

Service Manual

ML Series

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We want to personally introduce you to our labor of love: The Microamplifier Lead Series. They symbolize our continuing effort to make the musician's life easier and more fulfilling. Everything, from the input stage to the speaker outputs, has been redesigned and refined for one purpose: the ultimate guitar sound.

After getting accustomed to the fact that this little package puts out an unbelievable amount of power, the first thing you'll notice is how quiet the amp is. That's due to a newly designed input stage that reduces noise at it's most prominent source. And the

hum that is normally induced into your guitar pickups from a typical amplifier is gone, thanks to our advanced power supply design.

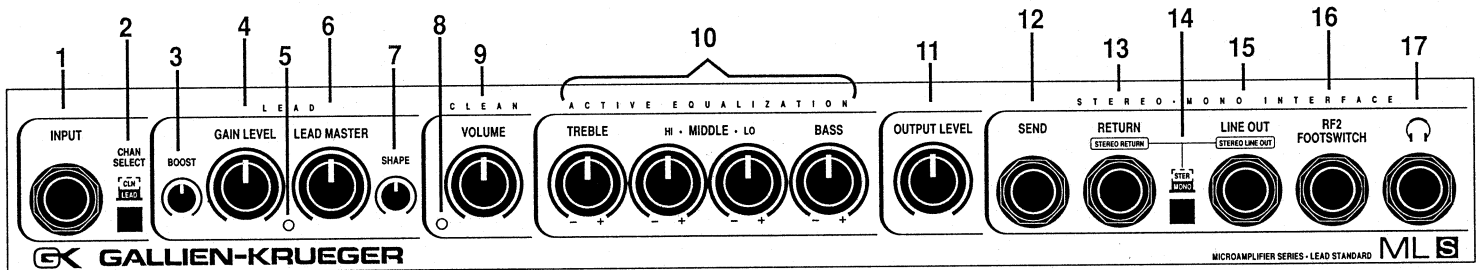
All this quiet can be instantly transformed into a roar of metal thunder or a smooth singing sustain at your whim. The Lead Channel offers flexibility that surpasses anything we've ever produced with all the balls you could ask for. And the Clean Channel gives a sweet, shimmering clean sound with vintage warmth and character.

As you read through this manual, we hope you will gain an understanding of the care that went into

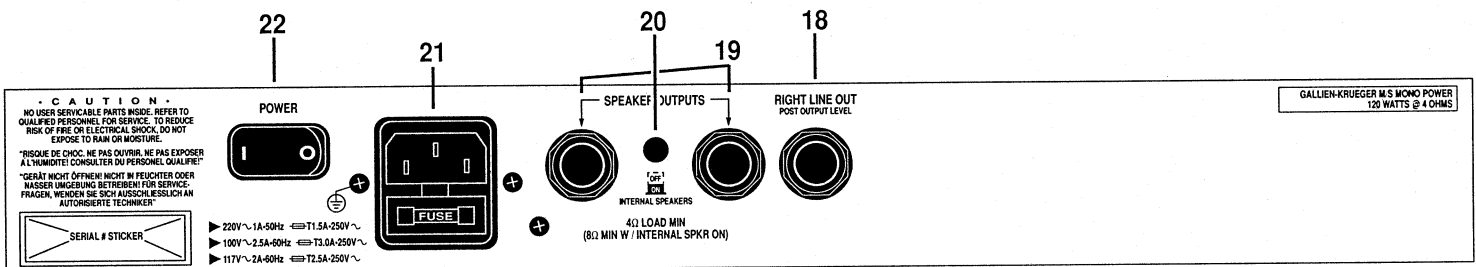
the design and manufacture of your new amplifier. Each feature has been designed to give you as much control over your sound as possible and with a little experimentation you should easily obtain your ultimate sounds.

We are proud of these amplifiers and feel they have passed their final test with your purchase. We hope you enjoy this great guitar instrument and wish you the best in your musical endeavors.

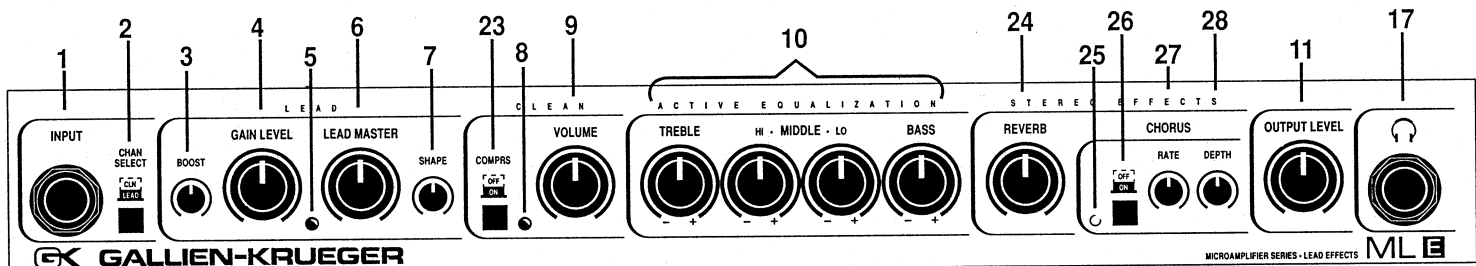
Bob Gallien & Rich Krueger



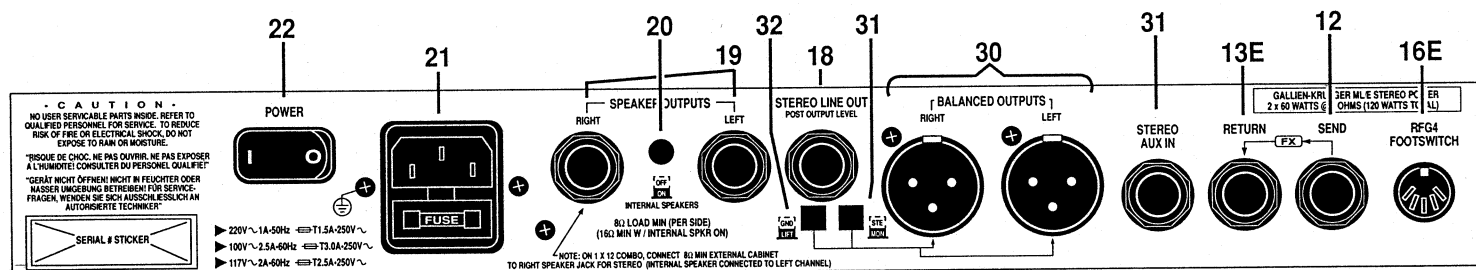
ML/S FRONT PANEL



ML/S REAR PANEL (MONO)



ML/E FRONT PANEL



ML/E REAR PANEL (STEREO)

FRONT PANELS

(1) Input Jack

Accepts a 1/4" phone plug and can be driven by a variety of instruments; however, the internal electronics have been optimized for use with an electric guitar.

(2) Channel Select Switch

Allows you to switch between the Lead and Clean channels. The RF2 Foot Controller (on the ML/S) or the RFG4 Foot Controller (on the ML/E) will switch

channels when this switch is in the "in" position and the footswitch is plugged in.

(3) Boost Control

This unique feature works like a third footswitchable channel.

It controls the amount of gain before the first overdrive stage. Turning clockwise increases the gain level. It is footswitchable with the RF2 Foot Controller (on the ML/S) or the RFG4 Foot Controller (on the ML/E).

You can achieve two different, footswitchable lead

sounds by setting the Gain Level control first for your low overdrive sound, then setting the Boost control for your extreme overdrive sound. The Boost can then be taken in and out of the circuit with the footswitch.

The Boost has no effect when the Gain Level (4) is set all the way up (clockwise).

(4) Gain Level

Controls the gain of the first and second overdrive stages using a dual potentiometer. Turning clockwise will increase the amount of "saturation" in the gain

stages, producing fuller harmonics and increased sustain.

The gain of the first overdrive stage will be increased when the Boost control is used.

(5) Lead Channel Indicator LED

When lit, the Lead channel is activated.

(6) Lead Master

Controls the volume of the lead channel. It affects the Send (12), Headphones (17), and Balanced Outputs (30).

(7) Shape Control

This is a passive midrange control (post overdrive). It effectively varies the midrange frequencies in the Lead channel, allowing a variety of lead voicings to be attained easily. Rotating clockwise boosts the midrange.

(8) Clean Channel Indicator LED

When lit, the Clean channel is activated.

(9) Clean Channel Volume Control

Controls the volume of the Clean channel. It affects the Send (12), Headphones (17), and Balanced Outputs (30).

(10) 4-Band Active Equalizer

Provides boost and cut over four different frequency bands. Each band has a specially selected Q and center point optimizing it for a particular guitar spectrum.

(11) Output Level Control

Adjusts the level of the signal being sent to the internal power amplifier(s) and headphones, affecting the Speaker Outputs (19) and the Headphone Output (17). The Balanced Outputs (30) are not affected.

(12, 13, 13E) Effects Loop

Provides a means of adding in-line effects. The Send (12) can drive most standard foot and rack mountable effects. (see Sample Hookups)

The Return (13) on the ML/S is switchable, allowing you to return a regular mono signal with a standard 1/4" phone plug or a stereo signal using a stereo 1/4" stereo phone plug. The Stereo/Mono Switch (14) must be in the appropriate position to take advantage of the Return's mono/stereo capability.

If the Send signal should overdrive the outboard effects (causing unwanted distortion), keeping the Output Level greater than the 1 o'clock position will usually solve the problem.

The Effects Loop comes after the Channel (1-9, 23) and Equalization (10) stages and before Output Level (11) and Line Outputs (15 & 18) on the ML/S and ML/E. The internal effects (24-28) and Balanced Outputs are also post Effects Loop on the ML/E (see Block Diagram).

(14) Return and Line Out Stereo/Mono Switch

(ML/S only)

Affects the Return (13) and Line Out (15). In the "Mono" position, the Return and Line Out accept a standard 1/4" phone plug and accept (Return) or provide (Line Out) a mono signal. In the "Stereo" position, the Return and Line Out accept a stereo 1/4" phone plug and accept (Return) or provide (Line Out) a stereo signal when using outboard stereo effects through the Effects Loop.

If the Effects Loop and Line Out are not being used, the position of this switch is not important.

(15) Line Out (stereo/mono) (ML/S only)

Provides a line level signal that is switchable mono/stereo to take advantage of the stereo capability of the Effects Loop Return. When used in the "Mono" mode, it accepts a standard 1/4" phone plug. When used in the "Stereo" mode, it accepts a stereo 1/4" phone plug.

Unless you are using stereo outboard effects through the Effects Loop and the Stereo/Mono Switch (14) is in the "Stereo" position, only a mono signal will be present.

(16, 16E) RF2 and RFG4 Foot Controller Jacks Provides a means to hook-up the optional footswitch for your amplifier.

The ML/S accepts the RF2 two-button Foot Controller, allowing remote Channel Switching (Lead/Clean) and Boost On/Off. The RF2 requires any standard 1/4" stereo phone cord for operation (available from GK (Part # 304-2500-0)).

The ML/E accepts the RFG4 four-button Foot Controller, allowing remote Channel Switching (Lead/Clean), Boost On/Off (when in the Lead channel) or Compressor On/Off (when in the Clean channel), Reverb On/Off, and Chorus On/Off. The RFG4 requires any standard 5-pin DIN (MIDI) cable for operation. Please make sure that the 5-pin DIN cable has all five wires, not two or three.

(17) Stereo Headphone Output

Accepts a stereo 1/4" phone plug, delivering a stereo signal for use with any standard headphones. Headphone Output level is controlled by the Output Level (11).

REAR PANELS

(18) Right/Stereo Line Out

Provides a line level signal (post Output Level) for interfacing with outboard power amplifiers; Right Line Out for mono internal power units, Stereo Line Out for stereo internal power units. (see Sample Hookups)

...on Mono Power Units:

Plugging into the Right Line Out splits the preamp signal; "left" going to the internal 130 watt power amplifier and "right" going to the Right Line Out. By connecting this line out signal to an external power amplifier (in this case the GK ML/P), you have created a 130 watt per channel stereo guitar system. A standard 1/4" phone plug is required for hook up. A slight volume loss in the internal channel is normal.

...on Stereo Power Units:

A stereo signal is provided for connecting to an external stereo power amplifier or two external mono power amplifiers (the GK 265ML/P or 130ML/P are recommended for these applications). Any standard stereo 1/4" plug is required for hookup.

