# EQX™

## EQUALIZER / CROSSOVER

INSTALLATION MANUAL

AudioControl

Congratulations on buying a truly unique enhancement to any quality car stereo system.

The Audio Control EQX is a compact, audiophile grade, **digital-ready** line level sound processor. It contains a 5-band half-octave bass equalizer, 7-band upper octave equalizer, 2-way 18 dB/octave fully programmable electronic crossover, bridging adapter for mono subwoofer applications, and input/output level matching circuits. In short, a solution to almost every stereo system problem encountered in a quality installation.

It provides a perfect buffer with input RF protection circuitry, overload protection against super-high input power booster levels and internal specs that match any deck. Your cassette/tuner head "sees" the perfect input.

The EQX accepts any output level from any head unit and converts it to just the right input for any power-amp/speaker combination. A special variable gain amplifier allows astonishing variation in drive signal without ANY overload distortion.

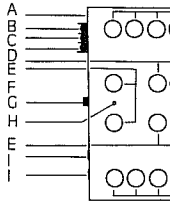
Even more important, the EQX's variable gain circuitry handles drive signal variations with maximum signal-to-noise ratio, instead of just "boosting" or "turning down" a signal in relation to the output. Internally, the same design matches the deck output to the EQX's internal equalizer and crossover stages. Then on the "other end", the EQX again provides perfect output level and signal-to-noise ratio to drive virtually any power amplifier made. Gain can be set so that mid-setting on the volume control is truly mid-volume in relation to power amplifier output. (Instead of being in the first three clicks of the volume control.)

It's a precision half-octave and octave equalization system. Just as our home equalizers can be found in some of the most expensive Hi-Fi systems, the EQX's finesse and accuracy are ready to go to work on quality auto systems. Half-octave precision allows subtle cavity resonance adjustments, compensations for speakers and the chance to get the very most from the last two octaves where most cassette tapes need compensation. Octave band centers range from 250Hz all the way to 16,000Hz to fully utilize the new breed of high performance decks and speakers.

It's also an ultra-precise, fully programmable, electronic crossover. Carefully integrated into the EQX design, this electronic crossover lets you add bi-amping and subwoofers without the distortion and power waste caused by passive crossovers. The EQX's crossover slopes are sharp—18dB per octave—to ensure tight bass while protecting midrange and tweeters from excessive bass.

## QUICK REFEREN
## TO INSTALLATI

While initially design
isn't beyond the capab
yourselfer. Either way
tions down into the "s
reference and pro-inst
wherein we talk each i
death with charts and
Suit yourself. By all me
discussion even if you
for actual installation.



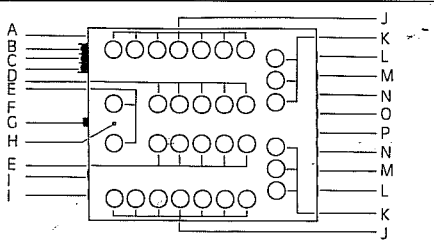
# QUICK REFERENCE GUIDE TO INSTALLATION

While initially designed for installers, the EQX isn't beyond the capabilities of the average do-it-yourselfer. Either way, we've broken the instructions down into the "short form" (for quick reference and pro-installers) and the "long form" wherein we talk each individual facet of the EQX to death with charts and graphs and even formulas. Suit yourself. By all means, read the technical discussion even if you only use the "short form" for actual installation.

## The Most Important Instruction of All

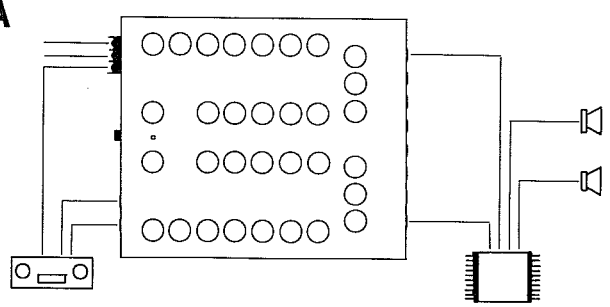
**FILL OUT THE WARRANTY CARD! If you're installing the system for a customer, remember to include the EQX warranty card with his packet of other cards and manuals and urge him to send it in.

