LARGE CONCERT HALL - B: (PART NO. 075-01847) REV. 0

This program replaces "LARGE CONCERT HALL - A" on all systems V2 and later.

Initial Sound:		Hall-like - uneven for 200ms
Decay:		Much longer final rate than initial rate
Initial Diffusion:		Very low - obvious clicking on transients
Coloration:		Very Low
INPUTS	MONO:	both "LEFT" and "RIGHT" in parallel
	STEREO:	left "LEFT" right "RIGHT"
OUTPUTS	MONO:	either "A" or "C" (plus source)
	STEREO:	left "A", right "C" (plus source)
	QUAD:	left front "B", right front "D" (plus source)
		left rear "A", right rear "C"
REVERB TIME	BASS:	0.6-70 sec
REVERB TIME	MID:	0.6-70 sec
CROSSOVER	FREQ:	100Hz-10.9kHz
TREBLE DECAY	FREQ:	100Hz-10.9kHz
	DEPTH:	0-71
	PRE-DELAY:	24-152 ms

This program is basically a modification of "LARGE CONCERT HALL - A". In the old program the "TREBLE DECAY" control affected the sound only after the first 300ms. In "LARGE CONCERT HALL - B" "TREBLE DECAY" affects the early sound too, and reduces the decay more rapidly. It mimics the effects of air absorption better than "LARGE CONCERT HALL - A". and sounds more natural.

This is not the program to use with material containing bold transients! Its very low coloration is terrific on symphonic music, organ music, or any smooth music. The final rate of decay is much longer than the initial rate. This program is excellent whenever a very long reverb time is needed. It will sustain a guitar or flute tone beautifully.

Recommended Settings

When used with "Mode Enhancement" and/or "Decay Optimization" "LARGE CONCERT HALL - B" sounds most natural if the "BASS" and "MID" control are relatively close to the same setting. "BASS" should be usually set somewhat higher than "MID". The "CROSSOVER" control is useful over the entire range. If it is set to 200Hz, the "BASS" will tend to be emphasized. If it is set to 1.5kHz it can be used to change the character of the high frequencies. When the subprograms are not used "BASS" should be set about a factor of two higher than "MID". When neither subprogram is used the setting of the "TREBLE DECAY" control is very important to achieving a natural sound, but the correct position depends strongly on the type of music and the desired reverb time. With chamber music, or for film sound, a short reverb time (1.5 to 1.7 sec.) is useful, and the "TREBLE DECAY" might sound best at 3.0 kHz. A longer reverb time might sound best with a "TREBLE DECAY" of 4.4kHz or higher. If reverb times shorter than 2 seconds are desired, "SMALL CONCERT HALL - B" might give a more natural sound.

ACOUSTIC CHAMBER: (PART NO. 075-01793) REV. 1

Initial sound:		Gradual - flat for 150ms, then decays
Decay:		Moderately non-uniform
Initial diffusion:		*Moderate*
Coloration:		Moderate
INPUTS	MONO:	both "LEFT" and "RIGHT" in parallel
	STEREO:	left "LEFT" right "RIGHT"
OUTPUTS	MONO:	mix "A" and "C" equally (plus source)
	STEREO:	left "A" or "D", right "C" or "B" (plus source)
REVERB TIME	BASS:	0.6-70 sec
REVERB TIME	*MID:*	*0.6-70 sec*
CROSSOVER	FREQ:	100Hz-10.9kHz
TREBLE DECAY	FREQ:	100Hz-10.9kHz
	DEPTH:	0-71
	PRE-DELAY:	25-255 ms

The "ACOUSTIC CHAMBER" sounds like a chamber, but with less initial diffusion. It is good on many types of popular music. It sounds very different from the "PLATE", mostly due to its very different initial sound, and the way the diffusion builds somewhat slower. It is not very good at very long reverb times, but short times may be interesting. Try:

BASS:	2.8 sec
MID:	2.2 sec
CROSS OVER:	1.0 kHz
TREBLE DECAY:	4 kHz to 10.7 kHz
DEPTH:	0 to 20
PRE-DELAY:	to taste

The chamber program digitally averages the two inputs to mono. If only one input feed is available, it should be bridged to both inputs. The main outputs are "A" and "C". It should be noted that there is less inherent pre-delay in output "A" than output "C", a difference which can be distinguished on some material. Outputs "B" and "D", which are derived from "A" and "C" through a form of time delay matrixing, do not differ in their inherent pre-delays. Thus outputs "B" and "D" may be used instead of "A" and "C" for better timing characteristics but at the expense of marked coloration from output "D". For a single (mono) output "D" should not be used because of its coloration.