(19) External Speaker Outputs

Allows external speakers to be driven by the internal power amplifier(s). For optimum performance and to avoid damaging your amplifier, use the following minimum external speaker impedances:

HEADS:

ML/S & ML/E Mono Heads:

4Ω Minimum Impedance Total

(1 x 4Ω speaker, 2 x 8Ω speakers, or 4 x 16Ω speakers)

ML/S & ML/E Stereo Heads:

8Ω Minimum Impedance Per Side

(1 x 8Ω speaker or 2 x 16Ω speakers per side)

COMBOS:

206 & 208 Mono Power Combos:

- With Internal Speakers "on": 8Ω Minimum Total External Impedance

- With Internal Speakers "off": 4Ω Minimum Total External Impedance

206 & 208 Stereo Power Combos:

- With Internal Speakers "on": 16Ω Minimum External Impedance Per Side

- With Internal Speakers "off": 8Ω Minimum External Impedance Per Side

112 Mono Power Combos:

- With Internal Speaker "on": 8Ω Minimum Total External Impedance

- With Internal Speaker "off": 4Ω Minimum Total External Impedance

112 Stereo Power Combos:

- With Internal speaker "on": 8Ω Minimum Impedance plugged into "Right" Side Jack Only!!!

Note: DO NOT plug external speaker into the "Left"

Side Jack on the 112 Stereo Power Combos when the internal speaker is "on"!!!

- With Internal speaker "off": 8Ω Minimum External Impedance Per Side

IMPORTANT:

Warning: Under no conditions should the two speaker outputs of a stereo power unit be connected together in any way!!! This will damage the amplifier and void your warranty, so please be careful in setting up your speaker configurations!

Auto Amplifier Shutdown: To protect against failure, the ML/S and ML/E heads and combos are equipped with an Auto Shutdown feature that is enabled when the Speaker Outputs are overloaded or when the temperature of the unit exceeds safe operation. The power dissipation in the outputs is actually computed to determine if it is within safe operating conditions and automatically shutdown when limits are exceeded. When shutdown occurs, the unit will appear to be on and all functions and LED's will work; however, there will be no power output to speakers.

To reset the amplifier, turn the power switch off, wait 3 seconds, remove or lower the input signal, and turn the amplifier back on. If you experience more shutdowns, even after correcting the cause of the initial shutdown, check all speakers and cables. If further action is necessary, please call your local GK Service Center.

(20) Internal Speaker On/Off Switch

(Combos only)

Turns the internal speaker(s) on and off. In the "off" position, full power can be taken from the internal power amplifier(s) to drive external speakers (see Minimum External Speaker Impedances above).

(21) AC Receptacle and Fuse Holder

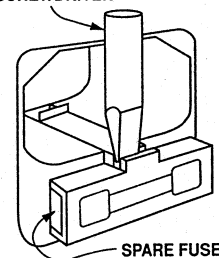
This combination grounded AC jack and fuse holder is designed to accept a detachable power cord. If a replacement is needed, it should be UL rated at 10 amps/125vac or 5 amps/240vac.

The fuse (and spare) are located as indicated in the drawing below. Never operate this amplifier with any other than the recommended fuse type: 5mm x 20mm, slow blow, 250V with ampere ratings as follows:

Line Voltage	Fuse Rating	Fuse #
117VAC	2.5 Amps	T2.5A • 250V
220VAC	2.5 Amps	T2.5A • 250V
100VAC	3 Amps	T3.0A • 250V

SCREWDRIVER

The fuse can be easily removed with a screwdriver as shown on the right. A spare fuse is located in a sliding compartment.



Warning: The Ground Pin on your power cord is for your protection. Do not remove it!!!

(22) Power Switch

Turns the unit on (1) and off (0). Unplug the unit if it is not being used for an extended period.

ML/E ONLY:

(23) Compressor Switch

Turns the Clean Channel's Compressor on and off. The Compressor boosts low level signals while decreasing high level signals to add sustain. It is preset to an overall general purpose 2:1 compression

ratio, ideal for most applications.

The Compressor can be turned on and off with the RFG4 Foot Controller only when this switch is in the "on" position and the RFG4 is plugged in.

(24) Stereo Reverb Control

Controls the amount of delayed signal mixed with the main signal from the internal reverb. Clockwise rotation of this control increases the amount of reverberation effect in the signal. The Reverb can be turned on and off using the RFG4 Foot Controller.

(25) Stereo Chorus On/Off Indicator LED

When lit, the Stereo Chorus effect is activated.

(26) Stereo Chorus On/Off Switch

Turns the Stereo Chorus on and off. The Chorus can be turned on and off with the RFG4 Foot Controller only when this switch is in the "on" position and the RFG4 is plugged in.

(27) Stereo Chorus Rate and Depth Controls

Allows for variation of the internal chorus effect from a very subtle "doubling" to a more dramatic "spatial" effect. Only the higher frequencies are chorused, allowing the lower frequencies to be unaffected and thereby eliminating the detuning problems found in some chorusing units.

The Rate varies the speed of the effect and the Depth its intensity.

(29) Stereo Aux Input

Accepts a stereo 1/4" phone plug to allow a stereo signal to be mixed with the internal preamp signal (post internal effects, pre Output Level). This input can be used in place of the Return when using stereo outboard effects through the Effects Loop. It can also accept a stereo signal from sources such as tape machines, recorders, stereo receivers, etc., for playing along with prerecorded music (see Sample Hookups).

(30) Stereo Balanced Outputs

These are standard XLR low impedance jacks providing a means of hooking your ML/E directly to a mixing console or recording equipment, in both live and studio settings (see Sample Hookups). It is suggested you use the GK VCV™ Recording Compensation Module when using these outputs.

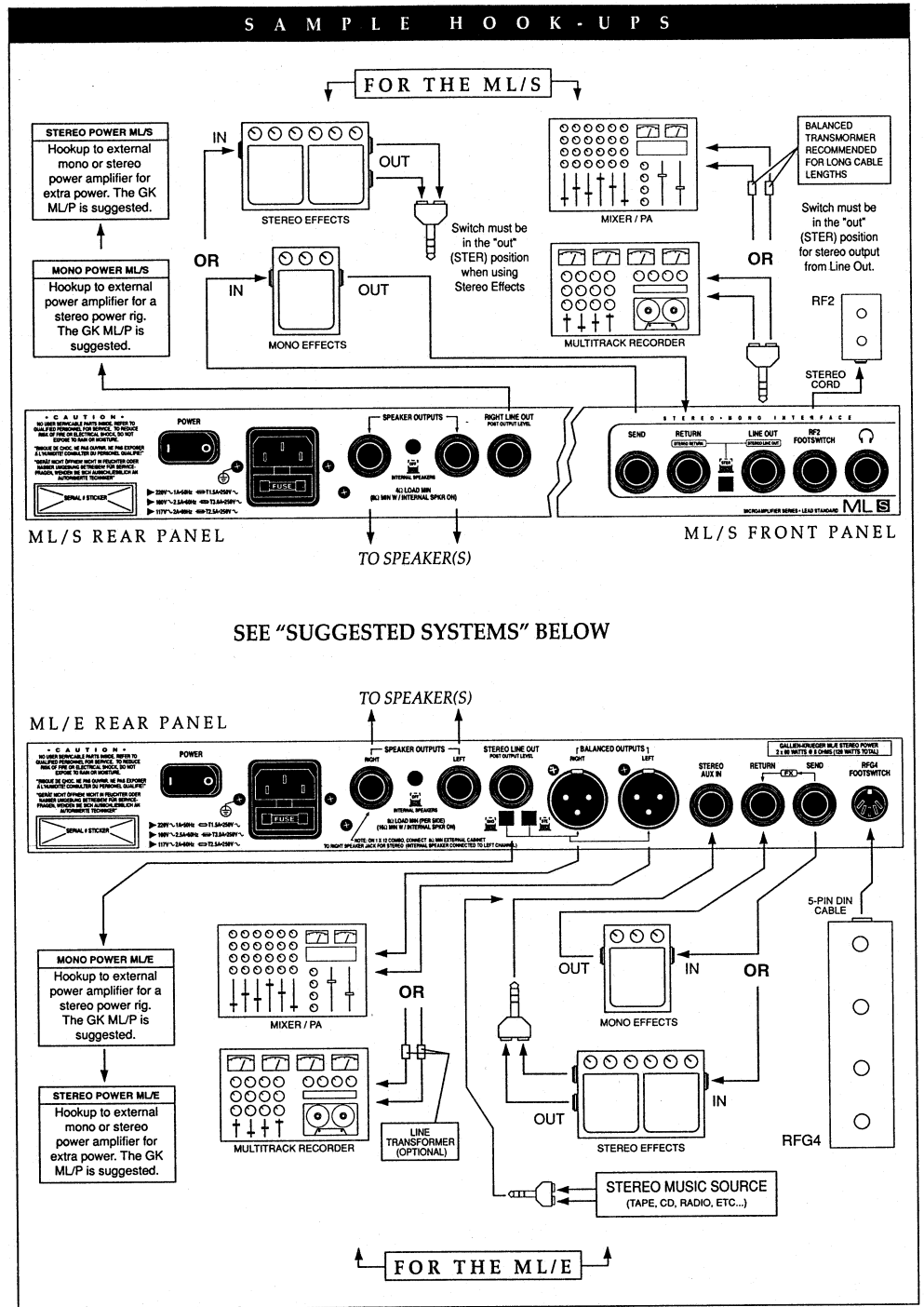
The Stereo Balanced Outputs are post internal effects and are not affected by the Output Level Control and can be switched to stereo or mono.

(31) Balanced Outputs Stereo/Mono Switch

In the mono mode, both outputs are providing identical signals. In the stereo mode, you have true stereo left and right output signals.

(32) Balanced Outputs Ground Lift

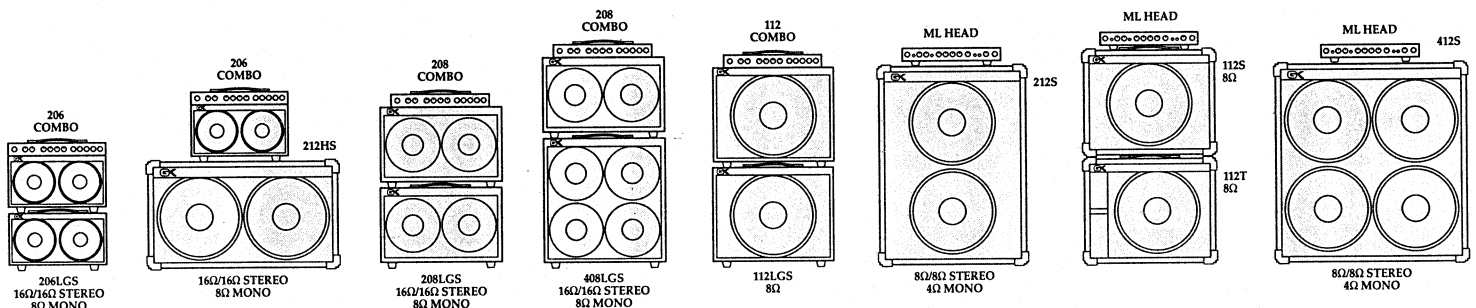
Disconnects the ground from the Balanced Outputs. There may be situations where a ground loop occurs when using the Balanced Outputs, resulting in a noticeable hum. By disconnecting the ground, the hum may be reduced or eliminated.



SUGGESTED GALLIEN - KRUEGER SYSTEMS

Putting together the right system is as important to your final sound as choosing the right amplifier or the right guitar. Here are our favorite systems, each designed to use all the power from the MicroLead, running at a total of 8 ohms per side stereo, or 4 ohms mono.

Combo systems are on the right, systems incorporating heads on the left. The size of your final system will depend largely on the portability you require.



SETTING UP YOUR SOUND

The ML/S and ML/E are capable of producing a wide range of great guitar sounds. Below you will find the basic procedures needed to get started. We have also provided several sample settings that can be used as starting points for various guitar voicings.

