HeadRoom

The Manual

The HeadRoom Headphone Amplifier and Audio Image Processor Product Description

HeadRoom

Dear Reader:

I sometimes get calls and letters from customers thanking me for HeadRoom. They say, "I'm hooked!" (Ken, Richmond, CA), or "You really have given us a product who's time is long overdue." (James, Maumee, OH). I love getting feedback like that . . . Thanks.

But I also get phone calls from people who have other ideas about how HeadRoom should work or sound. This manual is dedicated to those of you who have voiced a complaint, because without you, we wouldn't have felt the need to introduce two new products: The Premium (high-end sound and pro-level inputs), and The Supreme (near-ear emphasis filter for brighter sound). Now we can truly begin to say . . .

HeadRoom has the right headphone amp for you.

I'm sure I will still get complaints. Now it might be, "Your manual is too complicated." Well . . . it is pretty complicated, but I feel strongly that product literature should be a comprehensive look at the product, not just slick marketing pictures and vaporware.

I spend a lot of time on the phone answering questions on how HeadRoom works. When I sat down to write this, I went through the product piece by piece and answered the questions people have asked. If it's too complicated for you, just call 800-828-8184, I'll be happy to help. After all, it's not the techno-babble that's important. It's enjoying the Music.

Happy Listening,

Tyll Hertsens
President

Contents

This manual has two main sections: The Basic Stuff and The Details. Each main section has two parts: The things you need to know to purchase a HeadRoom, and the things you need to know to operate the equipment. Don't be overwhelmed by all the information.

If you call us, we'll be glad to help: 1-800-828-8184

HeadRoom

The Basic Stuff

Which box for me?

Audio engineering for a portable product requires striking a compromise between efficiency (battery life) and audio fidelity. Basically, if you want a very good audio signal, you have to use electronics that require a lot of energy. In other words, the better the sound, the shorter the battery life. (All units come with an AC wall adapter. Battery life is therefore not an issue when used at home.) The Standard is more efficient than The Premium and Supreme and, therefore, does not sound quite as good.

The other difference is the near-ear emphasis filter. The audio image processing circuitry improves the audio image, but has a natural by-product of reducing the high frequencies slightly. The Premium and Supreme have a filter to slightly boost the highs to compensate.

We also have an upgrade policy that will allow you to upgrade your unit for the price difference between the unit you currently have and the one you want.

The Standard

The Standard HeadRoom is the best unit for general use. It is best for people who want quality sound and have good headphones, but don't want to be tied to wall socket for power. It lasts 3½ hours on Duracells or Energizers, and sounds very good.

The Standard and The Premium look the same from the outside.

The Premium

The Premium HeadRoom is for people who appreciate the qualities found in Audiophile category equipment. If you will be using HeadRoom mostly home or in the office, and have very good headphones, this is the unit for you. It will run about two hours on batteries. It comes with the near-ear emphasis filter on internally.

The Supreme

The Supreme is for true Audiophiles. It uses the same electronics as the Premium but includes a switchable near-ear emphasis filter. It also uses very high quality capacitors and resistors on the main circuit board.

The Near-Ear Emphasis Filter synthesizes the improved high frequency response of the ear closest to a speaker. The filter provides a slight increase in the high frequencies of the audio signal. Filter performance is custom selected for your headphones and listening tastes. It runs about two hours on batteries.

HeadRoom and Audio Line Levels

The electrical signal voltage level between audio components has two general standards: consumer and professional (4VPP and 8VPP respectively). Portable CD players and most home audio equipment use the consumer standard audio signal. Professional and Audiophile quality equipment may use the higher voltage signal.

If you are planning to use this equipment at home on Audiophile or Pro equipment, you may have to use The Premium or Supreme HeadRoom Amplifiers. Please call for details.

HeadRoom

How to use HeadRoom

Inputs

HeadRoom has left and right RCA inputs on the rear of the unit. These jacks are well recessed within the unit, allowing more clearance at the rear of the unit and better strain relief on the cables when used in a carrying case.

Please be sure the connectors are pushed in completely.

Headphones

When you construct a sound system, speaker selection is the most difficult and important decision. The same is true for headphone selection. Don't short change yourself on headphones. The difference in sound quality between $89 and $250 headphones is vast and well worth the $169.00. So, if you're on a budget, put your money into the headphones and buy The Standard HeadRoom.

HeadRoom will drive any standard dynamic headphone. It is designed to comfortably drive headphones with 40 Ohm to 600 Ohm impedance, and 80dB/mW to 110dB/mW efficiency.

Volume

Please be careful not to damage your hearing. There is a natural tendency to listen to headphones much louder than speakers. Listening too loud and too long can cause permanent damage. If you begin to hear ringing in your ears give them a rest with the sound of silence.