The best guide for using this program is to keep the reverb time between 2 and 5 seconds. The most chamber-like sound is achieved with the "DEPTH" at 0. Beware that if the "MID" reverb time is long compared to the "BASS" reverb time, and if the "TREBLE DECAY" frequency is high, then the machine is apt to feed back internally. This condition will be readily apparent and can be useful as a special effect. It can be defeated by raising the "BASS" or lowering the "TREBLE DECAY" controls.

We have also found that equalizing the return from the 224 (adding about +3dB below 200 Hz) can add to the richness and naturalness of the reverb. This effect cannot be achieved with the reverb time controls. Boosting the reverb time of the "BASS" excessively makes the bass reverberate too long without increasing richness.

The pre-delay display reads a minimum of 24 ms with this program. Actually there is a strong single reflection at 27 ms on the left and at 20 ms on the right. The time difference in the pre-delay for the two channels can make a pleasant spread in the sound of a mono source. However, with a mono feed solo instruments or voice will sound stronger on the right. If the soloist appears on the left in the mix it may sound more natural to reverse the returns from the 224.

BASS:	3.4 sec
MID:	2.6 sec
CROSS OVER:	540 Hz
TREBLE DECAY:	4.0 kHz
DEPTH:	10 to 40
PRE-DELAY:	24 to 60 ms

In both stereo and quad the feeling of spaciousness is enhanced by using a stereo feed, either similar in placement to the source or reversed. Reversing the returns may decrease the apparent width of the reverb. In stereo or mono operation the outputs "A" and/or "C" should be used as the main echo returns and summed with the source (through a mixer). For quad operation outputs "A" and "C" should be sent directly to the rear, not the front. The "DEPTH" control affects only outputs "A" and "C" and should be set from 0 to 10 for Quad, providing a strong early delay to the rear channels. The outputs "B" and "D" should then be summed with the source at the front.

NOTE: Outputs "B" and "D" are not as satisfactory as "A" and "C" for purposes other than quad.

SMALL CONCERT HALL - A: (PART NO. 075-01790) REV. 1

Initial sound:		Hall-like - uneven for 200ms
Decay:		Moderately non-uniform
Initial Diffusion:		Moderate - some clicking on an impulse
Coloration:		Low
INPUTS	MONO:	both "LEFT" and "RIGHT" in parallel
	STEREO:	left "LEFT" right "RIGHT"
OUTPUTS	MONO:	either "A" or "C" (plus source)
	STEREO:	left "A", right "C" (plus source)
	QUAD:	left front "B", right front "D" (plus source)
		left rear "A", right rear "C"
REVERB TIME	BASS:	0.6-70 sec
REVERB TIME	MID:	0.6-70 sec
CROSSOVER	FREQ:	100Hz-10.9kHz
TREBLE DECAY	FREQ:	100Hz-10.9kHz
	DEPTH:	0-71
	PRE-DELAY:	24-152 ms

The "SMALL CONCERT HALL - A" is useful whenever a sense of space and depth needs to be added to music. It is best on popular music which has already been mixed. The initial sound is brighter than "SMALL CONCERT HALL - B", and the "TREBLE DECAY" control is more gentle. This program can be used to fill out a vocal or drum track if clicking is not too apparent. All the concert hall programs are intended to put their sound behind the music, not with it. They do not try to alter a close miked sound. This program produces best results with reverb time settings of 1.5 to 5 seconds. Program 3, "LARGE CONCERT HALL - B" has less coloration and is better for long reverb times.

