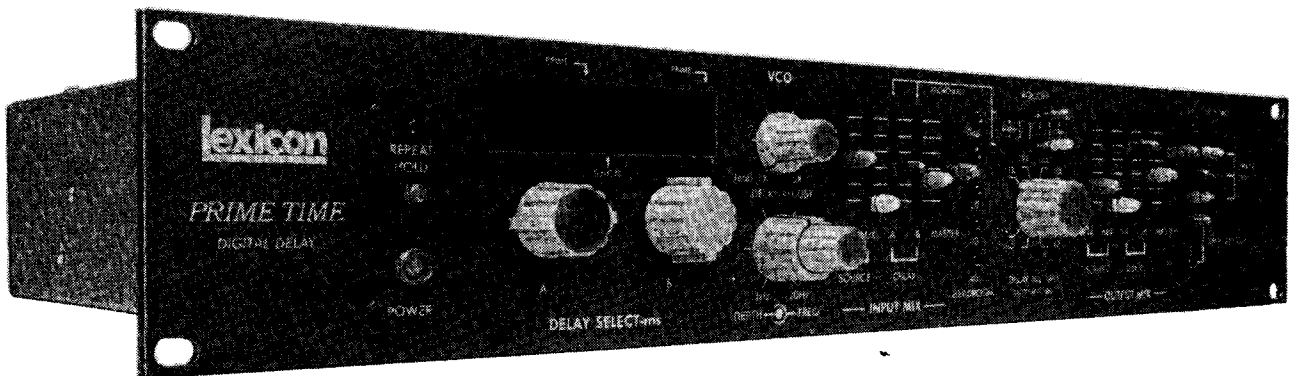


# *PRIME TIME*

**MODEL 93  
DIGITAL DELAY  
PROCESSOR**



## **Owner's Manual**

**Lexicon**

PRIME TIME MODEL 93 OWNER'S MANUAL

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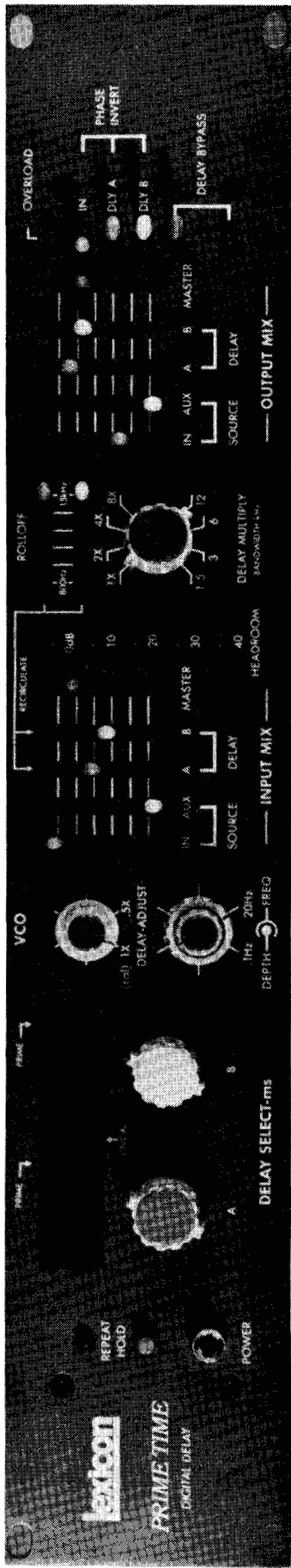


FIG. 1.0 FRONT AND REAR PANELS

## 1.0 INTRODUCTION AND INSTALLATION

### 1.1 INTRODUCTION

The PRIME TIME Model 93 is a sophisticated digital delay system incorporating a high performance delay line, special effects capabilities, and versatile mixing functions. The heart of M.93, its digital delay circuitry, is the very same as that of our professional DELTA-T series' Model 92 with one important exception: there's more delay -- twice as much, over  $\frac{1}{4}$  second, at the full bandwidth and up to 16 times as much, over 2 seconds, at reduced bandwidth (utilizing an optional memory extension).

For special effects M.93 incorporates a delay time modulator (VCO), feedback equalization, phase inversion, a repeat-hold function (for unlimited repetition without degradation) and more. Multiple inputs and outputs and independent four-function input and output mixers make M.93 an extraordinarily flexible instrument. M.93 is capable of reverberation enhancement or distant echoing, of flanging or doppler pitch shifting, of musical vibrato or discordant resonance -- of nearly anything that can be done with time delay.

### 1.2 UNPACKING AND INSPECTION

Remove M.93 from the packing material taking care to avoid breaking or bending any of the many switches, levers, and knobs. Thoroughly inspect both the unit and packing carton for indications of shipping damage and report any damage found to the carrier. If in good condition, be sure to save the carton and packing materials in the event it becomes necessary to reship the machine.

### 1.3 INSTALLATION

M.93 is designed to be rack mounted in a standard 19 inch relay rack (unit dimensions:  $3\frac{1}{2}$ " H X 12" D), but it can also be rested on a flat surface. If the unit is to be shipped while rack mounted, it may be desirable to support the rear of the chassis to protect it from mechanical shock. Be sure to leave ventilation space around the top and bottom covers since electronic equipment lasts longer and is more reliable if kept cool:

### 1.4 POWER REQUIREMENTS

M.93 can be operated from either 115 or 230 volts at 50 or 60 Hz, provided

that the voltage changeover switch located inside the unit is set to the appropriate position and that the unit is appropriately fused: 3/4 A for 115V, 3/8 A for 230V. See section 1.5 for voltage changeover instructions. But beware that voltages are normally set at the factory and should not be changed except by a qualified service technician. The unit will draw a maximum of 35 Watts and will tolerate line voltage variations of +10%.

### 1.5 VOLTAGE CHANGEOVER

The M.93 can be set to operate at either 115V, 50-60Hz or 230V, 50-60Hz +10%. The voltage set at the factory will be indicated on the rear panel. To change the operating voltage, first remove the power cord to avoid contact with power line voltages. Remove the top cover screws and the top cover. Locate the clear plastic High Voltage protection shield in the front left hand corner (facing the unit) through which the voltage changeover switch can be viewed. First look to verify that the switch does not indicate the desired voltage. If not then remove the plastic shield by depressing each (one at a time) of the small locking barbs on the three nylon standoffs while simultaneously lifting the shield at the nearest corner. The barb can be depressed with a small pliers or screwdriver. Change the fuse, F2, located beneath the shield to a type 3AG 3/8 Amp slow blow for 230V operation (or to 3AG 3/4 Amp slow blow for 115V operation). Then flip the voltage changeover switch, S6, to expose the correct voltage setting (230 or 115).

Snap the insulating plastic shield back onto the nylon standoff making sure that all the barbs lock in place. Refit the cover. Finally, plug in the power cord, and verify correct operation.

### 1.6 CONNECTOR REQUIREMENTS

Standard versions of M.93 require male 3 pin XLR connectors to mate with the two inputs: "INPUT" and "AUX INPUT". The MASTER OUTPUT requires a female 3 pin XLR connector. All other rear panel connections require 1/4" standard phone plugs. An optional version uses tip/ring/sleeve type 1/4" phone jacks for the two inputs and main output instead of XLR connectors.



XLR connections at inputs and outputs are as follows:

- Pin 1 : ground
- Pin 2 : signal, high
- Pin 3 : signal, low

For single-ended (unbalanced, two-conductor) connections, connect the ground (low side) to both pins 1 and 3.

Optional TIP/RING/SLEEVE  $\frac{1}{4}$ " phone jack connections are as follows:

- Tip : signal, high
- Ring : signal, low
- Sleeve : ground

For single-ended connections use standard  $\frac{1}{4}$ " phone jacks:

- Tip : signal, high
- Sleeve : ground, low

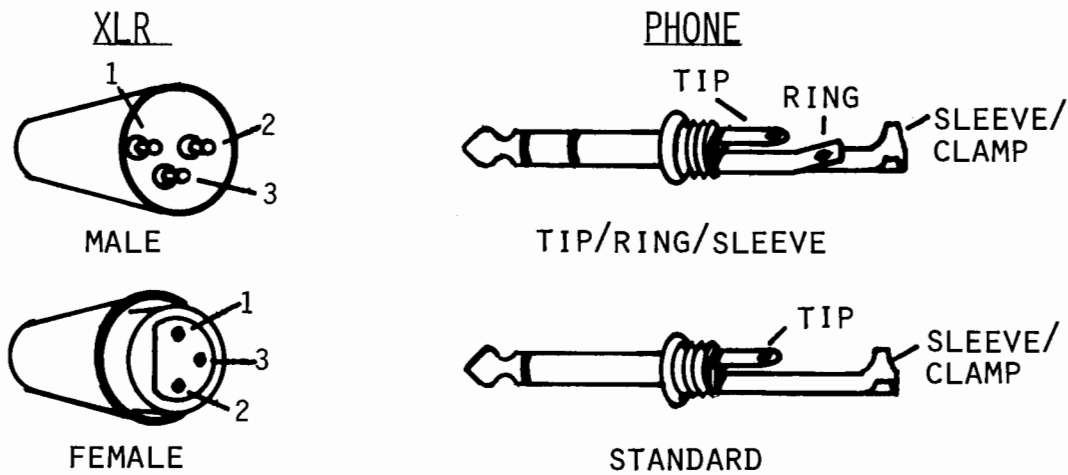


FIG. 1.1 CONNECTOR DETAILS

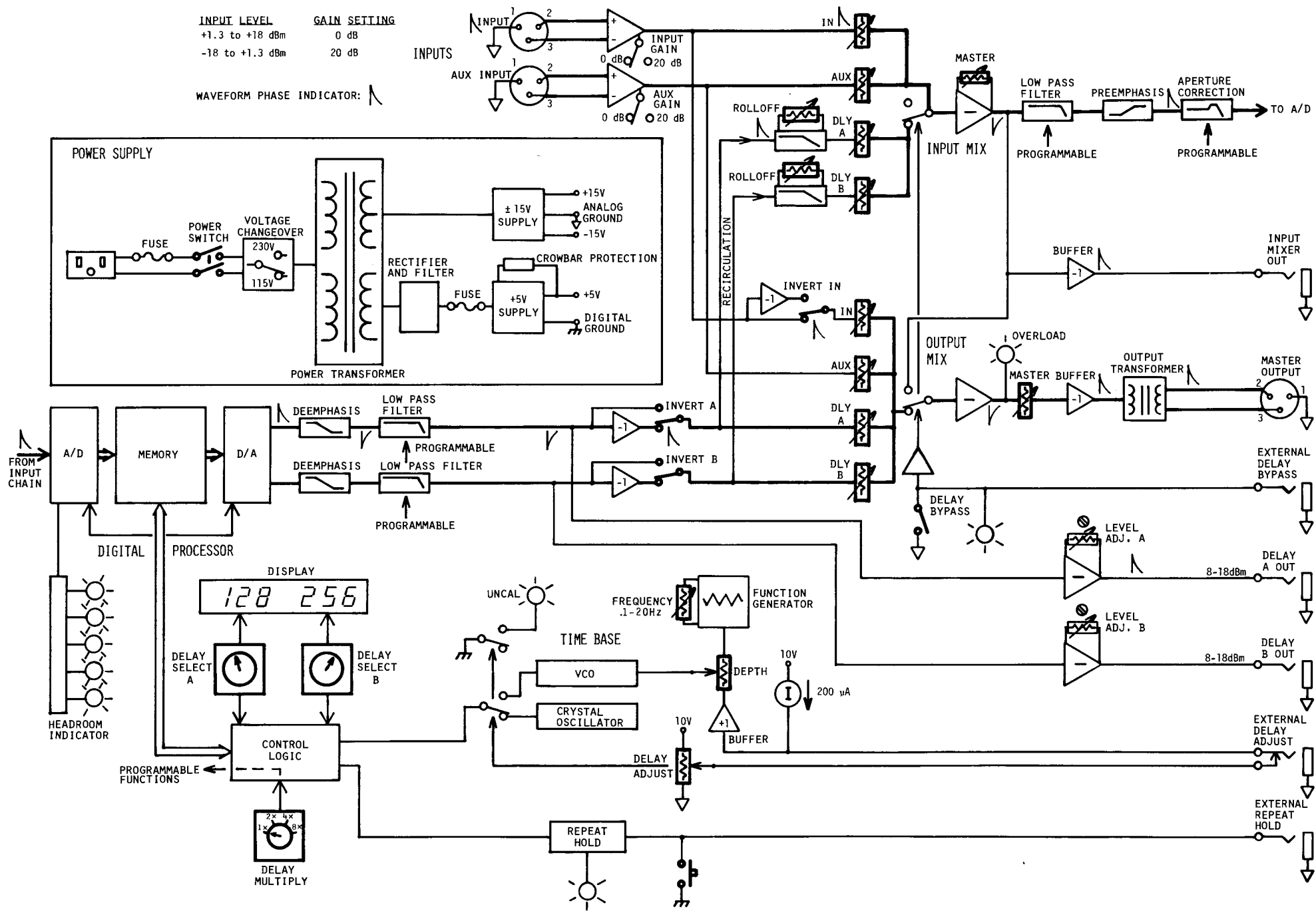


FIG. 2.0 PRIME TIME BLOCK DIAGRAM

## 2.0 SUMMARY OF CONTROLS

This section is a brief run-down of the functions of all controls and indicators to be followed in the next section by a more comprehensive set of operating instructions. See FIG. 2.0 for reference.

### 2.1 POWER SWITCH

M.93 comes on with the opening of a blue eye in its push-push type power switch. It switches both sides of the power line, consistent with good safety practice.

Note: The REPEAT HOLD function may occasionally be activated during power-up disabling other M.93 functions. If the REPEAT HOLD indicator lights, simply press the REPEAT HOLD button to return to normal operation.

### 2.2 DELAY SELECTION

Each of the delay selectors, A and B, selects one of 60 possible delay settings which is then displayed (in milliseconds) in the display window. If the delay time selected is a prime value, the "prime" indicator will light.

The maximum delay for a standard M.93 occurs at the 128 msec position. However, there are seven more positions, up to 256 msec, for those machines equipped with optional memory. When without optional memory and beyond 128 msec, an overrange indication is given by a decimal point in front of the delay time displayed. When in the overrange condition, the actual delay is 128 msec, the maximum allowed, regardless of the longer delay setting appearing in the window.

The indicated delay settings can be multiplied by factors of 2, 4, and 8 with the DELAY MULTIPLY switch to achieve delay times up to  $128 \text{ msec} \times 8 = 1.024$  seconds (or  $256 \text{ msec} \times 8 = 2.048$  seconds for machines with optional memory). The 1, 2, 4, and 8 positions also program the system bandwidth so that the 12kHz bandwidth (available at the DELAY MULTIPLY 1X position) becomes 6kHz at the 2X position, 3kHz at the 4X position, and 1.5kHz at the 8X position.

In addition to the discrete display selection described above, one can select any delay from a continuous sweep using the DELAY ADJUST control. It can

be continuously adjusted from the displayed value down to 50% of that value, e.g. 128 msec can be adjusted down to 64 msec. A maximum sweep range of one second is possible with optional memory. Uncalibrated delays set with DELAY ADJUST are indicated with a bold UNCAL light centrally located in the display window. With DELAY ADJUST in the detented "(cal)" position, M.93 locks into an accurate crystal time base for the actual indicated delay time (the displayed value times the multiplier).