Also stress just how important it is that he or she keep your invoice or sales slip, since it is their proof of warranty should anything happen to the EQX. It's also good insurance proof if the local hot car ring takes a fancy to your fine workmanship and makes off with the whole system. Insurance companies are notably reluctant to believe something like the EQX was part of a system, since it doesn't fall in any of their little pre-defined niches the way decks, amps and speakers do.

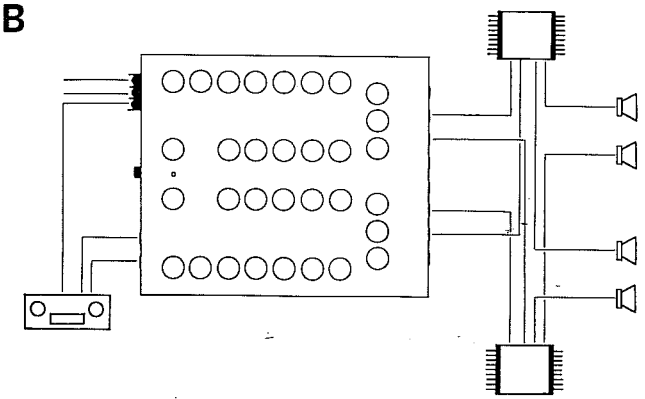



A- 12 VOLT DC PIN PLUG
B- POWER GROUND
C- +12 VOLT POWER
D- REMOTE ON
E- HALF-OCTAVE EQUALIZER
F- INPUT LEVEL ADJUSTMENTS
G- EQUALIZER IN/OUT SWITCH
H- 3dB HEADROOM INDICATOR
I- SIGNAL INPUTS
J- OCTAVE EQUALIZER
K- OUTPUT LEVEL ADJUSTMENTS
L- FULL RANGE OUTPUTS
M- HIGH FREQUENCY OUTPUTS
N- LOW FREQUENCY OUTPUTS
O- MONO LOW OUTPUT (NORMAL)
P- MONO LW OUTPUT (INVERTED)

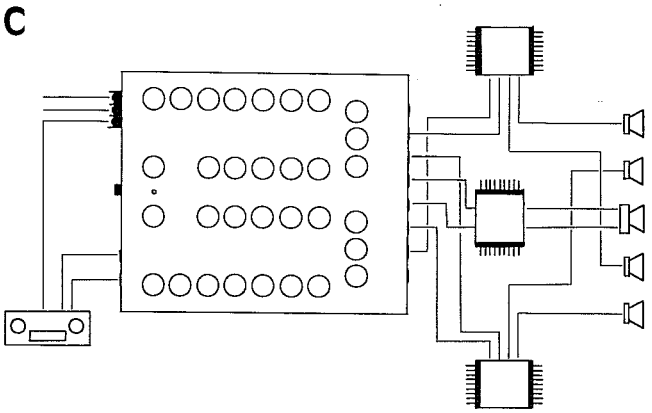
A



B



C



## INSTALLATION EXAMPLES

A SINGLE AMPLIFIER.

B BI-AMPLIFIED SYSTEM.

C BI-AMPLIFIED WITH BRIDGED SUB-WOOFER.

# SHORT FORM INSTALLATION INSTRUCTIONS

1. OBTAIN CABLES LONG ENOUGH TO ALLOW YOU TO SIT IN THE DRIVER'S SEAT AND ADJUST THE EQX. After the following instructions you can install the EQX in a permanent, out-of-the-way place.
2. HOOK THE EQX TO THE TAPE DECK ONLY. Use the long patch cords from deck output to EQX input.
3. SET ALL EQX EQUALIZER CONTROLS AND THE DECK TONE CONTROLS FLAT.
4. SET THE EQX OUTPUT CONTROLS TO ZERO ALSO.
5. PLAY A TAPE WITH THE DECK VOLUME CONTROLS ALL THE WAY UP.
6. ADJUST THE EQX's INPUT LEVEL CONTROLS UNTIL THE OVERLOAD LED BARELY BEGINS TO FLICKER.
7. TURN THE DECK OFF.
8. CONNECT THE EQX TO THE POWER AMP USING **LONG** PATCH CORDS.
   NOTE: At this point you should consult the power amplifiers manual to determine amp sensitivity. If it is adjustable, set for between .8 volts (800mV) and 1 volt (1000mV).
9. TURN DECK ON BUT LEAVE THE VOLUME CONTROL TOTALLY OFF.
10. AFTER SHUTTING THE CAR DOORS, LISTEN FOR HISS. IF ANY IS AUDIBLE, ADJUST THE EQX OUTPUT CONTROL TO MINIMIZE OR ELIMINATE IT.
11. NOW PLAY A TAPE WITH THE VOLUME CONTROL AT 3 O'CLOCK. IF IT'S A GOOD SYSTEM WITH BEEFY AMP, THAT SHOULD BE REALLY LOUD. If it is too loud, or overdriving the system, use the EQX output controls to reduce the volume. Conversely, crank up the EQX if the sound is not loud enough.
12. USING A TAPE YOU ARE FAMILIAR WITH, LISTEN FOR FREQUENCY RANGES THAT ARE AUDIBLY TOO LOUD. REDUCE THEM WITH THE EQX. Typical rises that are noticeable will be in the mid-bass (90-250Hz) and in the mid-range areas.