Recommended Settings

When used with "Mode Enhancement" and/or "Decay Optimization" "SMALL CONCERT HALL - A" sounds most natural if the "BASS" and "MID" control are relatively close to the same setting. "BASS" should be usually set somewhat higher than "MID". The "CROSSOVER" control is useful over the entire range. If it is set to 200Hz, the "BASS" will tend to be emphasized. If it is set to 1.5kHz it can be used to change the character of the high frequencies. When the subprograms are not used "BASS" should be set about a factor of two higher than "MID". When neither subprogram is used the setting of the "TREBLE DECAY" control is very important to achieving a natural sound, but the correct position depends strongly on the type of music and the desired reverb time. With chamber music, or for film sound, a short reverb time (1.5 to 1.7 sec.) is useful, and the "TREBLE DECAY" might sound best at 3.0 kHz. A longer reverb time might sound best with a "TREBLE DECAY" of 4.4kHz or higher. If reverb times longer than 3 seconds are desired, "LARGE CONCERT HALL - B" might give a more natural sound.

We have also found that equalizing the return from the 224 (adding about +3dB below 200 Hz) can add to the richness and naturalness of the reverb. This effect cannot be achieved with the reverb time controls. Boosting the reverb time of the "BASS" excessively makes

4.0 THEORY OF OPERATION

The 224 is partitioned into 9 major functional blocks (not including the option module). They are:

1. Single Board Computer - SBC/BLC
2. Data Memory - D-MEM
3. Timing and Control - T & C
4. Arithmetic Unit - ARU
5. Floating Point Converter - FPC
6. Audio Input - A-IN
7. Audio Output - A-OUT
8. Remote Panel
9. Power Supply - PS1, PS2 and PS3

4.1 SBC SINGLE BOARD COMPUTER

The single board computer controls all functions of the front panel such as reading switches, slide pots and display of data. The SBC also contains the 224 music software which is used to control the "Digital Processor". These programs are stored in Read Only Memories, "ROM's". It is these ROM's which have to be re-programmed whenever software is updated.

An RS232 interface is also provided on the SBC board to allow automation interface as well as diagnostic procedures to be executed with no additional hardware. This interface may be set to any data rate between 9600 and 110 baud.

4.2 INPUT/OUTPUT SIGNAL PATHS

Input analog signals are transformer coupled, gain conditioned and filtered prior to digitization. The input digitizer sequentially converts each analog signal into a digital representation which the FPC card transfers to the digital processor as a 16 bit offset binary word.

The FPC card is also used to process output data to the output DAC. The output DAC circuitry reconstructs the analog information which is then low pass filtered and transformer coupled to the output channels.

4.2.1 Self Test

In the event of operating difficulties it is possible to determine proper operation of the Input, Output and FPC cards by enabling self test mode. This mode is a reasonably good test of Audio and FPC subsystems. Additional information about self test is obtained in Section 6 of this manual. Self test mode is enabled by loosening the D-MEM, T&C and ARU boards. When these cards are loose a control signal to the FPC card is allowed to fly high placing it in self test

the bass reverberate too long without increasing richness.

The pre-delay display reads a minimum of 24 ms with this program. Actually there is some output before this time, building to a peak at about 27 ms in the left channel and 20 ms in the right. The time difference in the pre-delay for the two channels can make a pleasant spread in the sound of a mono source. However, with a mono feed solo instruments or voice will sound stronger on the right. If the soloist appears on the left in the mix it may sound more natural to reverse the returns from the 224.

BASS:	3.0 sec
MID:	2.0 sec
CROSS OVER:	540 Hz
TREBLE DECAY:	4.4 kHz
DEPTH:	10 to 40
PRE-DELAY:	24 to 60 ms

In both stereo and quad the feeling of spaciousness is enhanced by using a stereo feed, either similar in placement to the source or reversed. Reversing the returns may decrease the apparent width of the reverb. In stereo or mono operation the outputs "A" and/or "C" should be used as the main echo returns and summed with the source (through a mixer). For quad operation outputs "A" and "C" should be sent directly to the rear, not the front. The "DEPTH" control affects only outputs "A" and "C" and should be set from 0 to 10 for Quad, providing a strong early delay to the rear channels. The outputs "B" and "D" should then be summed with the source at the front.

NOTE: Outputs "B" and "D" are not as satisfactory as "A" and "C" for purposes other than quad.