GETTING STARTED

Lead Channel

- 1) Set Channel Select Switch (2) to "Lead".
- 2) Turn the volume and any tone controls on your guitar to "10" before making adjustments on the ML/S or ML/E. These will be fine tuned later.
- 3) Set the Output Level (11) at the 2 o'clock position, the Gain Level (4) at the 10 o'clock position, the EQ at the 12 o'clock position, and the Boost off (counter-clockwise). While playing, set the Lead Master (4) to desired level.
- 4) Try the Shape (7) control to get a feel for how it alters the voicing of the Lead channel. Set to achieve the desired starting sound.
- 5) You will find that the Equalization (10) is quite responsive and takes some trial and error to get to know. From the flat (12 o'clock) position, take each control one at a time and turn it all the way up and all the way off while playing your guitar through the unit. After you have become familiar with each one, set to the desired position.
- 6) Before setting up any effects, adjust the Gain Level and set to the desired amount of gain. The Gain Level will add saturation to the overdrive sound and should be set before engaging any effects.
- 7) For the ML/E only: With your tone roughly set, familiarize yourself with both the Reverb (24) and the Stereo Chorus (25–28) the same way as with the tone controls. If you choose to use the effects, set to desired levels.
- 8) Try adjusting the Boost (3) in conjunction with the Gain Level. If you have the footswitch hooked up, try footswitching the Boost on and off to explore the two separate gain levels that can be achieved.
- 9) The final adjustment on the amplifier is the volume level. Turn up the Lead Master (6) to your desired playing level.
- 10) Finally, fine tune your level and tone with adjustments on your guitar.

Clean Channel

- 11) Set Channel Select Switch (2) to "CLN".
- 12) Repeat Step 2.
- 13) Set the Output Level (11) at the 2 o'clock position, then while playing, set the Volume (9) to desired playing level.
- 14) Repeat Step 5.
- 15) Repeat Step 7.
- 16) Try playing with the Compressor (23) on and off to hear the effect it creates.
- 17) The final adjustment on the amplifier is the volume level. Turn up the Volume (9) to your desired playing level.
- 18) Finally, fine tune your level and tone with the adjustments on your guitar.

Note: Generally, keeping the Output Level greater than the 1 o'clock position will avoid the problem of overdriving outboard effects.

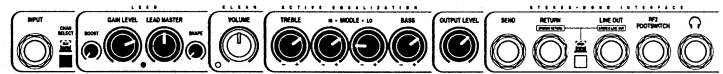
Final note: Once the levels of each channel (Lead Master (6) and Volume (9)) have been set, use the Output Level (11) to control your overall stage level.

SAMPLE SETTINGS

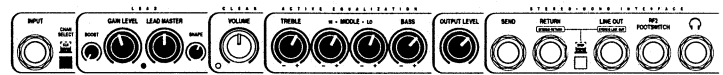
- Controls shown in black are active or in the "in" position.
- Lead Master, Volume, and Output Level settings are dependant on speaker configuration, desired volume level, and outboard effects.
- Basic channel parameter settings on the ML/E shown below are intended to be used with the ML/S as well.

LEAD

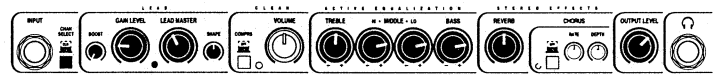
CRUNCHING METAL OVERDRIVE (*Bridge pickup*)



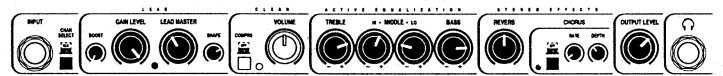
DRIVING RHYTHM OVERDRIVE (*Bridge pickup*)



R & B FAT — Slight Overdrive + Reverb (*Neck pickup*)

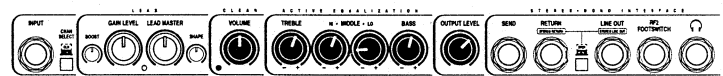


SUSTAINING LEAD — w/Reverb & Chorus (*Bridge pickup*)

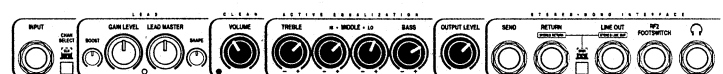


CLEAN

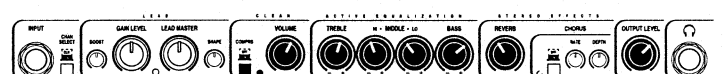
COUNTRY CLEAN (*Center or Bridge pickup*)



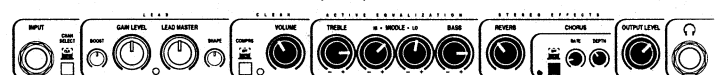
DRIVING CLEAN RHYTHM (*Center or Bridge pickup*)



PUNCHY BLUES — w/Reverb (*Center pickup*)



BRIGHT CHORUS CLEAN (*Center pickup*)



ACCESSORIES

There are a variety of accessories for the ML/S and ML/E Heads and Combos, each designed to blend perfectly with the Microamplifier Series.

Footswitches

For the ML/S

With the addition of the RF2 Foot Control, you can take control of Channel Switching (Lead/Clean) and Boost (On/Off) with a tap of your toe. A standard 1/4" phone stereo cord is included for hookup to the ML/S.

For the ML/E

The RFG4 Foot Control is designed to give you control over five functions in the ML/E. Channel Switching (Lead/Clean), Boost (On/Off) or Compressor (On/Off), Reverb (On/Off), and Chorus (On/Off). A standard 5-pin DIN (MIDI) cable is included for hookup to the ML/E.

VCV™ Recording Compensation Module

For recording directly from your Microamplifier, simply plug in the VCV (Vintage Cabinet Voicing) Module. It fits easily into the Effects Loop and has two switchable settings. The Line Outs, Headphones, Speaker Outputs, and Stereo Balanced Outputs (ML/E) are affected by the VCV.

It is also recommended for use with small speakers and when using headphones.

Rack Mounting Kits

All ML/S and ML/E Heads and Combos can be rack mounted with the addition of our optional rack mounting kits.

All Heads: GK Part # 304-1005-0 (2 rack spaces)
112 Combos: GK Part # 304-1065-A (10 rack spaces)
208 Combos: GK Part # 304-1025-0 (8 rack spaces)
206 Combos: GK Part # 304-1077-0 (7 rack spaces)

Mic Stand Kit

The 206 Combo can be mounted on a standard mic stand with the addition of a Mic Stand Mounting Kit. (Order GK Part # 304-1080-0)

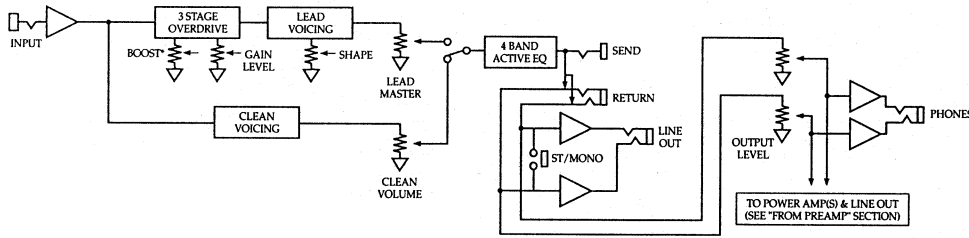
Road Bags

To keep your amp looking it's best, we offer custom fitted Road Bags for every model. They feature a fully padded lined interior with a shell made of Cordura Nylon. Cordura is waterproof, colorfast, self-healing and grease resistant. There is also a front zipper pocket for your cords and footswitches. An adjustable shoulder strap lets you carry your amp and instrument together easily.

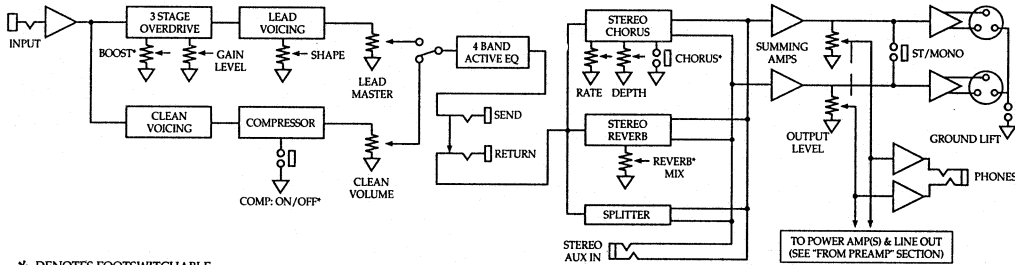
They are recommended for unracked traveling protection.

Note: Accessories are subject to availability. Ask your Gallien-Krueger dealer about specific items.

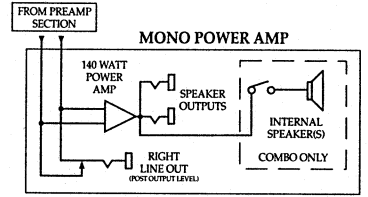
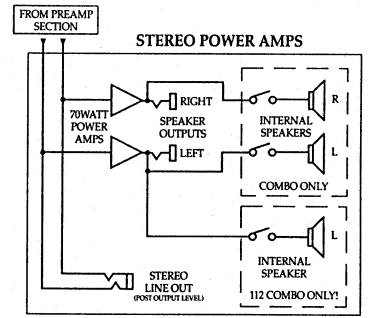
ML/S



ML/E



* DENOTES FOOTSWITCHABLE



S P E C I F I C A T I O N S

- Max Input: 1.4Vrms
- Output: 70W into 8Ω per channel (stereo)
140W into 4Ω (mono)
@ less than 1% THD
- Headphones: 1.4Vrms max into 8Ω (.25 watt)
- Signal to Noise Ratio: >74dB (Clean Channel referenced to max input; EQ flat)
- Input Sensitivity: (Clean Channel) 1.8mVrms @ 1KHz
- Return Sensitivity: .46Vrms @ 1KHz
- Active Equalization: ±15dB @ 80Hz
±18dB @ 800Hz
±16dB @ 4.0kHz
±12dB @ 10kHz
- Shape: Cut @ 560Hz (up to -14dB)
- Input Impedances: Input.....1MΩ
Return (ML/S).....12KΩ
Return (ML/E).....22KΩ
Stereo Aux Input (ML/E).....12KΩ

- Output Impedances: Send.....470Ω
Line Out.....1KΩ
- Compressor (ML/E): 2:1 Compression Ratio w/ margin of 3
- Chorus (ML/E): Crossover Filter: 6dB/oct @ 340Hz
Modulation Rate: .35Hz-2.4Hz
Maximum Width (delay time): 17.5ms-22.5ms
- Reverb (ML/E): Electronic Analog Type with Stereo Outputs
(multi-tap bucket brigade)
- Dimensions: Heads: 13.75"W x 1.9"H x 7"D (7.2 lbs)
206 Combo: 13.75"W x 10.25"H x 7.75"D (23 lbs)
208 Combo: 17.20"W x 14"H x 10.50"D (36 lbs)
112 Combo: 17.20"W x 16"H x 10.50"D
(32 lbs: Celestion™ / 40 lbs: EV™)
- Footswitch: ML/S: GK model RF2 and standard
3-conductor stereo cord (1/4" plugs)
ML/E: GK model RFG4 and standard
5-conductor cord with 5-pin DIN connectors (MIDI type)

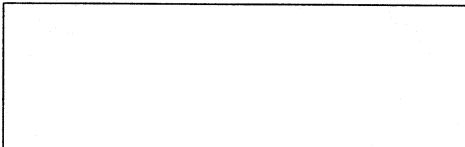
T R O U B L E S H O O T I N G

Your new amp, if kept in a well constructed rack, road case, or GK Road Bag and handled with care, should give you trouble-free performance. If operated with care your only maintenance should be occasional external cleaning.

Often when an electrical component provides poor, erratic, or no performance, it is due to minor problems or irregularities which may be corrected easily by someone knowing very little about electronics.

We have provided the accompanying chart for your reference. If you have any problems at all, please check this first. If your problem is major and there is definitely something wrong with the unit, please refer to the list of Service Centers included with the paperwork in the packing box. If necessary, call your local GK Dealer for your nearest Authorized GK Service Center. You may also call our Service Department at (408) 441-7970 for reference to your nearest Authorized GK Service Center.

