

**LE8<sup>\*</sup>**  
**LOGIC CONTROLLED EQUALIZER MODULE**

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**OPERATING INSTRUCTIONS**  
**and trouble-shooting guide**

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**LECTROSONICS, INC.**  
Rio Rancho, NM

\* Patent No: 5,206,913

# INTRODUCTION

Thank you for purchasing the Lectrosonics LE8 Logic Controlled Equalizer. The LE8 represents a significant advance in equalization technology. The LE8, when used in an automatic Modular Audio Processor system, provides an economical solution to the problem of multiple microphone equalization and notch filtering. Each of up to eight microphones may be equalized using a four band equalizer. In addition, three variable frequency notch filters are available for each microphone. This allows all microphones to be individually optimized for best quality sound, and the feedback frequencies that are unique to each microphone position may be eliminated.

The heart of the LE8 is a sophisticated microprocessor, which controls all functions of the digitally programmed EQ and notch filters. The microprocessor also reads all user accessible controls to provide user interface. When a microphone becomes active, the appropriate EQ curve and notch filter frequencies are loaded, into the digitally programmed filters in the LE8. Since the filters in the LE8 are "time-shared" between all microphones, very sophisticated filtering can be provided at a reasonable cost.

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## TABLE OF CONTENTS

INTRODUCTION .....	1
GENERAL TECHNICAL DESCRIPTION .....	2
EQUALIZATION AND NOTCH FILTERING .....	3
FRONT PANEL DESCRIPTION .....	4
REAR PANEL DESCRIPTION .....	5
INSTALLATION .....	6
OPERATING INSTRUCTIONS .....	7
MULTIPLE LE8 SETUP .....	8
TROUBLESHOOTING .....	9
SERVICE AND REPAIR .....	10
RETURNING UNITS FOR REPAIR .....	10
SPECIFICATIONS .....	11
WARRANTY .....	Back cover

The LE8 is FCC type accepted under the following Parts:

Part 15

# GENERAL TECHNICAL DESCRIPTION

The LE8 is comprised of five major functional subsystems: the balanced input, the programmable four band equalizer, three programmable notch filters, the balanced and floating output driver, and the microprocessor (see block diagram below).

The input circuit of the LE8 is a fully balanced, RF filtered differential amplifier. The balanced circuit topology provides high rejection of common mode signals. It may also be configured to accept unbalanced signals.

The balanced and floating output driver is fully RF filtered, and provides the benefits of transformer coupling without the low frequency distortion and core saturation that plagues transformers. High current operational amplifiers are used in the output driver, allowing long cable runs to be driven easily. The output driver may also be easily configured for unbalanced use.

The microprocessor, a Motorola MC68HC705C8, provides all control and interface functions for the LE8. The MC68HC705C8 has internal non-volatile memory which stores the control program for the LE8 (note that filter setup values are stored in a separate off-chip non-volatile memory with data retention that exceeds 100 years). The microprocessor also provides both parallel and serial ports for interfacing with filters, controls, and indicators. The high integration density of the microprocessor allows for a much lower parts count design, thus increasing reliability. All filters are programmed by the microprocessor as appropriate for the particular active microphone. In addition, all user controls are scanned by the microprocessor to provide the user interface. Link In and Link Out functions are provided so that more than one LE8 may be used in an installation.