4.5.2 +12 and -12 Volt Supplies

The + and - 12 Volt supplies are both derived from a single secondary fused in both legs by a pair of 2 amp slo fuses. Refer to Section 6 for fuse locations.

The +12 Volt supply is a LM317K monolithic voltage regulator programmed by a pair of 1% resistors. This supply is both thermal and current protected - it will provide 1.25 amps.

The -12 Volt supply is derived from 7912 monolithic regulator which is thermal and current protected - it will provide 150ma.

It should be noted that the +12 Volt supply is sequenced by the -5 Volt supply so that +12 Volts can not come up until after -5 Volts is available. Should any problems occur with +12 Volts the presence of -5 Volts should also be checked.

4.5.3 +15 and -15 Volt Supplies

The + and - 15 Volt supplies are a tracking design which allows the -15 Volts to track the +15 Volt supply. Both supplies are derived from a single fused secondary. The +15 Volt supply is a LM317 programmed with an adjustable resistor network.

The -15 Volt supply is a 7912 controlled by a 301 op amp which senses the +15 and -15 Volt outputs and forces the -15 Volt output to track the +15 Volts. A balance control is provided to trim the -15 Volt output. It should be noted that the +/-15 Volt supply is not ground referenced to the +/-5 and +/-12 Volt supplies unless the analog boards are installed in the 224 chassis. When measuring voltages it is essential to refer all measurements to the correct ground.

The +/-15 Volt supplies will provide 750ma and are current and thermally protected.

4.5.4 Mains Circuit

The mains circuit for the 224 uses a dual primary transformer with 115 and 100 Volt taps - a pair of DPDT selector switches select the operating voltage. This supply is switched on both sides of the line. A primary fuse is provided on the chassis ahead of the RFI filter unit. Fan power is maintained at 115 Volts by placing the fan across one of the 115 Volt primaries.

mode. It should be noted that the SBC card must be installed simply to provide a clock signal for the FPC board.

4.3 DIGITAL PROCESSOR

The processor unit consists of three cards, D-MEM, ARU and T&C. These cards provide the basic digital processing and data storage capability to allow the 224 to synthesize reverberant sound in either stereo or monophonic formats.

Refer to Section 6 for troubleshooting information should any problems arise.

4.4 REMOTE PANEL

The remote panel interfaces to the main frame via a 25 conductor ribbon cable. 10 Volt AC power is sent to the control head where it is rectified, filtered and regulated to power the control head logic. All data sent to and received from the control head is sent over an 8 bit bidirectional data bus. Address data is sent over a 4 bit address bus for pot selection and digit scan. All slide pots are digitized under software control and converted into an 8 bit word for transmission to the SBC/BLC board.

4.5 POWER SUPPLY

The 224 Power Supply produces six regulated dc voltages and one unregulated ac voltage to power the control head.

4.5.1 +5 and -5 Volt Supplies

The +5 and -5 Volt supplies are both derived from a single secondary winding. The +5 Volt supply consists of a us 723 regulator, current boost transistor and a pair of high current pass transistors. The regulator is a current foldback design which will limit short circuit currents to less than 3 amps.

Over voltage protection is provided by a crowbar circuit and the entire supply is fused by a 15 amp 3AG fuse. This supply is designed to provide a continuous 10 amp - both voltage and current limit are adjustable.

Refer to Section 6 for fuse locations.

The -5 Volt supply is a 7905 monolithic regulator fused at 2.5 amps. This supply is both current limited and thermally protected. It is designed to provide 250ma.

6.2.1 Diagnostic Programs (operating system V2 and later only)

Model 224 Resident Diagnostics are run whenever the machine is turned on or reset. They may also be entered by holding the "SHIFT" key and pushing the "PRE-DELAY" button. The diagnostics make a single pass though all testable features of the machine. If the machine passes, it commences normal operation. If an error is detected, an error message is displayed.

During an error display or the panel test display all controls and buttons on the panel are inactive except the program switches. Briefly pressing "PROGRAM 1" will stop the display and go to the next diagnostic test. Pressing "PROGRAM 2" bypasses all further diagnostics and starts the regular system.

A stereo delay line program is provided which can be used for setting output levels, or as a quick test of the machine. This program is reached by pressing "PROGRAM 8" while the remote panel test is running, or by pressing "SHIFT" and "PRE-DELAY" during normal operation. The delay is about 0.4 seconds and is not adjustable.