PROBLEMS:	PROBABLE CAUSES/SOLUTIONS:
LEDs light but no signal from Speaker Outputs, Headphones, Line Outputs, or Balanced Outputs.	Be sure all tone controls and volumes are turned up to at least part way.
LEDs light, tone and volumes turned up but no sound.	Auto Amplifier Shutdown may have tripped. Reset by turning the Power Switch (22) off, wait 3 seconds, then turn the Power switch back on. If the condition still exists, check interconnections with speakers.
LEDs light, tone and volumes up, external speakers OK, but no signal from output.	Reset amplifier with Power Switch as described above. If condition still exists, check guitar volume, pick-ups, cord, and repair or replace if necessary.
LEDs light, tone and volumes up, external speakers OK, guitar cord OK, guitar volume up and still no sound.	Call your Authorized GK Service Center.
Channel Switching, Boost, Compressor, Chorus or Reverb not functioning with footswitch plugged in and appropriate LED indicators "on".	Be sure the effect parameters are up and front panel ON/OFF buttons are "in". Check footswitch cable.
External effects hooked up through Effects Loop are distorting.	Effects Loop Send too "hot", overdriving the effect. Keeping the Output Level (11) above the 1 o'clock position will, in most cases, solve the problem.
Loud hum.	Check grounding of the unit and any effects going through the effects loop. Proper grounding is mandatory.
Excessive noise.	Repair or replace guitar cord. Make sure external effects are patched into the Effects Loop and not before the Input. Test guitar pick-ups.
No LEDs on front panel are lit and no signal from Speaker Outputs, Headphones, Line Outputs, or Balanced Outputs.	Check power cord, AC outlet and fuse. If all are OK or fuse is blown, call your local Authorized GK Service Center. Note: Be sure the correct fuse is being used.



Microamplifier Series- Lead
Disassembly and Preliminary Troubleshooting Procedure
GK Document # 426-0063-A
Model #'s: ML260E, ML260S, ML120E, ML120S- all options
2/15/91 Rev. 9/10/99 SW

Disassembly Procedure

- 1) Remove the bottom cover first by removing the six # 6 screws on the bottom and the three # 6 screws on each side. One side has an extra screw which may require a # 4 screwdriver. Note that the center screw on each side is a machine screw and will need to be returned to the tapped hole in the side of the heat sink when reassembling the unit. On a combo unit, removing only the side screws will allow the electronics to be lifted away from the speaker compartment. The wires connecting the speaker to the electronics should then be detached from the power amp.
- 2a) ML-S: The ML-S preamp removes easily by removing the three # 6 flat head screws attaching the front panel to the heat sink.
- 2b) ML-E: The ML-E preamp requires the same three screws to be removed. Also, at the rear panel, remove the two # 2 screws that secure the RFG4 jack and the two # 6 screws holding the balanced outs in place. Using a 15mm nut driver, remove the plastic nuts from the Stereo Aux. In, Return, and Send jacks. Pull the preamp board out and away from the rear panel being careful not to lose the fiber washers from the 1/4" jacks.
- 3) The two separate parts- the power amp/power supply attached to the heat sink, and the preamp board- can be set on a flat surface with the component sides facing up and the wires remaining connected. The required troubleshooting can be done.

Problems with the Amp- Where to Look for Help

This short troubleshooting guide will attempt to analyze problems to quickly determine whether preamp, power amp, or power supply related. Use the power supply/amp troubleshooting guide or the preamp circuit descriptions wherever applicable to fix the problem.

- 1) **Front panel LED's do not light (no power):** Possible blown fuse or other power supply problem; see power supply troubleshooting procedure.
- 2) **LED's work but no output from power amp:** Could be preamp or power amp problem. First, turn power switch off for 3 seconds, then back on without input signal to clear shutdown feature. Set all knobs to 10 and put in a signal at 5mVrms. If there is still no output, look at either end of the red and white wires going between the preamp and power amp with a scope probe. If there is a signal there but no output, then there is most likely a problem with the power amp. If there is no signal, the problem is in the preamp. Check the wires to make sure there is a good connection at either end.
- 3) **Distortion at the Output:** Follow procedure from #2 above (may want to start with output level on 0 and gradually increase it). This time, note whether the signal is a clean sine wave like the input, or if it is clipping off part of the signal or has any distortion. If the signal is clean, the problem is most likely from the power amp. If the signal is cut in half, check the 15V supplies (any LF353- pins 8 & 4 should have +/- 15VDC). If those supply voltages are not there, or are not clean DC levels, refer to the power supply/amp troubleshooting procedure. If there isn't a problem with the 15V supplies but the signal is still distorted, the problem is most likely preamp related.
- 4) **Excessive noise or humming:** If the problem goes away when the output level is set to 0, it is probably a preamp problem- often a loose part or bad jack. If it doesn't, the power amp/supply has the problem.
- 5) **Amp works OK except for some individual features:** Problem is usually in the preamp, but check the footswitch as well.

Scope

This document lists some steps to follow to quickly troubleshoot the microamplifier series of power supplies and power amps. Only common failures for Rev. E power amps / supplies will be addressed. Previous power supplies used TIP50 transistors, which have different failure modes. For more detail, this procedure should be used along with the assembly line power supply / amp start-up procedure, GK Document #420-0071.

NOTE: The following instructions are given with the heat sink on the bench and the rear panel away from the technician.

Fuse Inspection

Lightly blown- Very often an amp in service has a blown fuse, and is one of the first things a service tech checks. Sometimes, much can be determined from the condition of a blown fuse. With the amp series, it is possible that the amp is OK and the fuse is the only problem. a lightly blown fuse may indicate merely an overload condition that did not trip the overload protection circuit, or a weak

Troubleshooting Procedure (contd.)

fuse. In this case, the element is open in the center, and the ends are intact and visible. If it is suspected that the overload circuit was affected, refer to the test in the start-up procedure. Also, make sure the unit is equipped with a spare fuse.

A failure in either the +15V or -15V supply may also cause a lightly blown fuse. If the amp had been operating normally for some time, a preamp problem may exist. To check, remove the wires connecting to the preamp and check the power supply waveform. If OK, the problem may be in the preamp and a prime suspect may be a TL604, if it has one. If a problem still exists, check the 15V supplies on the power amp board.

Mildly blown- If the fuse is mildly blown, the power amp may be blown. This type of failure will often result in a fuse with a black band in the center. Refer to Sec. 3.

Violently blown- If the fuse is violently blown, most of the fuse will look black, the glass body may be cracked and break upon removal. This usually indicates a blown power supply. See Sec. 5.

Power Amp

Caution! - The power amp must always be operated with the outside output transistors, Q824 and Q759, firmly clamped to the heat sink with screws through the brass heat clips with A06s inside. These latter transistors, Q823 and Q758, provide feedback for the biasing of the outputs. Failure to clamp these parts may result in thermal runaway, as the bias current becomes several amps and the transistors operate outside their safe operating area. Mono amps do not have Q759, but the board needs to be positioned at each end anyway. Always screw down all power transistors to the heat sink when providing output power for any length of time. Also, the ground must be connected, which is completed by screwing a 4-40 having a captive lock washer into the hole directly between Q824 and Q808. Make sure the lock washer is not touching the board. Do not use a flat washer. The heat sink for the hole is not anodized.

Ohm Check of Outputs – Failed output transistors usually measure zero or low for collector to emitter. This turns out to be the two leftmost terminals. Check all TIP33s and TIP34s. bad transistors will usually have a cracked or broken plastic body. Replace both outputs if one measures bad. Usually, transistor replacement is all that is necessary to fix the amp, unless some other problem caused the amp to fail. These other problems are not within the scope of this document. Note that the outputs can be disengaged by moving the clips near the transistor terminals. The rule is, the transistor is engaged when the clip is closest to the .33 ohm emitter resistor of the transistor.

Auto Shutoff Feature – The unit may be in service to correct the problem of nuisance tripping of the output, usually caused by other equipment on the same power circuit or by radiating equipment in close proximity. See GK Document #450-0062-01 for an explanation of the shutdown feature and how to disable it.

Power Supply

Caution! – The two power MOSFETs, (BUK456-800A), must be firmly clamped to the heat sink when powering the amplifier. It is OK to run them without the heat sink under no load conditions.

Visual Inspection – Look the board over for obvious problems. Severe power supply failures will sometimes result in burn marks around R521. If so, R521 and the following may need to be changed: control chip oscillator U506, zener diode D507, and possibly Q515 and R509.

Power MOSFET Ohm Check – Power supply failure usually means failure of the power FETs. When failed, they will usually measure short from drain to source, the two leftmost terminals. Usually the gate measures short to drain and source as well. A good transistor will measure either open or body diode resistance from drain to source, depending on the orientation of the probes. Always replace both BUKs. Power supply failure often results when the power amp fails. Simply replace the BUKs when this happens; no setup of the power supply is necessary, since the characteristics of the transistors are very uniform. When replacing BUKs, cut off some length on the leads and flair the outputs slightly. Always install the BUKs with the board firmly in place to assure proper alignment of the heat sink holes. When bringing up a power supply that has a blown power amp, it may be necessary to disconnect the outputs using the clips mentioned before (see **Power Amp-Ohm check of Outputs**).

Oscillator Circuit

Visually inspect U506 for cracks. Whenever replacing IC s, it is always a good idea to install the new piece in a socket. Check that U515 is OK by measuring diode drops from base to emitter and collector. R509 sometimes opens up under severe power supply failure, check that it is low ohms. After failed parts are replaced, bring the supply up slowly with the variac as noted in the Start Up Procedure.

Microamplifier Series

Circuit Description of Output Disable

GK Document # 450-0062-01

A. Mihalka, 2-13-91, Rev. 9/10/99-SW

Scope

This document describes the shutoff feature of the microamplifier series. Some boards may be stereo, but all boards work on the same principle. There are 4 conditions whereby the output is disabled, each of which are described below (see **Circuit Descriptions**).

Disable Modes

Pop Elimination with Power Switch

The first type of output disabling is for the elimination of speaker pops when the unit is either turned on or off. In the case of turn-on, the output is clamped for a couple of seconds and then released. At turn-off, the output is disabled and clamped until the entire power supply decays. This takes about 10 seconds, after which a low thump may be heard if listening close to the speakers.

Output Overload

The second type of output disabling occurs when an unsafe output operating condition exists. A circuit senses overload conditions by comparing output voltages and current. The unit is able to drive 4ohms per side stereo or 2ohms mono without tripping off. Some conditions that will cause output disable are shorted cords, blown speakers, heavy loads, and plugging into the output jack while the unit is on. If an overload condition is detected, the outputs will be clamped indefinitely. In this condition, the LEDs on the front panel will remain on, and the preamp and its outputs will function, but no output is heard. The power switch must be turned off for 3 seconds before the unit can be turned back on and again produce output power. Both outputs of a stereo unit are clamped if the condition is detected in one side.

Thermal Shutdown

Finally, if the heat sink becomes too hot the unit will shut off. This is also considered an unsafe operating condition and will disable the outputs indefinitely. A circuit senses the temperature of the case of the output transistors. Both sides of a stereo unit will be disabled if one side detects a problem. The power switch must be turned off for 3 seconds before output power is again enabled.

Circuit Descriptions

Output Disabling

The outputs are disabled by Q648 and Q647, an A06 and A56 respectively, which are either both on (disabled) or on (enabled). When on, these transistors effectively clamp the output drivers. When off during normal operation, the base of Q648 should be low and that of Q647 should be high. The bases are driven by U605 (LM324), a low speed quad op amp. If the unit has no output, U605/7 will be low and U605/14 will be high. If these points are not OK, check the power supplies for U605. Pin 4 should be about + 5.3V and pin 11 -5.3V. Q722 and Q723 clamp the other side of a stereo unit.

Turn-On Pop

U605 is powered from the rails by 6.8K resistors and 5V zeners. This IC starts operating at about 3 volts. When the unit is powered up, pin 5 follows the + 15V on its way up to 3.14V. Meanwhile, pin 6 is climbing up to 4.8V, but is slowed by C821. Therefore, the output of the op amp, pin 7, is initially high, disabling the outputs. Note that pin 14 is an inversion of pin 7 and drives the opposite polarity transistor. After a delay the voltage on pin 6 exceed 3.14V, forcing pin 7 low and enabling the outputs.