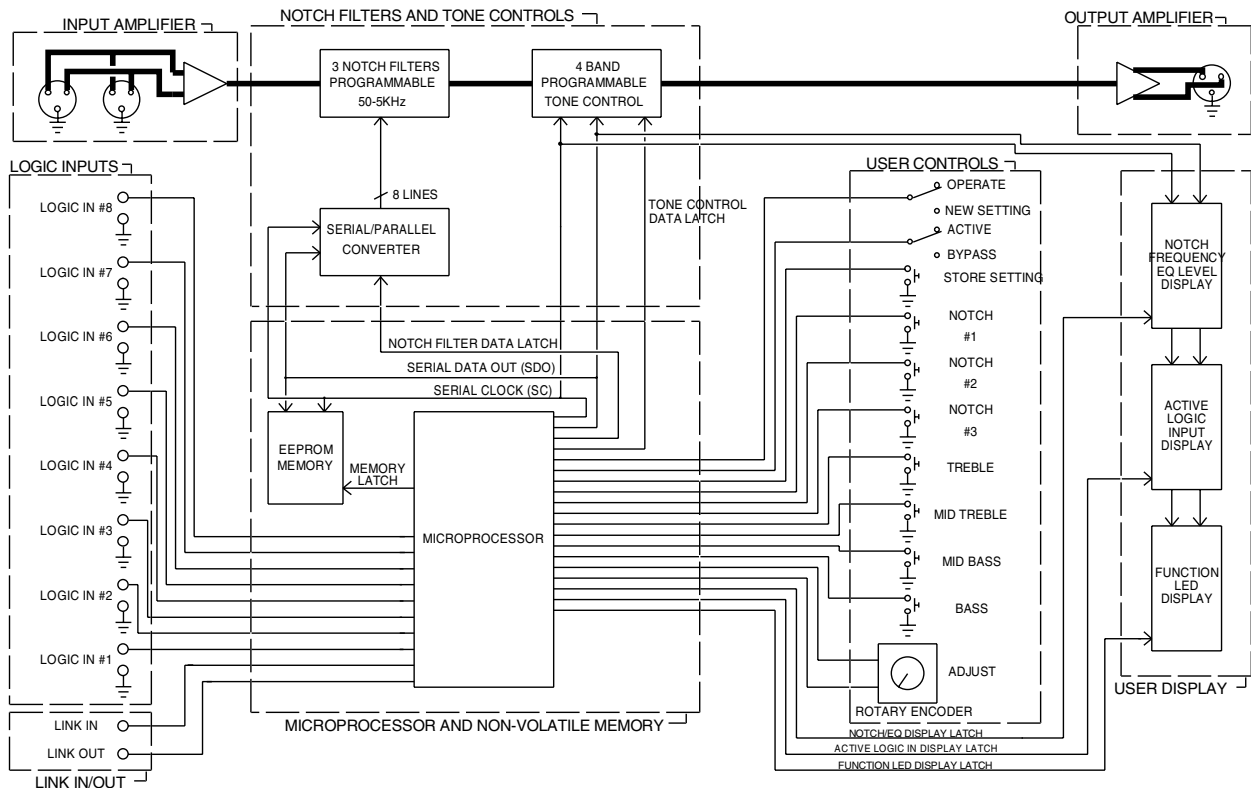


Figure 1 - LE8 Block Diagram

# EQUALIZATION AND NOTCH FILTERING

## FOUR BAND PROGRAMMABLE EQUALIZER

The four band programmable equalizer contains both low and high frequency shelving filters, as well as mid bass and mid treble bandpass type filters. The low frequency (bass) filter hinge frequency (the frequency at which cut or boost begins) is 1 kHz. The mid bass center frequency is 300Hz, and the Q of the filter is 0.33. The mid treble center frequency is 3 kHz, and the Q of the filter is also 0.33. The high frequency (treble) filter hinge frequency is 1.2 kHz. All filters can be adjusted for 10dB of cut or boost. The LE8 uses one filter set with programmable parameters (instead of eight separate filter sets) to implement the tone controls and notch filters. The filter set is "time-shared" between up to eight mics. This time sharing is accomplished using the logic outputs from the AP4 or EP4 module to signal which microphone is active at any time. The filter parameters associated with the active mic are then loaded into the programmable filter. Needless to say, only one mic at a time may be equalized. When two or more mics are active, the mic which activates the highest number Logic In on the LE8 will have its filter parameters loaded. For instance, if mics 2 and 4 were both on, the filter parameters for mic 4 would be loaded.