### 2.3 MIXERS, THE IN'S AND OUT'S

The INPUT MIX supplies the input signal to the digital delay processor. It consists of four functions with independently adjustable level controls and a MASTER control which determines the level of the resultant blend. The four functions are two identical but independent inputs, IN and AUX, and two delay taps, A and B. The delay taps are recirculated from the outputs through variable 6 dB/octave ROLLOFF filters which adjust the high end rolloff frequency from 15 kHz to 800 Hz.

Monitoring the delay processor input, the HEADROOM indicator displays peak signal levels on a sequential array of five LED's indicating from 40 dB below limit to 0 dB (limit). When the 20 dB LED just comes on, for example, there is 20 dB of dynamic range left before limit, i.e. 20 dB of headroom. Optimum levels can be achieved by proper adjustment of the INPUT MIX MASTER control which provides up to 6 dB of gain and up to 25 dB of attenuation.

The OUTPUT MIX supplies signal to the MASTER OUTPUT. Like the INPUT MIX, it blends four functions of which two are the inputs, IN and AUX, and two are the delay taps, A and B. The overall level is adjusted with the MASTER control which can provide from zero to infinite attenuation. When in danger of overloading the output stage, the OVERLOAD indicator will light. The OVERLOAD function indicates the levels of the four mixer functions only and is not affected by the MASTER control. For additional flexibility IN, A, and B functions can be inverted with their respective PHASE INVERT switches before the OUTPUT MIX. The PHASE INVERT switches also determine the phase of the recirculated delays to the INPUT MIX.

### 2.4 VCO

The voltage controlled oscillator (VCO) provides continuously variable delay

whenever the DELAY ADJUST control is out of its counterclockwise detent "(cal)". The UNCAL indicator lights when M.93 is in the VCO mode and serves to remind the user that the indicated delay times are no longer accurate. Rather, the delay times are a function of the VCO frequency which can be varied over a 2:1 range resulting in a delay sweep from 1 times the indicated delay settings to .5 times the indicated settings. The VCO (and hence the delay time) can be varied manually with the DELAY ADJUST control, controlled externally with a pot or voltage, or modulated by an internal triangle function generator.

The frequency of the triangle waveform is determined by the FREQUENCY control (.1 Hz to 20 Hz), while its amplitude is determined by the DEPTH control. The DEPTH control pans between the manual DELAY ADJUST and the triangle function generator. The DEPTH control can thus select either all manual control, all function generator control, or a mix of the controls. Normally, the triangle waveform extends up and down from the manually selected DELAY ADJUST level unless the waveform excursion exceeds the limits of the range. In that case the level shifts towards the middle so that there are no settings which will force the VCO outside of its correct operating range. In addition, the VCO will not alter the signal bandwidth and it will not cause aliasing problems.

## 2.5 DELAY BYPASS

The DELAY BYPASS sends the output of the INPUT MIX directly to the OUTPUT MIX MASTER control bypassing the delay electronics and disabling the OUTPUT MIX and RECIRCULATE functions. The DELAY BYPASS indicator lights when in the bypass mode. The DELAY BYPASS can also be operated externally.

## 2.6 REPEAT HOLD

The REPEAT HOLD function repeats an audio segment indefinitely without degradation. The repeated segment consists of the audio entered into the delay line just before pressing the REPEAT HOLD button. Pressing the button again deactivates the REPEAT HOLD, outputting the contents of the delay line to make room for new input. When activated, the REPEAT HOLD blocks additional input to the delay line memory so that no further delay processing (including delay recirculation) can occur. The repeating segments from A and

B delay taps can be mixed with new source material from IN and AUX in the OUTPUT MIX. In addition, when 0 delay is selected, new source material can be entered into A or B delay taps so that the source can be bandwidth limited and recirculated though it cannot be delayed.

The length of the repeated segment is the product of the DELAY MULTIPLY setting, the VCO settings, and the maximum displayed delay setting, 128 msec (256 msec with optional memory). In the calibrated delay mode (VCO off) the segment lengths can be tabulated:

<u>DELAY MULTIPLY</u>	<u>SEGMENT LENGTH (msec)</u>	
	<u>STANDARD MEMORY</u>	<u>OPTIONAL MEMORY</u>
1X	128	256
2X	256	512
4X	512	1024
8X	1024	2048

While REPEAT HOLD is activated, changes in the DELAY MULTIPLY setting cause corresponding changes in the segment length as well as octave related pitch shifts. Variations in the VCO settings also cause variations in segment length and pitch. The DELAY SELECT switches determine the relative timing between the two delay taps A and B so that they will be in synchrony only if they are at the same delay setting.

## 2.7 REAR PANEL

The inputs, IN and AUX are on the left side of the rear panel. Located below each of these two balanced inputs is a switch which sets either 0 dB or 20 dB of input gain. The 0 dB position accommodates peak signal levels from +1.3 dBm to +18 dBm while the 20 dB position accommodates peak levels from -18 dBm to +1.3 dBm. This yields a 36 dB input range for optimum performance with a variety of input sources.

The Master Output is transformer coupled (balanced) from the OUTPUT MIX and can deliver up to +18 dBm, as determined by the OUTPUT MIX MASTER control setting, into 600 ohms.

### CAUTION

*It is possible to overload*

*the inputs without being aware of it, since there are no input overload indicators.*

Additional outputs are the INPUT MIXER OUT which comes from the INPUT MIX MASTER control, the DELAY A OUTPUT and the DELAY B OUTPUT. Delay A and B outputs each have level adjustments for peak output levels anywhere from +8 to +18 dBm. These additional outputs are single-ended (unbalanced) and can also drive 600 ohm loads.

Three functions can be controlled externally via rear panel jacks. Delay Bypass can be activated by a closure to ground through the DELAY BYPASS jack using a single pole, single throw switch. External delay adjustment can be achieved by plugging a 50k ohm potentiometer or a 0 to 10V source (including a function generator source) into the EXTERNAL DELAY jack. And a closure to ground, using a normally open momentary switch, through the REPEAT HOLD jack will enable or disable the REPEAT HOLD function.

### 3.0 OPERATION AND APPLICATIONS

During the following instructions, it may be helpful to consult FIG. 2.0, the M.93 BLOCK DIAGRAM.

#### 3.1 THE BASICS: STRAIGHT DELAY

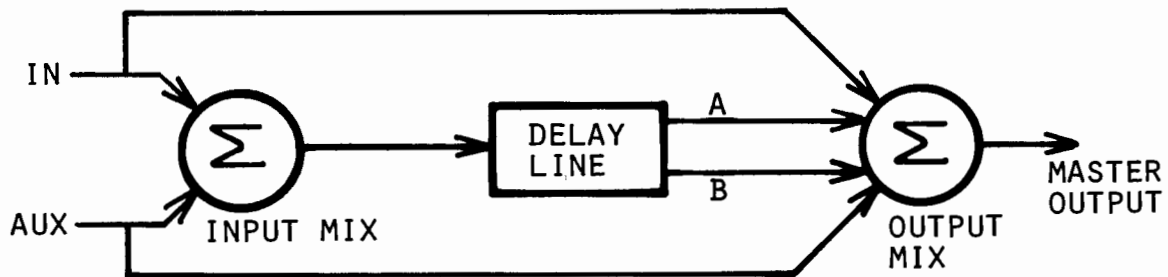


FIG. 3.0 SCHEMATIC REPRESENTATION OF STRAIGHT DELAY

Because it takes time for sound to travel in air, there is a delay from the time a sound is made to the time it reaches a listener's ears. This delay is the basis of many perceptual phenomena. Perhaps the most obvious example of delayed sound is that of an echo, a reflection of sound occurring perhaps seconds after the original. Less distinct but also striking are the delayed sounds reflected from the walls of large halls or cathedrals which follow the direct sound by about 50 or more milliseconds.

The delayed sounds immediately following the direct sound are called early reflections. Following the early reflections are multiple reflections which become increasingly dense in time and space. So long as they are less than 30 - 50 msec apart, they are perceived as a continuous sound and are known as reverberation. Early reflections which follow within 30 - 50 msec of the direct sound are similarly perceived as continuous so that they appear to be part of the original sound. These reflections determine the room



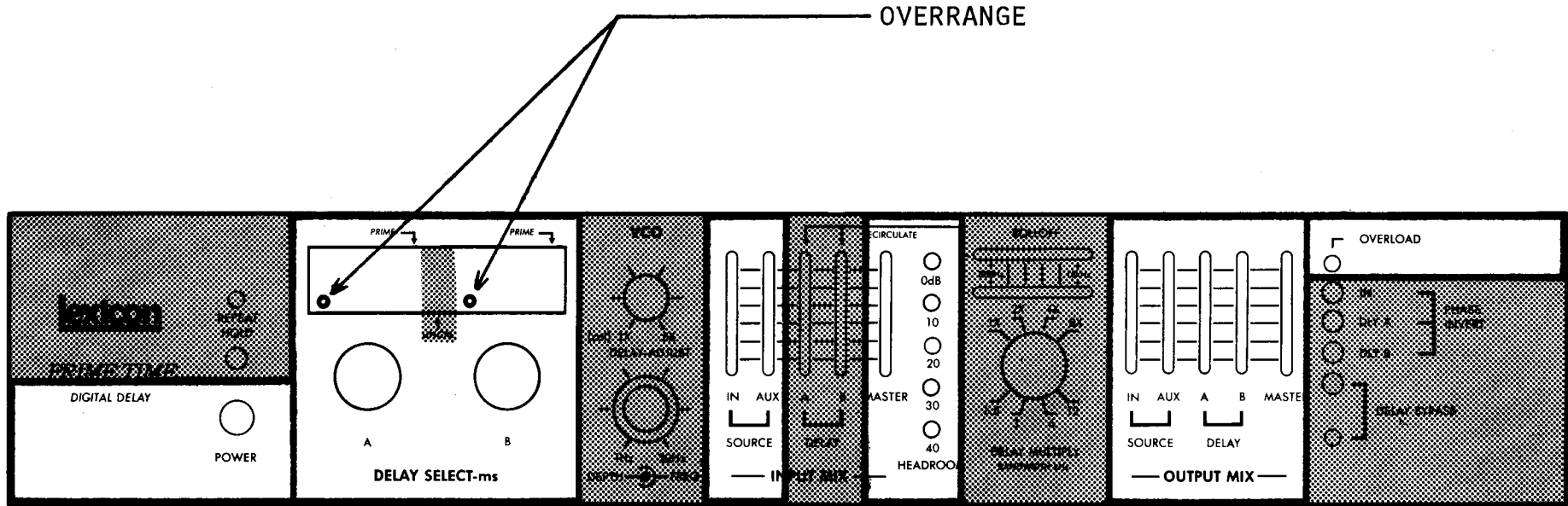


FIG. 3.1 THE STRAIGHT DELAY

ambiance, a "live" or reverberant room being one in which many reflections take place before dying away.

Another effect is that of localizing a source using "interaural" time differences. For example, a sound reaching the right ear before it reaches the left ear will be perceived as coming from the right. Delays less than one millisecond can produce this effect. This is a factor in determining one's spatial orientation, and, along with reverberation and echo, can be simulated on M.93.

Before starting, set controls as follows:

REPEAT HOLD: Off  
DELAY ADJUST: Cal.  
DEPTH: CCW (fully counter clockwise)  
INPUT MIXER AUX, A, B: All down  
DELAY MULTIPLY: 1X  
INVERT IN, A, B: All left (normal)  
DELAY BYPASS: Off

These controls will not be used further in this section. See FIG. 3.1

#### REAR PANEL CONNECTIONS

Plug an audio source into the INPUT from a mixing console, microphone, guitar, tape, record, or radio, etc. Make sure that appropriate equalization of the source is done before putting it into M.93 (e.g. connect a turntable to a phono preamp and phono preamp to M.93). To start, use a simple source such as a single voice, guitar, or other instrument so that the effects of delay will be readily discernable. Set the INPUT GAIN to 0dB initially. Connect the MASTER OUTPUT to a monitor amplifier and speaker or headphones (all M.93 outputs can drive high impedance headphones, 600 ohms or more, directly if necessary).

#### FRONT PANEL GAIN SETTINGS

With all MIXER controls down to avoid overloading the circuitry, and M.93 plugged in, push the POWER switch on. With the audio source playing, bring the IN control of the INPUT MIXER up. (If "0dB" of the HEADROOM INDICATOR lights (and the MASTER control is down) then the input level is too high;

see section 2.7.) Bring up the MASTER control so that "10dB" of the HEADROOM INDICATOR lights on peaks but so that "0dB" does not light at all. If the level is still not high enough, increase the INPUT GAIN to 20dB and reset the MASTER control for the correct HEADROOM indication.

Now bring the IN control of the OUTPUT MIX (the source) up to the third division. Bring up the OUTPUT MIX MASTER control until a comfortable volume is reached. Set DELAY SELECT A for 128 msec and bring up the OUTPUT MIX A control until the echo can be heard distinctly. Be sure not to light the OVERLOAD light with too much level from the OUTPUT MIX sources (the OUTPUT MIX MASTER control does not effect OVERLOAD).

#### SLAP ECHO

M.93 is now simulating a 128 msec single echo ("slap echo") which can be thought of as a very short mountain-like echo or as the first reflection from a distant wall of a cathedral. The closer the volume of the delayed sound to the original, the harder seems the imaginary surface from which it was "reflected". If the delayed sound is as loud or louder, however, then the situation seems unnatural.

#### EARLY REFLECTIONS

Keeping the delayed level lower than the original, reduce the delay time to make the simulated space become smaller. Below 30 - 50 msec the delayed sound is no longer discernable as separate from the original. It is perceived as crude ambiance: crude because only one reflection is represented. Another "reflection" can be derived from M.93 by setting Delay B to, say, about twice the time of delay A and bringing up the OUTPUT MIX B control to an amplitude somewhat smaller than that of A. That is, the longer the delay, the smaller the amplitude. The second delay tap can also enhance the echoes which are perceived at longer delay times.

#### DOUBLING, TRIPLING

So-called "doubling" can be achieved by setting one delay to about 40 msec or less and to about the same volume as the source (OUTPUT MIX IN). Since the sounds merge at such short delay times, the effect of doubling is to thicken and intensify the source. When using voice as a source, this is

known as "vocal doubling". "Tripling" is done by adding a second delay. The second delay time does not have to be within 40 msec of the source as long as it is within 40 msec of the first delay. So by making the second delay longer than the first, the sound is "thickened" even more. Doubling and Tripling are different from simulated reflections because levels of the delayed signals are not reduced.

#### LOCALIZATION

Using delay to perceive the direction of a sound can be accomplished with a modified set-up. Connect the input via the INPUT MIXER OUT to the left channel of the monitor amplifier and connect the MASTER OUTPUT to the right channel. Now by using only one delay of short duration, the sound will appear to be coming from the left (the input). The longer the delay, (but less than about 30 msec) the more the effect is enhanced. One can also achieve the effect by monitoring the two delays, A and B, one in each channel from their rear panel outputs (instead of INPUT MIXER OUT and MASTER OUTPUT). The location of the sound can then be moved from left through center to right by changing the relative delays. In this way single instruments or voices can be positioned in the mix-down of complex multi-track recordings. It is the left and right discrimination which can be accomplished with time delay that enables the synthesis of stereo from a mono source.