Turn-Off Pop

Pin 5 is connected to pin 3 and is 3.14V. Pin 2 is 3.05V. Note that these voltages are obtained with 1% resistors, plus a 470j to give a higher voltage on pin 3. The output pin 1 is always high when the outputs are enabled, and D802 is back-biased to enable pin 6 to function. When the unit is turned off, the + 15V supply drops and pin 3 follows, but pin 2 lags because of C803, a 10uF cap. This causes pin 1 to go low, forward-biasing D802 and pulling down pin 6. Also, R801 provides feedback to clamp pin 3 low and keep

Turn-Off Pop (contd.)

it there. All this causes pin 7 to go high, disabling the outputs. This condition persists for many seconds until the rails can no longer power U605 through the zeners, at which time a very faint, low rumble is heard.

Output Overload

The overload circuit is developed around U604, another slow, quad LM324 op amp. The voltage and current are summed to determine if a safe operating point exists. The unit is allowed to operate down to 2 ohms total load (4 ohms each side). When an additional 8 ohms is paralleled, giving 1.6 ohms, after a second or two the unit shuts off indefinitely. This protects the outputs from shorted cabinets and from driving too many speakers. This condition may also occur while the speaker jacks are moved in and out.

The following circuit works for positive waveforms only. The voltage is obtained from a divider on the output, R784 and R777. Current is derived from R604 and R605, and is inverted and amplified at U604/1. These signals are now out of phase and subtract from each other at pin 9. When current is too large for a given voltage, pin 9 will tend to go more negative. This is because pin 1 is negative during a positive waveform excursion, and large loads keep the voltage from going high and demand more current. When pin 9 goes lower than the 2.5 –2.65V reference on pin 10, the output pin 8 will go high. D766 is now forward-biased and starts to charge up C741, a 10uF cap, through R743, a 220K. When this unsafe condition persists long enough to charge C741 and turn on Q742, U605/3 is momentarily pulled down. This causes U605/1 to go low, and R801, a 100K, provides hysteresis to keep pin 1 low by providing enough current to keep pin 3 lower than pin 2. The outputs will now be turned off indefinitely. The unit must be turned off for 3 seconds to allow the system to bleed down before output power can resume.

Since the overload sensing circuit is not made from precision resistors (current sense resistors are 10%) and is somewhat sensitive, occasionally a 1K resistor must be paralleled with R777. Also the original boards did not have a spot for R741A, which bleeds C741. Without this bleeder C741 may charge up slowly through excess solder flux around the pins of Q742. Whenever output is inhibited for no apparent reason, check Q742 and find out which of the diodes feeding its base through R743 is responsible.

Thermal Overload

The final method of output disable is provided by U602, which happens to be a fast LF353 dual op amp, although there is nothing fast about the circuit. Q807 is situated on top of one of the output transistors. As Q807 heats up with the output, pin 2 will drop from about 2.75V. Pin 1 is low until pin 2 drops below the 2.06V reference on pin 3. Pin 1 will go high and stay high enough for the outputs to be disabled by the same mechanism using Q742 described above. Once again, the LEDs will remain lit and the preamp will continue to function while the output is off. During this time the heat sink will continue to cool. To resume power at the instant of shutoff, not only must the power switch be turned off for 3 seconds, but the outputs must cool off as well. Q782 senses the temperature of the other channel in a stereo unit.

Defeating the Disable Circuit

There will be situations where the auto shutoff feature of the microamplifier will be triggered by the noise from other equipment that is either connected to the same AC line or is operated in close proximity to the amp. An easy way to prevent this circuit from tripping is described. This method also disables the thermal trip circuit; however the thermal trip circuit does not fire under most operating conditions.

Procedure: Remove the bottom cover of the amp. Look through the side of the amp with the heat sink down and the front panel on the left. On the left side of the lower circuit board you will see an MPSA06 transistor labeled Q742. Directly to the right of Q742 and also on the board edge is capacitor C741. To defeat tripping, solder a wire across C741.

Microamplifier Series – Lead Preamp Circuit Description

GK Document # 450-0063-A

Preamp Board #'s- 206-0063-E & 206-0073-D

Models #'s ML260S, ML260E, ML120S, ML120E-all options

1/28/91 Rev. 9/9/99-SW

Introduction

The following is a brief description of the operation of the circuits found in the ML Series amplifiers. It should provide enough information to get a basic understanding of the circuits in order to perform any repairs. When calling attention to a component with the use of a reference designator, the r.d. will be that of the E preamp board. If the two boards (E & S) share the same number then only one number will be shown. However, if they are different, the S reference designator will be shown in these brackets [].

Input Stage

The input stage is very low noise and is built around the JFET-Q9 (J113). In the “clean” mode it has a gain of just over four and should swing approximately 22 Vp-p. The 1K trimpot, R5, is used to adjust the DC bias voltage at the source of Q9 which in turn sets the output (drain of Q9) for the maximum voltage swing. U1 is a unity gain buffer used to drive both the lead and clean channel circuitry. Its output (pin 1) should be about 2V DC for the maximum possible voltage swing out of Q9. When the channel switch is engaged, the capacitor C15 [C16] is switched into the circuit. Its presence increases the input gain to nearly six at 100Hz.

Channel Switching

The Channel Select switch, S1, selects the clean channel in the ‘out’ position and the lead channel in the ‘in’ position. When out, the C/L line is grounded and the clean LED lights. This puts a –14Vdc signal on the collector of Q30 [Q26], which in turn shuts off Q20 [Q19]. This gives the lower gain condition at the input stage. The –14Vdc at the base of Q36 [Q35] turns on the FET Q40 [Q36], grounding out the signal through the lead channel so it won’t bleed through. (The 4.7K resistor, R35 [R41], also keeps the FET on for less noise in the lead channel when there is nothing plugged in at the input jack.) The C/L line also controls the analog switch control pin, U6-2 [U3-2], that switches between the clean and lead circuitry. A low voltage there selects pin 4 and clean voicing. When S1 is in, the C/L line gets pulled up to 2Vdc and selects the switch at pin 3 of U6 [U3] for the lead channel output. This also lights the lead LED and puts a 0.63Vdc signal at the collector of Q30 [Q26]. This puts the FETs in the opposite state, giving higher gain at the input and letting the signal go through the lead channel. When the footswitch is inserted, the channel select switch needs to be in the ‘in’ position so that it is floating. This allows the footswitch to perform in the same way as the front panel switch did.

Lead Channel

The overdrive of the lead channel is generated by the high gain of three FETs. The first stage, with Q50 [Q48], has a gain of 9 at 100Hz and a fixed bias of about 7.3Vdc. The next stage, with Q67 [Q59], has a gain of 10 (adjustable with R68 [R70]) and has a bias set around 4.2Vdc with R66 [R63]. The stage, Q78 [Q69], has a gain of 8 and a bias set around 6Vdc with R87 [R86]. The signal at each of those stages should clip softly and therefore have rounded rather than sharp corners when driven into the rails. The gain throughout all these stages can be controlled by the Dual Gain pot, R38 [R29], and the Boost pot, R18 [R17]. The boost pot is normally in the circuit with a 15Vdc signal at U2-2 (2Vdc with a footswitch), the switch between pin 3 and pin 7 is selected. But it can be bypassed when the control pin U2-2 becomes grounded via the footswitch and selects the switch between pins 4 and 6. Finally, the Shape control pot, R74 [R61], provides a variable midrange cut just before the lead channel Master pot.

Clean Channel

The first stage of the clean channel is a notch filter leading into an op-amp, U1 pins 5-7, with a gain of 3. This buffers the signal before it goes to the clean volume control (assuming the compressor is not selected) and into the FET stage. Q121 [Q87] provides a gain of about 20 and its drain is biased at about 7.6Vdc. When the signal hits the rails, it should again clip softly as described above.

Compressor (ML-E only)

The compressor circuit provides 2:1 compression and consists of half of U4 and half of U5. Correct operation of a compressor means that as the input signal level increases, the gain of a circuit decreases, so that a change in level at the input doesn’t result in an identical change in level at the output. Therefore, for a 2:1 compressor, if the input increases by 6dB, the output only increases by 3dB. The attack and release voltages are set by C106 (335). There is a 1.8Vdc reference voltage that appears at pins 2,3,5,6, and 8 of U5 and pins 2 and 3 at U4. The voltage at U5/1 is a rectified DC voltage and increases with increasing

Compressor (ML-E only-contd.)

input voltage- a higher voltage at this point corresponds to a lower compressor gain. C97, R98, and R99 are used to bias the output down to approx. 0Vdc. Diodes D105 and D107 limit the transient output to 2.8V. The 4.7K resistor, R100, sets the maximum gain of the compressor to about 2. The R108 resistor prevents the RC5532 circuit from oscillating. The analog switch (U3) selects between the compressed signal and the dry signal from U1/7. When a footswitch is used, a 2Vdc level at U3/2 will select the compressed signal while a 0.14Vdc there will send the dry signal through. The front panel compressor switch (S2) then selects between the dry signal and the output of U3 (pins 6 and 7). Thus, the compressor can be footswitched in and out only when the front panel switch is in.

Tone Controls

The tone controls are active and provide boost and cut at four preset frequencies. The Hi-Mid and Lo-Mid controls are peaking filters and provide boost and cut of 16dB at 4kHz and 18dB at 800Hz, respectively. The treble and bass controls are shelving filters. The treble filter provides a boost and cut of up to 12dB at 10kHz, while the bass gives 15dB or cut at 80Hz.

Footswitch Circuit

The footswitches themselves consist of two (RF2) or four (RFG4) SPST switches each wired across a green LED that has its cathode tied to a common ground. When attached to the unit through the proper connecting wire, the internal resistors to +15V will light the LED when its corresponding switch is open. When the switch gets closed, the LED becomes grounded on both sides and no longer lights. The RF2 is meant for use with the ML-S and controls channel switching and the boost function. It should be connected with a standard ¼" 3-conductor stereo cable. The RFG4 should be connected to the ML-E through a 5 conductor DIN cable. This looks like a standard MIDI cable but it must have all five wires inside rather than just three, which is very common. The RFG4 controls channel switching, boost/compressor, reverb and chorus. In both cases, the front panel select switch must be in for the function to work properly from the footswitch. The same goes for the chorus feature of the RFG4. Further operational information on the footswitches (with the functions they control) is covered in the individual circuit descriptions described herein.

Effects Loop (and Stereo Aux. in on ML-E)

The effects loop consists of the Send and Return jacks. The return is set up in such a way that plugging into it will disconnect the signal that was previously going to it from the preamp. The E-preamp has a mono return so that it may later be split into stereo with the use of the stereo effects (chorus and reverb). If a stereo return is desired, the Stereo Auxiliary In can be used to mix in a stereo signal without breaking the straight signal coming through. It mixes in at U15, which is where the chorus and reverb signals also get mixed together into stereo. The S-preamp has a Stereo-Mono switch with its return to allow for putting stereo effects directly in line.

Headphone Outputs

The level at the output of the headphone jack is controlled by the Output Level knob. U11 and U12 [U8, 7] are LM386 chips and can provide about ¼ W each into headphones of 8 ohms minimum. The chips run off of ground and -15Vdc so there is a DC voltage of about 7V on pin 5 of each. The LM386s also have a gain of about 20 so the resistor dividers of R182/R179 [R159/R149] and R194/R190 [R151/R150] provide attenuation of the signal from the output level that makes the headphone outputs clip at about the same time that the power amp reaches full power into a load.

