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*Solution Delivery Series*

AURAL EXCITER  
AND  
OPTICAL BIG BOTTOM

# *Instruction Manual*

P/N 999-4140  
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Manufactured by  
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**APHEX**  
S Y S T E M S

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## Safety Declarations

	<b>WARNING</b> SHOCK HAZARD DO NOT OPEN		<p>TO PREVENT FIRE OR SHOCK HAZARD DO NOT EXPOSE THIS DEVICE TO RAIN OR MOISTURE. DO NOT REMOVE THE COVER. NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL ONLY.</p> <p>ATTENTION: AFIN DÉVITER DES CHOCS ÉLECTRIQUES. N'ENLEVEZ PAS LE COUVERCLE. IL N'Y A AUCUNE PIÈCES D'ENTRETIEN À L'INTÉRIEUR. RÉFÉREZ LES RÉPARACIONES À UNE PERSONNE QUALIFIÉE.</p>
	AVIS: RISQUE DE CHOC ELECTRIQUE NE PAS OUVIR		



**CAUTION:** For continued protection against risk of fire, replace only with the same type and rating of fuse.

**ATTENTION:** pour une protection continue contre les risques d'incendie, ne remplacer qu'avec la même valeur et même type de fusible.

**WARNING:** This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the operating guide, may cause interference to radio communications. Operation of this equipment in a residential area is likely to cause interference in which case the user will be required to correct the interference at his own expense.

The user is cautioned that changes and modifications made to the equipment without approval of the manufacturer could void the user's authority to operate this equipment.

It is suggested that the user use only shielded and grounded cables to ensure compliance with FCC Rules.



Conforms to standards UL60950 and EN60950.

## A MESSAGE FROM THE PRESIDENT

Dear Aphex Customer,

We are very pleased to have been able to create the Model 204's unique, powerful processing and deliver it to you in such a cost effective package. Years of research and development, as well as over 20 years of direct experience in the recording, broadcast and PA fields produced the latest refinements of the Aural Exciter and the development of Optical Big Bottom.

There are other devices on the market which claim to do the same things as the Model 204 but the comprehensive patent protection on our technology simply makes those claims unrealizable. The truth is clearly evident every time a proper comparison is made. We are happy that you have made the right choice and we are sure that you will be happy with that choice for many years to come.



Marvin Caesar

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## ATTENTION

This instruction manual is intended to be a complete reference on the Model 204. We encourage you to read it! If you don't, at least peruse the Table of Contents to familiarize yourself with the scope of information available to you.

We want you to get the fullest measure of satisfaction from your new Model 204. To that end, this manual was written to anticipate most of the questions and problems users are likely to encounter. Please let the manual serve as your guide and mentor. You may find its various sections on wiring and connecting especially helpful.

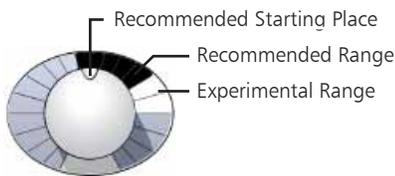
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## 1.0 Quick Start

### 1.1 SET UP

To get started fast, first pay attention to unpacking and inspection covered in section 2.3. Then, follow the wiring diagram for an in-line application shown below. If you need to run the Model 204 with an insert patch instead, refer to section 5 for more information. Finally, refer to the control settings below to get your Model 204 sounding great. Don't neglect to later run through this manual, however, as there is a wealth of useful information here for you.