#### AUX INPUT

M.93 accomodates two independent inputs, IN and AUX, which can be used interchangeably or in combination in the INPUT MIX. Thus all functions described using the IN source can be performed with the AUX source or with a combination of IN and AUX sources equally well. IN and AUX can also be combined in the OUTPUT MIX to provide direct signal output from either one or both sources. To connect a second source use the AUX INPUT on the rear panel.

The effects in this section, including echo, reverb, stereo simulation, and vocal doubling will all be discussed again using more sophisticated techniques available with M.93. But the basic principles are here in the straight delay.

#### 3.2 VCO, DELAY BYPASS

See FIG. 3.2

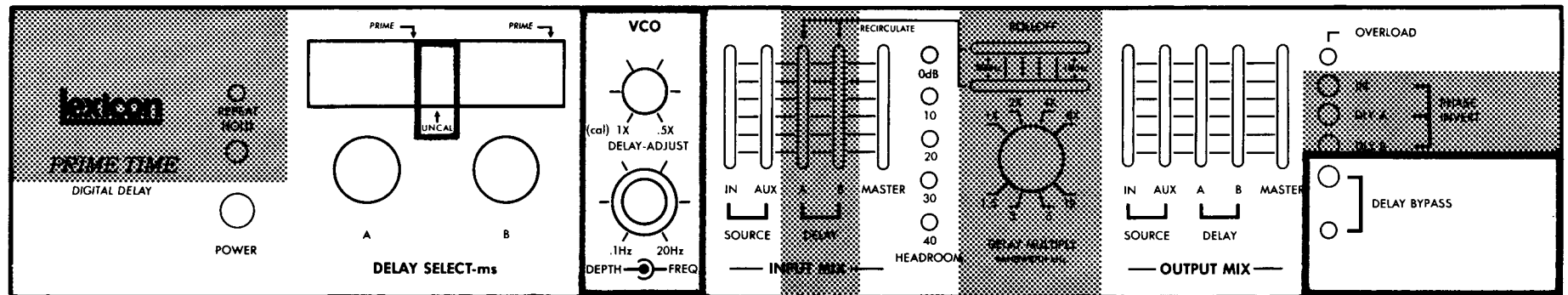


FIG. 3.2 VCO AND DELAY BYPASS

The vocal doubling from the previous section relies upon a constant time difference to create an illusion that there are really two voices. But in reality, two voices will have varying time differences between them. By varying the time delay on M.93, which can be done automatically with the VCO, vocal doubling seems more realistic.

A variety of other special effects can be generated by varying the time delay either manually or automatically. Changes in pitch can be accomplished by rapidly changing the delay, so called "doppler" pitch shifting. If this is done at the appropriate speed and degree, then a vibrato can be simulated. Flanging is created by varying the time difference between the source and the delayed signal or between two delayed signals which are mixed at equal levels. The VCO is also applicable to other effects which will be discussed in coming sections.

#### VARIABLE DELAY

Using a delay set-up from the previous section, turn the DELAY ADJUST control away from the "(cal)" position (make sure DEPTH is CCW). The UNCAL indicator will light indicating that the delay is now determined by the VCO and not by a crystal frequency standard. Varying DELAY ADJUST will change both delays A and B by a factor corresponding to the position of the control from 1X to .5X of the indicated delay times. Thus, delay times which are not available from the DELAY SELECT controls can be gotten using DELAY ADJUST.

#### PITCH SHIFTING

DELAY ADJUST can also be used to create some of the special effects referred to earlier. Listening to the MASTER OUTPUT with OUTPUT MIX controls IN and B down (so that only a single delay output is heard), vary the DELAY ADJUST control to create "doppler"pitch changes in the output. Turning the control clockwise increases the pitch; turning the control counterclockwise decreases the pitch. Greater pitch changes up to a maximum of one octave can be achieved by turning DELAY ADJUST more rapidly or by selecting a longer delay time. Create a vibrato by rapidly turning DELAY ADJUST back and forth, selecting a delay time for an optimum effect.

## FLANGING

To set up a flanging effect, bring up the second delay in the OUTPUT MIX to the same level as the first. Then adjust the DELAY SELECT controls for delay times which are within about three to ten msec of each other (the closer the delays are to each other, the higher the frequency of the flange). This creates a "comb" filter which is perceived as an emphasized frequency component determined by the delay difference. Slowly turn the DELAY ADJUST control to make a flange (which is just a frequency sweep of the comb filter). Depending upon the source material, comb filtering effects can be used over a range of delay differences from .5 to 70 msec. Switch to higher delay times to make the "doppler" pitch shifting phenomenon more apparent, adding its effect to the "comb" filter flanging.

## FUNCTION GENERATOR

While the effects above were achieved manually with the DELAY ADJUST control, they can also be done automatically using the built-in function generator controlled by the DEPTH and FREQUENCY controls. Turning the DEPTH control up corresponds to increasing the amount of rotation of the DELAY ADJUST control. When it is fully counterclockwise it has no effect, but fully up it encompasses the entire delay range of the VCO (from the indicated delay setting to half of that setting) and renders the DELAY ADJUST control inoperative. Turning the FREQUENCY control up corresponds to increasing the speed with which the DELAY ADJUST is turned back and forth. It ranges from one cycle every 10 seconds to 20 cycles per second. As in the case of manual control, the greater the frequency and the greater the excursion, the more pitch shifting there is. When flanging, turn up the DEPTH control to increase the rate of the sweep and the amount of pitch shifting (doppler) accompanying it.

## DELAY BYPASS

When creating special effects such as flanging and pitch shifting, DELAY BYPASS can be used to make an "A-B" comparison with the original source. It can also be used to switch the effect in and out as needed. The DELAY BYPASS function connects the output of the INPUT MIX to the MASTER control of the OUTPUT MIX, thus bypassing four OUTPUT MIX controls. The levels of these four controls can make the overall output level differ depending upon

whether DELAY BYPASS is in or out. So to match levels, first set the OUTPUT MIX MASTER control to give the desired output level (from the MASTER OUTPUT) while the DELAY BYPASS is in. Then switch the DELAY BYPASS out and adjust the levels of the four OUTPUT MIX functions for the same overall output level.

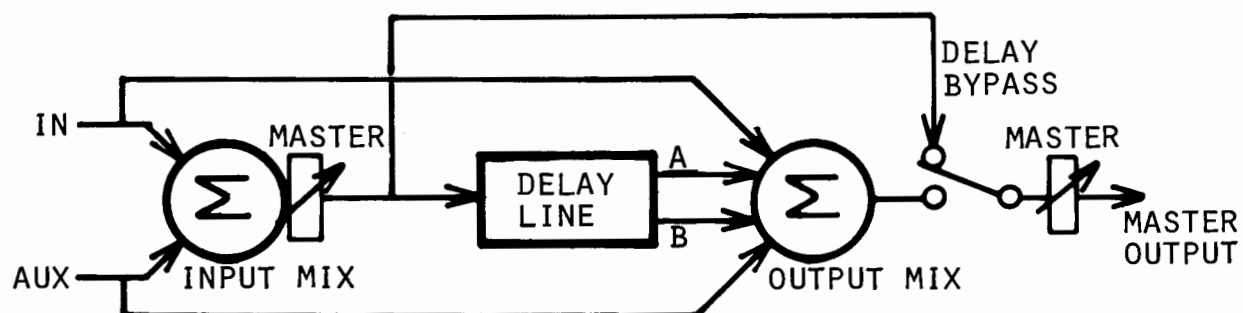


FIG. 3.3 SCHEMATIC REPRESENTATION OF DELAY BYPASS

### 3.3 DELAY MULTIPLY, REPEAT HOLD

See FIG. 3.4

With M.93 delay times are not restricted to the range of the DELAY SELECT controls. Turn the DELAY MULTIPLY switch to increase the indicated delay by a factor of 2,4, or even 8 with a corresponding decrease in the frequency bandwidth. The bandwidth is limited by steep 30 dB/octave filters to avoid high frequency digitizing errors known as aliasing. Using DELAY MULTIPLY, the short 128 msec echo from section 3.1 can be lengthened to a healthy 512 msec or even 1.024 seconds at multiplication factors of 4 and 8 respectively. With the optional extended memory, a maximum delay of 2.048 seconds can be achieved.

### SOFT REFLECTIONS

In the real world sound reflected from walls and other surfaces loses some of its high frequency content. If the surface is soft or padded such as a curtain or rug, more high frequency content will be lost than if the surface



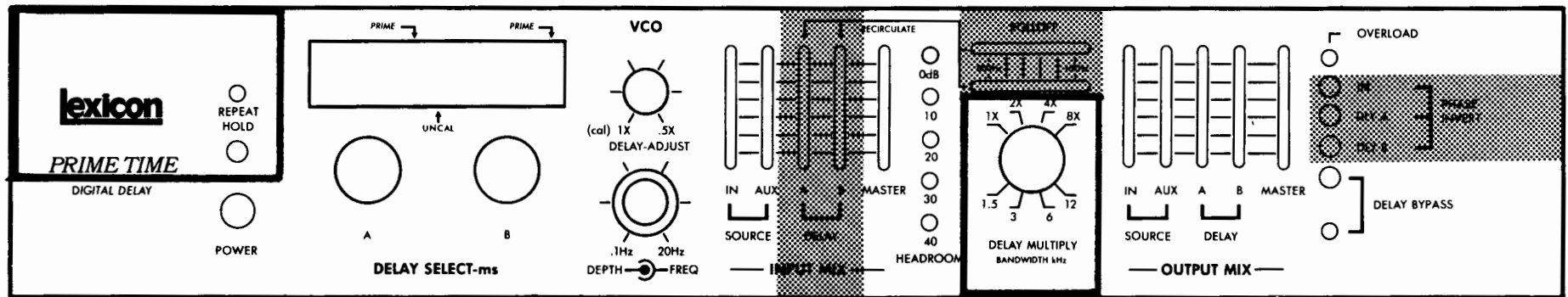


FIG. 3.4 DELAY MULTIPLY, REPEAT HOLD

is hard like tile or panelling. Harder surfaces give rise to more reverberance; they are more "live".

The simulated reflections from section 3.1 can be made to account for the nature of the surface by choosing an appropriate bandwidth with DELAY MULTIPLY. For example, simulate a softer reflection by selecting 25 msec at 2X (6kHz bandwidth) rather than selecting 50 msec at 1X (12kHz bandwidth) so that the delay time remains the same.

#### REPEAT HOLD

The DELAY MULTIPLY can also be used for special effects with the REPEAT HOLD function. Once something interesting is happening in M.93, activate REPEAT HOLD to continue it indefinitely. The duration of the repeating segment is equal to the maximum amount of delay time available at a given multiplier setting. For example at 4X, with DELAY ADJUST in the "(cal)" position, the repeated segment will be 512 msec (1024 msec with extended memory) so that pushing REPEAT HOLD saves anything that has occurred in the last 512 msec and repeats it until the button is pushed again. Change the segment length to an intermediate value by turning the DELAY ADJUST control. The segment length then becomes the maximum delay setting at a given delay multiplier times the DELAY ADJUST factor (from X1 to X.5). Because M.93 can be adjusted to any desired REPEAT HOLD interval within its delay range, it can provide a corresponding rhythm line (using a bass, for example) - in effect an electronic metronome.

It is possible to make other special effects by modifying the REPEAT HOLD function after it is in operation. Activate REPEAT HOLD with DELAY MULTIPLY at 4X. Then turn DELAY MULTIPLY to 2X to halve the time of the segment and to double the frequency of its content. Turn to 8X to double the segment time and to halve the frequency of its content. Turn DELAY ADJUST to continuously vary the pitch (and segment time). Use the DEPTH and FREQUENCY controls to vary the pitch and segment time automatically. The DELAY SELECT controls also have an effect by changing the relative timing between the two delay taps. Listening to a mix of both delay taps A and B rotate DELAY SELECT B to displace the B output with respect to the A output. Any of these modifications of REPEAT HOLD may be undone by resuming the initial settings.

To overlay the repeating segment with new source material bring up IN and AUX inputs at the OUTPUT MIX, or select 0 delay which will send the INPUT MIX signal to the respective delay tap. Use the 0 delay setting to recirculate and bandwidth limit the input through the ROLLOFF and DELAY MULTIPLY functions. See section 3.4 for an explanation of the ROLLOFF and RECIRCULATE functions. This allows some flexibility in creating the output mix even though the new input material cannot be delayed.

### 3.4 RECIRCULATION, ROLLOFF, PHASE

See FIG. 3.5

At this point virtually all of the functions of M.93 have been covered and with them corresponding delay effects. But, with the exception of REPEAT HOLD, none of these effects have been sustained. The delayed effects lasted 2.048 seconds at most. This section will cover sustained effects -- more natural sounding reverberation and echoing and bizarre feedback resonance effects. It will also cover a few fine points and variations of already familiar effects.

#### ECHO

Set up an echo effect as described in section 3.1 with delays A and B set to 97 and 128 msec respectively, DELAY MULTIPLY at 4X, and an OUTPUT MIX of IN, A and B in order of descending levels. The result is the source with two "slap" echoes. But now bring up A and B in the INPUT MIXER (not so far as to cause limit) to hear recirculated delays increasing in number (echo density) until they die away. The ROLLOFF controls determine the bandwidths of the recirculating delays. Decreasing the ROLLOFF frequency corresponds to high frequency absorption from reflecting surfaces and through air -- similar to the bandwidth limitations of the DELAY MULTIPLY function, but at a gentler 6dB/octave slope.

#### REVERBERATION

In a similar manner the RECIRCULATE and ROLLOFF functions enable the simulation of reverberation at lower delay settings. Reduce the delay times by decreasing the DELAY MULTIPLY factor from 4X to 2X and to 1X noticing that the apparent room size decreases correspondingly. Significant amounts of recirculation at relatively small delay times will display some unnatural side effects, particularly if the delay times contain common numerical factors.

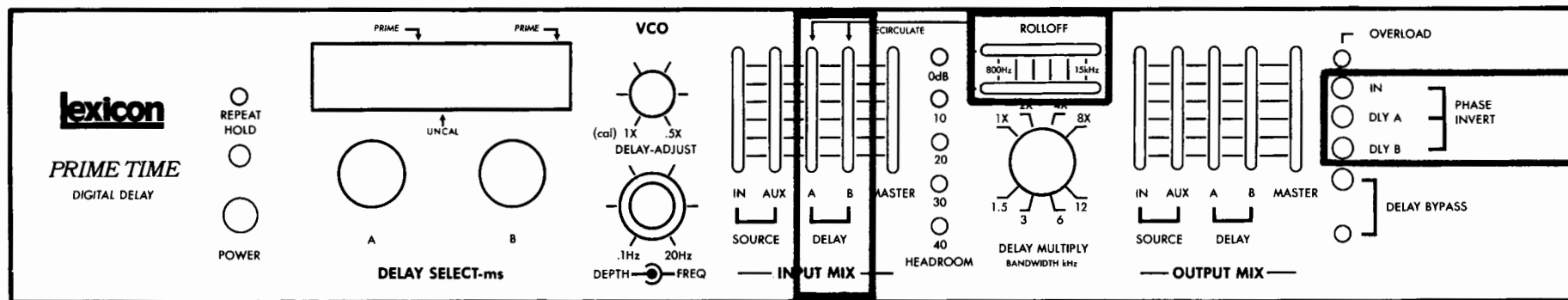


FIG. 3.5 RECIRCULATION, ROLLOFF, PHASE

For example, a metallic sound can be heard as a result of comb filtering among the recirculating delays. More generally, the frequency response of the recirculating delayed signal becomes distorted as a result of these filtering effects.