(continued on next page)

13. LISTEN FOR AND BOOST FREQUENCY RANGES THAT ARE DEFICIENT USING THE SAME SELECTION. Almost always 45 and 63Hz need some increase just due to the design limitations of cassettes and smaller woofers.
14. AS A FINAL CHECK, SWITCH THE EQX EQ BUTTON IN AND OUT TO COMPARE "BEFORE" AND "AFTER".
15. INSTALL THE EQX IN ITS PERMANENT LOCATION.

Congratulations! That is all there is to adjusting the EQX. The rest of this manual will deal with each of the features, mounting tips and good old cracker-barrel opinions.

# LONG FORM INSTALLATION INSTRUCTIONS

Here is the "long version" of how to use the EQX to eliminate many of the problems systems have always had no matter how good the electronics.

## Adjusting input levels

1. As we said before, don't mount the EQX in its final position and try to do things by remote control.
2. Get long cables. Connect up the system. Sit in the driver's seat, shut the windows, control heavy breathing and go for it. In most cases, maximum volume overload (when the EQX LED lights) should be at ¾-volume with an average tape. This leaves some room for gain on quiet tapes and weird radio stations which may be a few decibels louder. If system gain is too high, the volume control of the deck will be frustratingly hard to use with all adjustments made in the first part of rotation. This is one way the EQX can make a deluxe, custom system truly nice to use.

3. Make sure to leave the EQX equalizer controls flat. Watch the LED closely when the deck volume control is at ¾. You want to bring up the EQX input level controls until the light is obviously blinking to the music (which you can't hear). NOW BACK OFF THE INPUT GAIN JUST SLIGHTLY (about 6dB). Slightly MORE if you have a dbx tape deck or CD player.

   Be gentle about backing it off since it is this flickering of the LED which indicates the EQX is getting the most headroom with the least amount of hiss.

## Adjusting output levels

4. Now you're ready to work on output levels. Make sure the deck and EQX equalizer controls are set to 0dB.
5. Connect the power amp(s).
6. Put in the same tape you used for the input adjustments and turn it to ¾ volume. What you are trying to do is get the amp just BELOW clipping (assuming the speakers can handle it).

6A. If you are working with a bi-amped system, start with the low-end amplifier. We recommend an analyzer (see below) for the initial balancing. Either way, then bring up the high end to get a final balance.

## Adjusting equalization

1. Adjust with your expert ears, and your tastes, and a well-recorded tape you know in your sleep. Don't forget to use a fairly wide range of tapes to reflect the owner's listening tastes as well.
2. First, get rid of obvious bumps and resonances. Then concentrate on deficient areas. We know that you pride yourself on making a system that theoretically doesn't need EQ. But there are areas that even the best system cannot control, just as there is in even the best home system. Factors of environment, woofer performance and even a persons individual taste. Switch the EQ IN/OUT button to compare. If you take the time, you can really boost a systems performance.

   NOTE: It is not uncommon for the 90, 120 or 180 HZ bands to be cut quite a bit due to resonances. Nor is it odd for the 45 and

63Hz bands to be boosted a bit. Aside from that, the optimal setting for all cars we've installed it in is fairly gentle, often around plus or minus 3-5dB. In all cases the overall "curve" should be centered around 0dB, the way it would with a home hi-fi graphic equalizer. Otherwise the overall curve will affect the level of the system and create ripples in the total response pattern of the system.

2A. If you are running a bi-amped or subwoofed system, we do recommend getting the rough settings with an analyzer system. Audio Control makes some superb analyzers, but we are not pushing them here. Still, make the final adjustments with your ear and trusted tapes.

