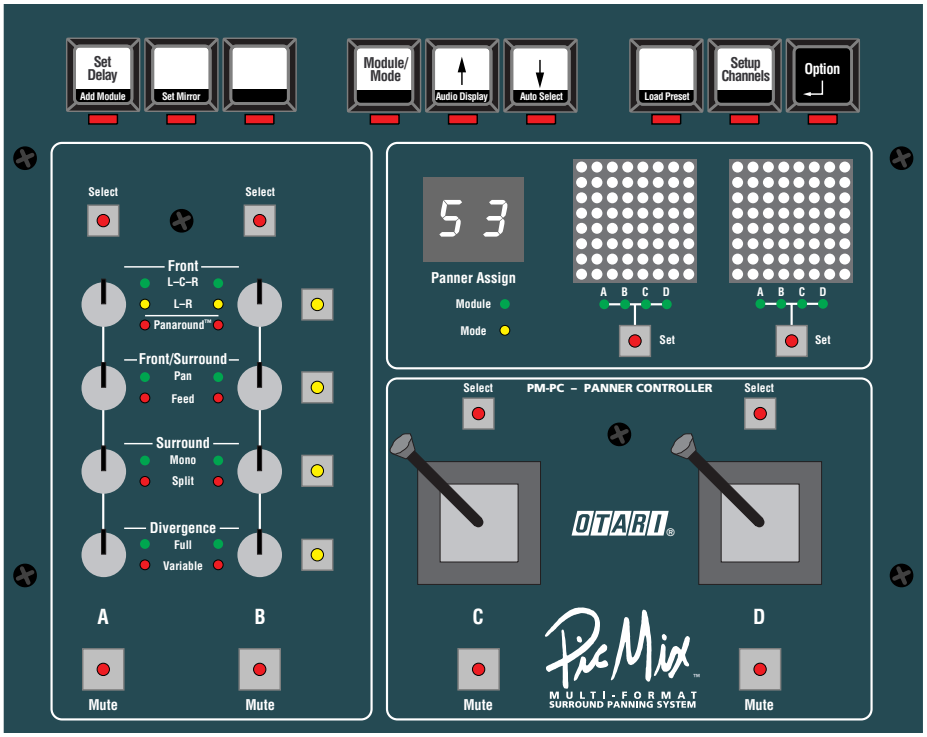
- Up to 8 dual input Panner Audio Modules (16 audio panners) per panning rack
- Each Panner Audio Module can be configured for all common panning configurations
- Compatible with all surround sound formats including Dolby Stereo, Dolby Digital (SR-D), DTS Digital, Sony SDDS, and multimedia.
- Up to 4 panner controller remote panels may be used
- Compatible with almost any multi-bus audio console
- All audio I/O is electronically balanced at +4 dB nominal level
- 8 presets are available for instant setting of panning formats
- LED matrix display shows current panning formats
- Each panner controller remote panel has 2 knob-style panner control sets and 2 joystick-style panner control sets
- Any control set (knob or joystick) can be assigned to an audio panner or group of panners
- Grouped audio panners can have time delays associated with them
- Grouped audio panners can have “mirror type” special effects associated with them
- Optional MIDI I/O provides panner automation link to external (user provided) MIDI sequencer.

Panner Audio Rack



This 2U rack unit is the core of the PicMix Panner. All audio connections interface to the Panner Audio Rack. The standard rack is fitted with 2 Panner Audio Modules (PAM), but up to 8 PAMs can be accommodated. Each PAM has 2 audio inputs and can be configured from the front panel into 1 of the 6 available panning modes. Therefore, the standard Panner rack has 4 audio panners, while a fully loaded rack with 8 PAMs has 16 audio panners.

Panner Controller



This 8.8w X 7h (inches) panel is designed to mount in or on your console in a blank panel or in an available desktop box. The Panner Controller is the remote control for the PicMix Panner and is necessary for panner operation. Multiple Controllers may be utilized for multi-section console operation. Each Controller has 4 panner control sets (A, B, C, D), 2 with knobs (A&B) and 2 with joysticks (C&D). Each of these 4 control sets can be assigned in a virtual fashion to any of the 4 to 16 audio panners in-

stalled in the Panner Audio Rack. The Controller communicates to the panner rack via the PicMix Control Network (PCN), a full duplex serial link which also powers the controller. The PCN can function over a single 9-conductor flat ribbon cable for short cable runs (25 feet and under).

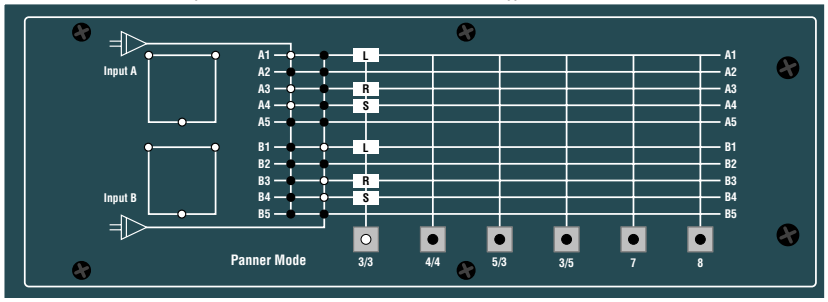
Panner Audio Rack Features

Panner Module Audio Modes

Each of the Panner Audio Modules (PAM) can be configured into 1 of 6 different panning modes from the front panel of the Panner Audio Rack.