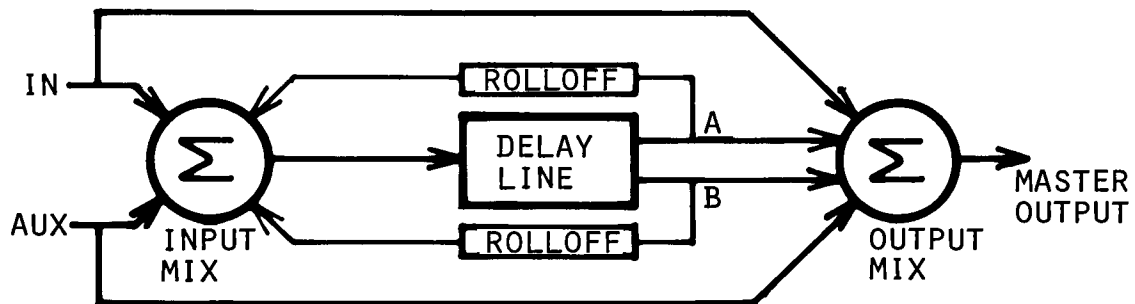


FIG. 3.6 SCHEMATIC REPRESENTATION OF RECIRCULATION AND ROLLOFF

M.93 incorporates three methods of combatting these effects. The first is that of setting the delays to prime number values, identified by the PRIME indicator. Relatively prime delays insure that there are no common factors and consequently a minimum number of repetitive delay patterns which contribute to unnatural side effects. Second, a small amount of automatic VCO cycling randomizes the delays to break up repetitive delay patterns. However, the FREQUENCY must be low enough and the DEPTH must be shallow enough so as not to introduce any audible "doppler" or flanging effects. Finally, the invert function on the input signal at the OUTPUT MIXER enables a Schroeder\* "all-pass" filter to be constructed. This is a technique of providing smooth frequency response through a system of recirculated and delayed signals. It turns out that the input invert function provides a qualitative improvement even though the exact amplitudes prescribed by Schroeder are not duplicated. See FIG 3.7. These methods all contribute to a smoother, more realistic simulation of room ambiance.

\*Schroeder, M.R., "Natural Sounding Artificial Reverberation", Journal of the A.E.S., Vol.10, No.3, (July 1962), p.219.

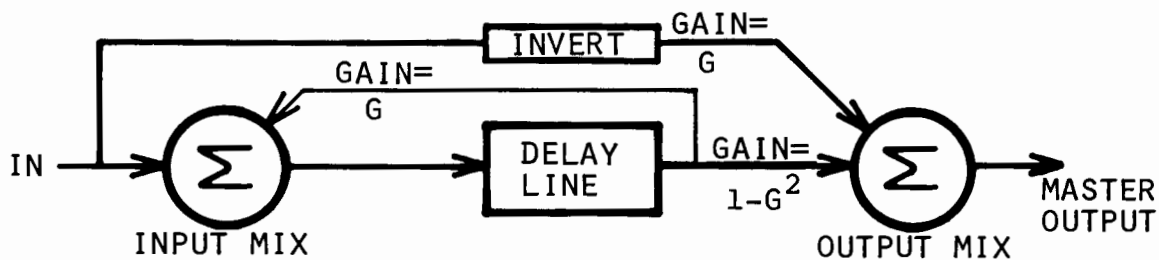


FIG. 3.7 SCHEMATIC REPRESENTATION OF SCHROEDER SECTION

Reverberation synthesis can also incorporate external reverberation devices such as plates, spring reverbs and echo chambers. Use an "echo send" as the input to M.93 and DELAY A or B as input to the reverberation device. Bring the reverberant signal back into M.93 via the AUX input which can be combined with delays A and B in the OUTPUT MIX to create an "echo return". In this way discrete delays from M.93 can simulate early reflections while the external device simulates later reverberation; alternatively, recirculated delay on M.93 can be filled with reverberation from the device.

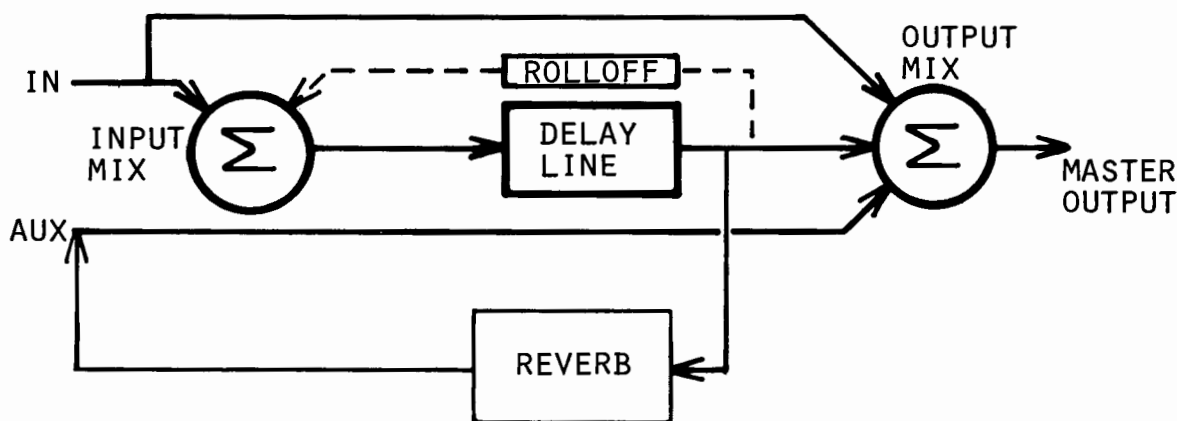


FIG. 3.8 SCHEMATIC REPRESENTATION USING EXTERNAL REVERB UNIT

## RESONANCE

Higher levels of delay taps A and B in the INPUT MIXER cause longer durations of recirculated delay. At some point the levels become high enough to cause resonances, the frequencies of which are determined by the delay times used. Turn up just one of the delay taps until the resonance effect begins. At this point resonances will be activated by the audio signal information, being heard at peaks but otherwise decaying. It is possible to increase the amplitudes until the resonance "runs away", increasing in level without any additional stimulus. The ROLLOFF frequencies can be lowered to minimize this runaway tendency but it can still happen and should be avoided. Resonances can be used in conjunction with other effects such as doppler pitch shifting, double and triple tracking, and flanging to create more exotic sounds.

## FLANGING

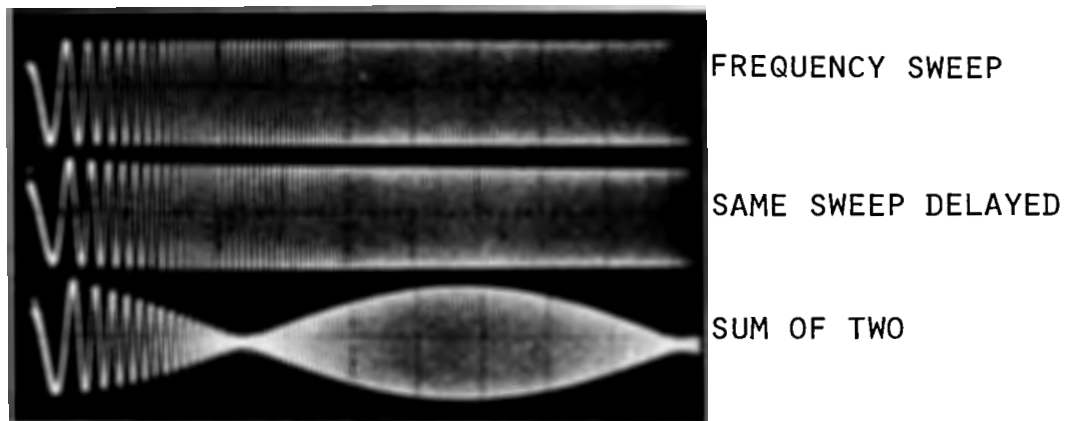
Flanging and, more generally, comb filtering is effected by the PHASE INVERT function. Set up a flange with DELAY SELECT A and B at 0 and 1 msec respectively: monitor equal levels of both delay taps through the MASTER OUTPUT and adjust the VCO for obvious effect. Broadband noise can be used as a source to make the effect even more obvious. Now switch the phase of one of the delay taps using the INVERT function. Notice the change in tone quality of the effect resulting from this phase inversion. This can be explained in terms of the comb filter (which is implemented like the flanging in section 3.2 except without varying the delay with the VCO).

In the first case with no phase inversion, the delayed signal simply adds to the undelayed signal. This reinforces low frequency components, since the short delay time represents only a small phase shift. The phase shift increases with frequency until at 500Hz it is 180 degrees causing a null which is repeated at 1500Hz and at 1kHz intervals thereafter. See FIG. 3.9.

In the second case, the *phase inverted* delayed signal adds to the undelayed signal. This cancels out low frequency components, but there is less cancellation as frequency (and phase shift) increase until a peak at 500Hz is reached after which nulls occur at 1000Hz and every 1000Hz thereafter. The inverted comb filter is in effect a low freq. filter which has a higher cutoff frequency as the delay time gets smaller. This is the reason for

the change in tone quality.

CASE 1



CASE 2

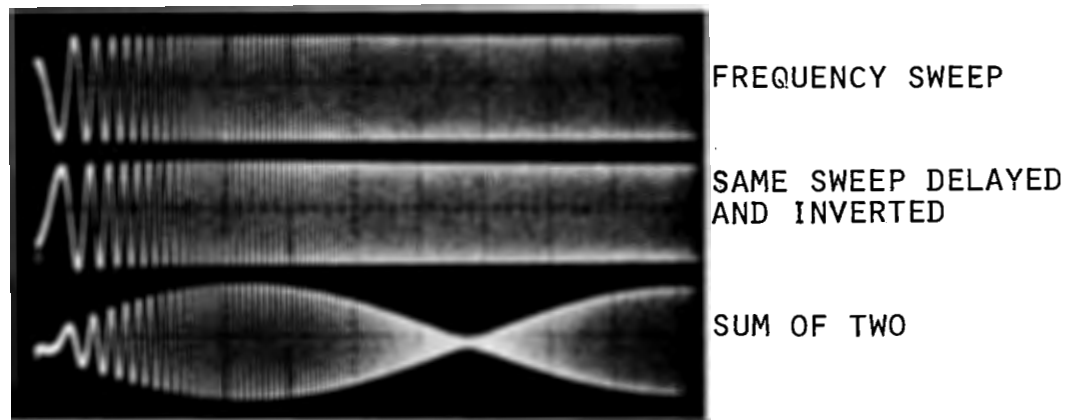


FIG. 3.9 COMB FILTERS

HUM FILTERING

The above discussion leads to an interesting conclusion that a single frequency and all of its harmonics can be eliminated in the nulls of a comb filter. This is particularly useful for eliminating hum from a source since hum can be the line frequency plus all of its harmonics (therefore high pass "hum filters" are not entirely satisfactory). To eliminate hum from a 60Hz line an inverted delay of 16.7 msec can be added to a delay of 0 at the same amplitude. This creates nulls at 60Hz and all of its harmonics. The comb filter will change the timbre of the source, however. Since the perceived change in timbre depends upon the delay time and the source material used, a different delay setting might be more suitable for a given source.



For example, a delay of 33.3 msec can be used (which eliminates 30Hz and all of its harmonics) instead of 16.7 msec. These delay times can be approximated with DELAY SELECT and fine tuned, listening for a null, with DELAY ADJUST.

### 3.5 STEREO AND QUAD

Using the INPUT MIXER for the left channel and the MASTER OUTPUT for the right channel, M.93 can synthesize stereo effects from a mono source. Make an echo bounce back and forth between left and right by bringing up a 128-msec delay in the OUTPUT MIX and by recirculating a 256 msec delay in the INPUT MIX. A more realistic mountain-like echo can be simulated by recirculating both delays and by using 97 instead of 128 msec. This scheme makes for spacious reverberation at delay times too short for echoing. Set up other stereo reverberation and recirculating mixes by using various combinations of IN, A, and B functions in each mixer and by varying the PHASE INVERT functions. For stereo mixes of reverberance alone, without direct signal, use the DELAY A and DELAY B outputs for left and right (perhaps rear) channels respectively. See FIG. 3.10.

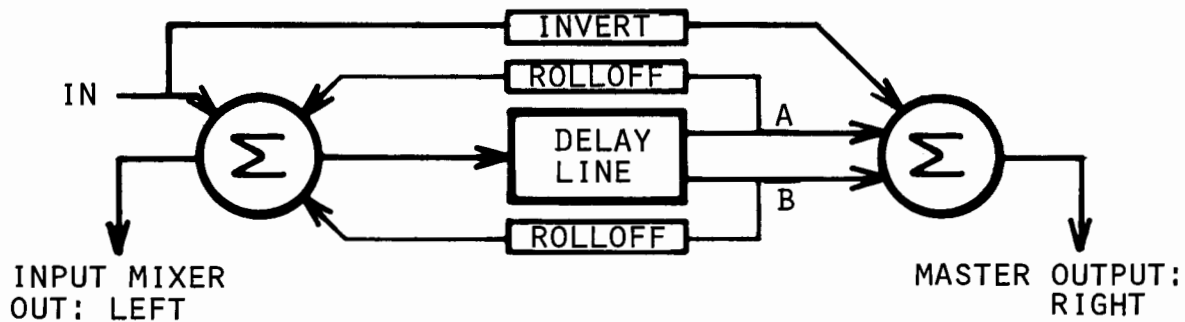


FIG. 3.10 SCHEMATIC REPRESENTATION OF STEREO SYNTHESIS

Doubling and tripling effects can be made in stereo by sending the source to the left channel from the INPUT MIXER OUT and the delayed signals to the right channel from the MASTER OUTPUT. Make flanging in stereo by mixing equal

levels of the delay functions into the INPUT MIX, and mix some of the input into the OUTPUT MIX. In general an effect can be spatially enhanced by using the INPUT MIXER OUT as the left channel and the MASTER OUTPUT as the right channel (or vice versa). A proper balance between the two can be made by adjusting the OUTPUT MIX MASTER control.