Indicator Legend

### Suggested Control Settings

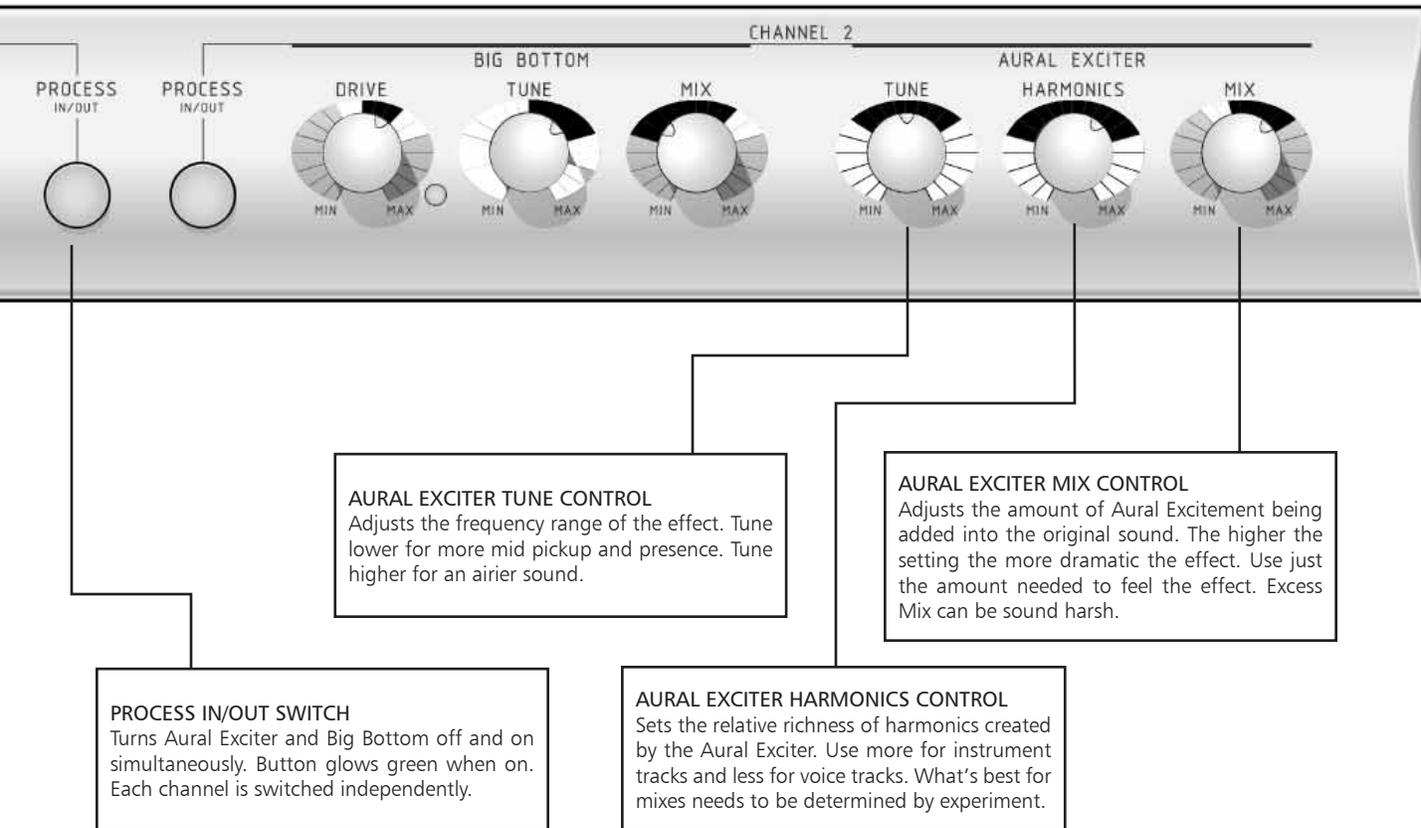
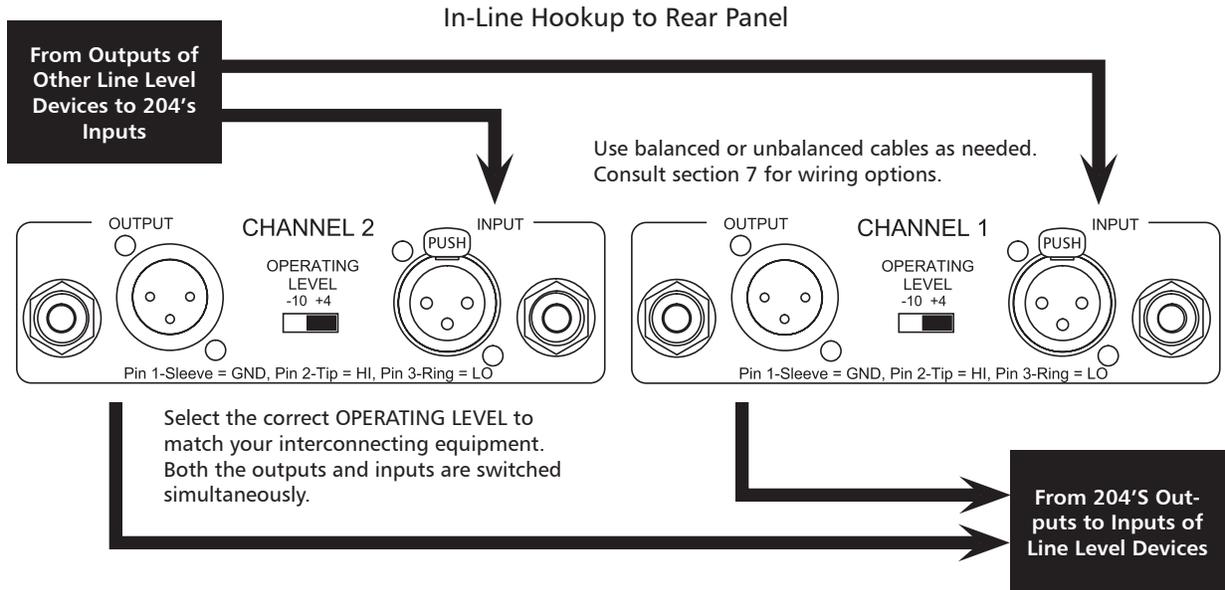
Start with the knobs pointing as shown. Then experiment with the different settings. When testing the effect of Big Bottom, turn off the Aural Exciter Mix. Likewise, turn off the Big Bottom Mix when testing the effects of the Aural Exciter. When you feel you have them both set up nicely, turn up both mixes and A/B with the IN/OUT buttons.