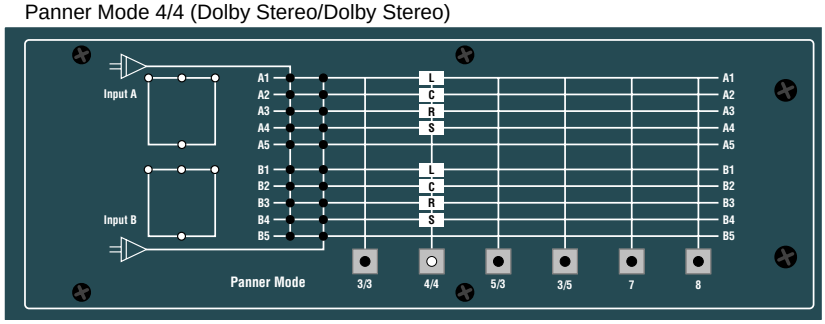
The front panel features an active block diagram, that graphically displays, via LEDs, the panning mode and bus assignments for the selected PAM. Each PAM can have up to 2 active audio panners.

Panner Mode 3/3 (Phantom Center/Phantom Center))



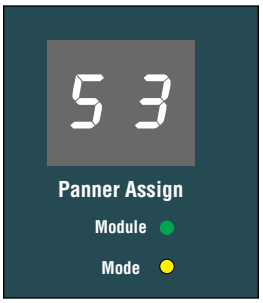
Input A pans to buses Left(A1), Right(A3), Surround(A4)
Input B pans to buses Left(B1), Right(B3), Surround(B4)

Panner Mode 4/4 (Dolby Stereo/Dolby Stereo)

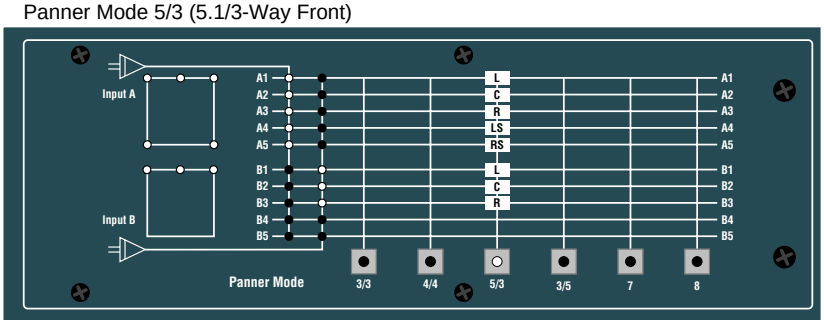


Input A pans to buses Left(A1), Center(A2), Right(A3), Surround(A4)
Input B pans to buses Left(B1), Center(B2), Right(B3), Surround(B4)

Panner Modes are also displayed and set on the Panner Controller.



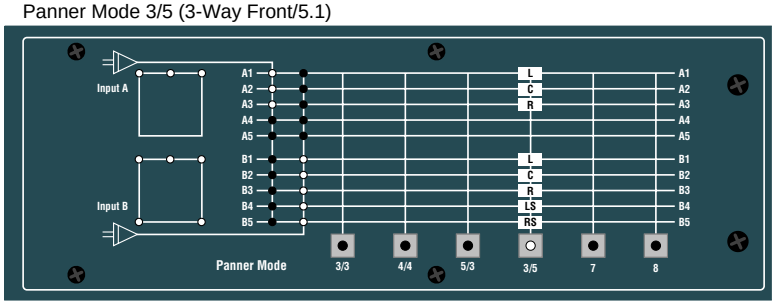
Panner Mode 5/3 (5.1/3-Way Front)



Input A pans to buses Left(A1), Center(A2), Right(A3),
Left Surround(A4), Right Surround(A5)
Input B pans to buses Left(B1), Center(B2), Right(B3)

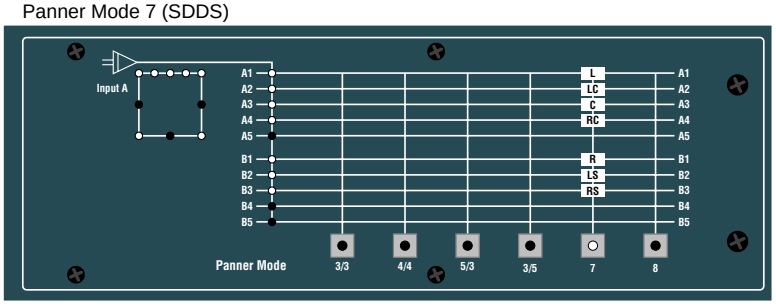
Each of the above panner modes (except 7 and 8) can be configured as "Summed to A" so that both audio panners feed the "A" set of panner buses. This is useful when the 2 panners are part of the same stem and do not need to be kept separate.

Panner Mode 3/5 (3-Way Front/5.1)



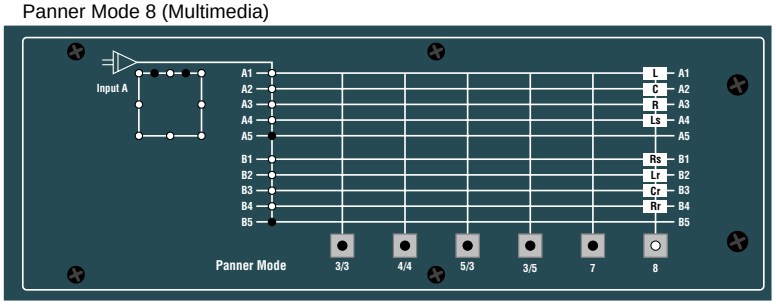
Input A pans to buses Left(A1), Center(A2), Right(A3)
Input A pans to buses Left(B1), Center(B2), Right(B3),
Left Surround(B4), Right Surround(B5)

Panner Mode 7 (SDDS)

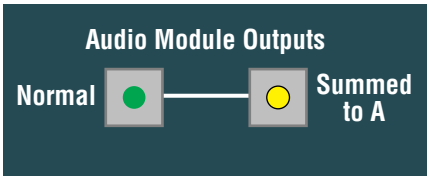


Input A pans to buses Left(A1), Left Center(A2), Center(A3), Right Center(A4)
Right(B1), Left Surround(B2), Right Surround(B3)
Input B is unavailable in this mode

Panner Mode 8 (Multimedia)