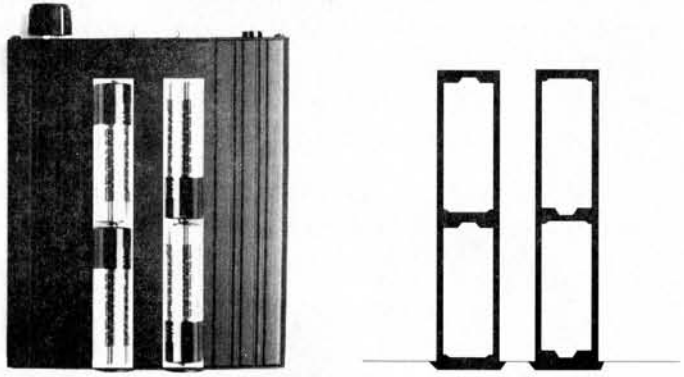
You only have two ears, and you need them both to enjoy music.

Battery Installation

This is a little tricky, sorry. HeadRoom uses 4 AA batteries. It will run on both NiCads and Alkaline batteries. The batteries are inserted into two battery compartments on the rear panel. Since a picture is worth a thousand words, we'll show you two pictures, and save a lot of words.

- side out

+ side out



The rear panel has a diagram of the batteries loaded in the compartments. The bottom of the diagram represents the rear panel. In the right compartment the batteries are loaded with the + side out, in the left compartment the - side is out. The battery compartment caps have + marks on them, please ignore these indicators.

AC Wall Adapter

The AC Wall Adapter delivers regulated 5 Volts DC. When it is plugged into HeadRoom it disconnects the batteries internally. It will not charge the batteries. All HeadRooms come with a wall mount power supply.

HeadRoom

Setting it up for Travel

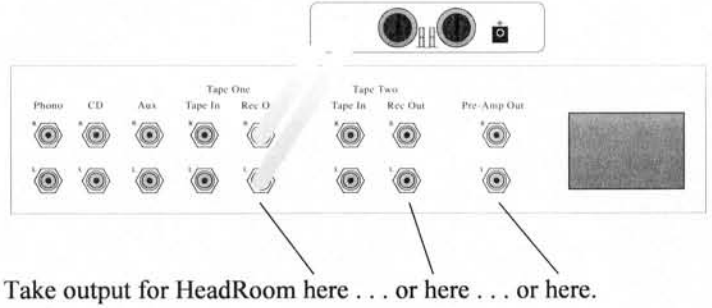
HeadRoom is designed for use with most Portable CD player carrying cases. It is typically installed in the compartment under the CD player. You should use a cable with a 90 degree angled stereo mini-plug on one end and left and right RCA plugs on the other. This cable should go from the line output on the CD player to the jacks on the rear of HeadRoom. To route the cable you will have to cut a small hole in the fabric between compartments.

Setting it up at Home

The great thing about HeadRoom is that you can set up incredible sound for around $1,000. And I mean, really incredible sound. With good headphones, portable CD player, and HeadRoom, you've got sound equivalent to a normal stereo costing five times as much. And you can use it anywhere - den, office, bed, workshop, lawn mowing, plane, train, automobile.*

If you want to add HeadRoom to you're home system, the most convenient place to get a signal from is the Tape Record Output on your pre-amp or receiver. However, you may use any line level output on your system.

If you have a very expensive system with high voltage line levels, you may want The Premium or The Supreme HeadRoom. Call for details.



Take output for HeadRoom here . . . or here . . . or here.

*It is illegal to drive while wearing headphones in most states.

HeadRoom

The Details

HeadRoom Common Features

All HeadRoom models share a number of common features. They are housed in the same black anodized extruded aluminum enclosure. They use the same back panel and battery holder. They take the DC voltage from the batteries or AC wall adapter, and use a DC to DC converter to provide +15 Volt DC to the amplifier electronics. All active HeadRoom electronics are potted in the same 1" x 2" x 0.5" module. All models use the same electrical configuration and circuit boards. All units use a discrete transistor output amplifier stage.

All units use Operational Amplifiers for the Audio Image Processor filter circuitry and buffer and summing stages. But we use differ op-amps on The Standard. The other differences are the gains of the buffers, and the near-ear emphasis filter components.

The Standard

The Standard uses LM833 Op-Amps. These devices are high quality audio Op-Amps with moderate current requirements and very good audio and noise performance. They represent the best compromise between audio quality and battery life. This unit sounds as good as the best of the Mid-Fi's and runs 3 !/2 hours on batteries.

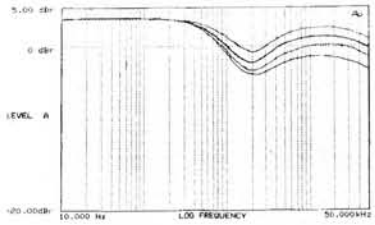
The Premium

The Premium uses Burr-Brown OPA2604AV Op-Amps. These Op-Amps are honest-to-goodness audiophile devices. They draw lots of current, but they are fast and clean . . . and sound really, really good. To describe the difference between The Standard and The Premium, you have to use words like musicality, timing, soundstage and depth. This unit definitely breaks into the Audiophile category.