Chorus (ML-E only)

After the return, the signal goes through a unity gain inverting op amp, U27. R377 and C376 pass the low frequencies straight through to the summing amplifier U15. The high frequencies are sent, via the filter of C378, R379, and R380, to the chorus input compressor, U14, and the chorus select analog switch, U16. The compressor and expander around the chorus circuitry provides for low noise operation. The compressor is built around one half of U14 and works very much like the compressor circuit described above. Pins 11, 12, 14, and 15 should all have the 1.8Vdc offset. Pin 16 again has a DC voltage that changes with the level of the input signal. The internal op amp is used in this case so the output is pin 10 and it is biased to 7.3Vdc for operation between ground and +15V. This goes into a 2-pole lowpass filter, with a cutoff at 3.6kHz, built around U27. The 1N747 diodes limit the signal so that it doesn't overload the Bucket Brigade Delay chip, U24. The center position of the trim-pot R356 is generally an acceptable DC bias setting of around 6.3Vdc at U24/3, but if the output of U24 appears to be distorting early, it can be adjusted to eliminate that problem. The MN3101, U25, takes a single 0-to-15V square wave clock pulse from a LM355 timer chip, U26, and generates the two, out-of-phase clock pulses used by the BBD for its sampling. These square wave signals are 0 to 15V and have a constantly changing period of 34 to 44 microseconds (with depth at max). The voltage that defines the frequency of the LF355 comes from an oscillator circuit around U10. R172 (rate) adjusts the frequency of the oscillation and R178 (depth) adjusts the amplitude of the triangle wave that becomes the control voltage at U26/5. After the signal has been sampled, the delayed version appears at pins 7 & 8 of U24. The two signals are summed together through R369 and R365 and the must be low-pass-filtered to remove the sampling frequency element. It then passes

Chorus (ML-E only-contd.)

through a 5-pole filter, around U17, that has a cutoff frequency (like the chorus input filter) of 3.6kHz. Finally, it reaches the output expander that 'undoes' what the input compressor did and expands the dynamic range back to that of the original input signal. The expander circuit is built around the other half of U14 and uses an external op amp, U13. It also has the 1.8Vdc level at pins 2,3,5, & 8 and at U13/2,3. The output, U13/1, should be at 4Vdc. And again, U14/1 has a DC voltage that varies with the incoming signal level. At this point, the high frequency (above 3.6kHz) components are added back in, using the high pass filter of C231 and R233 and the summing resistor of R232. This signal then goes to U16/3 where the status of the chorus is selected either by the front panel or the footswitch. When U16/2 is low (chorus is out) the dry signal going to pin 4 is selected and the chorus is off. If the chorus switch is engaged (with or without the footswitch), the voltage on U16/2 becomes 2Vdc and the chorus signal going to pin 3 is selected. The output of U16/6 & 7 is summed at U15.

Reverb (ML-E only)

The reverb circuit of the ML-E is a BBD type similar to the chorus but it has an overall longer delay and multiple tapped outputs. The signal comes from U27/1, full range, and goes into U5, which is a compressor circuit, similar to that of the chorus. In this case, it is used as a turn on/off gate and as a dynamic range compressor. This means that it will take smaller signals, boost them through the BBDs and reduce the larger signals so they won't overdrive the BBDs. As with the chorus compressor, there should be 1.8Vdc at U5/11, 12,14 & 15. The output, U5/10, should be biased at 4.6Vdc. The rectifier output from U5/1 (clean channel compressor) is used as a gating voltage to turn the compressor on or off. With no input signal, the voltage at U13/7 is +15Vdc and the voltage at U5/16 is 1.6Vdc, which gives the compressor a very low gain, so in effect it is off. When the input signal gets to be greater than 25mVrms, the DC voltage on U13/6 becomes greater than the voltage on U13/5, and U13/7 becomes -15Vdc. This causes D208 to become back-biased and drop out of the circuit. Then the compressor starts acting as it normally would, with the voltage at pin 16 going to about 1.05Vdc, then increasing as the incoming signal increases. From the compressor, signal then goes through a 5-pole low-pass filter around U18. This is nearly identical to the output filter of the chorus and has the limiting zener diodes, D269 & D271. R341 and R342 can adjust the DC level going into the BBDs, U21, & U22, in case one side starts clipping before the other. The MN3101, U23, generates the sampling clock pulses at about 11kHz which is set by R354, R355, and C353. These clock pulses drive the BBDs to sample the filtered signal. The signal gets sampled and delayed at U22, then goes to U21 where it is summed with 6 more delay taps. Taps 2,4, and 6 combine with one side of the stereo reverb, and 1,3, and 5 combine with the other. The final tap, 6 (U21/4) is fed back to the input of the first low-pass filter (U18) to be used as the regeneration of the reverb so that it gradually fades out. The signals that were summed together each pass through a separate 5-pole low-pass filter that differs slightly from the input filter. The last stage (U20/5-7 & U19/5-7) has a notch at approximately the sampling frequency of 11kHz. The outputs then go to the dual reverb pot where the level at which they will be mixed is adjusted. U9 allows the reverb output signal to be turned off with the footswitch. In its normal operating mode, U9/2 is at 15Vdc (2Vdc if the footswitch and LED are on), and the signals pass freely. But if the reverb is turned off by the footswitch, then U9/2 becomes 0Vdc and the switch between pins 3 & 7 grounds out pin 4. This results in reverb being turned off.

Summing Amps (ML-E only)

The summing amplifiers built around U15 combine the dry, chorus, reverb, and auxiliary signals going to the power amp. The signal at U15/7 contains a 4:1 mix of chorus to dry signal, when chorus is on, and U15/1 has the opposite mix of 1:4. The reverb mix of the MN3007 output and the MN3011 taps 2,4, and 6 appear on U15/7 in a 1:10 ratio with the dry signal and the other taps 1,3, and 5 are in the mix at 1:10 at U15/1. This mix is what gives the stereo imaging when the effects are on. The signal from U15/7 ultimately goes to the left power amp output and balanced out, and the tip of the headphone jack. The signal from U15/1 goes to the right power amp output and balanced out, and the ring of the headphone jack. Also mixed in at these points are the signals from the Stereo Aux. In with the headphone jack mixing from the above points.

Balanced Outputs (ML-E only)

The signals from the summing amps are sent to balanced outputs so they can be used for recording or going direct without miking in a live situation. The signal appearing at pin 2 of each of the balanced outputs, J3 & 4, is in phase with the summing amp output. The signal going to pin 3 passes through an inverting unity gain op amp, U28, so that it is 180 degrees out of phase with pin 2. When the Stereo/Mono switch, S5, is out, J3 (Balanced Out R) carries the signal from U15/1 and Balanced Out L is the same as U15/7. When S5 is pushed in, however, J3 carries the in-phase signal from U15/1 and the out-of-phase signal from U15/7. J4 then carries just the opposite signals. This gives a mono signal when pins 2 & 3 get mixed at the board.

**Microamplifier Series Power Supply and Power Amp
Assembly Line Start-Up Procedure
GK# 420-0071 Power Supply Board #206-0071-C
Power Amp Boards 206-0064-D, and 206-0074-D, -75-D, and -76-D
6/7/90 Rev. 9/10/99-SW**

Scope

This procedure is for bringing up Rev. C power supplies and Rev. D power amps for the assembly line. (It can also be used for troubleshooting and technical purposes.) This procedure is written with the board oriented in such a way so that the heat sink is on the bench and the rear panel is facing from the technician, so that the channel on the technician's left is labeled the Right Channel. There are various combinations of units (heads and combos) that will be turned on with this procedure.

Preparation

Equipment. The equipment list includes a 35MHz oscilloscope connected to the output through the load box, a 100MHz scope and probe for looking at the supply, a variac w/ current meter, a VOM, a Panasonic VP-7201A oscillator, a load box with toggle switches and monitoring features for 2 each 4 ohm and 8 ohm loads, and an 8.2 ohm load on a ¼" jack.

Line Jumper. For 117V and 100V operation, the jumper on JU528 should be towards the rear panel. For 230V operation, this jumper should be away from the rear panel.

Transformer Jumpers. For 117V and 230V operation, JU524 and JU527 should be towards the right side of the board. For 100V operation, they should be towards the left side as noted on the silkscreen.

Power Amp Output Jumpers. The power amp is provided with jumpers that disconnect the output transistor emitters. Move them when there is a power amp problem- there will be no output current. The unit should then have the emitters connected unless there is a problem. To disconnect them, move P612A, P655A, and P683A away from the rear panel and P602A towards the center of the board.

Floating Instruments. All instruments, including the oscilloscope, must float with respect to the chassis. Use a three-pronged adapter for this purpose, and also float the loads.

NOTE: The voltages listed in this procedure are for a 117V ac line.

CAUTION

Primary common (transformer T523/7) floats at -160Vdc with respect to the chassis and must be distinguished from the secondary common, which is referenced to the chassis. Never look at primary and secondary voltages simultaneously on the same scope or a scope that is referenced to earth, but always check that loads are floating when looking at the primary. The following procedures do not require monitoring primary voltages. If it is necessary to do so, the scope must be floating and referenced to primary common. Do NOT touch the primary, which is 640V square wave at 100KHz, and readily burns flesh.

Power Supply Start Up

Visual Check

Position the unit with the heat sink on the bench and the rear panel away from you. Check that all the jumpers are in the proper positions, as described above. Visually check the solder connections near the center of the board. The components to check are (parentheses denote parts not applicable for mono): Q823, 824, 827, 808, 783, (Q782 and 758), Q759, VR601 and VR602. Also check Q742 for a build-up of solder flux. Inspect the board edges for holes not filled with solder.

Scope Setup

Connect the 100MHz scope probe to the cathode of D537, which is the secondary for the main negative supply. Hook onto the left leg between the body of the part and the board. Secondary common is available on the bottom of the rightmost of the two power supply 2200uF filter caps on the power amp board, or on the topmost pin of the connector between the two boards. Also, the power supply shield and rear panel may be used for common when the rear panel is assembled. Set the 100MHz scope to 20V/div and 2 usec/div, with zero at the centerline.

Adjust Reset

Caution: The following procedure calls for increasing the variac from 25Vac to 117Vac in less than 5 seconds. The startup circuit is designed as such that Q518 turns on when line voltage is below 90V. This causes it to dissipate a large amount of power. **Q518 will fail after about 10 seconds if line is set at 50Vac.** During normal turn-on, when power is switched with 117Vac applied to the line, the transistor will dissipate for only a few milliseconds. Set the variac to zero. Connect the power cord and turn power on. Set the voltmeter to the 100V scale. With an insulating adjuster inserted into R508, slowly raise the variac to 25V. The line current should be less than 200mA. Compare the waveform with Fig. 1 (*As of 9/99- picture available only as poor copy, see accompanying wave form pages- Ed.*). The top part of the waveform should be starting to break over and droop towards the centerline. Adjust R508 until the scope looks like the photo. Counterclockwise increases droop.

Full Line Voltage

Bring the variac up to 117Vac within 5 seconds, making sure that droop increases with voltage. During this period, the supplies will turn on and the presence of current may be noticed in the bottom of the waveform. Obtain the droop as shown in Fig. 2 (*see above note regarding waveform pictures-Ed.*) by adjusting R508 so that it stops 10V (1/2 div) below centerline. NOTE: If there is a problem with shorted supplies, it can be detected by the shape at the bottom of this waveform as the variac is increased. It will show as excessive ringing and may look similar to the bottom of the waveform of Fig. 6. If this occurs, do not increase the variac to 117Vac and refer to the Service Manual.

Adjust Period

At this stage the period is set such that the bottom flat part of the waveform is 4usec/ wide, +or-0.2usec. This may cause the period to be about 10.5usec, which can be adjusted by connecting or omitting C503, 504, & 505 with the shorting block JU502. As a shorting clip is added from the board edge towards the interior, the capacitance added to the oscillator increases, and the period will increase. Always turn the unit off when adding or removing clips. Adjust the reset as above as necessary. The waveform should now be similar to Fig. 2. The period and droop will be finalized below. Leave the unit on.

IMPORTANT! – Only a polyester or polypropylene capacitor may be used for the oscillator, which is used for temperature stability. If it is necessary, change one of the caps to get a waveform like Fig. 2. However, the caps provided will usually be sufficient.

Power Amp Start-Up

Preparation

Check that the emitter jumpers connect the transistors to the outputs. P612A, 655A and 683A should be toward the rear panel and P602A should be towards the edge of the board. Connect the loads and set their toggle switches toward the middle, open circuiting them. Set the rear panel pot of a power amp (ML/P) to be fully on. Set the 35MHz scope to 10/div. @ 200usec/div.

Continuity Test

With the DVM check that there is a short circuit between the grounding screw and the rear panel. The grounding screw is between Q824 and Q808, and its washer must be touching the board. If an open circuit is measured, check that the screw hole in the heat sink is not anodized. It is crucial that this connection is made.

Adjust Bias

With the loads open and the DVM on the 200mV DC scale, adjust R652 so that 8.5mV (+ or – 0.5mV) appears between the emitters of Q808 and Q824. (The emitter is the leftmost pin on TIP33 and TIP34). This voltage will increase as the unit warms up, and 8.5mV is recommended when the unit is cool. For a stereo amp, repeat this procedure with R711, Q759 and Q783. For a mono amp, check above Q's to see if base connections have been made. Usually, a smaller voltage will appear between the left channel emitters of a mono power amp.