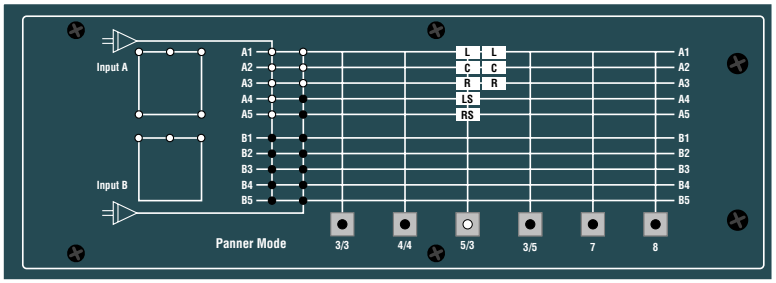


Input A pans to buses Left(A1), Center(A2), Right(A3), Left Side(A4)
Right Side(B1), Left Rear(B2), Center Rear(B3), Right Rear(B4)
Input B is unavailable in this mode



Each Panner mode (except 7 & 8) can be set to normal mode so that each panner feeds a separate stem, or summed mode so that both panners feed the "A" stem buses.

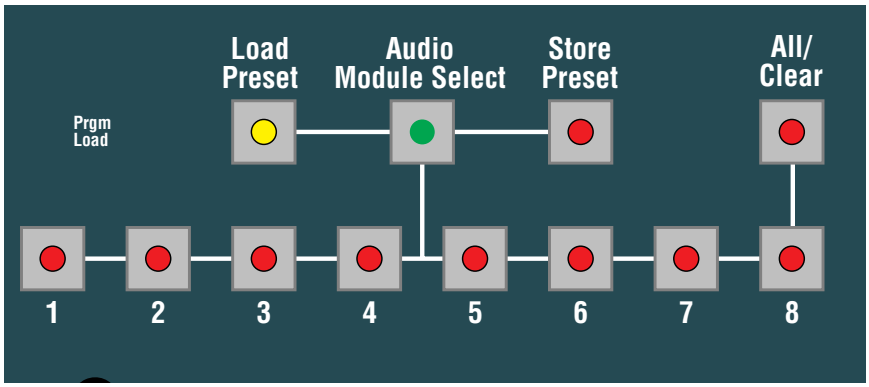
Panner Mode 5/3 Summed (5.1/Dolby Stereo Front)



Input A pans to buses Left(A1), Center(A2), Right(A3),
Left Surround(A4), Right Surround(A5)
Input B pans to buses Left(A1), Center(A2), Right(A3)

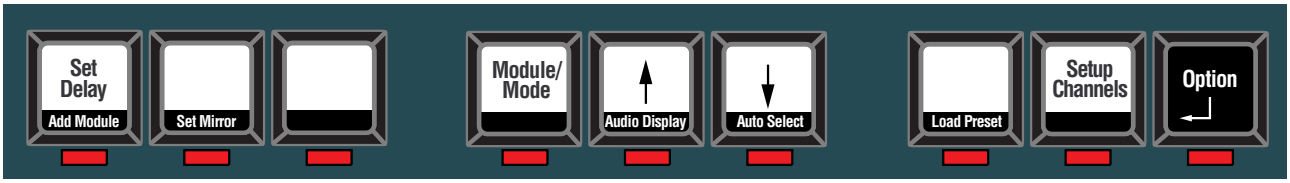
Selector Buttons

The front panel selector buttons allow the selection of any PAM so it's panning mode can be viewed or changed. Up to 8 system presets can also be stored to or loaded from memory by using these buttons.



Panner Controller Features

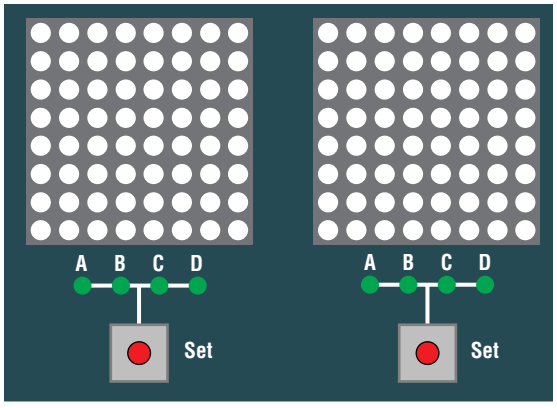
Panner Controller Master Buttons



The Panner Controller Master Buttons control the assignment of panner control sets (knob or joystick) to the PAMs in the audio rack. Panner modes and special effects may also be set via these buttons.

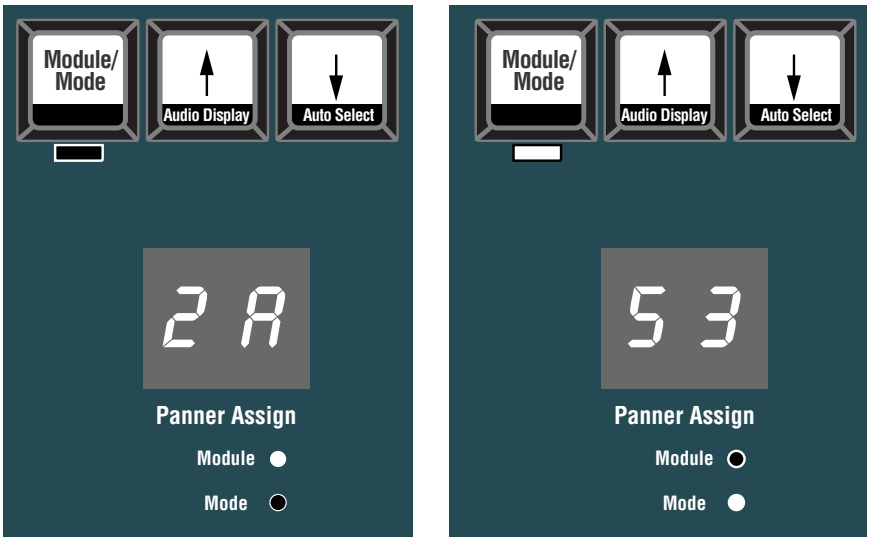
Audio Position Display Grids

The Audio Position Display Grids show the placement of the audio in the sound field taking all parameters, including divergence, into account. The grids can automatically switch to the panners in current use by setting them to the auto select mode. The Set LEDs indicate when a panner is Set exactly to the center of the left/right panorama.