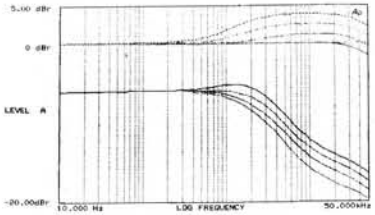
The Supreme

The Supreme uses the same electronics as The Premium but includes a front panel switch that allows the user to turn the near-ear emphasis filter on and off.

Additionally, all main board resistors are Caddock MK 132 metal film types, and the signal capacitors are Mallory SXK series polystyrene film caps.



Mono (L+R) Frequency Response



Direct and Crossfeed Channel Frequency Response

The curves to the left show HeadRoom frequency response with 30kOhm, 20kOhm, 10kOhm, and no filter resistances. The top graph is with the processor on and left and right channels driven with a mono signal. The bottom graph shows the frequency response of the direct channel (top curves) and the crossfeed channel (bottom curves) with only one channel driven.

The Premium comes with a 20kOhm resistor. When ordering The Supreme you will be asked about the headphones you use and the type of music to which you listen. The filter performance will then be custom optimized to suit your listening habits.

Inside the Box

We invite you to look into your HeadRoom, but please do so only if you feel comfortable taking things apart. You will not void your warranty if you follow the directions, the procedure is pretty simple. But our warranty will not cover any errors you make during the process.

You will need: a #1 Phillips screwdriver, a comfortable seat at a clear desk or table, a clean tea cup, and possibly, a cup of coffee.

Disassembly

It is preferable to sit at an anti-static workstation. The unit is pretty well protected, however, so this is not a requirement.

Remove the two front panel screws and place them in the tea cup.

Put the screw driver down.

Place the unit on the table with the front facing you.

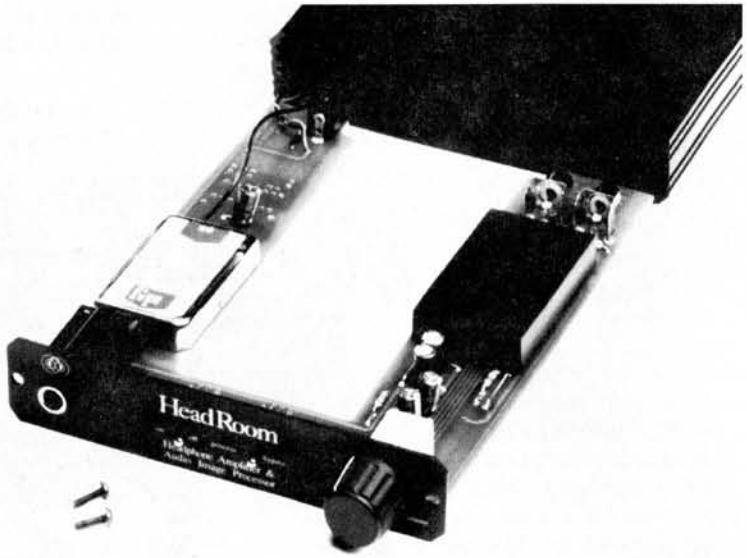
With the left hand on the case, and the right on the volume control, slowly pull the main board out of the case.

Do not put the cables to tightly.

Put the main board down.

You have just successfully disassembled HeadRoom. After all this hard work, now would be a good time to drink some coffee and look at the unit.

(When re-assembling the unit, just slide the main circuit board back into the enclosure using the bottom set of grooves. The board sometimes hangs up on the battery bracket. Just jiggle it around a little bit, and it should go right in. Then screw in the front panel screws. Be careful not to strip them, the aluminum is soft. Enclosure extrusions will cost you $29.00.)



The Enclosure Sub-Assembly

The Enclosure Sub-Assembly is the entire back part of HeadRoom. It includes: the enclosure body, rear panel, battery holders, and batter holder brace. DO NOT TRY TO REMOVE THE BACK PANEL OR DISASSEMBLE THIS SUB-ASSEMBLY.

The enclosure body is a black anodized aluminum extrusion. You will notice the slight outward bend of the top and bottom of the unit. This bend is intentional, and is formed by the internal battery holder brace.

HeadRoom

Our RCA jacks are gold plated but the real trick was finding PC board mounted jacks that could withstand the abuse portable equipment must be designed to survive.

The magic of HeadRoom - the electronics module. All active electronics is here. In your unit, this will be a little black box.

Gain Boost Jumpers are available for people with very low sensitivity headphones.