The diagnostics test the whole machine, including the SBC/BLC computer. To do this they must erase the program numbers and parameters stored in the four registers A through D. These registers must be reset after diagnostics.

Diagnostics make the following tests:

E00 to E0F	Rom checksum
E10 to E13	Computer RAM test - destroys the contents of all registers unless optional memory card is installed
—	Remote panel test - all LEDS illuminated for 2 seconds and operating system version number displayed
E20 to E49	T&C board tests (may also implicate circuits on DMEM)
E51 to E8F	ARU board tests (T&C failures will usually cause ARU and DMEM errors too)
E91 to E93	Data Memory test (DMEM)

All the diagnostics work by comparing the actual data in some part of the machine to the data which should be there if the machine were working perfectly. The diagnostic programs display the expected data pattern (the "good" data) on the lights in the program buttons. The actual data returned by the machine are displayed on the mode-register lights. Usually an error is displayed when the two patterns do not correspond. The pattern displayed on these lights is vital to interpreting the cause of the error. If errors appear you should write the error numbers and the light patterns in the order in which

* DIAGNOSTICS RUN WHEN:

1. MACHINE IS TURNED ON
2. RESET BUTTON IS PUSHED
3. SHIFT & DEPTH ARE PUSHED

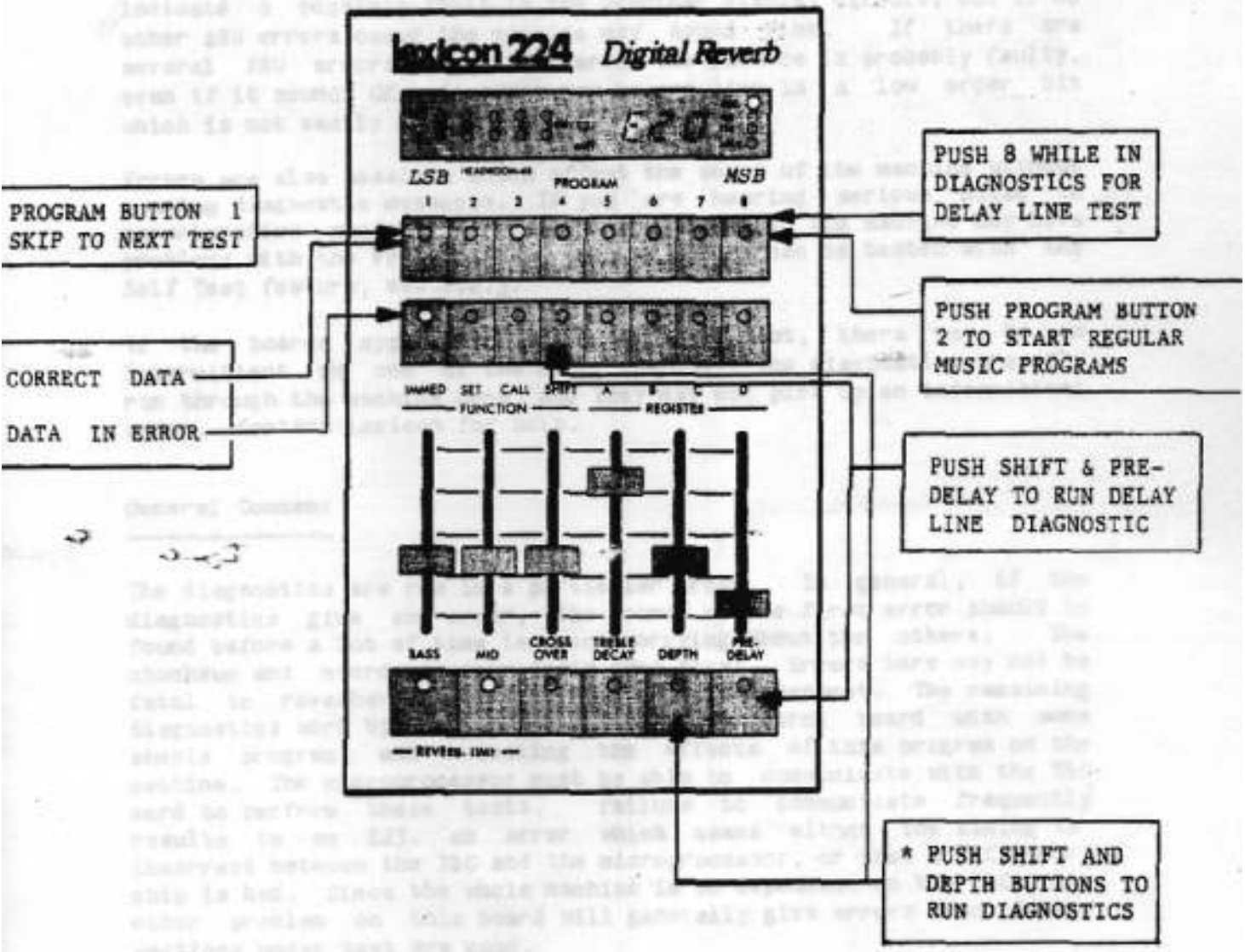

FIG. 6.3A

ERROR DISPLAY ON CONTROL HEAD

they occur prior to contacting Lexicon's customer service department.

Error displays may occur which do not indicate a fault in a vital part of the 224. For example, there may be a problem in the error detection circuits themselves. This is especially true if the only errors which display are T&C errors. On the ARU card, E80 would indicate a possible fault in the overload display circuit, but if no other ARU errors occur the machine may sound fine. If there are several ARU errors or a DMEM error the machine is probably faulty, even if it sounds OK. An error may be occuring in a low order bit which is not easily audible.

Errors are also possible which affect the sound of the machine without causing diagnostic messages. If you are hearing serious noise in *reverberation and/or* the delay line diagnostic the machine may have problems with the FPC or analog boards. These can be tested with the Self Test feature, see 6.2.3.

If the boards appear to work in self test, there may be an intermittent on one of the other boards. The diagnostics are only run through the machine once, and they may not pick up an intermittent error. Contact Lexicon for help.

General Comment