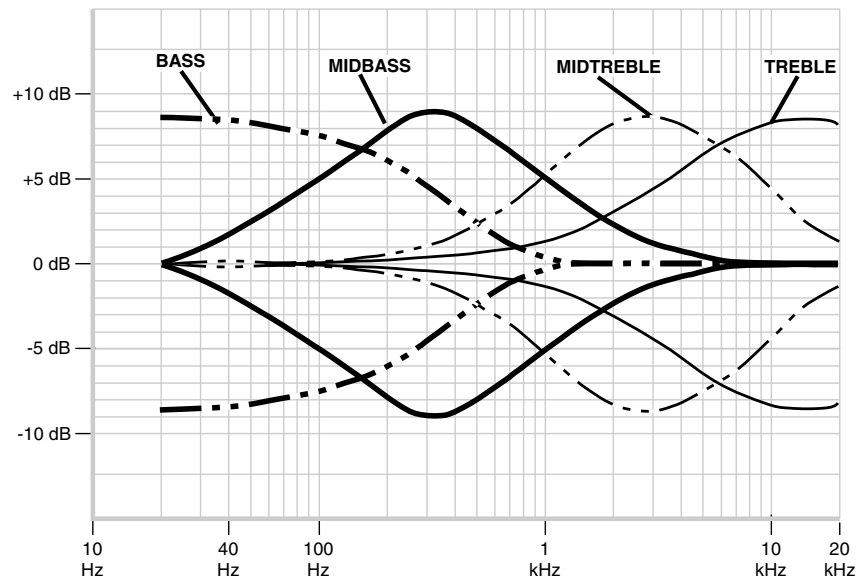


Figure 2 - LE8 Tone Control Curves

## NOTCH FILTERS

The three programmable notch filters are of the fixed depth, variable frequency type. Notch depth is 12dB, and the notches are 1/7 of an octave wide. The filters are designed to be easily tunable, while being completely inaudible. The center frequency can be varied from 50Hz to 5kHz. Frequency resolution from 50Hz to 500Hz is 1.76Hz, and resolution from 500Hz to 5kHz is 19.4Hz.

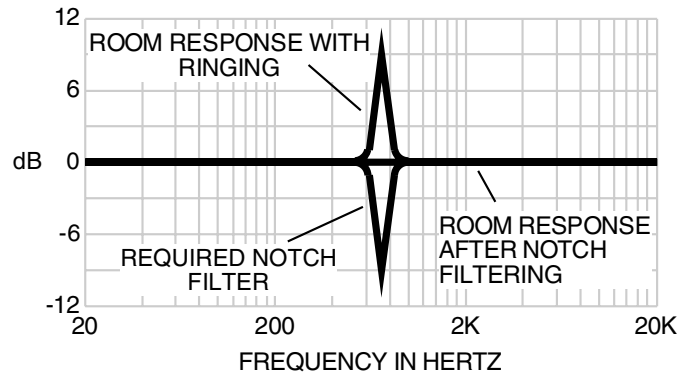


Figure 3 - LE8 Notch Filter Example

## FRONT PANEL DESCRIPTION

**ACTIVE/BYPASS SWITCH** - The Active/Bypass switch provides the user a means to bypass both the equalization and notch filters in the LE8. All other functions and controls are active (consistent, of course, with the position of the Operate/New Setting switch). When the Active/Bypass switch is in the Bypass mode, the Link Out signal is brought to logic low.

**ACTIVE LOGIC INPUT DISPLAY** - The Active Logic Input LEDs indicate the Logic Input whose associated filter parameters are currently loaded. The Active Logic Input LED will continue to be on until another Logic Input is active. Note that the LEDs stay on even if the previously active microphone is no longer in use, until another Logic Input becomes active. The LEDs will blink if the Active/Bypass switch is switched into the Bypass mode.

**EQUALIZER (TREBLE, MID TREBLE, MID BASS, BASS)** - The Equalizer buttons select which of the equalizer filter functions is currently active. The LEDs associated with the buttons serve to indicate which function is active after the button is pressed. Once a filter function has been selected, it may be adjusted using the Adjust control. Note that these buttons are active only when the Operate/New Setting switch is in the New Setting position.

**NOTCH FILTERS (1, 2, AND 3)** - The Notch Filter buttons select which of the notch filters is currently active. The LEDs associated with the buttons serve to indicate which filter is active after the button is pressed. Once a filter function has been selected, it may be adjusted using the Adjust control. Note that these buttons are active only when the Operate/New Setting switch is in the New Setting position.

**NOTCH FREQUENCY/EQ LEVEL DISPLAY** - The Notch Frequency/EQ Level display indicates the particular setting of the selected filter function. When one of the equalizer filters is active, the LEDs indicate the amount of cut or boost of the selected filter function. Adjustment range for the equalizer filters is +/-10dB in 1dB steps. When one of the three notch filters is selected, the LEDs indicate the frequency nearest the center of the selected filter.

**OPERATE/NEW SETTING** - The Operate/New Setting switch controls the operational mode of the LE8. In the Operate position, the LE8 scans the Logic Inputs and Link In. If an active Logic In is detected, and if Link In is at logic low, then the appropriate filter set is loaded into the programmable filters. All user controls except the Active/Bypass switch are ignored in the Operate mode. In the New Setting mode, operation is identical to the Operate mode with the exception that all user controls are active.

**STORE SETTING** - The Store Setting button provides a means for saving the filter parameter of the currently active filter to the non-volatile memory associated with the currently active Logic Input. Pressing the store setting button will store the setting of the currently active filter functions only and cause the currently active filter function LED to blink once to indicate successful filter value storage. Note that the Store Setting button is only active when the Operate/New Setting switch is in the New Setting position.