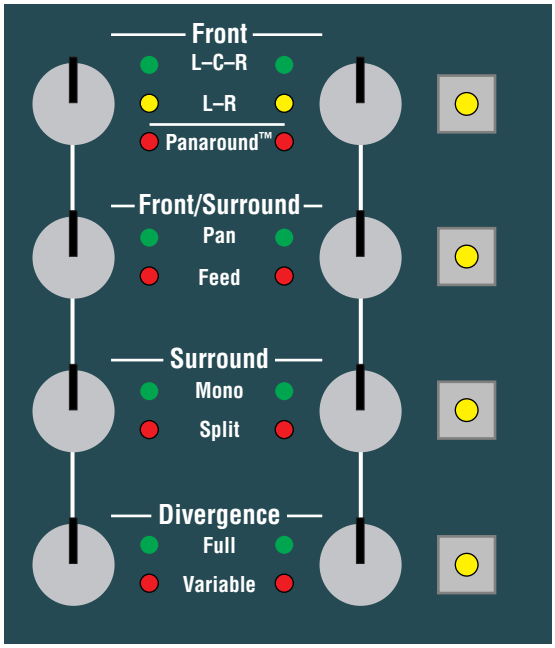
Panner Assign Display

The PAM assigned to the active panner control set is displayed when the Panner Assign is set to Module (shown left). When it is set to Mode (shown right), the panning mode is displayed. When in "Setup Channels" the arrow keys are used to cycle through either the PAM or panner mode. In this example, the A input of PAM 2 is assigned to the selected panner control set (not shown). Since PAM 2 is set to 5/3 mode, input A will act as a 5.1 format panner.



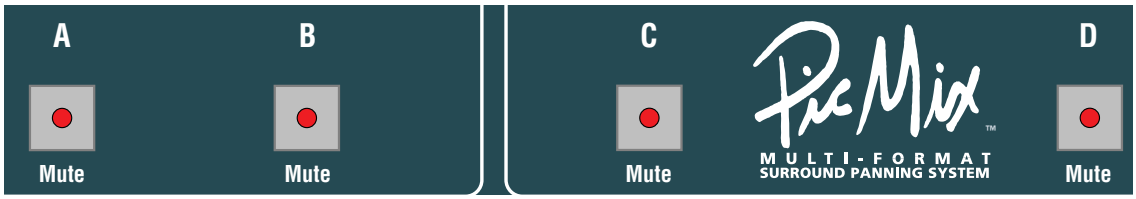
Parameter Set and Display

The LEDs between the knobs, and the buttons to the left of the knobs are used to display and set panning parameters. When a joystick is the active panner, the LEDs and buttons reference the joystick panners (C & D). When a knob control set is active, they reference the knobs (A & B). The buttons are only active when in "Setup Channels" mode.



Panner Mute Buttons

Each of the 4 control sets (A, B, C, D) has a large Mute button with LED indicator.