**BIG BOTTOM DRIVE CONTROL & INDICATOR**  
Turn clockwise until the green LED flashes brightly on bass peaks and fades out. This corresponds approximately to the amount of extra bass sustain you are creating. If the LED doesn't flash when you reach 2 o'clock, then check the Operating Level Switches.

**BIG BOTTOM MIX CONTROL**  
Adjusts the amount of bass enhancement being added into the original sound. The higher the setting the more dramatic the effect. Avoid using any more Mix than necessary or excessive peak levels will arise.

**BIG BOTTOM TUNE CONTROL**  
Sets the bass frequency range of the effect. Go clockwise to encompass higher bass frequencies, and counterclockwise to focus more on the lower bass sounds.



## 2.0 Introduction

### 2.1 THE AURAL EXCITER LEGACY

Congratulations, you have just purchased the latest in Aural Exciter technology, combined with the one and only Big Bottom circuit. Apex Systems, Ltd. started doing business in 1975 with the introduction of the Aural Exciter, which has become a standard in the professional audio industry. In the past 26 years, the Aural Exciter has been used on an innumerable number of albums, CD's, movies, broadcast productions, commercials and concerts.

Interestingly enough, the first Aural Exciter was only available on a rental basis for \$30.00 per minute! It wasn't until 1981, when the Type 2 processor was developed, that recording studios, touring companies and broadcast studios were able to purchase it.

The Aural Exciter has come a long way since then, though the basic principles of its operation are the same. After the Type 2 was well established in the professional realm, a simpler circuit was designed and placed in a low cost Type B unit in 1983, making the Aural Exciter available to DJ's and musicians for use in modest P.A. systems and project studios.