**TO RESET MEMORY** - To restore the original factory settings, hold down the NOTCH FILTER 3 and STORE SETTING buttons while turning on the MAIN POWER SWITCH on the AC1, EC1, or SC1. The EQ and NF LEDs will blink. Now turn the MAIN POWER SWITCH off, release the buttons, and turn the MAIN POWER switch back on. Memory is now reset to original factory settings.

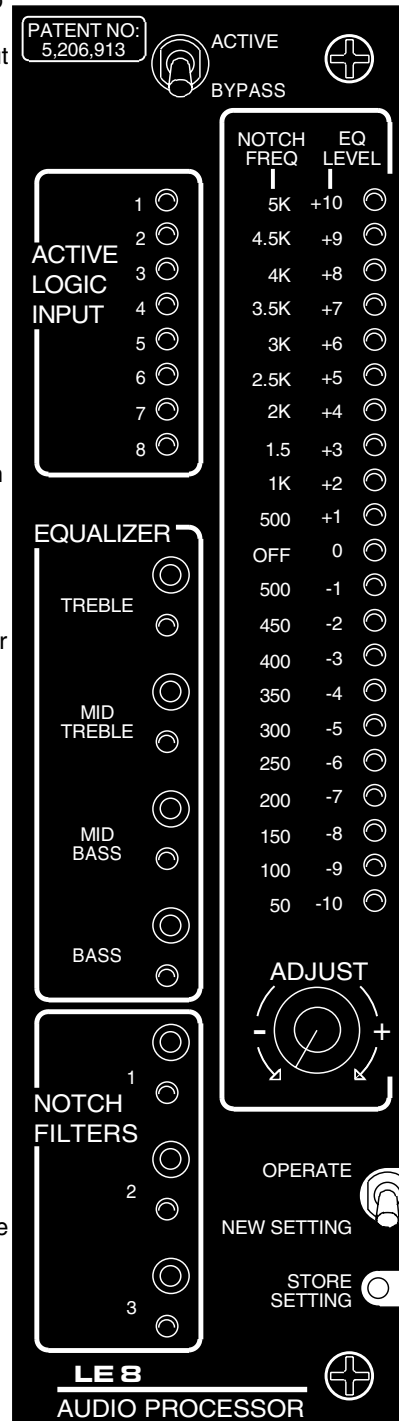


Figure 4 - LE8 Front Panel

## REAR PANEL DESCRIPTION

**LOGIC INPUTS 1-8** - The Logic Inputs provide the input for a contact closure (or other means) to indicate to the LE8 what filter set should be loaded. A contact closure (i.e. a short) between the Logic Input "+" and Logic Input "-" is needed to activate the input (this is referred to as "active low logic"). Logic Input "+" is connected through a 10K Ohm resistor to the internal +5 Volt supply, and Logic Input "-" is connected to the internal digital ground. Any contact closure (or other means) used must be able to conduct 0.5 mA continuous DC current. The Logic Inputs are pre-assigned a priority to prevent confusion when two or more channels are active. Logic Input 8 is the highest priority input, and Logic Input 1 is the lowest. For example, if both Logic Inputs 2 and 4 were simultaneously active, the filter set for Logic Input 4 will be loaded.

**LINK OUT** - The Link Out connector provides a means to use more than one LE8 in an installation. This terminal should be connected to the Link In terminal of the next LE8 used in systems where more than one LE8 is used. The Link Out of that LE8 should be connected to the Link In of the next LE8, and so on. (See page 7 for wiring detail.)

**LINK IN** - The Link In connector, in conjunction with the Link Out connector, provides a means to use more than one LE8 in an installation. This terminal should be connected to the Link Out terminal of the previous LE8 used in systems where more than one LE8 is used.

**INPUT** - The Input connector is a standard female balanced 3-pin XLR. Pin 2 is signal "+", Pin 3 is signal "-", and Pin 1 is ground. The Input may be used either balanced or unbalanced. If the Input is used unbalanced, a 2 wire plus shield type cable should be used. Refer to the diagram below for the proper wiring for unbalanced inputs and outputs.

**THRU** - The Thru connector (a male 3-pin XLR) parallels the Input connector, and is used for daisy chaining the input signal to the LE8 on to other devices. Note that since the Thru is directly parallel to the Input, if the Input is run unbalanced, the Thru will also be unbalanced.

**OUTPUT** - The Output connector is a standard male balanced and floating 3-pin connector. Pin 2 is signal "+", Pin 3 is signal "-", and Pin 1 is ground. The Output may be used either balanced or unbalanced. If the Output is used unbalanced, a 2 wire plus shield type cable should be used. Refer to the diagram below for the proper wiring for unbalanced inputs and outputs.