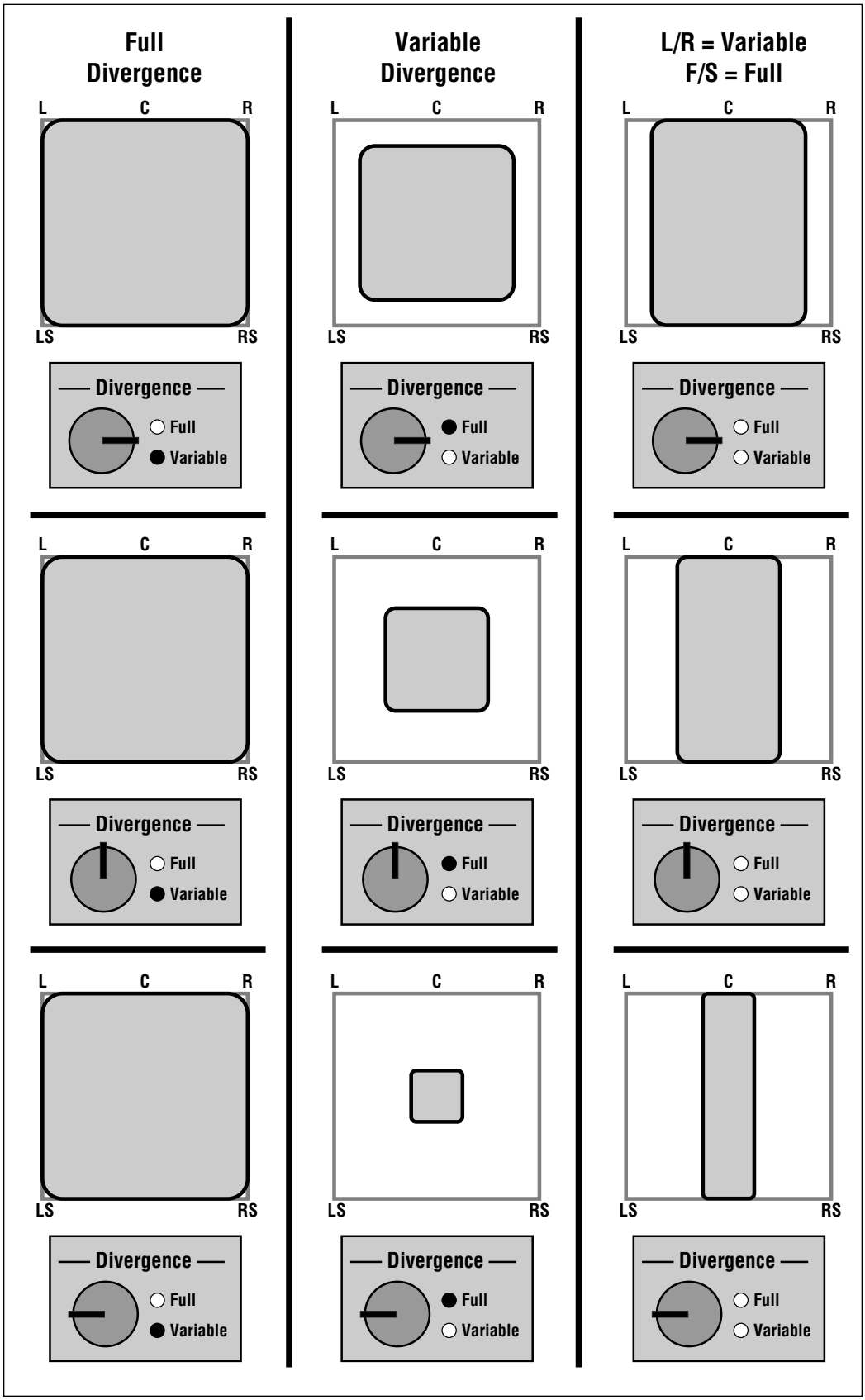
Divergence Modes

Each panner can be set to 1 of 4 divergence modes...the 3 shown at right plus a special effects Auto-Divergence Mode (not shown).

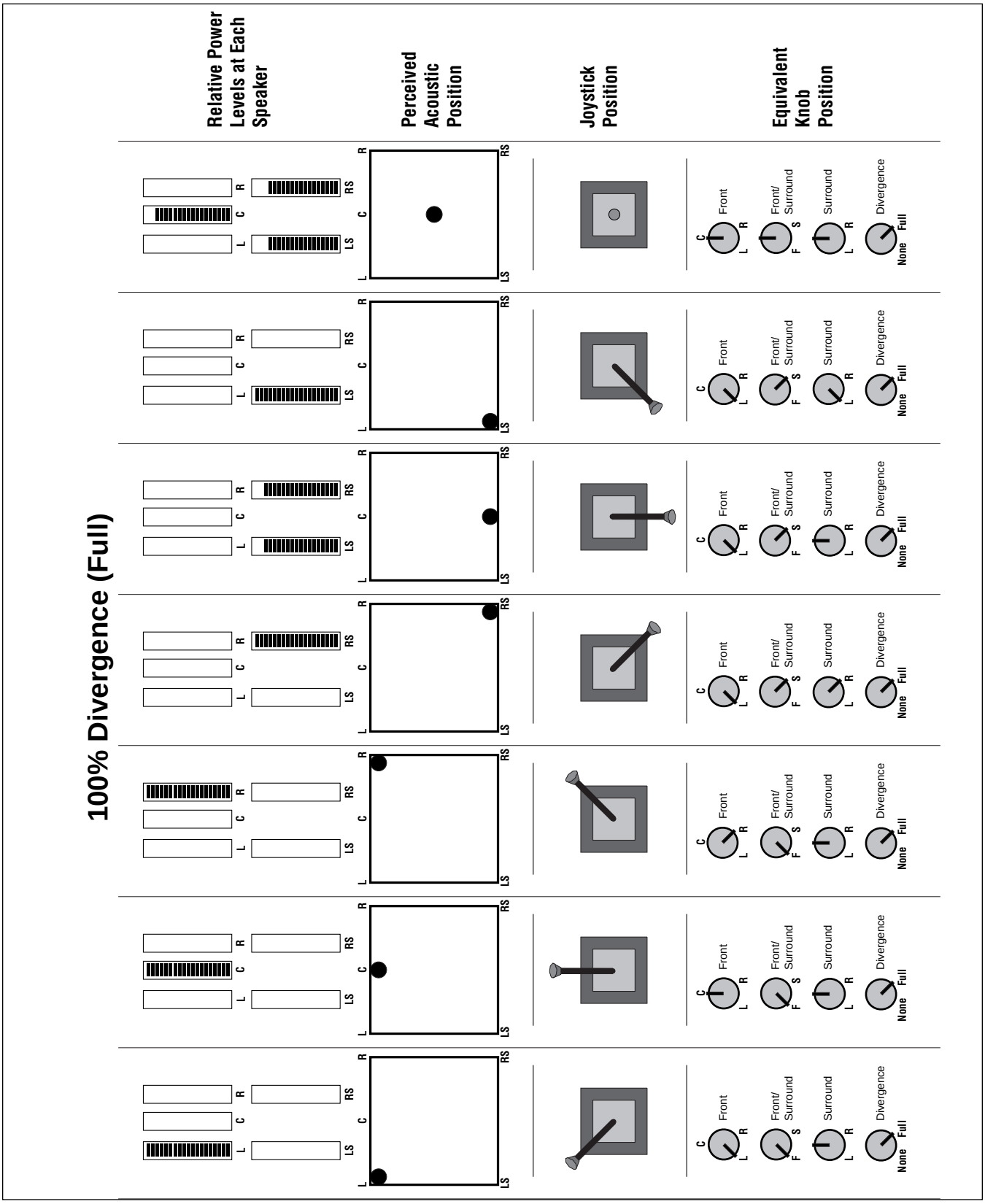
In Full Divergence Mode, (shown left column) the knob has no effect on divergence, which is full or 100%.

In Variable Divergence Mode (shown center) the divergence is controlled by the position of the knob. The grey inner box shows how lessening the divergence limits the scope of the panner within the sound field. Setting divergence to approximately 75% as shown in the top center example, smooths out fast dynamic pans that might otherwise sound jumpy.