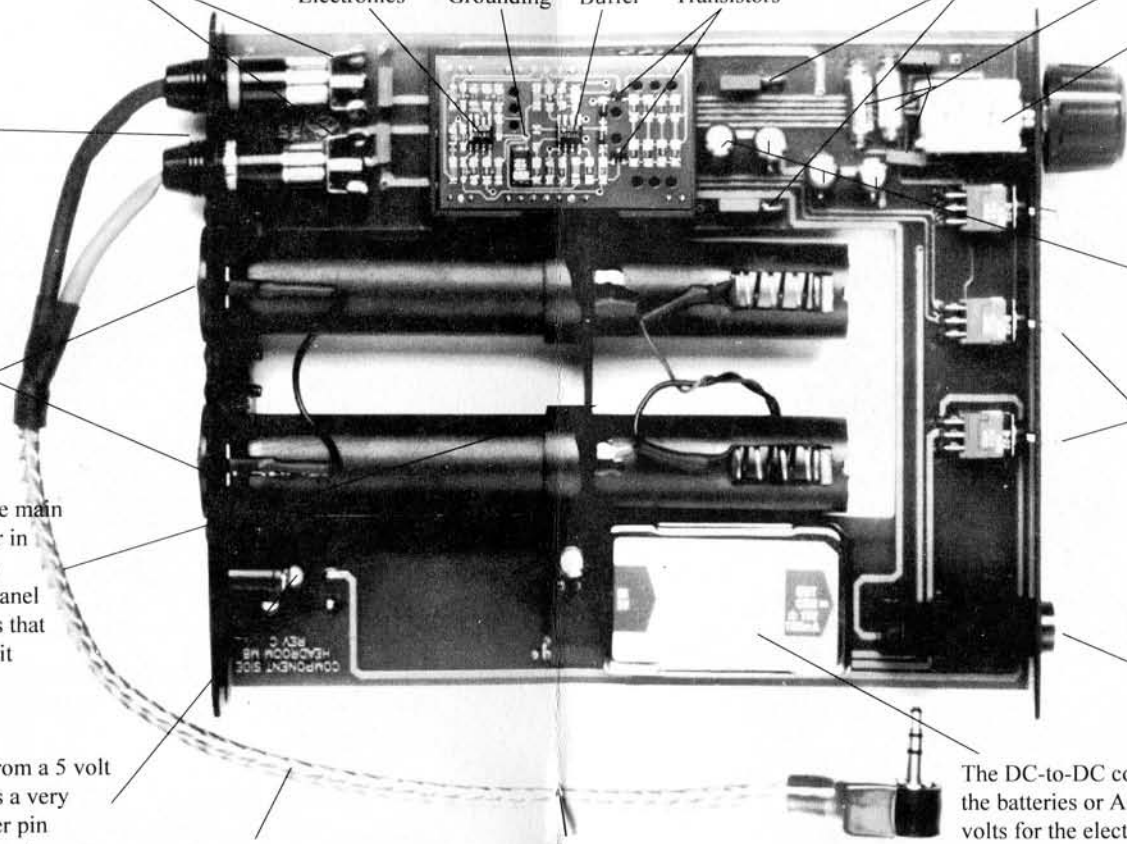
Near-Ear Emphasis Filters compensate for the improved high frequency response as a speaker toward the side

Crossfeed Electronics

Star-Point Grounding

Direct Buffer

Output Amp Transistors



Left and right RCA inputs with recessed jacks for more rear clearance when used in portable carrying cases.

The Clarostat conductive plastic element pot is an outstanding sounding control that is also built with the kind of durability needed in a portable application.

We feel pretty luck to have found our battery holders. We searched for quite a while for a panel mount holder before we found these. Each holder takes 2 AA batteries, and you can use Alkalines,

Power supply filter capacitors are low series resistance electrolytics. The configuration was carefully chosen to match the DC-to-DC converter requirements.

You'll never have to worry about these little guys. We use high reliability, gold contact, sub-miniature switches. The toggle is protected from being broke off by the size of the front panel hole.

The battery holder bracket is the main structural strengthening member in HeadRoom. It holds the battery holders to reduce strain on the panel flanges, and it has guide notches that hold the inside edge of the circuit board.

HeadRoom has a standard 1/4 inch headphone jack. It's just a nice, reliable, nickel-plated-contact jack.

The power jack requires input from a 5 volt regulated power source. It takes a very common 2.5mm plug with center pin positive. If you're in another country, you should be able to find a power plug to fit this jack at any electronics store.

The cable shown is made by Straight Wire from their LSI Encore cable. It's perfect for use with a portable CD player. Call us if you'd like more information on how to get one.

The DC-to-DC converter takes 4.5 to 6 volts from the batteries or AC adaptor, and converts it to +15 volts for the electronics. Without this much voltage available, you would not be able to drive high impedance headphones correctly. By the way, this is the most expensive part in the box, it costs us more