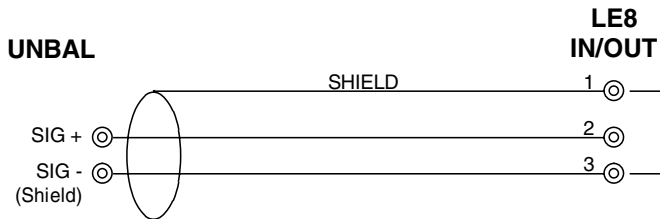


Figure 6 - Wiring for unbalanced use.

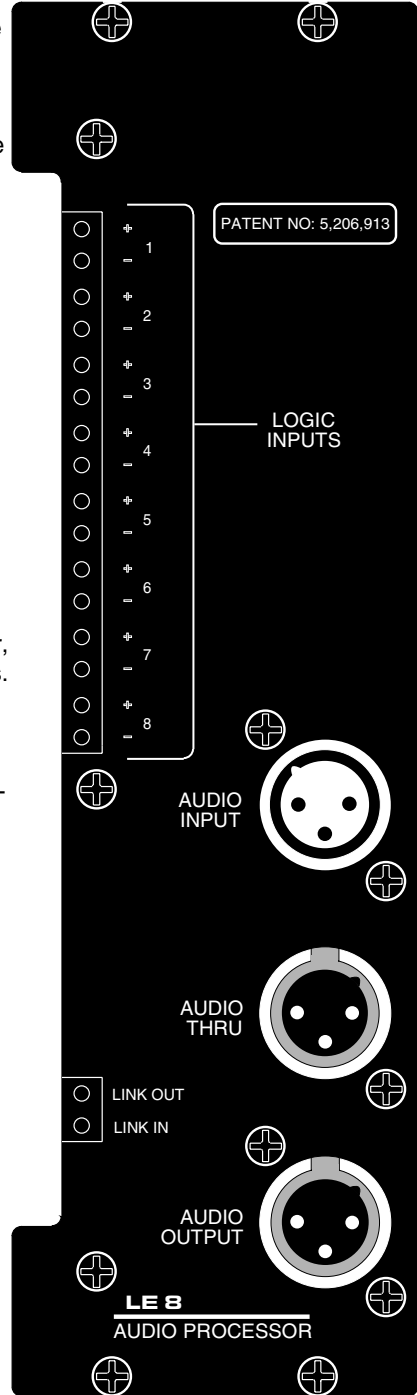


Figure 5 - LE8 Rear Panel

# INSTALLATION

**SYSTEM INSTALLATION** - The LE8 module, like any other equalization module, will normally be driven from either the AC1 Main Output, or from an EQN1 (if there is one in the system). The output signal from the LE8 should be routed to a DP1 (if there is one in the system), an XO2 or XO3 (if there is one in the system), or to the system power amplifier input.

## MECHANICAL INSTALLATION

Prior to installing the LE8 module into the mainframe, the position of the LINK mode jumper must be set. See the illustration below. The default setting is the jumper set on pins 2 & 3 for a single LE8 installed in the system. If you plan to link two or more LE8 modules then the jumper should be moved to pins 1 & 2.

The LE8 module is installed from the rear of the Modular Audio Processor mainframe. The printed circuit board fits into one of the ten sets of card guides provided in the mainframe. The module is then slid forward in the mainframe until the female connector on the board is firmly seated on the male pins of the bus board. Care should be taken when inserting the female connector onto the pins to be sure there is correct alignment. Four #4 machine screws are provided to fasten the rear panel to the top and bottom rear rails of the Modular Audio Processor mainframe. In addition, four #4 countersink machine screws are provided to secure the cover panel also provided, to the front of the mainframe after system adjustment is complete.

## ELECTRICAL INSTALLATION

Electrical interconnection from other Modular Audio Processor modules (or other equipment) to the LE8 is straightforward. When connecting to other Modular Audio Processor modules (or other balanced input equipment), simply use standard shielded XLR cables. When connecting to unbalanced equipment, see page 5 (Rear Panel Description) for instructions on proper wiring. The Thru output may be used if a non-equalized signal is desired. If more than one LE8 is in use, connect the Link Out of the first LE8 to the Link In of the next LE8. Then connect the Link Out of that LE8 to the Link In of the next LE8, and so on. See the illustration on page 7.