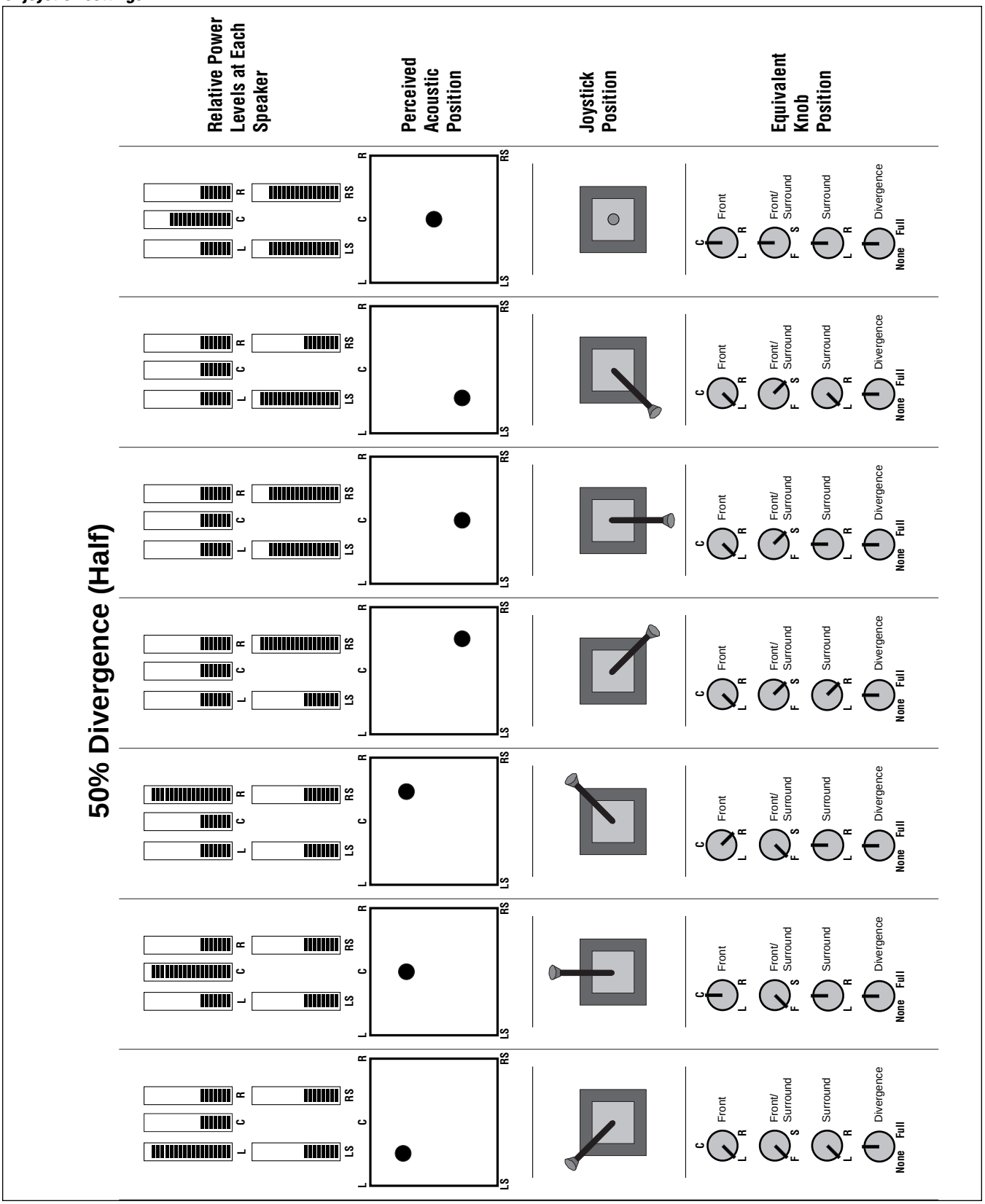
The rightmost column shows a special mode where the front/surround divergence remains at full (100%) while the left/right divergence varies with the setting of the knob. This unique feature allows the pan to maintain full front to back movement, while limiting the left/right motion for better theater coverage.



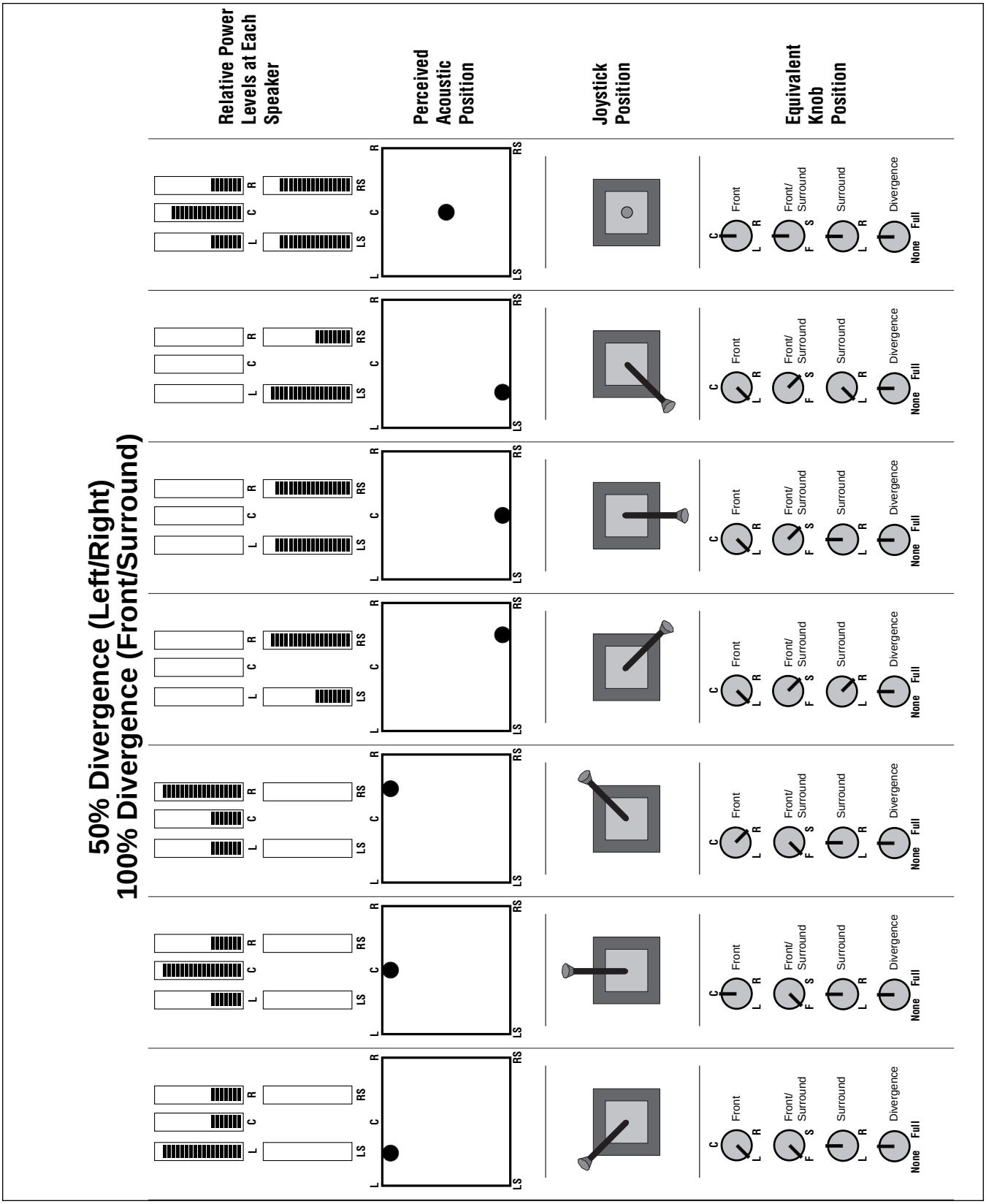
Full Divergence - This simplified chart shows the perceived acoustic position, as well as the approximate audio output level of each speaker, for a variety of panner knob or joystick settings.