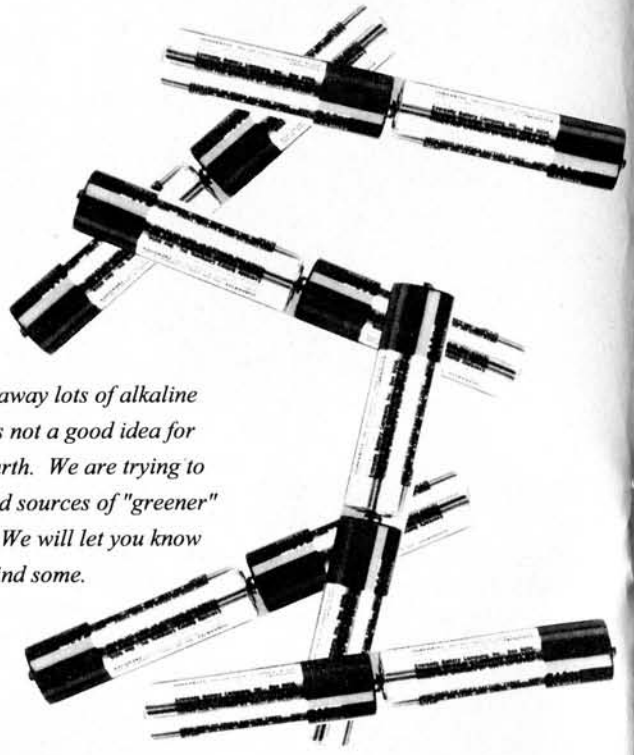
Battery Holders

The battery holders are quite unique. They are the only high quality panel mount AA battery holders that we could find, and they are made in the U.K. by Bulgin Ltd., Power Technologies distributes them in the U.S. call 201-736-5722.

The volume knob is also sold by Power Technologies.

The Battery Holder Brace

The battery holder brace is the small metal plate inside the enclosure sub-assembly. It serves as the main structural strengthening member of the whole box. It holds the inside of the main board in place. And it relieves the strain on the panel flange of the battery holders.



Throwing away lots of alkaline batteries is not a good idea for Mother Earth. We are trying to locate good sources of "greener" batteries. We will let you know when we find some.

Batteries

Here are some worthwhile notes on batteries.

Alkalines

Can't beat them for power, but they have a lot of voltage drop over their life. HeadRoom can only use about 70% of the power available in Alkalines.

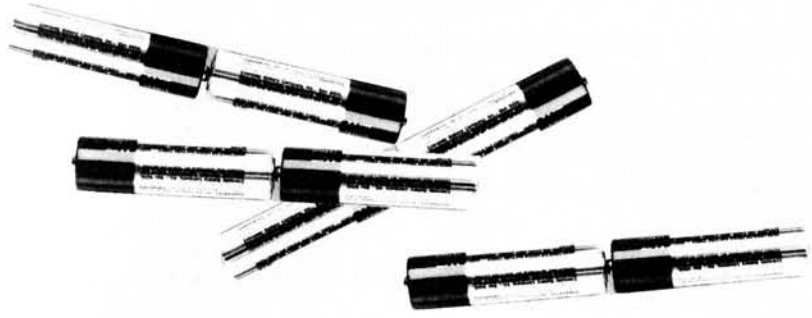
NiCads

NiCads are pretty poor batteries. They don't store much energy (30% of alkalines), they suffer from a recharge memory problem, and they will grow little fern-like crystal structures internally unless you charge them with a pulsing power supply/recharger.

But, they are commonly available. And they are greener than alkalines.

Nickel Metal Hydride

This is really a good battery. They have twice the energy of NiCads, no memory problems, and long lifetime. They do charge slower than NiCads. And they cost quite a bit.



Main Board

The main board is a big green U-shaped printed circuit board. (see page 11-12) We use 2 oz. copper with 1 oz. plating on a fairly standard FR4 board. On it you will find the following parts:

DC-to-DC Converter

The 5 Volts from the batteries or wall plug goes into the DC to DC converter. Commonly called a switching power supply, it is the silver box found behind the headphone jack. This unit converts 5VDC to pretty well regulated +15VDC.

Switchers basically dump DC voltage back and forth through a bunch of chokes and caps to create other DC voltages. They are efficient, but potentially noisy devices.

The internal oscillator runs at about 200 kHz, well out of the audio range. High frequency signals can trigger noise from other mechanisms, and corrupt the audio signal. Switching supplies are touchy and work best when they are designed carefully into the system. The Switcher we use is potted and shielded, we get 140dB signal-to-noise at 200mW output.

One nice thing about switchers is they do a good job of filtering the 60 Hz AC. Since 60Hz is in the audio range, the DC-to-DC converter makes for a pretty good sounding supply. Frankly, we were pretty surprised to get the level of performance we're measuring.

Power Jack

The power jack is a very common connector. It requires 5VDC on a 2.5mm center pin with ground on the outside. If you happen to loose your power adapter, you should be able to find a replacement to fit this connector anywhere in the world.

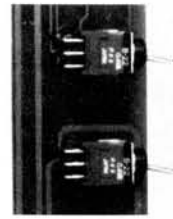
The power jack has an internal switch. When you plug in the wall adapter the batteries are disconnected and will not charge or drain.

Headphone Jack

It is a standard 1/4 inch headphone jack. Just your basic, reliable, nickel-plated headphone jack.

Switches

Both front panel switches are high quality, high reliability sub-miniature toggle switches. They are mounted so that the front panel opening provides protection against the switch handles being broken off if they are bashed during use.



The **Process/Bypass** switch activates the Image Processing Circuit. In the bypass mode, HeadRoom is simply a DC coupled amplifier. No intentional modification is done to the audio signal in this mode.