Logic input connections are also straightforward. Connect the one of the Logic Out "+" terminals of an AP4 or EP4 module to one of the Logic In "+" terminals of the LE8. Repeat for the Logic Out "-" and Logic In "-" terminals. As you assign each microphone in the system to one of the LE8 inputs, note that the Logic Inputs of the LE8 operate in a priority ranking manner, with Logic Input 8 being the highest priority. This means that in the case of two or more simultaneously active microphones, the LE8 will load the filters for the highest number microphone.

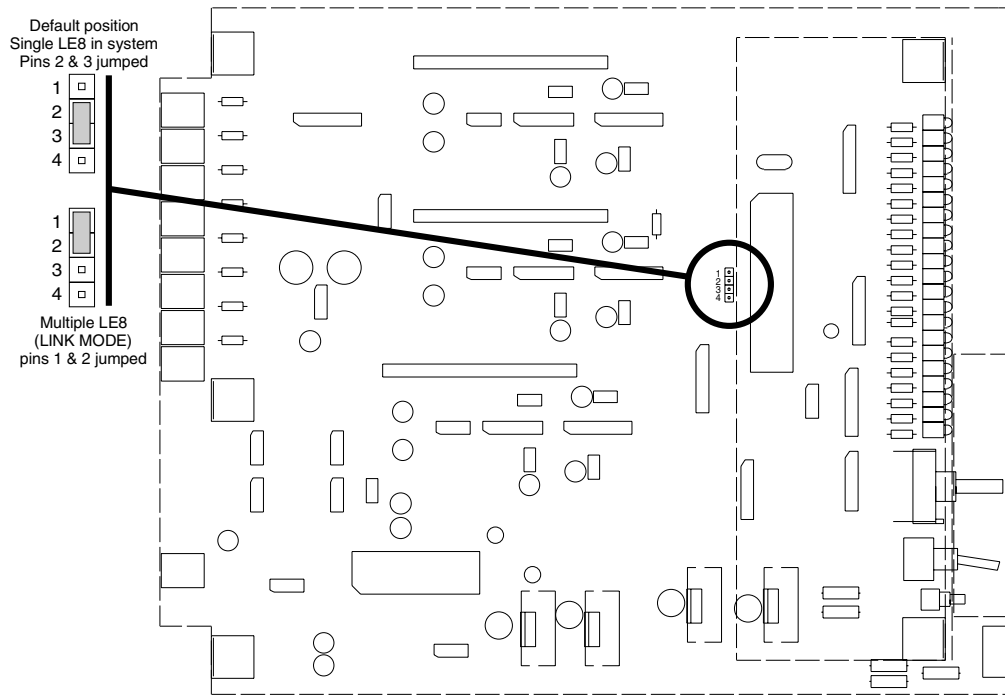


Figure 7 - LE8 Link Mode Jumper

# OPERATING INSTRUCTIONS

- 1) Connect the LE8 into the Modular Audio Processor system as described above in the Installation section.
- 2) On the AC1 Main module, note the position of the THRESHOLD control and then turn the THRESHOLD control fully clockwise. This will prevent multiple microphones from turning on during the adjustment procedure.
- 3) On all of the AP4 or EP4 Mic Preamp modules in the system, set the PRIORITY/AUTO/DIRECT switch on all channels to AUTO, except the microphone to be equalized. Set this microphone to DIRECT. The Active Logic Input LED on the LE8 corresponding to that microphone should light.
- 4) On the front panel of the LE8, set the ACTIVE/BYPASS switch to ACTIVE, and the OPERATE/NEW SETTING switch to NEW SETTING.
- 5) Press the TREBLE button, and adjust the Treble response as appropriate using the ADJUST control. To store this setting to permanent memory, press the STORE SETTING button. The Treble LED will blink once to indicate that the Treble value has been saved. The same procedure may be used to adjust and save the other three bands of equalization. The LE8 "remembers" any adjustments made in the New Setting mode, even if they are not saved to permanent memory, until the power is turned off. This allows adjustments to be made to all bands as many times as is necessary to achieve proper equalization. Only the final equalization values need to be saved by pressing the STORE SETTING buttons for each filter value while the LE8 is in the NEW SETTING mode.
- 6) After the microphone has been equalized, Notch Filters 1, 2, and 3 may be used to minimize feedback and ringing problems associated with the microphone. Press the NOTCH FILTER 1 button, and increase system gain (using the MAIN LEVEL CONTROL on the AC1) until feedback is encountered. Adjust the frequency of the notch filter until the feedback subsides. Press the STORE SETTING button to save the setting. The Notch 1 LED will blink once to indicate that the value has been saved. Repeat this process (if desired) for Notch Filters 2 and 3.