Load Tests

Open Circuit Test

Set the voltmeter to 30V full scale. Set the 35MHz scope to 10 div @ 200usec/div. Connect a 1kHz signal from the oscillator into the Stereo Line Out (stereo), Right Line Out (mono), or Line In (power amp ML/P). This jack is next to the output jack on the right. Use a mono-to-stereo adapter from the oscillator. With the loads open circuited, look at the output signal on each output jack with the 35MHz scope. The waveform should look sinusoidal at low input levels (-16dB) and distorted at high input levels

Open Circuit Test (contd.)

(-6dB). See Fig. 3 for a distorted signal. (*See note regarding waveforms above. -Ed.*) For a power amp (ML/P), check that turning down the rear panel pot reduces the output to zero on each channel. Return the pot to fully on. Set the oscillator to be a -6dB, 1kHz signal. With both loads set to 8 ohms, adjust R688A so that the output voltage from the left jack (R Channel) is 14.5Vrms, as indicated by the VOM. The output should be a clean sine wave, as shown in Fig. 4 (*see note above*). The line current should be about 1.2A. Change the input signal to a square wave and compare output with Fig.5. For a stereo unit, adjust R697 to obtain the same sine wave rms output voltage for the right output jack (L Channel). Change the input to a square wave and check the output. For a mono unit, check that the output jumpers are connected by viewing the signal on the right output jack, which should be the same as the left jack.

Resonance Check

With the loads at 8 ohms and a sine wave input, raise the input signal to 0dB and note that line current is 2A, which should send the output into the rails. View the cathode of D537 with the 100MHz scope as mentioned above (**Scope Setup**). The S-curve due to resonant current should stop about 0.5usec (deadtime) before the waveform rises, as shown in Fig.6. If this is not the case, the period must be readjusted (see **Adjust Period**). The condition of not enough deadtime may be the result of a transformer core having too high a relative permeability, which makes the magnetizing inductance too high. Therefore, the magnetizing current will be less, which will increase the ring-up time. In this case, add more capacitance. If there is too much deadtime, decrease the period by decreasing capacitance, making sure deadtime is still at a safe level. This will increase the operating frequency to a value closer to the transformer design goal. Once the period is adjusted with respect to the resonance, adjust the droop to 10V above zero. Securely glue the pot (R508).

Thermal Lift

With both sides connected to 8 ohms, set the input signal to be a -6dB, 1kHz sine wave. While observing the left output signal, short JU789 from the left outside pin to the middle with a screwdriver. After a short delay the output should go to zero. For a stereo unit, cycle the power switch, waiting 2 seconds before turning back on. Repeat the above procedure for the right side output, this time shorting the right side of JU789 to the center pin.

Overload

NOTE: in the following sections the amp will automatically shut off. To reset, the power switch must be turned off for 2 seconds before the unit can again produce output when turned on.

Stereo- With the input set to 0dB, set both loads to 4 ohms. The amp should not trip off. Switch in the 8.2ohm load on the left side. The automatic shutoff circuit should force the output to go to zero after a short delay (a few seconds max.). If this does not happen, R777 must be adjusted. This component must be decreased in value (from 470 ohms) by paralleling it with either a 2.2k or a 1k resistor. If the unit still stays on, R777 must be changed to a lower value. Settle on the value that trips first. Repeat the shutoff test on the right side, switching in the 8.2ohm load and adjusting R761 if necessary. Remove the 8.2 ohm load and switch the load box to 8 ohm on either side.

Mono- Remove the right jack from the unit and plug it into the left side of the load box, paralleling the loads. With a 0dB sine wave input and both loads set to 4 ohms, the unit should not trip off. Switch in the 8.2ohm load. The output should go to zero after a short delay. If this does not happen, R777 should be adjusted. This may be adjusted by paralleling a 2.2k or a 1k resistor, as noted in the above section. If this doesn't work, change R777 to a lower value, settling on the value that trips first. Switch loads back to 8 ohms and connect each output jack to a load.

ML Power Supply Start-Up Wave Forms

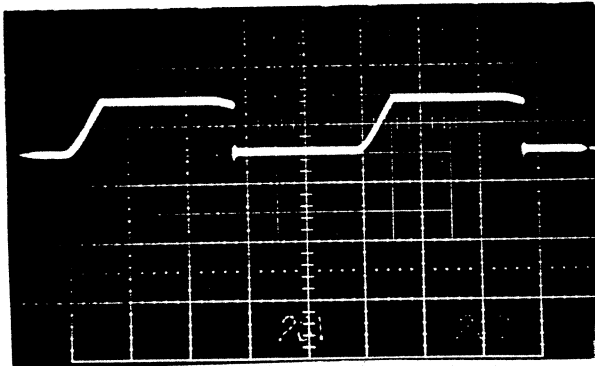


Fig. 1
D537, $V_{line}=25vac$

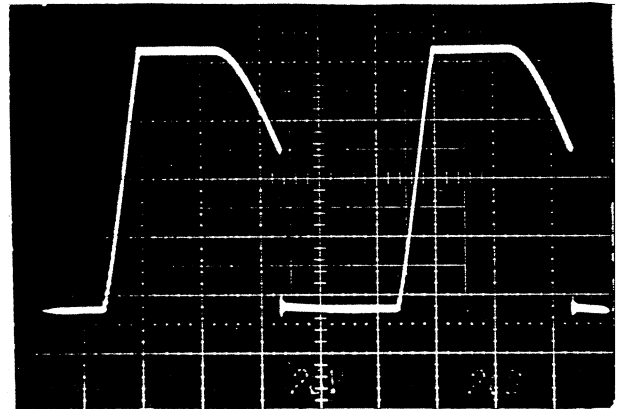


Fig. 2
D537, $V_{line}=117vac$

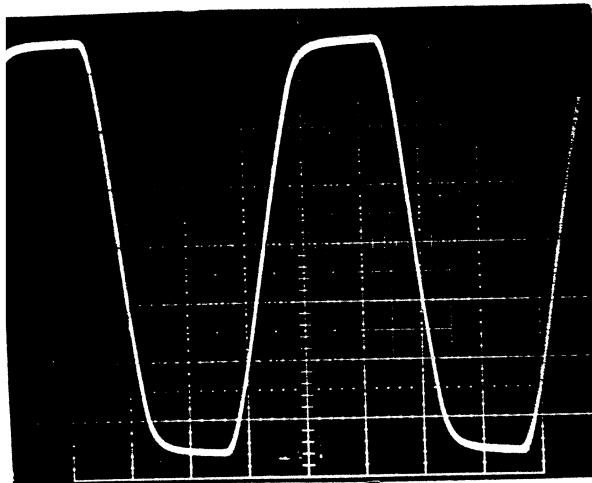


Fig. 3
Output with Load Open

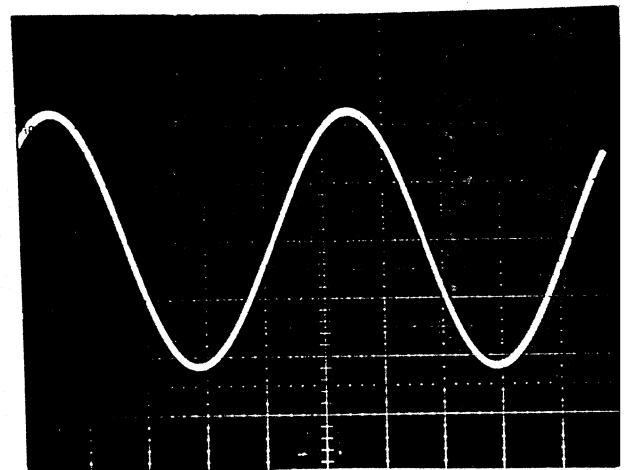


Fig. 4
Output, -6db Input

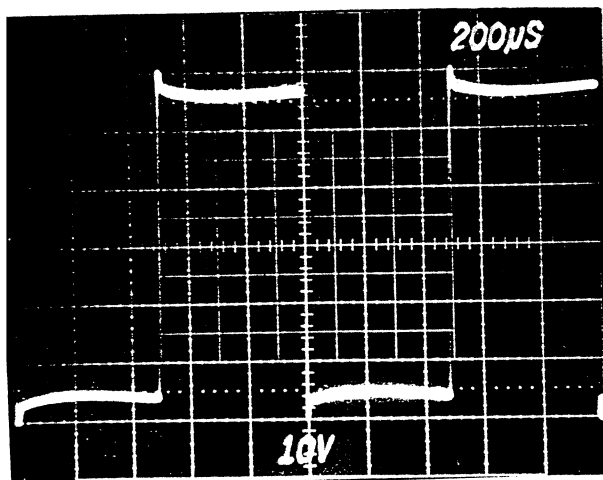


Fig. 5
Squarewave Output

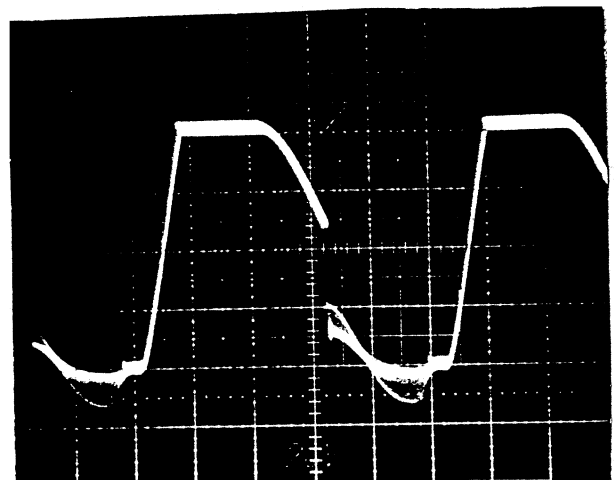


Fig. 6
Resonance at D537 Cathode

Microamplifier Series-Lead
Standard Preamp Turn-On Procedure

GK Document #420-0073-A
Preamp Board # 206-0073-D- ML/S board
Model #'s- ML120S, ML260S-All Options
5/18/90 Rev. 9/15/99-SW

NOTE: *Italics refer to stereo power units.*

SETUP

Power switch off- Connect power cord.

- 1) Connect power 3-pin connector from power amp to P1 on board. Colors should read (L-R): Black, Violet, Brown. P1 is furthest to the back.
- 2) Connect signal 3-pin connector from power amp to P2. These colors should read (L-R): White, Black, Red. P2 is furthest the front.
- 3) Connect outputs to load box- Left to Load A, Right to Load B.
- 4) Resistance loads open (switch in center).
- 5) Load box to scope-B and AC-VM.
- 6) Set scope switch on load box to look at load A (down).
- 7) Probe (1:1) to scope-A and DVM. (No gnd lead required).
- 8) Connect oscillator to unit.
- 9) Set oscillator on 100Hz sine wave @ 1.6Vrms (+4dBV).
- 10) DVM on 20V DC range.
- 11) AC Voltmeter on 30V range.
- 12) Scope-A on 5V/cm, scope-B on 10V/cm.
- 13) Scope sweep on 1ms/cm, scope trigger on A.
- 14) Output level to 0, switches out.
- 15) Boost, shape, gain, lead master to 0.
- 16) Clean volume, tones to 10.

INPUT SETUP AND LEAD CHANNEL TEST

- 1) Turn on power switch- clean channel LED only should light.
- 2) Engage channel switch- lead channel LED only should light.
- 3) Look at U1/1 with probe. Adjust R5 so that signal hits the rails evenly on both sides. Signal should be about 22Vp-p.
- 4) Look at drain of Q48 (square pad-J113): +7.3VDC.
- 5) Adjust R63 (1k trim) for 4.0-4.5VDC on drain of Q59 (J113).
- 6) Adjust R86 (1k trim) for 5.8-6.2VDC on drain of Q69 (J113).
- 7) Increase gain to 10 and watch the signal become a square wave- it should clip fairly evenly on both sides and reach 9Vp-p.
- 8) Decrease oscillator level to -66dBV (.5mV).
- 9) Change DVM to AC (20V) scale.
- 10) Adjust R70 (50k trim) for 2VAC at drain of Q69.