In process mode, the Audio Image Processor is active. The purpose of this circuit is to provide a correction to the audio signal for headphone listening. A full description of this process and the circuitry is available in a separate booklet called "HeadRoom: A White Paper. How the HeadRoom Headphone Amplifier and Audio Image Processor Works."

The **on/off** switch turns the power on and off. What more can I say?

Volume Pot

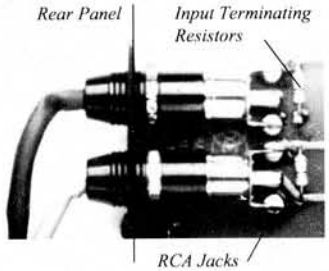
We use a Clarostat conductive plastic, linear taper, dual pot. It's a very good audio pot and it is extraordinarily well constructed.

We use a linear taper pot because headphones vary so widely in efficiency. Most volume controls have an audio or log taper. The reason for this is to allow the volume control to be less sensitive in the normal listening range. But since the normal level on the control may be dramatically different with differing headphone efficiencies, we use a linear taper to be fair to everyone.

RCA Jacks

Our major concern with RCA jacks was reliability. We knew that HeadRoom was going to get a real workout as a portable, so the jacks had to be very reliable. The jacks we use are mounted directly to the main circuit board with the ground side soldered in three places for maximum mechanical strength. They have, so far, proved themselves very reliable. And we've bashed the heck out of them.

You'll notice these jacks are significantly recessed from the rear of the unit. We did this to permit HeadRoom to be more fully inserted into a portable carrying case. The holes in the rear panel act to stabilize the connector body and reduces the strain on the RCA jacks.



Unfortunately, this configuration prohibits the use of very large and/or locking style RCA connectors. It also makes it difficult to visually ensure that the RCA plugs are fully inserted. As you can see from the photo, the plugs go in very deep.

Input Termination Resistors

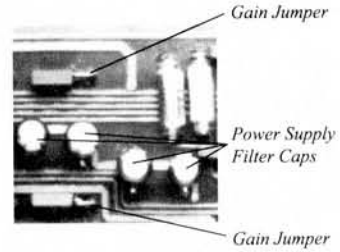
Because the amp is DC coupled, if it is turned on without an input there is a possibility of the output driving DC into the headphones. The input termination resistors provides a high impedance path to ground so that this does not occur.

Supply Filter Caps

The supply filter caps we use are very fast, low series resistance, electrolytic capacitors. Please do not try to modify this filter with any other type of capacitor. The correct nature of capacitance on switching power supplies is a careful balance of speed and resistance. The power supply may fail to operate if these capacitors are changed.

Module Gain Jumpers

In some very rare cases it may be necessary to increase the gain of the amp for very inefficient headphones. The two additional gain resistors are loaded on the main board for this reason. To increase the gain, simply cut the bypass jumper wires next to these resistors with a pair of diagonal cutters.



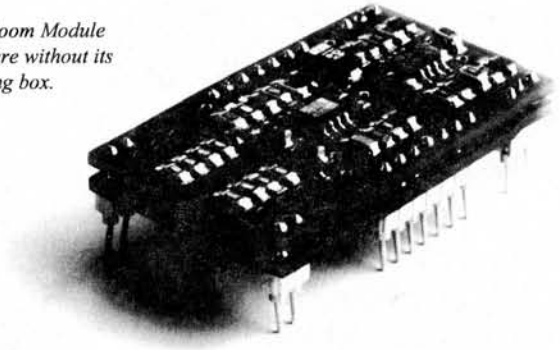
The Near-Ear Emphasis Filter

The Premium and Supreme both include a near-ear emphasis filter. The Near-Ear Emphasis Filter models the improved high frequency response of the ear closest to a speaker. The filter provides a slight increase in the high frequencies of the audio signal. Filter performance is custom selected for your headphones and listening tastes.

The Module

Ahh . . . well, herein lies the secret to HeadRoom. All active electronic circuitry is within this little black box. If you have an interest in modifying one of your home systems, we do sell these modules separately ($59 standard, $89 premium). They require only +15VDC, ground, a dual pot, a DPDT switch, and a headphone jack to be used.

The HeadRoom Module is shown here without its black potting box.



Physical Construction

Left and right channel electronics are constructed on separate circuit boards. Electronic components are surface mounted using silver solder paste and are soldered using an inert-gas, vapor phase oven system.

A special solder paste is used which includes a polymer conformal coating compound. During vapor phase soldering, the polymer flows to the outside of the solder joint and makes a plastic coating. This essentially seals all the electrical connections from oxidation and contamination.