**3. When the system sounds as good as you think it can, invite the customer to sit in the driver's seat and listen. Use several program sources and make any final adjustments. Also go out for a drive to add engine and road noise factors.**

## PLACEMENT OF THE EQX

We recommend that you place the EQX as close as possible to the tape deck. This is because, while the EQX is highly resistant to noise and interference, the intervening cable often isn't.

Under-dash, under-seat mounting is great. The trunk is fine, too, although in long runs like this it is IMPERATIVE to use 100% shielded wire between deck and EQX.

In all cases, try to avoid extreme shock and temperature stress environments. The EQX has been designed with very high quality parts and in a manner which reduces mass-related circuit board stress (a typical failing of a lot of car gear). Still, all electronics have a limit to enviornmental stress. So, no fair putting it on the front bumper or under the oil pan.

## POWER SUPPLY CONNECTION

Cars are rotten environments for anything approaching a "high fidelity" stereo system and it takes a lot of design and installation consideration to get the most from it. The EQX is protected from reverse polarity (+ to − or − to +) with an internal diode, spike protector, Zener diode, custom choke, and fuse. If it gets damaged from improper installation after all that, we want to know about it!

Noise isolation is provided by a choke, capacitor input filter, electronic power supply with built-in R-C filter, internal power supply output ferrite-based inductors and R.C. isolation.

### Grounding considerations

Even though the positive side of the EQX has no less than five stages of isolation, how you ground the unit is VERY important.

USE A SINGLE GROUND POINT THAT YOU KNOW IS COMMON WITH OTHER GROUNDED PARTS OF THE STEREO SYSTEM. MAKE THE CONNECTION WITH NO LESS THAN 16-GAUGE MULTI-STRANDED WIRE.

Keep in mind that the entire car is NOT one perfect ground. Even slight resistance can cause problems. If problems persist, consult an electronic engineer or your local Guru of The Gods of Ground.

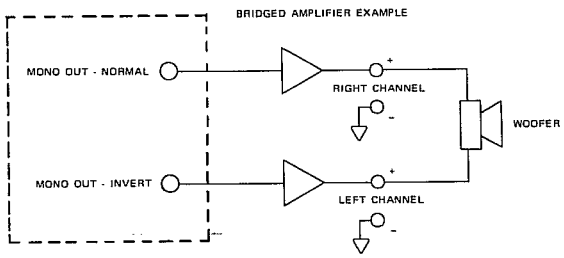
## WHAT KIND OF SIGNAL CABLE TO USE

Since the EQX has a very low output impedance (150 ohms), cable noise pick-up OUT of the EQX should not be a problem.

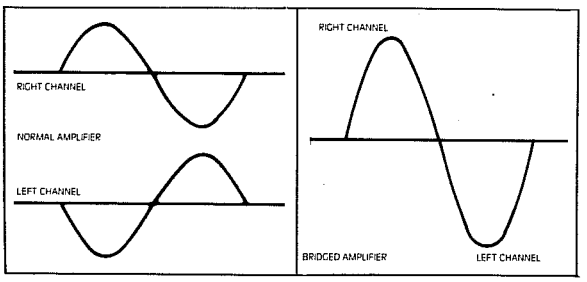
However, the deck that feeds the EQX most likely has a medium output impedance (2K to 10K ohms) and long cable lengths can be a problem. That's why we suggest mounting the EQX as close as possible to the head unit. The cables going from the deck of the EQX must be the best you can get. Not cheapo stranded shield with 80% shielding. Try to hold out for trusty 100% shielding to cut noise in this critical run.

## AMPLIFIER BRIDGING

We've provided a mono low-out for single amp/speaker low frequency systems. This is the way to go to get max power from an amp, PROVIDED THE AMPLIFIERS MANUAL SAYS IT'S ALL RIGHT. In the bridge mode, an amplifier sees ½ of the load impedance (4 ohms vs. 2 ohms).



How the amp delivers more power is the subject for some serious considerations. What a bridged amplifier does is output one channel in phase with the system and the other 180 degrees out of phase. The right channel supplies the positive half of the signal and the left channel does the negative side.