Further refinements and even lower costs were realized with the introduction of the TYPE C in 1985. In 1989 a new professional unit, the TYPE 3, was developed which included all the circuit and control improvements learned up to that time. In 1992, the TYPE C2, offered yet further improvements on the basic Aural Exciter circuitry making it quieter, more musical, and easier to set up and use. It also featured the original Big Bottom, a patented circuit which revolutionizes processing of low frequencies.

Now, the latest in this distinguished line is the Model 204 dual channel Aural Exciter and Optical Big Bottom. The 204 combines updated and improved circuitry with new attractive styling and full professional features at a very moderate price. The newly developed Optical Big Bottom circuit surpasses all other bass processors. It remains simple and easy to use.

Apex Systems is committed to providing high performance processors to the professional audio industry that are innovative and beyond the scope of similar products. The Aural Exciter and Big Bottom are patented in the United States, Japan and most of Europe. Others may claim they are doing the same thing, but they cannot. They simply have to resort to some form of EQ (amplitude correction or expansion), distortion generating, phase scrambling and/or filtering. They cannot add or restore detail, nor can they safely increase bass. They can only increase peak levels causing clipping, feedback, tape distortion and listener fatigue.

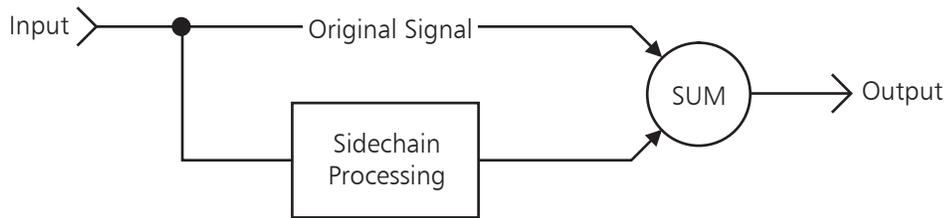
### 2.2 THE AURAL EXCITER AND BIG BOTTOM TECHNOLOGIES EXPLAINED

The AURAL EXCITER is an audio processor that recreates and restores missing harmonics. Harmonics are musically and dynamically related to the original sound, revealing the fine differences between voices and various instruments.

Reproduced sound is audibly different than the original live sound because of the loss in harmonic detail, often sounding dull and lifeless. The Aural Exciter adds harmonics, restoring the sounds natural brightness, clarity and presence, effectively improving detail and intelligibility. Using the Aural Exciter on specific instruments and/or in the final mix brings life back to the recording.

The original Aural Exciter patent disclosed a method for generating harmonics which was amplitude dependent. In nature, generally speaking, the higher the amplitude, the higher the amount of harmonics. There are instances, however, in which there are high level sinusoidal waveforms, which should not have harmonics added, and other instances which have low level transients, which could be enhanced by additional harmonics.

SIMPLIFIED SIDECCHAIN DIAGRAM



ics. Our latest patent, the Transient Discriminate Harmonics Generator, recognizes transients (transient discriminate) over a wide dynamic range and generates harmonics on them. The result is a more predictable and natural sounding enhancement over a wider range of inputs.

The Aural Exciter extends the high frequencies, unlike EQ's and other brightness enhancers which only boost the high frequencies and often alter the overall tonal balance. The stereo image is enhanced with the Aural Exciter, resulting in a greater perceived loudness without an introduction of noise into the audio path.

The Aural Exciter is a single ended process, that can be inserted at any point within the audio chain. The input signal is split into two paths. One path goes to the output unmodified, while the other path, known as a side-chain, goes through the Aural Exciter circuit which is comprised of a tunable high pass filter and a harmonics generator. The Aural Exciter circuit applies frequency dependent phase shift and transient discriminate harmonics. The output of the Aural Exciter's harmonic circuit is mixed back with the unmodified signal but much lower in level. When used at nominal settings, the Aural Exciter circuit does not add significant level to the original signal. Even though the added information is low in level, the perception is a dramatic increase in mid and high frequencies.