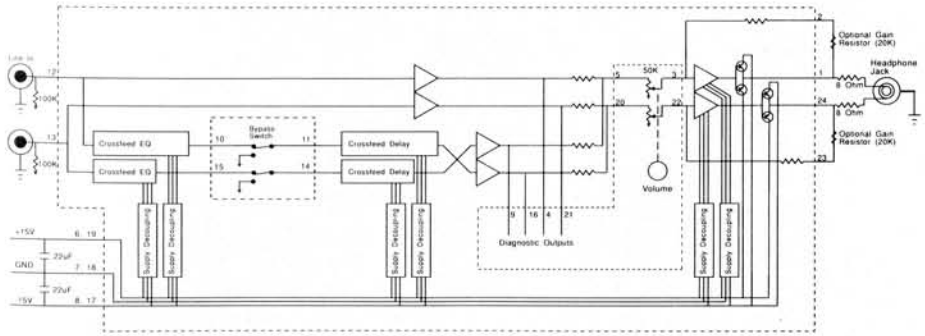
The electronics are then encapsulated in a black plastic box with epoxy potting compound. The epoxy hermetically seals the circuits and completely protects the electronics from moisture and contamination which might otherwise degrade the long term performance of the equipment. The epoxy potting compound also provides a relatively large thermal mass for the components and helps the electronics remain stable and well matched.

Block Diagram

The first thing to notice about the block diagram is that the audio from the inputs has a direct path to the outputs through the direct-buffer and output amplifier. This is the signal path when the amp is in the bypass mode.

With the Audio Image Processor enabled, the audio is allowed to pass through the Crossfeed EQ and Crossfeed Delay circuits, and is summed into the opposite channel. Notice also that all stages are separately de-coupled from the power supply. This gives HeadRoom excellent channel separation and clarity.

For a more detailed description of the module, please see the HeadRoom White Paper.



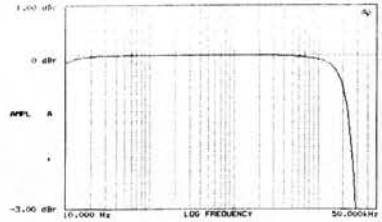
HeadRoom

Performance Specifications

Any good Audiophile will tell you that specs can be very misleading. Once a product exceeds a certain level of performance, the actual subjective musical experience has more to do with how well the system components are matched, than the measured performance.

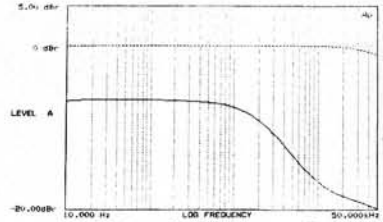
The Standard

All measurements on The Standard were performed at 0 dBu input and 1.5 volts output into 100 Ohms (22.5 mW). These settings represent a relatively loud listening level in most headphones.



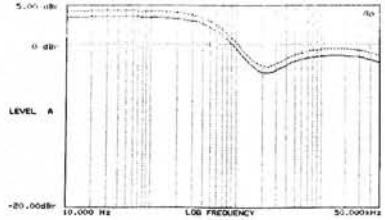
Frequency Response

Frequency response curves show that the unprocessed performance of The Standard is very flat with a 3dB down point at 30kHz.



Direct and Crossfeed Frequency Response

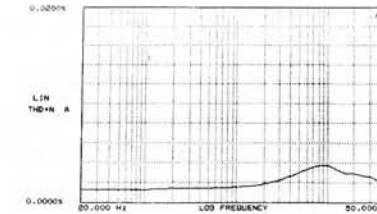
Crossfeed channel is intended to model the frequency response found at the ear opposite the speaker placement. It is flat to around 300Hz at -7dB, then falls to -17dB at 20kHz.



Processed Frequency Response, Both Channels Driven

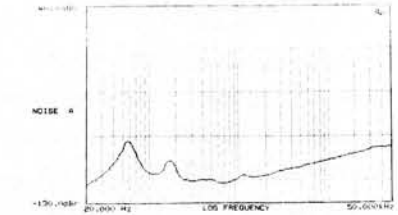
With a mono signal driving the inputs and the processor on, output frequency response shows a dip at 2500Hz. This is caused by the crossfeed channel delay being exactly 180° out of phase with the direct channel at this frequency. This curve is exists in this form only with steady state tones. With music the curves are significantly less exaggerated.

Total Harmonic Distortion measurements show that HeadRooms maximum distortion level is less than 0.005%. Measurements show a slight dependence on battery charge, but the magnitude never exceeds 0.01%.



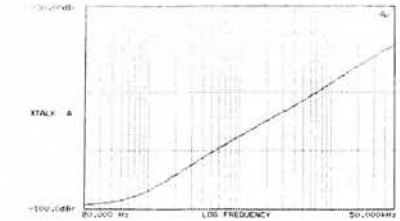
Total Harmonic Distortion + Noise

Signal/Noise levels are >100dB. You'll notice a 60Hz noise component in the measurements. We think this had more to do with our test setup than HeadRoom because there was no change with battery or wall power.



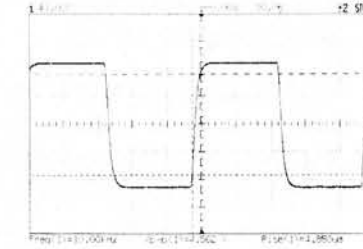
Signal to Noise Ratio

Channel-to-channel crosstalk performance of HeadRoom is a result of power supply decoupling in the electronics module. More than any other curve, x-talk show how dedicated we were to providing a quality product. Think about it: Our audio image processing intentionally crossfeeds the channels through the delay and EQ circuit. Why would we care about x-talk performance? Because we listen to HeadRoom too. And we want the best equipment we get our hands on. Even if we have to build it ourselves.