The formula for output power of an amplifier is:

$$\frac{(\text{Peak Voltage} \times .707)^2}{\text{Load Impedance}} = \text{Output Power (watts)}$$

1 CHANNEL EXAMPLE

$$\frac{(10 \text{ volts} \times .707)^2}{4 \text{ ohms}} = 12.49 \text{ watts}$$

BRIDGED AMPLIFIER EXAMPLE

$$\frac{(20 \text{ volts} \times .707)^2}{4 \text{ ohms}} = 49.48 \text{ watts}$$

Note this is four times the power of a single channel.

BIG HOWEVER: Current limitations of the power supply will almost always reduce the available current. Therefore the realized power output will be less than four times the amplifiers power output. Generally bridging is the best way to maximize output, but check the amps manual to make sure driving the amp into a 2 ohm load doesn't turn it to a pile of slag.

## CROSSOVER FREQUENCY SELECTION

Obviously, the crossover frequency will depend on the kind of installation you're doing, what kind of source, amps, speakers and the type of music the owner is going to listen to—which leads to how loud it's going to get played. Which also leads to cost. You've probably already sorted this out if you're reading this section. If you're just a do-it-yourselfer with time (and money) on your hands and aren't bi-amping or adding a subwoofer, read on and learn how you can make a good system even better.

We recommend that a crossover frequency be based on the design criteria of the midrange and tweeter. A 2-way system with 8" for low to mid and 2" dome tweeters would be determined by the tweeter's nominal frequency specs and power handling. The higher you cross over a tweeter, the higher the reliability when you decide to crank the head amp up to 5 o'clock.

In short, design for the system, not the woofers alone. We designed the EQX with a fixed but PROGRAMMABLE crossover that is the most reliable and accurate we could achieve. It will not change frequency over time.

We have provided the EQX with a 150Hz module ALREADY PLUGGED IN (so that we could fully test performance at the factory). This is a common subwoofer/dedicated woofer crossover point.

# MAKING YOUR OWN CROSSOVER FREQUENCY

We have ALSO provided you with a spare module and a chart of resistor values needed for whatever crossover point your particular system will need. Access to the crossover module is through the round access cover on the bottom of the EQX.

NOTE: The resistors used must be AT LEAST FIVE PERCENT TOLERANCE CARBON FILM.

If you don't want to make your own crossover module, we will supply one at a reasonable cost.

## Crossover resistors

Here is a table of resistors to select the appropriate one for the crossover frequency of your system.

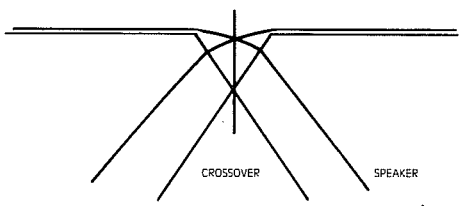
If you need a crossover frequency not listed here, use the following formula to calculate the resistor.

$$\text{RESISTOR (ohms)} = \frac{7234315.59}{\text{FREQUENCY}}$$

| Crossover Frequency | Resistor Value |
|---|---|
| 72 Hz | 100k ohms |
| 80Hz | 91k ohms |
| 88Hz | 82k ohms |
| 96Hz | 75k ohms |
| 117Hz | 62k ohms |
| 129Hz | 56k ohms |
| 142Hz | 51k ohms |
| 153Hz | 47k ohms |
| 168Hz | 43k ohms |
| 185Hz | 32k ohms |
| 212Hz | 34k ohms |
| 220Hz | 33k ohms |
| 241Hz | 30k ohms |
| 268Hz | 27k ohms |
| 300Hz | 24k ohms |
| 328Hz | 22k ohms |
| 361Hz | 20k ohms |
| 401Hz | 18k ohms |
| 452Hz | 16k ohms |
| 482Hz | 15k ohms |
| 556Hz | 13k ohms |
| 602Hz | 12k ohms |
| 658Hz | 11k ohms |
| 724Hz | 10k ohms |
| 794Hz | 9.1k ohms |
| 882Hz | 8.2k ohms |
| 964Hz | 7.5k ohms |
| 1167Hz | 6.2k ohms |

## Crossover slope

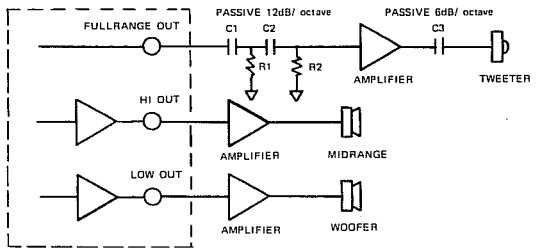
The crossover slope of the EQX is 18dB per octave. That means the speakers will blend together with an acoustically flat response and the tweeter will not be harmed by added low bass caused by flatter 6 and 12dB passive crossovers.