In addition to synthesizing stereo, M.93 can be used to enhance a stereo source with spacious ambiance: the output can be mono, stereo, or synthesized quad. Bring the left channel of a stereo source to the INPUT and the right channel of a stereo source to the AUX INPUT. Set up an input mix predominantly of IN, a smaller amount of AUX, and recirculation from delay taps A and B. Use an output mix predominantly of AUX with a smaller amount of IN, phase inverted, and the delay taps A and B. Take a mono output from the MASTER OUTPUT. For a stereo output use the INPUT MIXER OUT as left and the MASTER OUTPUT as right. To make quad, use DELAY A and B outputs for the rear channels. An alternative approach for quad is to use the original source for front channels and the stereo outputs of M.93 for the rear channels (either INPUT MIXER and MASTER or DELAY A and B output pairs). (The DELAY A and B outputs are likely to be superior for rear channels because they do not contain any direct source which might lead to confusion in localizing the sound.)

### 3.6 SOUND REINFORCEMENT\*

If a sound comes from two different sources but one delayed 40 msec or less with respect to the other, then the sound will appear to be coming from the first (earlier) source and not the second (providing that the second is not more than 10 dB louder than the first). This is called the "precedence" effect and because of it amplified sound in a hall, sufficiently delayed, seems not to come from the amplified source but from the real source. Since sound travels one foot in about .9 msec, delaying an amplified source by 1 msec for every foot that it is from the real source insures that sound from the real source reaches the listeners first. M.93 provides two independent delays from DELAY A and B outputs which can be used for sound reinforcing speaker systems at two distances from the source. In this application M.93 is used as a simple

\*Klepper, David L., "Application of Digital Delay Units to Sound Reinforcement Systems", Lexicon Application Note: AN-2, 1975.

delay system with no recirculation, VCO, or other special effects being normally employed. See FIG. 3.11.

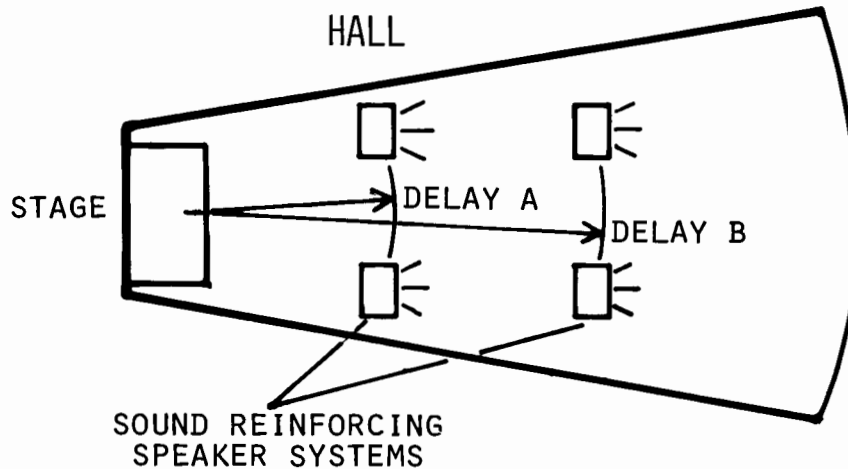


FIG. 3.11 SOUND REINFORCEMENT IN HALL

In classical sound reinforcement systems no attempt is made to alter the acoustics of a space using time delay. But with M.93's ability to create a wide variety of ambiance effects, the apparent acoustics of a room can be changed. Small rooms can appear larger and "dry" or "dead" rooms can appear livelier. To accomplish this, use one of the stereo or quad synthesis techniques described in Section 3.5 with a live source.

### 3.7 EXTERNAL FUNCTIONS

The external DELAY BYPASS and REPEAT HOLD functions were designed with live entertainers in mind. A foot switch which activates the DELAY BYPASS function allows a musician to preset M.93 for an effect which can be switched in or out during a performance. Such effects can be flanging, doubling, vibrato, or echo (etc.) and can be used for guitar, drums, keyboard or voice (etc.). A REPEAT HOLD foot switch enables the musician to lay down a rhythm line, harmony, or sequence on the spot, again having preset M.93 for the effect he wants.

The EXTERNAL DELAY control can be a remote hand or foot operated control allowing a musician to vary the delay time over a 2:1 range, for manual

flanging as an example. But it can also be used with a function generator providing square waves, ramps, or other functions for additional latitude in creating special effects. A square wave, for example, can provide several distinct and different resonance tones when used with a resonance effect.

### 3.8 TWO M.93'S

The subject of the two M.93's is perhaps deserving of a chapter all its own. For two not only double the capacity of one, they also give rise to new capabilities altogether. Flanging, for instance, can have a virtually infinite sweep. Reverberation techniques can utilize far more complex interconnections. Of course more straightforward applications can be enhanced: triple tracking can go to quintuple tracking; two slap echoes go to four slap echoes; mono effects go to stereo effects; stereo goes to quad, etc.

Flanging with a single M.93 spans a frequency range of 2:1 corresponding to a maximum delay difference change of 2:1 using the VCO. But with two M.93's the frequency range can be arbitrarily large. For example set one delay tap of M.93A to 10 msec with the VCO in the "(cal)" position. Feed the single delayed output to the AUX input of M.93B. Use the same source for the IN input of both units. Set one of M.93B's delay taps to 10 msec as well. This time use the VCO of M.93B to vary its delay time from 10 to 5 msec and mix the corresponding delay tap with AUX at identical levels in the OUTPUT MIX. At one extreme the time difference of the two delays is 5 msec. At the other extreme the time difference is 0. The range of delay differences is, then, 5:0. The notch of a positive flange will vary in frequency from 200Hz (corresponding to 5 msec) to an infinitely large frequency (corresponding to 0 msec). To lower the bottom frequency even more, increase the delay time in both units. To limit the highest frequency notch reduce the delay time in M.93B alone. Reducing the DEPTH will increase the lowest frequency of the flange. Reducing the DEPTH control will decrease the highest frequency of the flange if M.93B is set to 20 msec delay instead of 10.

Simulated reverberation with the two M.93's can be made to have much higher echo densities by recirculating four delay taps instead of only the two available with one M.93. Several approaches can be taken in order to accomplish this. Use one M.93 to provide two additional delay times which

can be fed to the AUX input of the other. More varied arrangements can be made using an external mixing console. These configurations can be complex and will require experimentation to find optimum settings.

### 3.9 RESEARCH TOOL

M.93 can be used as an effective research tool in fields such as linguistics and psychoacoustics. The REPEAT HOLD function, for example, enables syllables, words, or other sounds to be locked up and repeated over and over again for analysis. They can also be slowed down or speeded up and altered in pitch. Classic delay effects can be reproduced such as the "precedence effect" (section 3.6), comb filtering (section 3.4), and spatial localization (section 3.1). And undoubtedly, there is more to be learned about the effects of delay. The VCO also can be helpful in studying the perception of repetitive phenomena such as vibrato and "wow and flutter".

### 3.10 M.93 "LIVE"

One of the unique advantages of M.93 is the ability to achieve up to 2 seconds of delay time. This feature is very useful for echo type effects, and enables a live performer to produce musical textures not possible with a single instrument.

For example, mix a one second delay with the dry signal. Play a guitar chord and you will hear it repeat one second later. Slowly play a scale, and if you time it right, you can play harmonics on top of what you played one second earlier. Now add in another delay at two seconds and the texture becomes even fuller. Feed the longer delay back to the input and you have a decaying echo. You can simulate the effect of an echoplex and make one guitar sound like a whole chorus of guitars.

Try staggering the delay times to get syncopation effects, and feeding back different amounts of different delays to create widely varying rhythms and textures. The range of possibilities is extremely broad; experiment to find new and exciting sounds you've never heard before.

The REPEAT HOLD feature is extremely useful for live performance. You can lay down a two second riff, lock it up in REPEAT HOLD with the foot switch,

and then proceed to play lines on top of that. A band could lock something up in REPEAT HOLD, take off their instruments and walk off the stage, and the music would keep playing!

Footswitch control of BYPASS is another useful feature. You can set up an effect on M.93, then kick it in and out as you want it.

We cannot overemphasize the wide variety of effects available from M.93, nor our expectation that you, the long-term user, will continue to find new and creative uses for this versatile device.

#### 4.0 EFFECTS

This section consists of a limited number of set-ups for typical M.93 effects. Its intent is to provide the user with a point of departure from which he may begin using M.93. These basic set-up guidelines are not necessarily optimum for different sources and situations. Considerable variation of delay times, function settings, and/or relative levels from the settings depicted may be required depending on the source being processed and the particular shading of the enhancement or effect desired. Accomodating different input levels, altering the level of delay recirculation, and balancing outputs for stereo effects\* are good examples of situations where such variations will be common.

It is expected that users of M.93 will explore at considerable length the virtually endless possibilities for special effects and enhancements. Since the unit provides a very high degree of operational flexibility, many novel effects and applications will be developed by creative audio engineers and musicians. Should this happen and you feel that you would like to share it with us or discuss it, please drop us a line or call:

Lexicon, Inc.  
Prime Time Applications  
60 Turner Street  
Waltham, MA 02154  
(617) 891-6790

\* Note that varying the INPUT MIX MASTER control not only changes the level of the input mix but changes the delay tap levels as well. Increasing the INPUT MIX MASTER control, for example, causes a relative increase in the amount of recirculated delay. To balance the INPUT MIXER OUT and the MASTER OUTPUT for stereo effects, vary the OUTPUT MIX MASTER control matching the MASTER OUTPUT level to the INPUT MIXER OUT level.

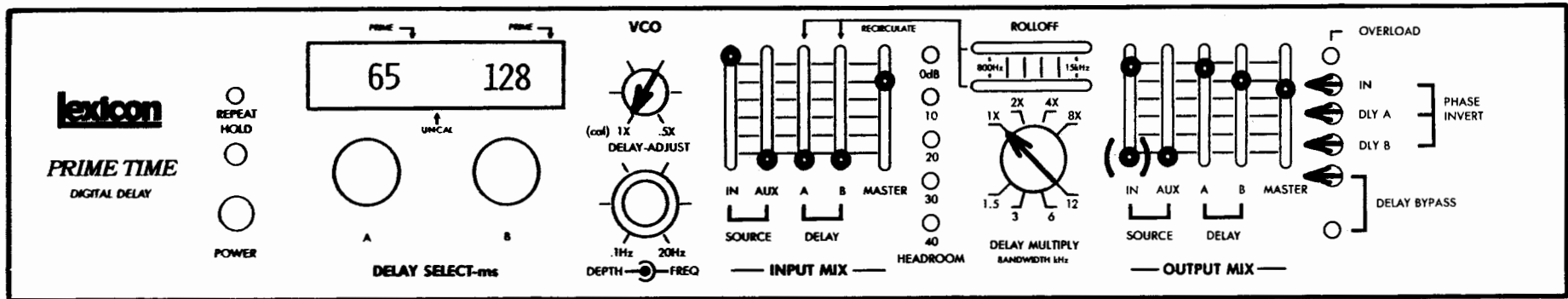
# PRIME TIME M.93 SET-UP SHEET

**NOTES:**

1. FOR STEREO REMOVE IN FROM THE OUTPUT MIX. THE STEREO VERSION PUTS THE INPUT LEFT AND THE ECHOES RIGHT. USE DELAY A AND B OUTPUTS WITH A MIXING CONSOLE TO VARY THE STEREO POSITIONING.
2. VARY DELAY TIMES TO TASTE USING LARGE DELAY MULTIPLY SETTINGS FOR LONG DELAY TIMES.

INITIALS LEXICON

DATE JUNE 1978



INPUTS: IN X  
 AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT X RIGHT  
 INPUT MIXER OUT LEFT  
 DELAY A OUT \_\_\_\_\_  
 DELAY B OUT \_\_\_\_\_

MONO      STEREO

EFFECT 4.1 SLAP ECHO      REVISED NOV 78



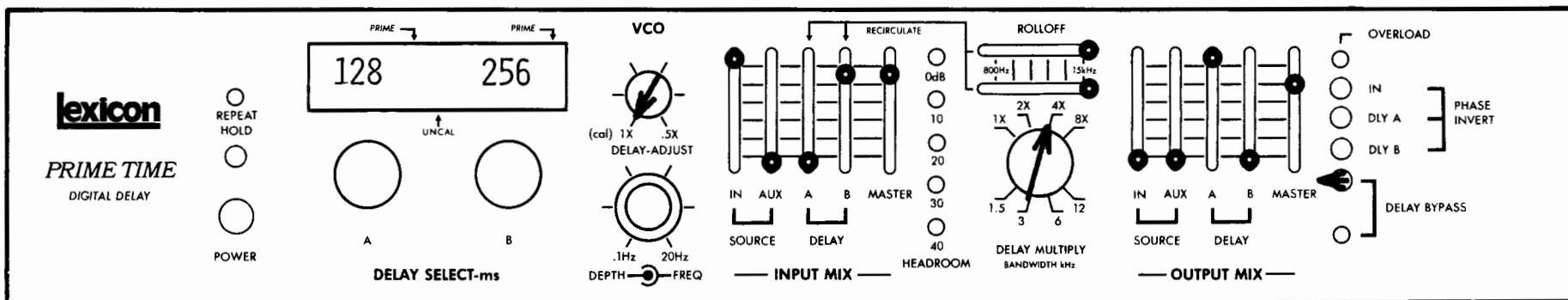


# PRIME TIME M.93 SET-UP SHEET

**NOTES:**

SET-UP IS FOR OPTIONAL MEMORY. WITH STANDARD M.93  
 USE DELAY MULTIPLY SETTING OF 8X AND SELECT DELAYS A AND B  
 60 AND 120 MSEC RESPECTIVELY.