Channel to Channel Cross-Talk

10kHz squarewave performance shows nicely damped, 4.85 usec rise time waveform.

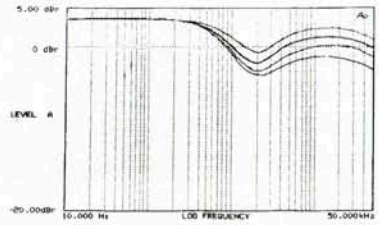


Squarewave Performance at 10kHz

HeadRoom

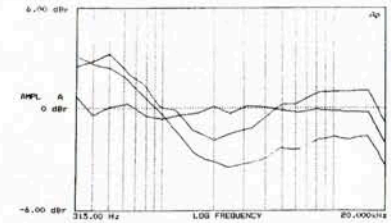
The Premium and Supreme

The Premium and Supreme have virtually identical performance graphs to the Standard HeadRoom. So we won't bore you with repetition. The graphs show here provide information on the Near-Ear Emphasis filter.



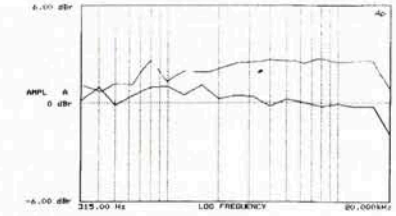
Processed Frequency Response, Both Channels Driven. Filter Resistance of 30k, 20k, 10k and none.

When a mono signal is fed into HeadRoom, and the processor is turned on, some unusual things happen. Because the crossfeed signal goes through a time delay, a comb filter is created with a notch frequency at 2kHz. The upper graph shows HeadRoom pure tone frequency response with both channels driven.



Mono Pink Noise, Bypassed, Processed, and with 20kOhm Filter.

The second graph shows mono pink noise frequency response. The analyzer used does not average, so the curves are somewhat noisy, but you can see that they are similar to the first graph (scales are different).



Uncorrelated Pink Noise Processed With and Without 20kOhm Filter.

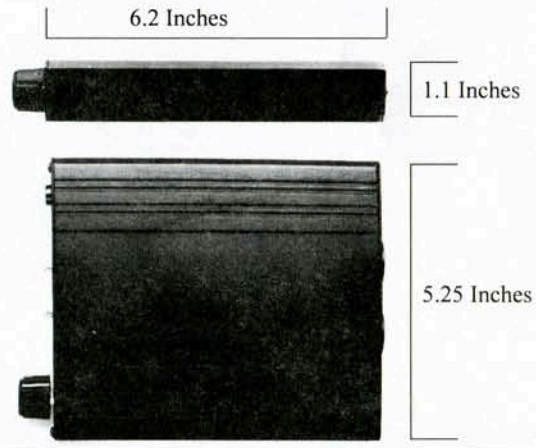
The bottom graph shows processed uncorrelated pink noise response. This means that two separate noise generators were use on the left and right channels. This plot shows that the processor is not providing much equalization when the channels are driven with different signals. Since a stereo signal is a mix of information that is the same, and information that is different between channels, the subjective HeadRoom frequency response is natural sounding.

To complicate matters even further, audio presented to a listener through headphones is subject to other psychoacoustic errors in frequency response. We feel that the frequency response presented by HeadRoom is very close to what is heard on speakers, and certainly better than a straight headphone amplifier.

Well . . . that's it. I can't think of anything else to say. Except that, in the final analysis, it's not all this technical stuff that really matters. What matters is that you get to spend more time enjoying music. And that's what HeadRoom is really all about. And if you've actually read this far you deserve a medal.

HeadRoom weighs:
1lb without batteries
1lb 4oz with batteries

Available colors:
Black



Specification	Standard	Premium and Supreme
Rated Input/Output	0dBu/22mWatt-100Ohms	4dBu/60mWatt-100Ohms
Frequency Responce	20-27kHz +0dB -3dB	20-27kHz +0dB -3dB
Max Power (<0.02% THD @ 1kHz)	400 mWatt	400 mWatt
THD 20-20kHz	< 0.01%	< 0.01%
IMD SMPTE/DIN 50Hz-8kHz	< 0.01%	< 0.01%
Phase Error 20 - 20kHz	< +15 degrees, - 10 degrees	< +15 degrees, - 10 degrees
Input Level	0 dBu	+4 dBu
Headphone Impedance Range	30 Ohm to 600 Ohm	30 Ohm to 600 Ohm
Headphone Sensitivity Range	80dB mW to 110dB/mW	80dB mW to 110dB/mW
Input Impedance	> 50 kOhm	> 50 kOhm
Battery Life	>3hrs Alkalines, >1.5hrs NiCads	>2hrs Alkalines, >1hr NiCads