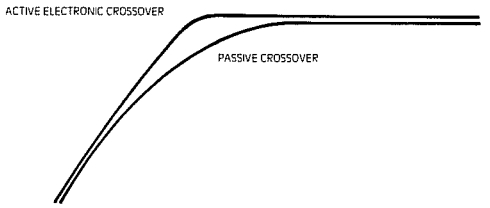

SPEAKER RESPONSE OVERLAP WILL CREATE AN ACOUSTIC FLAT RESPONSE

## Making two ways into three ways

Three-way systems can be done with the EQX by adding a "passive" electronic crossover as follows:




$C_1$ and $C_2$ form a 12dB per octave crossover. $C_3$ protects the tweeter from turn-on thump as well as providing an overall crossover slope of 18dB/octave. Note that the passive crossover slope will not be as sharp as the EQX provides.




If you want a really sharp 18dB/octave crossover, add another electronic crossover!

## LEVEL MATCHING AND WHY

One of the biggest and (up to now) least controllable factors that leads to car system noise problems is level matching. The same sort of level matching as is found in large commercial sound reinforcement systems. Audio Control engineers have a background in pro sound as well as hi-fi and it is this experience which has led to the concept and design of the EQX's level matching system.

Hiss, static and hum are caused by:

1. Poor grounding.
2. Incorrect operating level—incorrect gain structure which causes either noise or overload distortion.
3. Medium to high operating impedance. Caused by poor tape deck and pre-amp design.

## VERY IMPORTANT SECTION: THE DECK / HEAD UNIT LEFT AND RIGHT BALANCE CONTROL PROBLEM!!!!!

Allow us to get on our soap box . . . .

There is a serious problem with the balance control of most decks, that has been totally overlooked. The left/right "balance" is necessary in the midrange and high end BUT IS NOT NEEDED or even wanted in the lower, non-directional frequencies.

The problem is that an audible adjustment of mid/high balance SERIOUSLY ATTENUATES bass. Remember, just 3dB is a reduction of HALF POWER.

We seriously recommend that you adjust the high/mid output on the EQX to slightly BOOST the passenger side when the balance control is centered so that bass will not be attenuated in the most common, 1-person situations. When passengers are present, the deck balance control can be used with minimal loss of bass. That's the nice thing about having the mid/high output control on the EQX.

# THE AUDIO CONTROL EQX LIMITED WARRANTY

People are scared of warranties. Lots of fine print. Lots of noncooperation. Months of waiting around.

Well, don't be scared of this warranty. It's designed to make you rave about us to your friends. It's a warranty that looks out for you and helps you resist the temptation to have your friend "Who's good with electronics", try to repair your Audio Control EQX. So go ahead and read through this warranty, then enjoy your new component for a few days before sending in the warranty card and comments.

"Conditional" doesn't mean anything ominous. The Federal Trade Commission tells all manufacturers to use the term to indicate certain conditions have to be met before they'll honor the warranty. If you honor these conditions, we will warrant all materials and workmanship on your EQX for ONE YEAR from the date you bought it, and will fix or replace it, at our option, during that time.

Here are the conditions that make this warranty conditional:

1. You have to fill out the warranty card and send it to us within 15 days after you purchased your EQX.
2. You must keep your sales slip or receipt so you have proof when and from whom you bought your EQX. We're not the only company to require this, so it's a good habit to get into with any stereo purchase.
3. Your EQX has to have been originally purchased from an authorized Audio Control dealer. You do not have to be the original owner to take advantage of the one year warranty, but the date of purchase is still important so be sure to get a copy of the sales slip from the original owner.
4. You can not let anybody who isn't; (a) The Audio Control Factory; (b) An authorized service center; or (c) Someone authorized in writing by Audio Control to service your EQX. If anyone other than (a),(b), or (c) messes with your EQX, that voids the warranty.

(continued on next page)

5. The warranty is also void if the serial number has been altered or removed, or if the Audio Control EQX is used improperly. Now, that sounds like a big loophole, but here is all we mean by it. Unwarranted abuse is; (a) Physical damage (our mobile products are not meant to use as jack stands for your car); (b) Improper connection. We have done the best we can to protect the inputs, however 120 volts into the jacks can fry the innards of the poor beasty. (c) Sadistic things. This is the best mobile product we know how to manufacture, but if you use it for the front bumper of your Baja bug and get it full of water and dirt, things will go wrong.