INITIALS LEXICON  
 DATE JUNE 1978



INPUTS: IN X (MICROPHONE)  
 AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT RIGHT  
 INPUT MIXER OUT LEFT  
 DELAY A OUT LEFT  
 DELAY B OUT RIGHT

MONO

STEREO: EITHER PAIR

EFFECT 4.3 BOUNCING ECHO

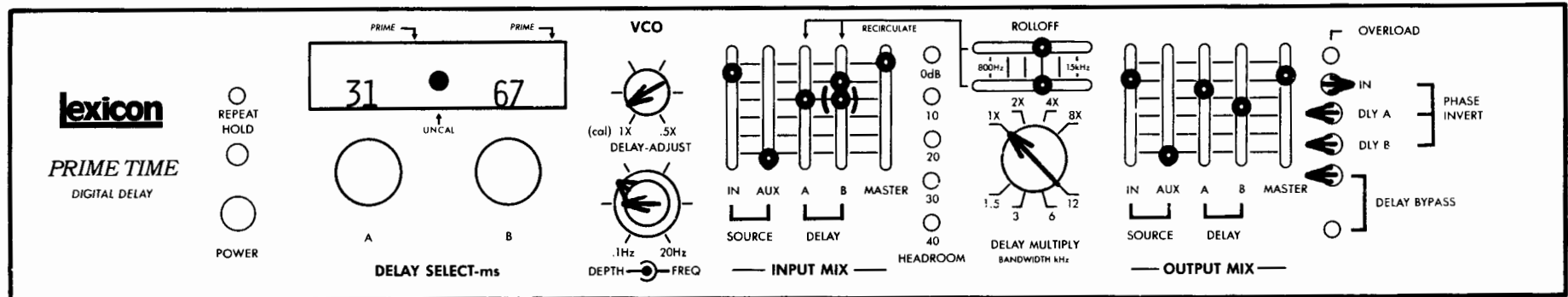


# PRIME TIME M.93 SET-UP SHEET

**NOTES:**

1. LOWER B TAP OF INPUT MIX FOR SOME MATERIAL SUCH AS BRASS
2. TRY DELAY MULTIPLY AT 2X WITH REDUCED VCO DEPTH
3. SWITCH PHASE INVERT FUNCTIONS FOR SUBTLE VARIATIONS

INITIALS LEXICON  
DATE JUNE 1978



INPUTS: IN X  
AUX \_\_\_\_\_  
  
MONO \_\_\_\_\_

OUTPUTS: MASTER OUTPUT <u>X</u>	RIGHT _____
INPUT MIXER OUT _____	LEFT _____
DELAY A OUT _____	
DELAY B OUT _____	
MONO _____	STEREO _____

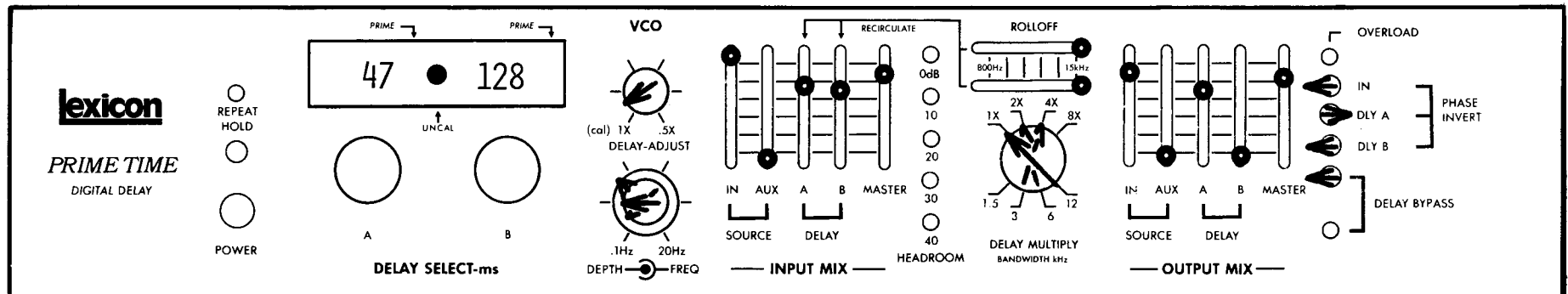
EFFECT 4.5 REVERBERATION: MONO/STEREO SYNTHESIS REVISED NOV 78

# PRIME TIME M.93 SET-UP SHEET

NOTES:

1. ANY SOURCE
2. EXPAND ROOM SIZE WITH DELAY MULTIPLY FROM 1X TO 2X TO 4X TO 8X CORRESPONDING TO A CHAMBER HALL, A LARGE AUDITORIUM, A SPORTS ARENA, A MOUNTAIN VALLEY, RESPECTIVELY
3. REDUCE VCO DEPTH AT LONGER DELAYS

INITIALS LEXICON  
 DATE JUNE 1978



INPUTS: IN X OUTPUTS: MASTER OUTPUT RIGHT  
 AUX \_\_\_\_\_ INPUT MIXER OUT LEFT  
 DELAY A OUT \_\_\_\_\_  
 DELAY B OUT \_\_\_\_\_

MONO \_\_\_\_\_ STEREO \_\_\_\_\_

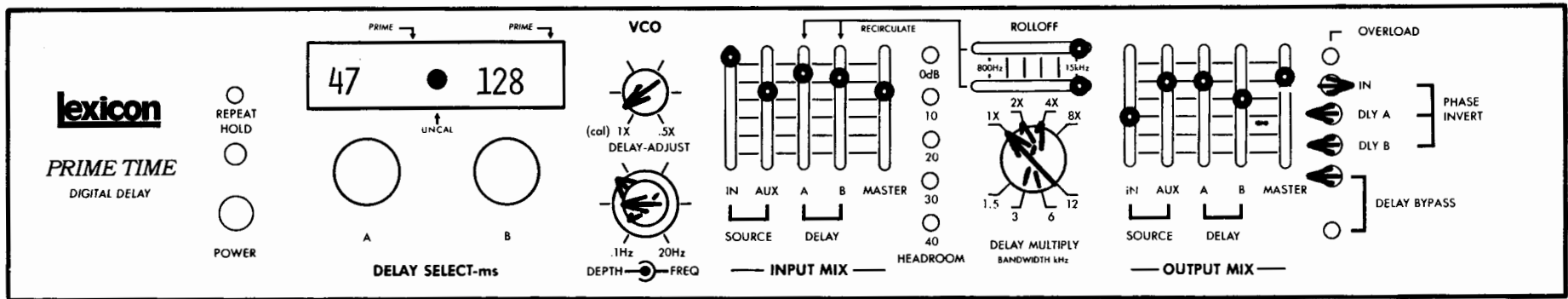
EFFECT 4.6 ROOM EXPANDER: SYNTHESIZED STEREO REVISED NOV 78

# PRIME TIME M.93 SET-UP SHEET

**NOTES:**

1. SIMILAR TO EFFECT 4.6
2. SYNTHESIZE QUAD USING MASTER OUTPUT AND INPUT MIXER OUT FOR FRONT CHANNELS AND DELAY A AND B OUTPUTS FOR REAR CHANNELS

INITIALS LEXICON  
DATE JUNE 1978



INPUTS: IN LEFT CHANNEL      OUTPUTS: MASTER OUTPUT RIGHT  
 AUX RIGHT CHANNEL      INPUT MIXER OUT LEFT  
    DELAY A OUT LEFT (REAR)  
    DELAY B OUT RIGHT (REAR)

STEREO

STEREO (QUAD)

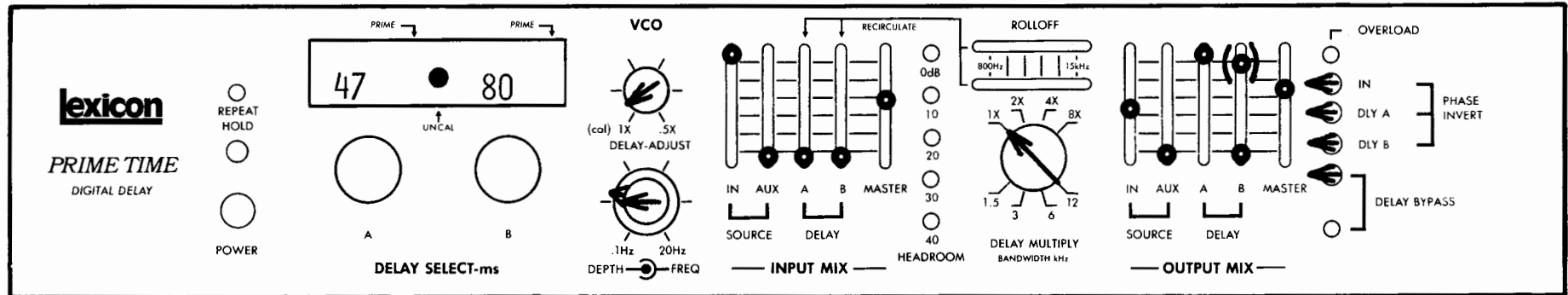
EFFECT 4.7 ROOM EXPANDER: STEREO SOURCE      REVISED NOV 78

## PRIME TIME M.93 SET-UP SHEET

**NOTES:**

1. BRING UP **B** OF **OUTPUT MIX** FOR TRIPLING
2. USE **DELAY ADJUST** TO FIND DELAYS MOST SUITABLE FOR SOURCE
3. ADJUST **DEPTH** AND **FREQ** FOR MOST NATURAL SOUND
4. AVOID IDENTICAL LEVELS OF **A** AND **B** TO PREVENT FLANGING EFFECTS

INITIALS LEXICON  
DATE JUNE 1978



INPUTS: IN X  
AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT <u>X</u> INPUT MIXER OUT _____ DELAY A OUT _____ DELAY B OUT _____	RIGHT _____ LEFT _____ _____ _____
--	---

MONO

MONO

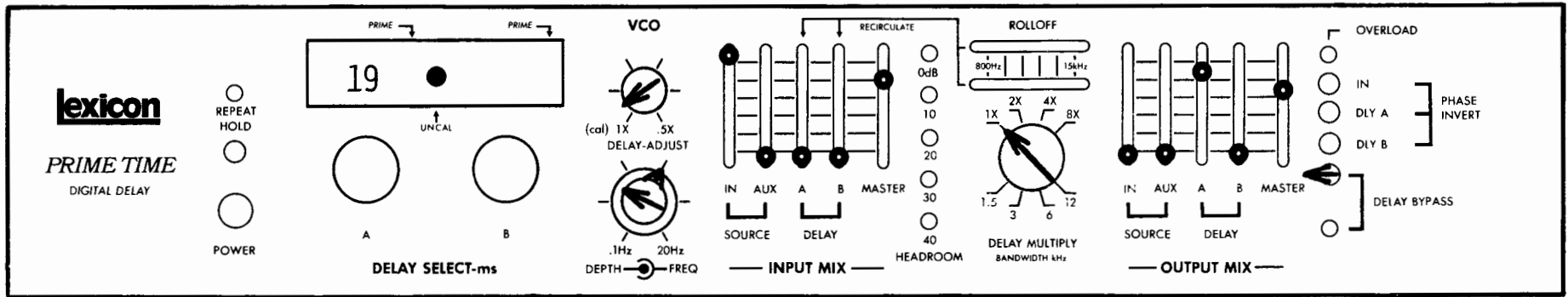
STEREO

EFFECT 4.8 DOUBLING AND TRIPLING

# PRIME TIME M.93 SET-UP SHEET

NOTES:

INITIALS LEXICON  
DATE JUNE 1978



INPUTS: IN X  
AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT X  
INPUT MIXER OUT \_\_\_\_\_  
DELAY A OUT \_\_\_\_\_  
DELAY B OUT \_\_\_\_\_

MONO

MONO

EFFECT 4.9 VIBRATO

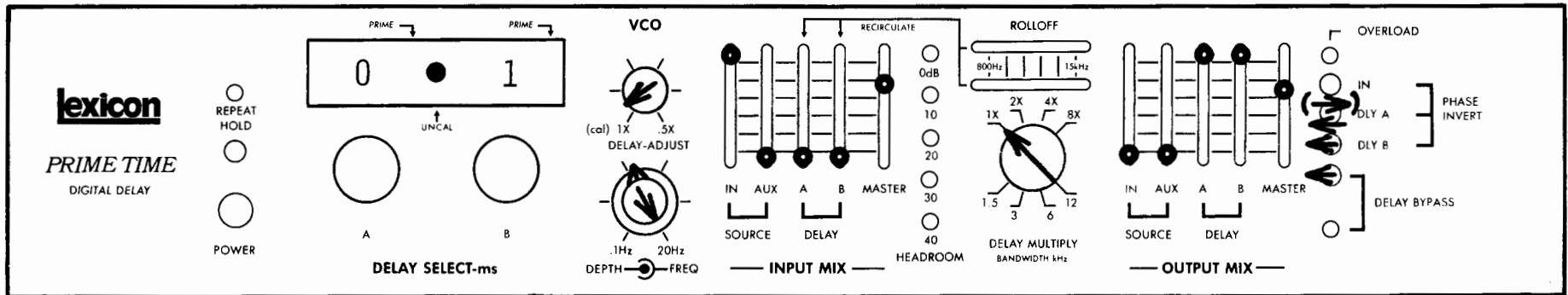


# PRIME TIME M.93 SET-UP SHEET

NOTES:

1. INCREASE THE DELAY TIME OF **B** FOR FLANGING IN THE LOWER FREQUENCY RANGES OF OTHER INSTRUMENTS
2. VARY FREQ AND DEPTH TO TASTE
3. INVERT DLY A FOR NEGATIVE FLANGE

INITIALS LEXICON  
 DATE JUNE 1978



INPUTS: IN X  
 AUX \_\_\_\_\_  
 \_\_\_\_\_

OUTPUTS: MASTER OUTPUT MONO  
 INPUT MIXER OUT \_\_\_\_\_  
 DELAY A OUT \_\_\_\_\_  
 DELAY B OUT \_\_\_\_\_

EFFECTIVE WITH CYMBALS

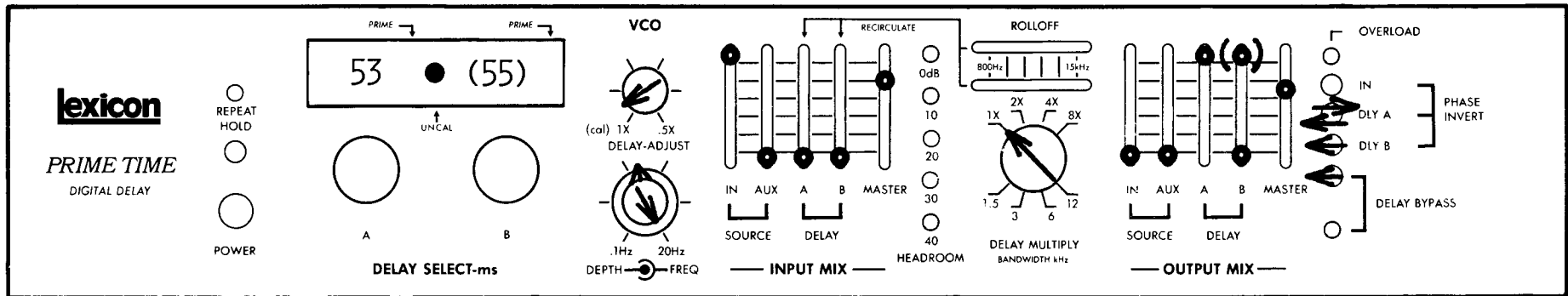
EFFECT 4.10 FLANGING: POSITIVE (AND NEGATIVE)

# PRIME TIME M.93 SET-UP SHEET

**NOTES:**

1. BRING UP B OF OUTPUT MIX FOR FLANGING
2. ADJUST THE DELAY TIME DIFFERENCE FOR DIFFERENT SOURCES
3. TRY DLY A INVERTED AND NONINVERTED
4. INCREASE DELAY TIMES TO INCREASE AMOUNT OF PITCH SHIFTING
5. ADJUST DEPTH AND FREQ TO TASTE

INITIALS LEXICON  
 DATE JUNE 1978



INPUTS: IN X  
 AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT MONO  
 INPUT MIXER OUT \_\_\_\_\_  
 DELAY A OUT \_\_\_\_\_  
 DELAY B OUT \_\_\_\_\_

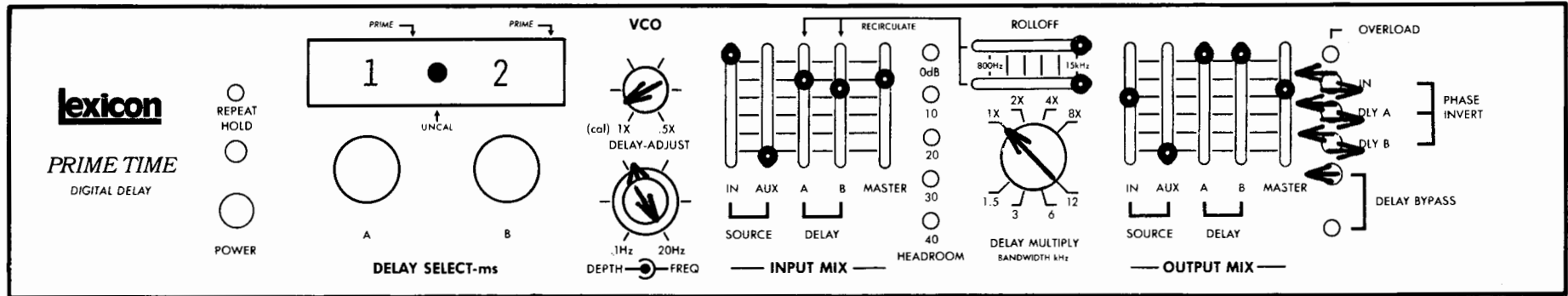
EFFECT 4.11 "DOPPLER" PITCH SHIFTING (PLUS FLANGING)

## PRIME TIME M.93 SET-UP SHEET

NOTES:

1. THREE FLANGING EFFECTS TAKE PLACE AT ONCE: DELAY A AGAINST DELAY B, INPUT AGAINST DELAY A, AND INPUT AGAINST DELAY B. SINCE ONLY TWO DELAY TIME DIFFERENCES OCCUR, 1 MSEC AND 2 MSEC, IT IS A DOUBLE FLANGE.
2. ADJUST A AND B OF THE INPUT MIX FOR GOOD RESONANCE EFFECT (BRING DOWN A AND B FOR NO RESONANCE). USE ROLLOFF TO LIMIT REQUENCY OF RESONANCES.
3. SET PHASE FOR VARIOUS COMBINATIONS OF POSITIVE AND NEGATIVE FLANGING.