The Model 204 also incorporates another exclusive Aphex patent, Big Bottom, providing a stronger, more powerful bass, increased sustain and density without an increase in the peak output. While static bass-boost EQ's and subharmonic generators will increase the bass energy level, the resultant large boost in peak level often increases overload distortion.

Big Bottom resembles the Aural Exciter in that a processed signal is mixed back into an unmodified signal to produce an enhanced output signal. The sidechain path goes through the Big Bottom circuitry, comprised of a variable low-pass filter and a phase and dynamics processor.

Big Bottom circuitry dynamically contours the bass response of a complex range of shapes in the 20Hz to 120Hz range. Big Bottom increases the perception of low frequencies without significantly increasing the maximum peak output. The bass frequency response is dynamically optimized to isolate and enhance the lowest bass frequencies to provide a deeper and more resonant bass.

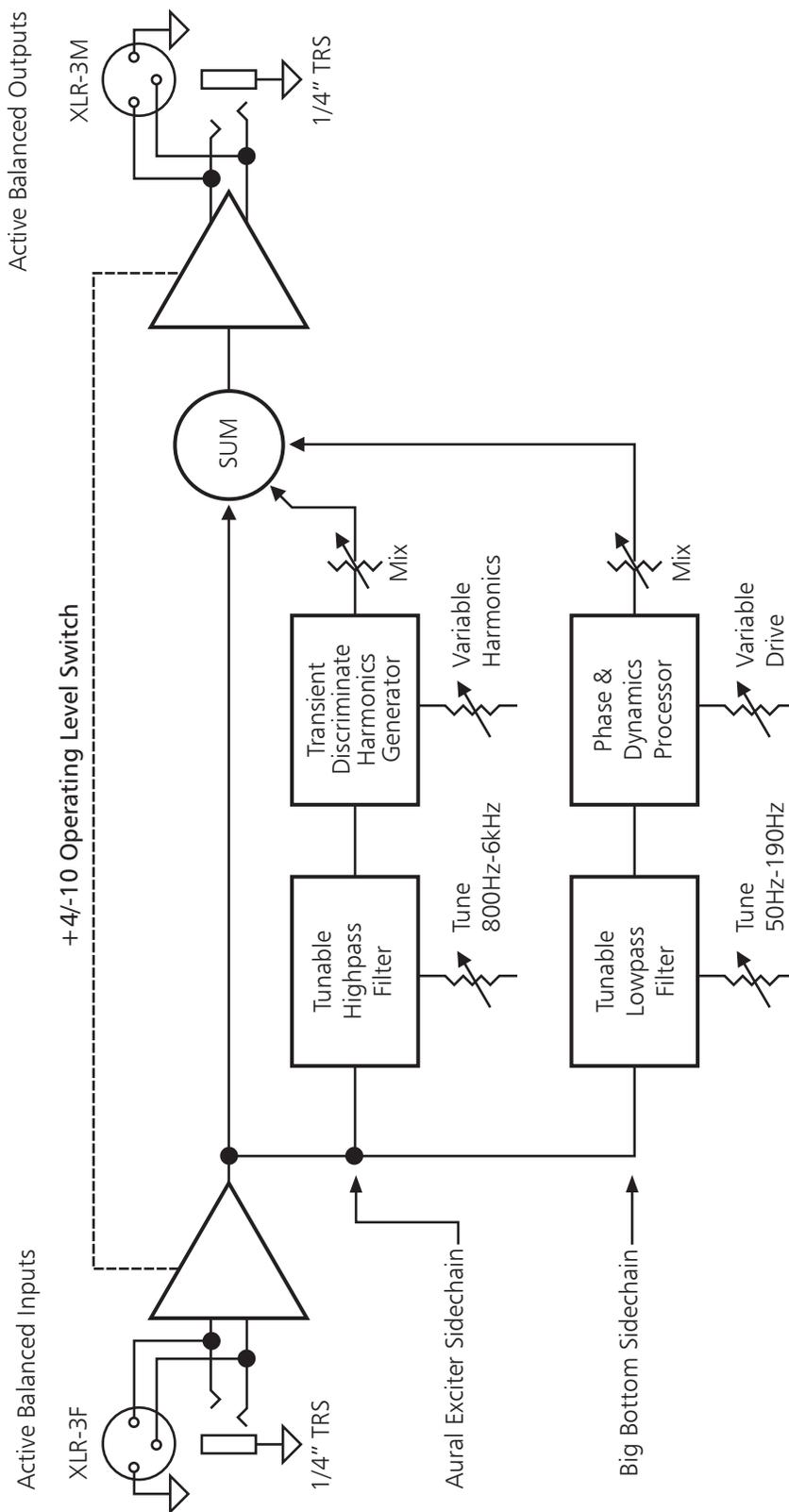
**2.3 UNPACKING AND INSPECTING**

Your Aphex product was carefully inspected and packaged at the factory prior to shipment. The carton and its internal packing materials are designed to protect the unit from most rough handling than can occur during transport and handling. However, you should thoroughly inspect the carton and its contents for signs of physical damage before attempting to use this device. It is your responsibility to immediately report any damage to your dealer or the freight company so that a damage claim can be appropriately filed. Shipping claims are always the responsibility of the consignee (that's you).

We also encourage you to save all of the original packing materials in the event that this unit should ever have to be returned to the dealer or factory for repair.

## Introduction

### 2.4 SIMPLIFIED BLOCK DIAGRAM



Effects are created through dynamic phase, frequency, and amplitude modification and recombination.