Assuming you conform to numbers 1-5, and it isn't all that hard to do, we get the option of deciding whether to fix your old unit or replace it with a new one.

## Legalese section

This is the only warranty given by Audio Control. This warranty gives you specific legal rights which vary from state to state. Promises of how well your EQX will work are not implied by this warranty. Other than what we've covered in this warranty, we have no obligation, express or implied. Also, we will not be obligated for direct or indirect consequential damage to your system caused by hooking up the Audio Control EQX.

Failure to send in a properly completed warranty card negates any service claims.

# OTHER APPLICATIONS

The EQX is an amazingly affordable solution to some other home and professional problems when you use the DC power plug on the EQX along with a 12 VDC, 200mA wall plug transformer. To have the EQX turn on using the DC power plug, place a jumper wire from the +12 volt screw terminal to the Remote On screw terminal.

These uses include:

Home hi-fi systems for a great combo EQ and crossover

Professional Audio systems

Professional Industrial Applications such as restaurant, stadiums and background installs

Pro recording studio monitor and headphone EQ

Discos

In short . . .

ANY APPLICATION NEEDING GAIN MATCHING, LOW IMPEDANCE OUTPUT DRIVE AMPS, PROGRAMMABLE CROSSOVER, AND PRECISE EQUALIZATION.

# EQX SPECIFICATIONS

All specifications are at 14.4 VDC (Standard automotive voltage)

**INPUT IMPEDANCE:** 33k ohms, **OUTPUT IMPEDANCE:** 150 ohms, **SIGNAL TO NOISE RATIO** (rated full output): −105dB, **TOTAL HARMONIC DISTORTION** (20Hz-20kHz): 0.005%, **MAXIMUM OUTPUT LEVEL:** 9.5 Vrms, **INPUT GAIN:** ±18dB, **OUTPUT GAIN:** ±15dB, **EQUALIZER GAIN:** ±12dB, **FREQUENCY RESPONSE:** −dB @ 10Hz and 40kHz, 20hz-20kHz; ±0.5dB, **ELECTRONIC CROSSOVER:** 2 way, 18dB/octave, **POWER SUPPLY PROTECTION:** Input fuse, Reverse Polarity diode, Over-voltage zener diode, Spike and noise protection choke, **SIZE:** 2.25"h x 9.5"l x 6.8"w



Audio Control Division
6520 212th Street Southwest, Suite B-1
P.O. Box 3199
Lynnwood, WA 98046
Phone (206) 775-8461

## THE AUDIO CONTROL STORY

We could be making electric toothbrushes, but we're not.

Audio Control's president made that observation while explaining why we design and handcraft stereo equalizers and other sound products. Of all the things a group of employees could legally produce in a Lynnwood, Washington factory, we think a device that lets you hear music better is just about the best thing we could be making.

We incubate and hatch our products in a modern plant complete with solder baths, non-stop FM over half dozen b speakers, a ping pong table in the breakroom, a Lab with a matched set of frisbees, more test equipment than a Japanes sci-fi flick, and employees so friendly that the UPS man regularly stops in to have lunch with us.

Maybe it's that we're located out here in the misty rain forest of the Northwest where moss grows on the wind-shields, the sun rarely makes it through the overcast, and Boston ferns grow so well they've formed a union. This fertile soil has grown Carver, Phase Linear, Speakerlab, and Tapco.

Whatever it is here in the Northwest, we're perfectly content to stay here and keep producing high quality, well-engineered, affordable hi-fi equipment without so much as a glimmer of the sort of greed and me-too-manship that so often pervades the stereo market. We like producing a high quality product that is useful and gives people pleasure without wasting energy or resources. Something nobody else thought of, though should have.

Thus, we're not only interested in what goes out of Audio Control, we're interested in the comments which come back. Our fearless leader and production staff still read every warranty card, suggestions from which have lead to customer-based product changes instead of marketing department speculation.

We're really glad you bought something from us. Our appreciation will come back to you in the thousands of hours of pleasure you'll receive from your high quality Audio Control product.

The people of Audio Control


AudioControl
6520 212th SW. Lynnwood, WA 98036
(206) 775-8461