INITIALS LEXICON  
DATE JUNE 1978



INPUTS: IN X  
AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT X RIGHT  
INPUT MIXER OUT LEFT  
DELAY A OUT \_\_\_\_\_  
DELAY B OUT \_\_\_\_\_

MONO \_\_\_\_\_

MONO \_\_\_\_\_ STEREO \_\_\_\_\_

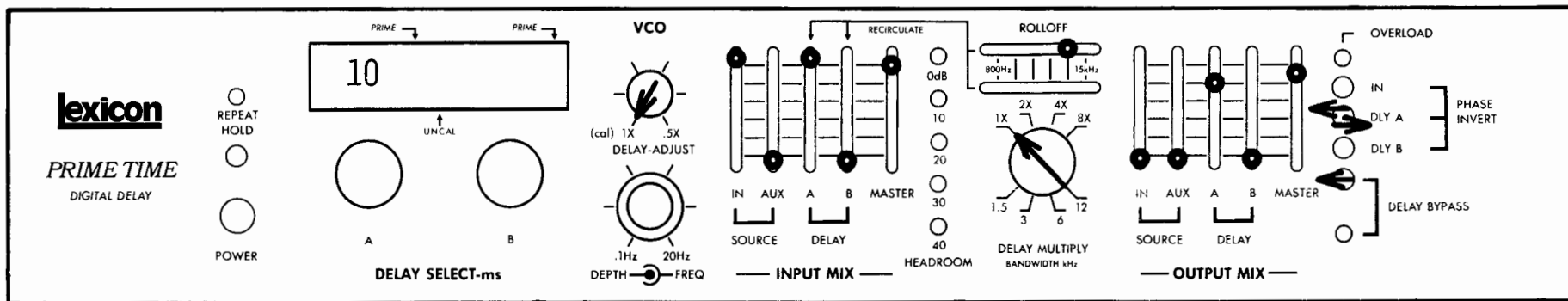
EFFECT 4.12 DOUBLE RESONANT FLANGE REVISED NOV 78

# PRIME TIME M.93 SET-UP SHEET

**NOTES:**

1. ADJUST INPUT MIX MASTER FOR MAX. LEVEL BEFORE FEEDBACK
2. CHANGE PHASE FOR DIFFERENT TONE QUALITY
3. CHANGE DELAY FOR DIFFERENT FREQUENCY RANGE
4. USE ROLLOFF TO CONTROL HIGH FREQUENCY COMPONENTS

INITIALS LEXICON  
DATE JUNE 1978



INPUTS: IN   X    
AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT   X   RIGHT  
INPUT MIXER OUT \_\_\_\_\_ LEFT  
DELAY A OUT \_\_\_\_\_  
DELAY B OUT \_\_\_\_\_

MONO

STEREO

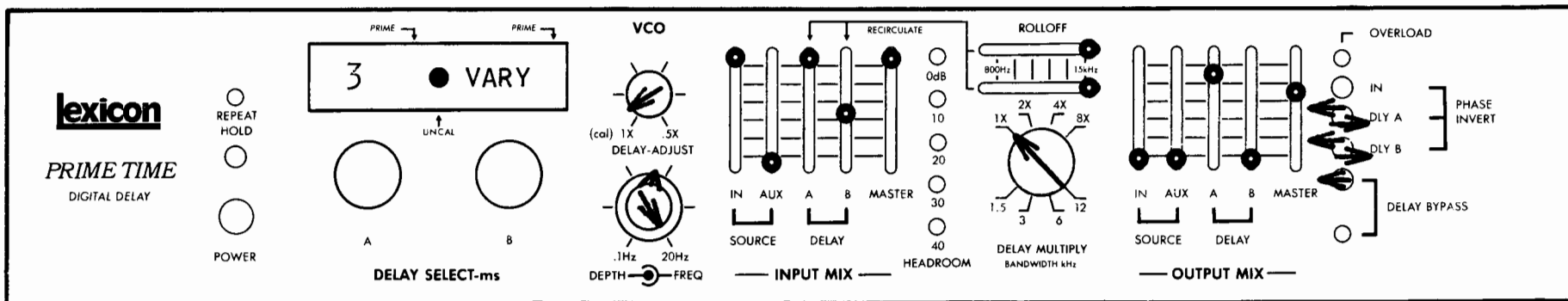
EFFECT   4.13 RESONANCE

# PRIME TIME M.93 SET-UP SHEET

NOTES:

1. ADJUST RECIRCULATION FOR A GOOD SIREN SCREAM
2. CHANGE DELAY SELECT A TO CHANGE FREQUENCY
3. USE ROLLOFF TO DAMPEN SCREAMING

INITIALS LEXICON  
 DATE JUNE 1978



INPUTS: IN X  
 AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT X RIGHT  
 INPUT MIXER OUT LEFT  
 DELAY A OUT \_\_\_\_\_  
 DELAY B OUT \_\_\_\_\_

MONO

STEREO

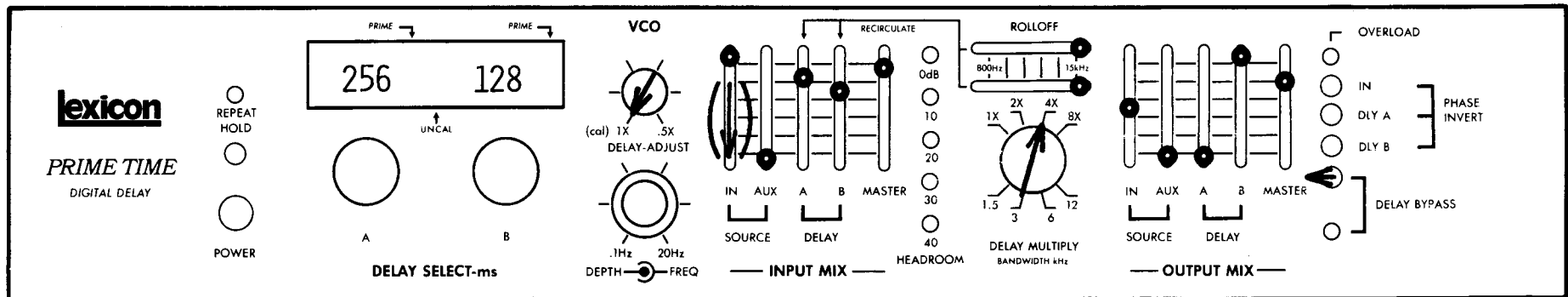
EFFECT 4.14 SIREN (RESONANCE) REVISED NOV 78

# PRIME TIME M.93 SET-UP SHEET

**NOTES:**

1. USE DELAYS OF 120, 60 MSEC AND DELAY MULTIPLY AT 8X FOR STANDARD MEMORY UNIT
2. ADJUST INPUT MIX MASTER FOR LONG REPEAT TIME
3. WITH LIVE SOURCE ENTER A TUNE LONG ENOUGH TO OVERLAP FIRST DELAY
4. AFTER TUNE IS ENTERED BRING IN OF INPUT MIX DOWN TO AVOID ACOUSTIC FEEDBACK (WHEN MIKING).
5. BRING INPUT MIX MASTER DOWN TO STOP

INITIALS LEXICON  
DATE JUNE 1978



<p>INPUTS: IN <u>  X  </u></p> <p>AUX <u>                    </u></p>	<p>OUTPUTS: MASTER OUTPUT <u>  X  </u></p> <p>INPUT MIXER OUT <u>                    </u></p> <p>DELAY A OUT <u>                    </u></p> <p>DELAY B OUT <u>                    </u></p>	<p>RIGHT <u>                                    </u></p> <p>LEFT <u>                                    </u></p> <p>MONO <u>                                    </u></p> <p>STEREO <u>                                    </u></p>
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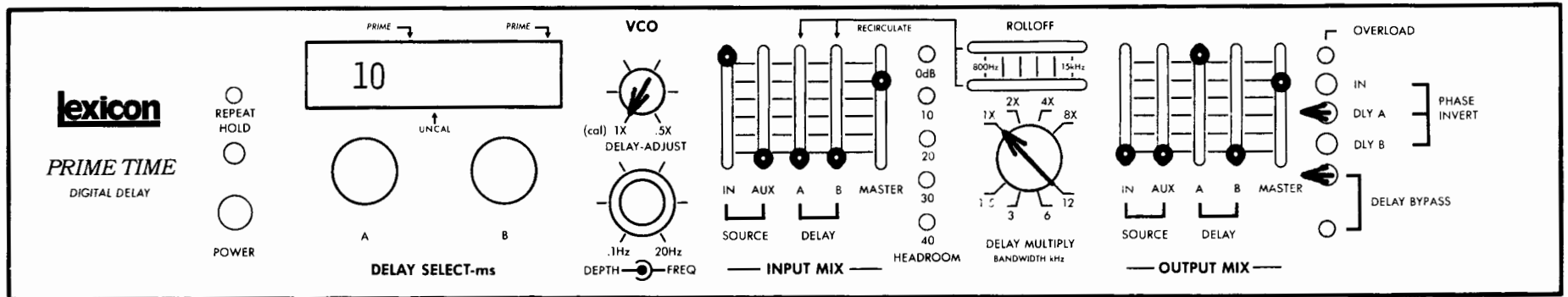
EFFECT   4.15   FUGUE EFFECT

PRIME TIME M.93 SET-UP SHEET

NOTES:

A UNIT: SIMPLE 10 MSEC DELAY

INITIALS LEXICON  
 DATE JUNE 1978



INPUTS: IN SOURCE  
 AUX \_\_\_\_\_

OUTPUTS: MASTER OUTPUT TO AUX INPUT OF B UNIT  
 INPUT MIXER OUT \_\_\_\_\_  
 DELAY A OUT \_\_\_\_\_  
 DELAY B OUT \_\_\_\_\_

EFFECT 4.16A DOUBLE DELAY LINE FLANGING

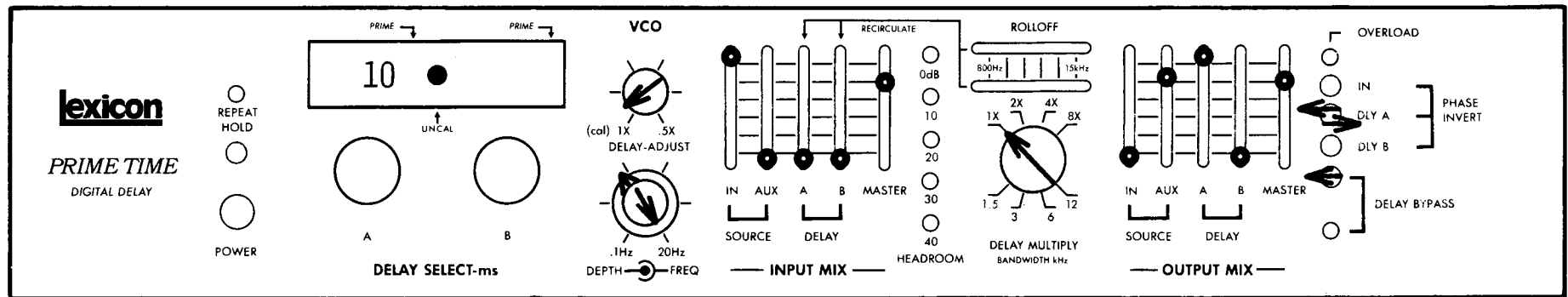
# PRIME TIME M.93 SET-UP SHEET

**NOTES:**

1. **B UNIT:** VARYING DELAY WITH VCO PROVIDES VIRTUALLY UNLIMITED OCTAVES OF FLANGING
2. TO MATCH LEVELS SET **DELAY ADJUST** TO CAL AND INVERT **DLY A**. ADJUST **AUX** LEVEL FOR NULL
3. ADJUST **DEPTH** AND **FREQ** TO TASTE
4. INCREASE DELAY TIME OF BOTH UNITS TO LOWER FREQUENCY OF FLANGE. LOWER B UNIT DELAY ONLY TO ELIMINATE VERY HIGH FREQUENCY FLANGE.

INITIALS LEXICON

DATE JUNE 1978



INPUTS: IN SOURCE  
 AUX MASTER OUTPUT, A UNIT

OUTPUTS: MASTER OUTPUT X  
 INPUT MIXER OUT \_\_\_\_\_  
 DELAY A OUT \_\_\_\_\_  
 DELAY B OUT \_\_\_\_\_

MONO

EFFECT 4.16B DOUBLE DELAY LINE FLANGING



## 5.0 IN CASE OF DIFFICULTY

Should you experience difficulty with your Model 93 the following information should be used as a guide for corrective action. It is assumed that the reader has already become familiar with operating and installation information in this manual and that he is still experiencing difficulties.

### WARNING

*All servicing of the Model 93 should be performed by qualified service personnel. There are hazardous voltages located under both the top and bottom covers of the Model 93. To avoid electrical shock, remove power cord from unit prior to removing covers. Servicing procedures consistent with good safety practice should be used at all times.*

## 5.1 UNIT WILL NOT POWER UP: FUSE REPLACEMENT

If the M.93 will not power up, first check the line cord and service outlet. Next check the power fuses. To gain access to the fuses, first remove the power cord and then remove the top cover screws and top cover. The main power fuse, F2, is located beneath a plastic shield in the front left corner (facing the unit). The +5V power supply fuse, F1, is located to the rear left side. Check the fuses for continuity with a continuity tester or ohm meter. If a fuse is open, replace it with an exact replacement fuse: F1 is a type 7AG 2½ Amps. F2 is a type 3AG 3/4 Amp slow blow for 115V operation; type 3AG 3/8 Amp slow blow for 230V operation.