CLEAN CHANNEL TEST

- 1) Change scope trigger to B.
- 2) Disengage channel switch so that clean channel LED lights.
- 3) Set oscillator to -46dBV (5mV) in at 100Hz.
- 4) Look at tip of Send jack (J2) with probe: 0.47Vrms.
- 5) Tip and ring of Line Out jack (J4) should be 0.92Vrms.
- 6) With output level at 0, there should be no output. Gradually increase output and it should hit the rails at about 1 o'clock and =30Vrms.
- 7) Flip scope switch to look at load B (up) and see that it also is about 30Vrms, and hits the rails at about 1 o'clock.
- 8) Look at tip of Headphone Output jack (J5) and continue increasing the output level. Headphone output should hit the rails at about 4 o'clock (it actually may not hit the rails even when all the way up). It should be about 4.4Vrms.
- 9) Repeat 8) looking at ring of headphone jack.

TONE CONTROLS TEST

- 1) Set all large knobs to center (12 o'clock), switches out.
- 2) Set scope-B to 2V/cm @ 1ms/cm.
- 3) Set oscillator to 100Hz square wave at -46dBV.
- 4) Look at output, compare to Fig. 1.
- 5) One at a time, turn tone control knobs and compare outputs, resetting after finishing:
 - A) Treble to 10- Fig.2; treble to 0- Fig.3.

- B) Hi-mid to 10- Fig.4; hi-mid to 0- Fig.5.
- C) Lo-mid to 10- Fig.6; lo-mid to 0- Fig.7.
- D) Bass to 10- Fig.8; bass to 0- Fig.9.

BOOST / SHAPE TEST

- 1) Engage Channel select switch to go to lead channel.
- 2) Change scope-B to 5V/cm @ 1ms/cm.
- 3) Increase shape to 10- compare to Fig.11.
- 4) Increase boost to 10- compare to Fig.12.

FOOTSWITCH TEST

- 1) Connect RFG2 to footswitch jack (J6).
- 2) Engage switches on RFG2 so that both LEDs are lit. Lead channel LED should also be lit.
- 3) Output should look like Fig.12.
- 4) Disengage boost switch on RFG2-compare to Fig.11.
- 5) Disengage channel switch on RFG2- compare to Fig.1 (change scope range to 2V/cm, if necessary. Clean channel LED should light.
- 6) Remove footswitch.

RETURN STEREO/MONO TEST

- 1) Set AC-VM to 10V scale.
- 2) Set oscillator to 100Hz sine wave at -26dBV (50mV).
- 3) Insert plug from oscillator halfway into return jack (J3).
- 4) Set output level to 10. R Channel = $7.1V_{rms}$ (stereo). 4V for mono amp. Scope switch should be set to load B.
- 5) Push in stereo/mono switch (S2); signal goes away.
- 6) Disengage stereo/mono switch; signal comes back.
- 7) Push plug in the rest of the way. *Signal disappears again on stereo unit*, measures 4Vrms on mono unit.
- 8) *Flip scope switch to down- L Output = 7.4vrms.*
- 9) Engage stereo/mono switch: L Channel output = 7Vrms.

NOISE TEST

- 1) Remove oscillator input.
- 2) Turn all front panel knobs to 10, switches out.
- 3) Connect speaker to Left Output (switches out) and listen for noise, should be smooth with no crackling.
- 4) Change AC-VM range to 1V.
- 5) Noise should measure less than: $400mV_{rms}$, 500mV-mono.
- 6) *Change speaker to Right Output (switch up) and listen for noise.*
- 7) *Also change scope switch (up) to measure noise in R Channel as $< 400mV_{rms}$.*
- 8) Engage channel select switch to change to lead channel.
- 9) Noise in speaker should be smooth, with no crackling and should measure: $250mV_{rms}$, 400mVrms-mono (on AC-VM).

RETURN KNOBS TO ZERO- READY FOR BURN-IN

Microamplifier Series-Lead
Effects Preamp Turn-On Procedure
GK Document # 420-0063 -A
Model #'s: ML120E, ML260E- All options
Board #: 206-0063-E (ML/E preamp)
5/18/90 Rev.9/15/99-SW

NOTE: *Italics refer to stereo power units.*

SETUP

- 1) Power switch off- Connect power cord.
- 2) Connect power 3-pin connector from power amp to P1 on board. The colors should read (bottom-top): Black, Violet, and Brown. P1 is closest to front.
- 3) Connect signal 3-pin connector from power amp to P2 on board. The colors should read (bottom-top): White, Black, and Red. The colors are clearly marked on the board for both connectors.
- 4) Connect outputs to load box- left to load-A, right to load-B.
- 5) Resistance loads open (switch in center).
- 6) Load box to scope-B and AC-VM.
- 7) Set scope switch on load box to look at load-A (down).
- 8) Probe (1:1) to scope-A and DVM. (No gnd lead required.)
- 9) Connect oscillator to input.
- 10) Oscillator on 100Hz sine wave @ 1.6Vrms (+4dBV).
- 11) DVM on 20V DC range.
- 12) AC-VM on 30V range.
- 13) Scope-A on 5V/cm, Scope-B on 10V/cm.
- 14) Scope sweep on 1ms/cm, trigger on A.
- 15) Boost, gain, lead master, shape, and output level to 0.
- 16) Clean volume, tones 10, all switches out.
- 17) Reverb, rate, and depth to 0.

INPUT SETUP AND LEAD CHANNEL TEST

- 1) Turn on power switch- clean channel LED only should light.
- 2) Engage channel switch- lead channel LED only should light.
- 3) Look at U1/1 with probe. Adjust R5 (1k trim pot) until signal hits the rails on both sides evenly. Should be about 22Vp-p.
- 4) Look at drain of Q50 (square pad-J113): +7.3Vdc.
- 5) Adjust R67 for 4.0-4.5Vdc on drain of Q67 (J113).
- 6) Adjust R87 for 5.8-6.2Vdc on drain of Q78 (J113).
- 7) Increase gain to 10 and watch the signal become a square wave- it should clip evenly and reach about 9Vp-p.
- 8) Decrease oscillator level to -66dBV (.5mVrms).
- 9) Change DVM to AC (20V) scale.
- 10) Adjust R86 (50k trim) for 2.0Vac at drain of Q78.

CLEAN CHANNEL TEST

- 1) Change scope-A to .5V/cm.
- 2) Disengage channel switch so that the clean channel LED lights.
- 3) Set oscillator to -46dBV (5mV) at 100Hz.
- 4) Look at tip of send jack (J7) with probe: 0.47Vrms.
- 5) Engage compressor. Send = 0.94Vrms. Disengage compressor. (Monitor both signals to make sure they are clean sine waves.)
- 6) Change scope trigger to B.
- 7) With output level at 0, there should be no output. Gradually increase output level and it should hit the rails at about 1 o'clock and = 30Vrms.
- 8) Flip scope switch to load B (up) and see that it also is 30Vrms and hits the rails at 1 o'clock on output level.
- 9) Look at tip of headphone jack (J5) and continue increasing output level. Headphone output should be about 4.4Vrms with output level at max (may not even hit rails with output all the way up).
- 10) Repeat 9) looking at ring of headphone jack.

TONE CONTROLS TEST

- 1) Set front panel knobs to center (12 o'clock) except: boost, shape reverb, rate and depth to 0, gain to 10, switches out.
- 2) Set scope-B to 2V/cm @ 1ms/cm.
- 3) Set oscillator to 100Hz square wave at -46dBV.
- 4) Look at output, compare to Fig. 1.

- 5) One at a time, turn control knobs and compare outputs to figures below (resetting after finishing):
 - A) Treble to 10 –Fig.2; treble to 0- Fig. 3.
 - B) Hi-mid to 10- Fig.4; hi-mid to 0- Fig.5.
 - C) Lo-mid to 10- Fig.6; lo-mid to 0- Fig.7
 - D) Bass to 10- Fig.8; bass to 0- Fig.9.

BOOST AND SHAPE TEST

- 1) Engage channel select switch to back to lead channel.
- 2) Change scope-B to 5V/cm (still 1ms/cm).
- 3) With boost and shape on 0, compare to Fig.10.
- 4) Increase shape to 10- compare output to Fig. 11.
- 5) Increase boost to 10- compare output to Fig. 12.

CHORUS AND REVERB TEST

- 1) Return to clean channel (w/ channel select). Set output level to 0.
- 2) Set oscillator to –6dBV sine wave @ 100Hz.
- 3) Adjust R342 for no clipping @ U21/4.
- 4) Set oscillator to –26dBV square wave @100Hz.
- 5) Change scope trigger to A and scope-A to .5V/cm range.
- 6) Look at balanced out-R (J3) pin 3 (center).
- 7) Turn reverb knob to 10- see bumps in output as in Fig. 13.
- 8) Move frequency dial on oscillator back and forth around 100Hz- see signal bounce a little then settle.
- 9) Repeat 8) for each: Bal. Out-R (J3) pin 2 (left), Bal. Out-L (J4) pin 3 and pin 2.
- 10) Return reverb knob to 0.
- 11) Engage chorus switch with rate and depth of 0.
- 12) Look at Bal. Out-R pin 3, compare to Fig. 14.
- 13) It should have a small spike that moves back and forth approx. 1 div. at the rate of once every 2-3 sec.
- 14) Increase rate to max. Spike travel should speed up to about once every .7 seconds. Reset rate to 0.
- 15) Increase depth to max. Spike should travel about 5 full divisions. Reset depth to 0.
- 16) Look at Bal. Out-R pin 2 (left) and compare to Fig. 14.
- 17) Engage stereo/mono switch (S5). Spike gets bigger (Fig.15).
- 18) Look at Bal. Out-L pin 3 (center)- compare to Fig. 14.
- 19) Disengage stereo/mono switch- compare to Fig. 15.
- 20) Move probe to Bal. Out-L pin 2- compare to Fig. 15.
- 21) Set DVM to ohms scale.
- 22) Look at Bal. Out-R pin 1 (right) and see reading on DVM (number not important).
- 23) Engage gnd lift switch (S4) and see reading change to 1-open.
- 24) Repeat for Bal. Out-L.

FOOTSWITCH TEST

- 1) Set oscillator to –46dBV square wave @100Hz.
- 2) Set scope-B to 5V/cm, trigger on B.
- 3) Set output level to 12 o'clock.
- 4) Connect RFG4 to footswitch jack (J8) using 5-pin DIN cord.
- 5) Make sure both channel select and chorus switches are in, and boost and reverb pots at max.
- 6) Engage switches on RFG4 so that all LEDs are lit. Lead channel, chorus LEDs on front panel should be lit.
- 7) Output should look like Fig. 16.
- 8) Disengage reverb switch on RFG4- reverb bumps should disappear.
- 9) Disengage chorus switch. Chorus LED should go off and chorus spikes should go away.
- 10) Disengage boost switch. Compare to Fig. 11.
- 11) Disengage channel switch. Compare to Fig. 1. (Change scope range to 2V/cm, if necessary.) Clean channel LED should light.
- 12) Engage compressor switch on RFG4- see output increase.
- 13) Remove footswitch. Set front panel switches out and reverb to 0.

RETURN AND STEREO AUX IN TEST

- 1) Set AC-VM to 10V scale.
- 2) Set oscillator to 100Hz sine wave @ -26dBV (50mV).
- 3) Insert plug from oscillator into return jack (J6).
- 4) Set output level to 10: R channel output = 5.5Vrms.
- 5) Insert plug from oscillator halfway into stereo aux in jack (J5). *R output = 15Vrms, 8Vrms-mono.*
- 6) Push plug all the rest of the way in- *signal goes away on stereo unit and = 7Vrms on mono unit.*
- 7) *Flip scope switch (down) to look at L output = 15Vrms.*

NOISE TEST

- 1) Remove oscillator input.
- 2) Turn all front panel knobs to 10, switches out.
- 3) Connect speaker to L output (switch down) and listen for noise. Sound should be smooth w/ no crackling.
- 4) Change AC-VM to 1V range.
- 5) Noise should measure less than: *400mVrms, 500mV-mono.*
- 6) *Change speaker to R output (up) and listen. Sound should be smooth.*
- 7) *Also change scope switch (up) to measure noise in R channel as less than 400mVrms.*
- 8) Engage compressor switch- noise should measure less than *600mVrms (400mVrms-mono)* and be smooth.
- 9) Engage channel select switch to change to lead channel.
- 10) Noise in speaker should again be smooth and measure: *250mVrms, 400mVrms-mono.*
- 11) Set AC-VM to 30mV range.
- 12) Set all knobs to zero except output level and reverb to 10, chorus switch in (may be a slight pop)- noise < 20mVrms.

RETURN KNOBS TO ZERO, SWITCHES OUT- READY FOR BURN-IN.