The diagnostics are run in a particular order. In general, if the diagnostics give an error, the source of the first error should be found before a lot of time is spent worrying about the others. The checksum and microprocessor tests come first. Errors here may not be fatal to reverberation, and are easy to interpret. The remaining diagnostics work by loading the timimg and control board with some simple program, and testing the effects of this program on the machine. The microprocessor must be able to communicate with the T&C card to perform these tests. Failure to communicate frequently results in an E23, an error which means either the timing is incorrect between the T&C and the microprocessor, or that a T&C memory chip is bad. Since the whole machine is so dependent on the T&C, any other problem on this board will generally give errors even if the sections under test are good.

Some other parts of the tests are impossible to separate. All tests of DMEM require that the ARU board work at least minimally. Much of the microprocessor communication and test circuits for both T&C and ARU are located on the DMEM board. A failure here may make the T&C test take a long time to complete, and may also cause a very odd flashing scan of the front panel. This flashing scan implicates DMEM. A short or defective IC on the ARU or FPC can also cause an error which appears to be on T&C. It is sometimes useful to unplug ARU and FPC to see if the error still occurs. The FPC is not testable by the microprocessor, and the machine should pass all diagnostics with FPC unplugged.

What if the machine does not appear to work at all? The cable to the

Remote Panel should be checked first. If there are no diagnostic errors the machine will eventually run reverberation with the remote head unplugged. If the machine does this, the Remote Panel or the cable is faulty. It is however more likely that the transformer plug in the power supply has come loose, or that a power supply fuse has opened. The Self Test mode can be used to check the audio boards and indirectly the power supplies. Self test does not check the +12V or the -5V supply. See section 6.1 for Power Supply test points. Failure of the machine to respond either with diagnostics or reverberation when the power supplies are good probably means that the SBC/BLC board has failed.

2.4 OPTIONAL MEMORY BOARD

Version 3 (and higher) software supports a memory board which plugs into the option slot on the 224. This board (available fall 1980) allows additional reverberation programs, permanent storage of registers preset by the user, and the restoration of the current operating state after the power has been turned off or has failed. See Section 5 for a complete description of this board.