To access F2, remove the plastic shield by depressing each of the small locking barbs on the three nylon standoffs while simultaneously lifting the shield at the nearest corner. The barb can be depressed with a small pliers or screwdriver. Replace the fuse. Then snap the insulating plastic shield back onto the nylon standoff making sure that all barbs lock in place.

Refit the cover and the cord. Power up. If the unit still does not power up or if a fuse blows once again, refer the problem to an authorized service technician or return the unit to Lexicon.

## 5.2 SERVICE PRELIMINARIES

If the field service is attempted, first verify the operation of all power supplies. A convenient place to probe power supplies is at their chassis-mounted three-pin regulators, U68, U69, and U70. Their corresponding voltages are printed on the circuit board near the appropriate leads. Use the chassis as a ground reference and take care when probing that the probe does not short adjacent leads of the regulators. See FIG. 5.0 to identify these test points. The following table indicates appropriate voltage limits:

REGULATOR	VOLTAGE	LIMITS	
		MIN.	MAX.
U68	+5V	4.75V	5.25V
U69	+15V	14.25V	15.75V
U70	-15V	-14.25V	-15.75V

NOTE: If both memory and analog subsystem modules are removed from the motherboard, the analog ( $\pm 15V$ ) ground and the digital (+5V) ground become isolated. This means that correct voltage readings are obtained only when measuring with respect to the corresponding ground. Do not remove modules under power.

Should module removal be required proceed as follows:

Each module is held in place by four nylon standoff retainers. Each retainer has a small locking barb which must be depressed with needle nose pliers or screwdriver while carefully lifting the circuit board at the nearest corner. Release one corner at a time and then lift the entire module from the motherboard.

Installation of circuit boards require alignment of all connector pins with their mating receptacles. After positioning board, firmly press each corner until all locking barbs are engaged.

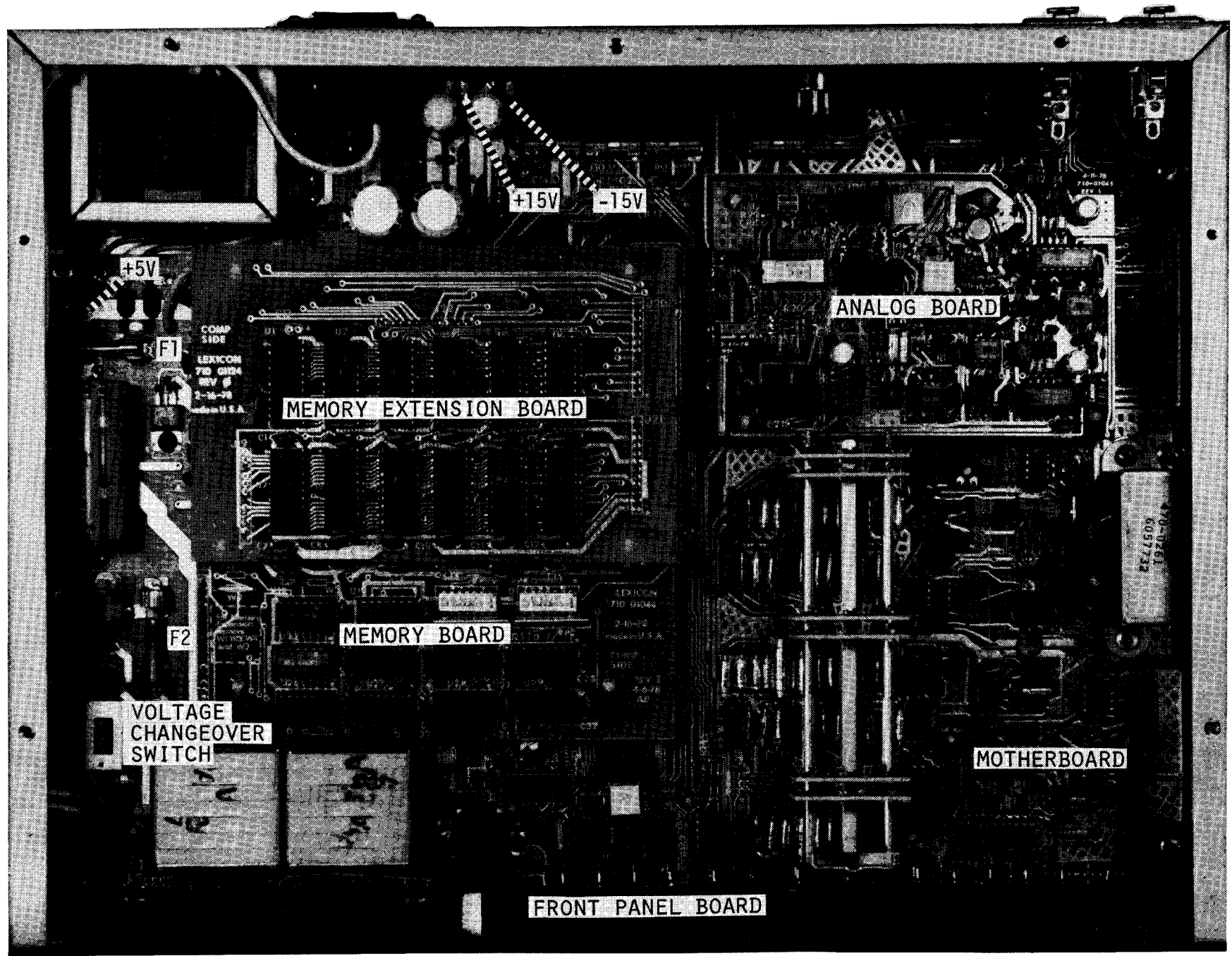


FIG. 5.0 INTERIOR VIEW

WARNING

*Do not attempt to install or remove modules with power applied to the unit. This practice can damage the electronics and can be hazardous to you. Turn OFF power and remove power cord prior to removing or installing modules.*

5.3 UNIT FUNCTIONS ONLY AT ZERO DELAY SETTING

If it is determined that the zero delay setting works but all higher delay settings are malfunctioning, the memory module is suspect. Check for proper installation of the memory card -- the connector pins should be fully engaged and the nylon locking standoffs should be firmly in place.

5.4 PROBLEMS AT ONLY ONE DELAY TAP

This is a good indication that the difficulty is on the Analog board only. Check for proper seating of the Analog board.

5.5 HEADROOM INDICATOR NORMAL BUT NO AUDIO

This is a good indication that all subsystems up to and including the Analog-to-Digital converter are functioning properly.

5.6 HEADROOM INDICATOR ACTS ERRATICALLY

This problem often indicates problems with the control logic. It should be noted that it is normal for all 5 Headroom LED's to illuminate when the analog module is not installed. Improper analog module installation can also cause erratic headroom indicator operation.

## 5.7 COMPONENT LEVEL TROUBLESHOOTING

We recognize that for many M.93 owners lack of test equipment or familiarity with digital techniques will prevent them from being able to efficiently troubleshoot to the component level. For these individuals Lexicon provides a module exchange program and fast turn around factory service.

For owners and service centers who plan to perform component level repair of the M.93, the PRIME TIME MODEL 93 SERVICE MANUAL, Lexicon DOC. NO. 070-1227 is available at a nominal charge.

## 5.8 RETURNING UNITS FOR REPAIR

If it becomes necessary to return a module, or machine for service, bear in mind that Lexicon assumes no responsibility for units in shipment from customer to factory, whether in or out of warranty. It is important, therefore, that shipments be well packed, properly insured, and consigned to a reliable agent, such as UPS or Federal Air Express. Be sure to include (in the carton) a note explaining the nature of the problem, referencing any conversation with Lexicon personnel, detailing the preferred shipping method, and indicating a date when the unit is needed again. It is also important to provide us with the name and telephone number of a person we may contact should any questions arise.

## 5.9 MODULE RETURN

In the event that a defective module is clearly identified, Lexicon can usually provide a repair/exchange module in advance of receipt of the defective module. For warranty repairs, Lexicon will ship prepaid by UPS, UPS Blue Label, or US Air Mail. If faster turn-around is needed, Lexicon can ship by Federal Air Express or other expedited air service, usually resulting in 24 hour delivery if the customer is near a major airport. In the case of an expedited shipment, however, the customer is expected to pay shipping.

## 5.10 REPLACEMENT PARTS

Replacement parts and service manual may be ordered from

Lexicon, Inc.  
60 Turner Street  
Waltham, Ma. 02154  
U.S.A.  
Attn: Parts Dept.

Parts will be shipped FOB Waltham. Price charges will be that price in effect at the time the order is received. Lexicon may be consulted at any time for a parts quotation.

When ordering parts refer to the appropriate parts list in the Model 93 Service Manual or order by complete description and give the following information.

- A. Assembly -- Motherboard, Analog, Memory, Memory Extension, or Front Panel
- B. Part ID if Available.
- C. Item Description.
- D. Quantity Desired
- E. Model 93 Serial No. if Available.

## 6.0 LIMITED WARRANTY

Lexicon warrants each M.93 to be free from defects in material and workmanship under normal use and service for one year. This warranty begins on the date of delivery to the purchaser or his authorized agent or carrier. During the warranty period Lexicon will repair, or at its option, replace at no charge, components that prove to be defective provided the equipment is returned, shipping prepaid, to Lexicon's factory or designated service facility.

This warranty is null and void under any of the following conditions:

- a. Abuse, neglect, alteration, or repair by unauthorized personnel.
- b. Damage caused by improper use, or operation from an incorrect power source.
- c. Damage caused by accident, act of God, war, or civil insurrection.

Lexicon shall not be responsible for any loss or damage, direct or consequential, resulting from machine failure or the inability of the product to perform. Lexicon shall not be responsible for any damage or loss during shipment to or from the factory or its designated service facility.

This warranty is in lieu of all other warranties, express or implied, and of any other liabilities on Lexicon's part, and Lexicon does not assume or authorize anyone to make any warranty or assume any liability not strictly in accordance with the above.

Lexicon reserves the right to make changes or improvements in the design and construction of the machine without obligation to make such changes or improvements in the purchaser's machine.

No equipment may be returned under this warranty without prior authorization from Lexicon. Authorized return shipments must be prepaid and should be insured. System modules being returned for repair/exchange should be wrapped or packed in soft packing material and shipped in an appropriate small protective box. In the case of returning the entire machine, it should be carefully packed in the original carton and packing material. If this is not available, new ones may be procured from Lexicon.

## 7.0 SPECIFICATIONS

<i>*Dynamic Range:</i>	95dB typical, 90dB Min "A" Weighted 90dB typical, 86dB Min Unweighted
<i>**Total Distortion and Noise</i>	Less than 0.08% at limit reference level and 1kHz; less than 0.3% at -34dB
<i>Frequency Response</i>	20Hz to 12kHz +1, -2dB, measured 12dB below limit level with Delay Multiply at X1; bandpass is reduced to 6kHz, 3kHz, and 1.5kHz with Delay Multiply at X2, X4, and X8 respectively.
<i>Delay Capacity</i>	128ms at full bandpass - standard; 256ms at full bandpass with optional add-on Delay Memory Module
<i>Delay Multiply</i>	Extends delays by X2, X4, or X8; (2048ms with add-on Memory option)
<i>Delay Taps</i>	Two, individually selectable in 60 steps with digital display of each setting
<i>Delay Adjustment</i>	Continuous and noiseless adjustment from 100% to 50% of selected delay time; max. sweep range up to 1024ms
<i>VCO Modulation</i>	Depth adjustable from 0 to 100% of Delay Adjustment range; Frequency adjustable from 0.1 to 20Hz
<i>Delay Accuracy</i>	0.01% long term in Cal mode plus .12ms delay offset
<i>Inputs</i>	Main and auxiliary inputs: balanced, 40k input impedance, 20dB gain switch allows matching of levels from -18dB to +18dB at limiting, XLR-3 type connectors.
<i>Master Output</i>	Transformer isolated, balanced, 90 ohms max., adjustable to 18dBm max., XLR-3 type connectors
<i>Supplemental Outputs</i>	Delay A, Delay B, and Input Mix, 100 ohms max, single ended, ¼" phone jack connectors; A and B Outputs adjustable from +8 to +18dBm
<i>Input Mixer</i>	5 faders for Main Input, Auxiliary Input, Delay A and B recirculation, and Master; 5 level LED Headroom Indicator verifies proper mix level
<i>Recirculated Delay Rolloff</i>	Individual control for recirculated Delays A and B from 15kHz to 800Hz
<i>Output Mixer</i>	5 faders for Dry Input, Aux Input, Delay A, Delay B and Master Out with overload indicator

*\*Defined as the ratio of the 1kHz output level at reference limit level to the output level with the input shorted across 600 ohms. Unweighted noise is measured over the bandwidth of 20Hz to 20kHz. Weighted noise is measured according to the ANSI "A" curve.*

*\*\*Input sensitivity set so that an 18dBm input corresponds to "0" LED just going out (this is "limit level"). Output sensitivity set to produce +18dBm with 600 ohm load under these conditions.*



<i>Repeat Hold</i>	Repeats signal in delay memory indefinitely without audio degradation, alternate action with LED indicator
<i>Delay Bypass</i>	Bypasses or cuts in delay system; when bypassed connects Input Mix to Master Output; switch actuated with LED indicator
<i>Remote Control Capability</i>	$\frac{1}{4}$ " phone jacks on rear panel for Repeat Hold foot switch, Delay Bypass foot switch, and Delay Adjust foot pedal pot or 0-10 volt signal
<i>Phase Inversion</i>	3 switches allow Input, Delay A and/or Delay B to be inverted
<i>Pre-emphasis/De-emphasis</i>	75/15 $\mu$ s; max boost 12dB at 12kHz
<i>Size</i>	Standard 19" rack mount, 3 1/2" high x 11 1/2" deep (483 x 89 x 292 mm)
<i>Weight</i>	11 lbs. (5 kg); 15 lbs. shipping
<i>Power</i>	115/230V $\pm$ 10%, switch selectable, (100/200V available as option) 50/60Hz, 35 watts max; standard IEC 3 wire power connector and cord
<i>Protection</i>	Mains fused, secondary supplies; fused with over voltage crowbar and/or current limited with thermal protection
<i>Connector Option</i>	Substitution of tip-ring-sleeve $\frac{1}{4}$ " phone jacks for all XLR-3 type connectors

8.0 APPENDIX

8.1 LIST OF AVAILABLE DELAY SELECTIONS (msec)

0	60				
.5	61*				
1	65				
2*	67*				
3*	70				
5*	71*				
7*	73*				
10	75				
11*	79*				
13*	80				
15	83*				
17*	85				
19*	90				
20	95				
23*	97*				
25	100				
29*	105				
30	110				
31*	113*				
35	115				
37*	120				
40	125				
41*	128				
43*	135	with optional	memory	only	
45	155	"	"	"	"
47*	175	"	"	"	"
50	195	"	"	"	"
53*	215	"	"	"	"
55	235	"	"	"	"
59*	256	"	"	"	"

\* PRIME SETTINGS

# **lexicon**

Lexicon, Inc., 60 Turner Street  
Waltham, MA, 02154 USA  
Tel (617) 891-6790

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DOC. 070-01060, REV 2, April 79, LJR

Price \$5.00