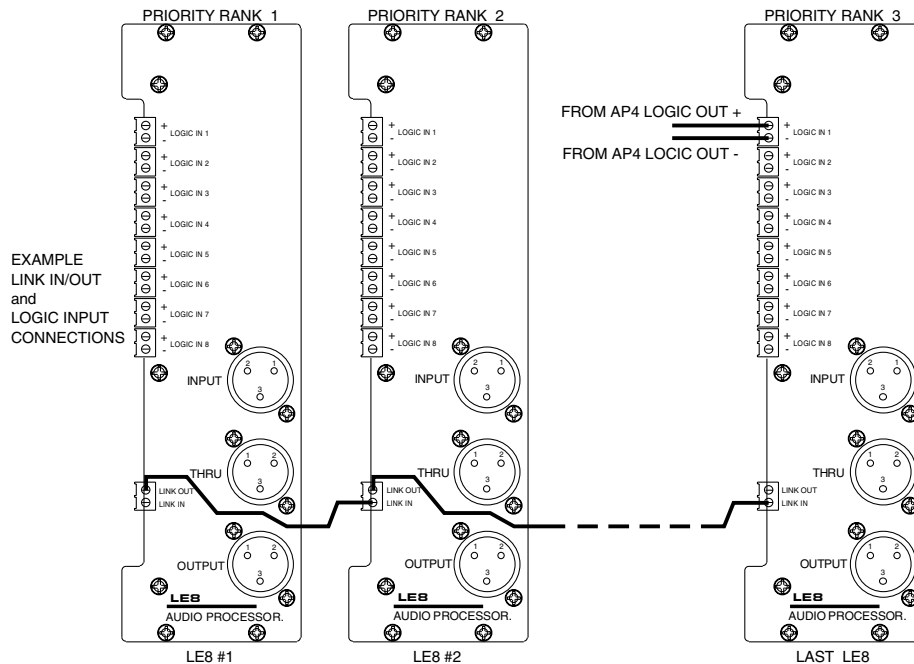


Figure 8 - Linking Multiple LE8s

NOTE: To restore the original factory settings, hold down the NOTCH FILTER 3 and STORE SETTING buttons while turning on the MAIN POWER SWITCH on the AC1, EC1, or SC1. The EQ and NF LEDs will blink. Now turn the MAIN POWER SWITCH off, release the buttons, and turn the MAIN POWER switch back on. Memory is now reset to original factory settings.

7) Using the PRIORITY/AUTO/DIRECT switch on the AP4 or EP4, switch the current microphone to AUTO, and the next microphone to be adjusted to DIRECT. Repeat steps 5 and 6.

8) When all system microphones have been adjusted, reset the THRESHOLD control on the AC1 Main module to the position it was in before this adjustment procedure, and restore the system to proper level using the MAIN LEVEL control on the AC1. Return all PRIORITY/AUTO/DIRECT switches on the EP4(s) to the AUTO position. Set the OPERATE/NEW SETTING switch on the LE8 to OPERATE, and be sure that the ACTIVE/BYPASS switch is in ACTIVE. This completes the setup procedure for the LE8.

## MULTIPLE LE8 SETUP

Set all mic preamp channels to "auto." Rotate THRESHOLD control on the AC1 system controller fully clockwise (max) to keep channels off, other than the one that is being adjusted. Set all LE8 switches to "active" and "operate."

Set up sequence:

- 1) Set ACTIVE/BYPASS switch on first LE8 to "active." Set OPERATE/NEW SETTING switch to "new setting." Set desired channel to "direct" on the microphone preamp module. Verify that the CH ON LED on the desired mic preamp channel is the only one turned on. Verify that the corresponding ACTIVE LOGIC INPUT LED on the LE8 is also lit.
- 2) Select the desired EQUALIZER switch (treble, mid bass, etc.) and adjust the boost/cut as needed. Press the STORE SETTING switch at each step once the desired adjustment is achieved. The filter function LED will blink once to verify storage of the setting.

NOTE: It is necessary to press the STORE SETTING switch at each step of the adjustment process.

For example: TREBLE adjust > STORE  
MID TREBLE adjust > STORE  
MID BASS adjust > STORE  
NOTCH FILTER 1 adjust > STORE  
etc.

- 3) When the adjustments are completed for the first mic channel, set the mic preamp channel back to the "auto" mode, and proceed to the next mic channel by setting it to "direct." Again, verify that the LEDs indicate as described in step 1 above.
- 4) Once all adjustments have been made and stored for all logic inputs being used on the first module, set the OPERATE/NEW SETTING switch to "operate" and the ACTIVE/BYPASS switch to "bypass."
- 5) Proceed to the next LE8 in the "chain." Go through steps 1 through 4 as listed above.

# TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE
Active Logic LEDs cycle through 1-8	No Active Logic Input detected
Equalizer/Notch Filter buttons and Adjust control do not respond	Operate/New Setting switch in Operate position. Switch to New Setting
Equalizer/Notch Filter buttons and Adjust control respond, but sound doesn't change.	Active/Bypass switch in Bypass position. Switch to Active.
"Clicking" sound heard when filters switch.	Output of MAP system too low (too much gain at power amp). Increase level of AC1 output and decrease power amp gain.

## SERVICE AND REPAIR

If your system malfunctions, you should attempt to correct or isolate the trouble before concluding that the equipment needs repair. Make sure you have followed the setup procedure and operating instructions. Check out the inter-connecting cords and then go through the TROUBLE SHOOTING section in the manual

We strongly recommend that you **do not** try to repair the equipment yourself and **do not** have the local repair shop attempt anything other than the simplest repair. If the repair is more complicated than a broken wire or loose connection, send the unit to the factory for repair and service. Don't attempt to adjust any controls inside the units. Once set at the factory, the various controls and trimmers do not drift with age or vibration and never require readjustment. **There are no adjustments inside that will make a malfunctioning unit start working.**

LECTROSONICS service department is equipped and staffed to quickly repair your equipment. In-warranty repairs are made at no charge in accordance with the terms of the warranty. Out of warranty repairs are charged at a modest flat rate plus parts and shipping. Since it takes almost as much time and effort to determine what is wrong as it does to make the repair, there is a charge for an exact quotation. We will be happy to quote approximate charges by phone for out of warranty repairs.

## RETURNING UNITS FOR REPAIR

You will save yourself time and trouble if you will follow the steps below:

- A. DO NOT return equipment to the factory for repair without first contacting us by letter or by phone. We need to know the nature of the problem, the model number and the serial number of the equipment. We also need a phone number where you can be reached 8 am to 4 pm (Mountain Standard Time).
- B. After receiving your request, we will issue you a return authorization number (R.A.). This number will help speed your repair through our receiving and repair departments. The return authorization number must be clearly shown on the outside of the shipping container.
- C. Pack the equipment carefully and ship to us, shipping costs prepaid. If necessary, we can provide you with the proper packing materials. UPS is usually the best way to ship the units. Heavy units should be "double-boxed" for safe transport.
- D. We also strongly recommend that you insure the equipment, since we cannot be responsible for loss of or damage to equipment that you ship. Of course, we insure the equipment when we ship it back to you.

Mailing address:

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**email:** [sales@lectrosonics.com](mailto:sales@lectrosonics.com)

## SPECIFICATIONS

### Input:

Type	Balanced and RF filtered
Impedance	20K balanced or unbalanced
Max input level	+20dBu

### Output:

Type	Balanced, floating, and RF filtered
Impedance	100 Ohms balanced, 50 Ohms unbalanced
Max output level	+20dBu

THD @ +4dBu, 20-20kHz <0.05%

IMD @ +4dBu, 60/7kHz mixed 4:1 <0.05%

Noise (20-20kHz) -90dBu  
(Tone controls flat)

### Equalization:

Bass	Shelving type, 10dB cut/boost range See Figure 2 on page 3 for response curves.
MidBass	Bandpass type, 10dB cut/boost range See Figure 2 on page 3 for response curves.
MidTreble	Bandpass type, 10dB cut/boost range See Figure 2 on page 3 for response curves.
Treble	Shelving type, 10dB cut/boost range See Figure 2 on page 3 for response curves.

Notch Filters: Fixed 12dB, 1/7 octave bandwidth @ -3dB points  
Variable center frequency from 50-5kHz

## LIMITED ONE YEAR WARRANTY

The equipment is warranted for one year from date of purchase against defects in materials or workmanship provided it was purchased from an authorized dealer. This warranty does not cover equipment which has been abused or damaged by careless handling or shipping. This warranty does not apply to used or demonstrator equipment.

Should any defect develop, we will, at our option, repair or replace any defective parts without charge for either parts or labor. If we cannot correct the defect in your equipment, we will replace it at no charge with a similar new item. We will pay for the cost of returning your merchandise to you.

This warranty applies only to items returned to us, shipping costs prepaid, within one year from the date of purchase.

This warranty gives you specific legal rights. You may have additional legal rights which vary from state to state.

**LECTROSONICS, INC.**

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**581 LASER ROAD  
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August 17, 1996