Half Divergence (50%) - This simplified chart shows the perceived acoustic position, as well as the approximate audio output level of each speaker, for a variety of panner knob or joystick settings.



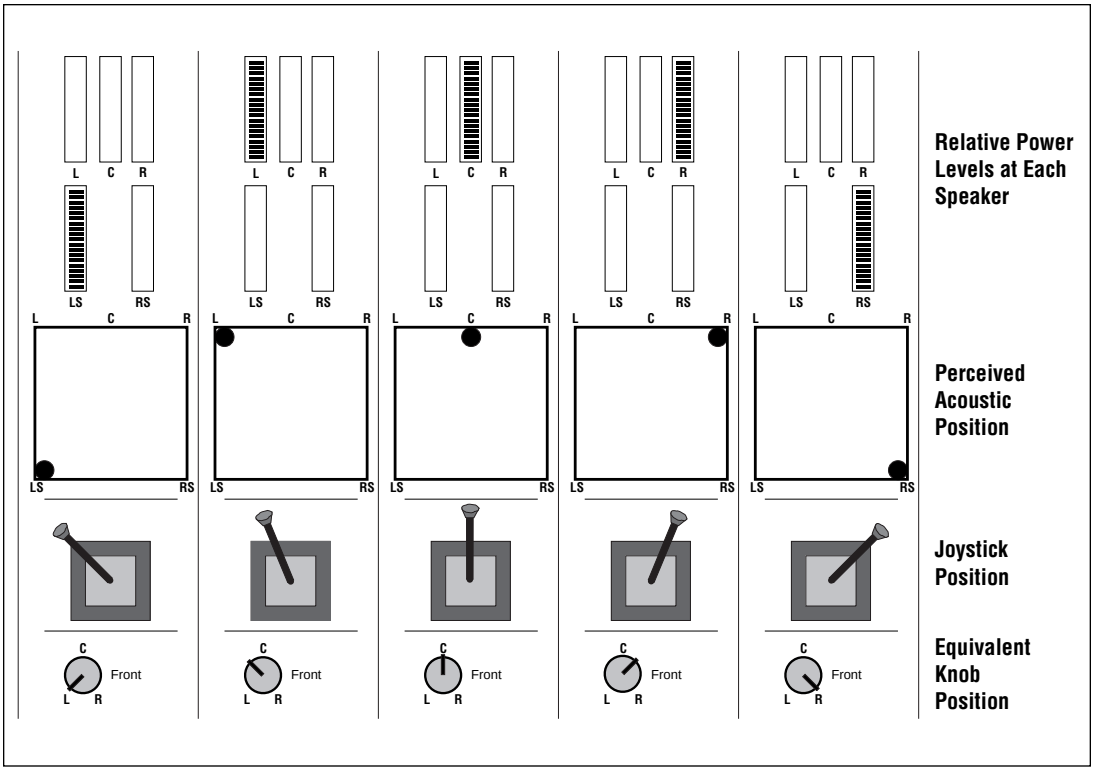
L/R = Half Divergence (50%) F/S = Full Divergence (100%) - This simplified chart shows the perceived acoustic position, as well as the approximate audio output level of each speaker, for a variety of panner knob or joystick settings.



Panaround™

A unique feature of PicMix is Panaround™. When a panner control set is in this mode only the Front knob (L/R) or the left to right swing of a joystick (X-axis) has any affect on the motion of the panner. By moving a knob (or a joystick) from left to right, the panner will go around the entire sound field for that format panner. For example, in a 5.1 format, panning the knob from left to right will send the signal from left surround, to left, to center, to right, to right surround. This single knob (or single axis for a joystick) control gives a mixer the ability to swing a sound element around the soundfield and back very smoothly and easily.

Panaround allows panning around a surround sound field with just one knob, or the easy left/right motion of a joystick. Divergence can be adjusted to optimize the smooth pan even further. Panaround can be applied to any of the panning formats.



Panning Automation

When the optional MIDI automation package is released for the PicMix Panner (2nd Qtr 1996), panning moves will be able to be recorded into many external MIDI sequencer systems. By syncing the sequencer to SMPTE time code, panning moves can be tied directly to picture.

Special Panning Effects

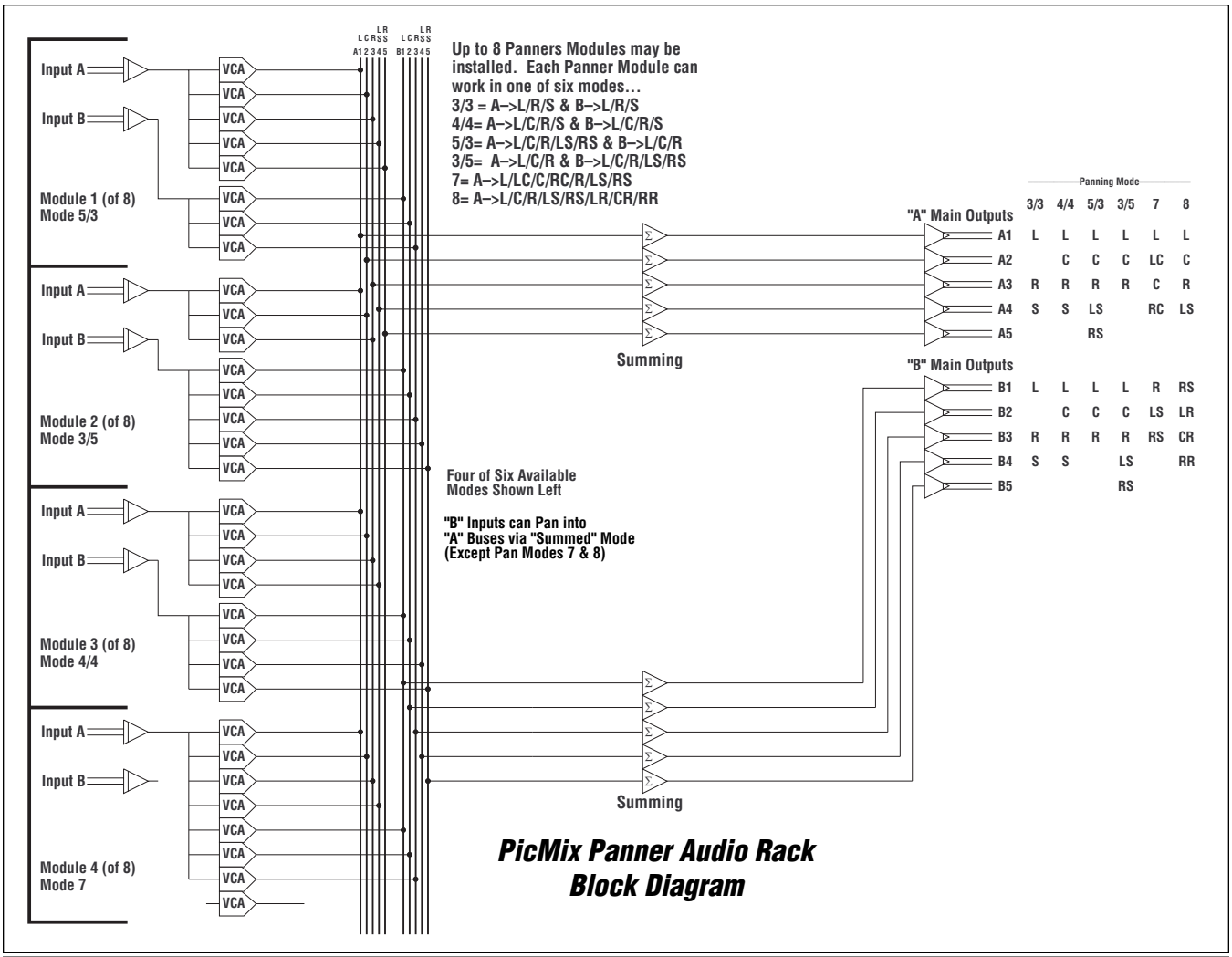
More then 1 audio panner may be assigned to any panner control set. Each additional audio panner that is assigned can have it's own panning format, can be delayed in time from the main audio panner. In addition, these added panners can be set to mirror the control movement in either the X axis, the Y axis or both. For example, 2 audio panners can be tied to one joystick. The second panner can be delayed from the first for 1/2

second. If the reverb return from the first sound element is fed into the second panner, the reverb return will trail the dry sound by 1/2 second during a dynamic pan. Or two audio panners can be mirrored around the X axis so that panning from right to left, moves the first sound from right to left, but the second from left to right. With these provisions for special effects, multiple audio elements can be panned in special ways, all from one control set.

Panner Summary

The PicMix Panner is a cost effective solution for those facilities that are doing mix to picture work and do not have multi-channel panning capabilities on each module of their console. However, even those facilities with limited (LCRS), or even more complete panning on every module, can speed their post production work by using the PicMix Panner. It blends multi-format capability, with amazing flexibility, and unique operating modes. The audio display grids give a unique view of the panned signals, while the multiple divergence modes set a new standard in multi-format panning. Quite simply the PicMix Panner brings a new and innovative approach to the art of panning.

PicMix Panner Audio Rack block diagram showing 4 of 6 available panning modes (5/3, 3/5, 4/4, 7).



PicMix Panner Audio Rack Block Diagram

...and fade to black...

I hope that this paper has educated and informed you about both PicMix and surround sound audio post production. Realistically my purpose was to educate and sell at the same time. These first 2 PicMix products were developed as innovative solutions to the problems posed by today's needs to marry audio to picture. If this paper serves to spawn discussion about these issues then I will be very pleased. I have tried to bring some light to topics that have previously not been widely written about. In some cases I have presented my own personal spin, and in some cases I have simplified the descriptions or drawings to get across the intended point. In all cases I have tried to further the understanding of the audio process. Your feedback regarding this paper and PicMix would be much appreciated. I can be reached at the numbers listed on the inside cover.

Thanks for all of the great sound!

Michael Tapes…January, 1996