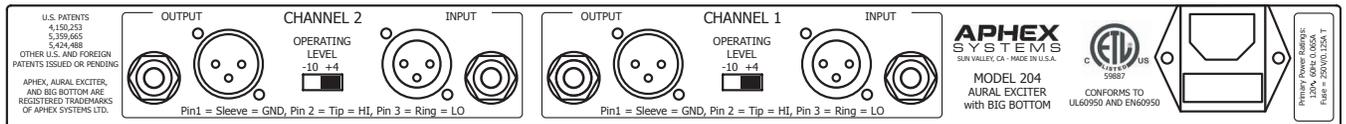
## 3.0 Installation & Interfacing

### 3.1 INSTALLATION

The Model 204 occupies a single rack space (45mm or 1-3/4 inches) of a standard EIA equipment rack.

When rack mounting, use appropriate cushioned rack screws. Never restrict air flow through the device's fan or vents. When installing the units into a rack, distribute the units evenly. Otherwise, hazardous conditions may be created by an uneven weight distribution. Connect the unit only to a properly rated supply circuit. Reliable earthing (grounding) of rack mounted equipment should be maintained. Try not to position the 204 directly above devices that generate excessive heat such as power amplifiers (unless adequately ventilated) or near equipment with heavy transformer hum fields.

### 3.2 REAR PANEL VIEW



### 3.3 AC LINE CONNECTION

Observe the label to the right of the fused receptacle indicating the nominal ac supply voltage that your 204 is built for. If your supply voltage does not agree with this rating, you will have to consult the factory or an authorized distributor or representative about changing the line voltage of your unit.



**WARNING:** The line voltage setting is not user convertible.

### 3.4 INPUT CONNECTORS

The input connectors are located on the rear panel. There are two input connectors per channel, one 1/4" TRS phone type and one XLR-3F type. All inputs are fully balanced at all operating levels. Either of the input jacks can be used unbalanced whenever necessary (consult the wiring diagrams, next page). You can take advantage of the true balanced inputs by using a "pseudo-balanced" wiring scheme from any unbalanced outboard gear. Refer to Appendix A for more wiring information.



**NOTE:** Be aware that the TRS and XLR input jacks are wired directly together, and will severely load each other down if equipment is plugged into both inputs. Use only one or the other.

### 3.5 OUTPUT CONNECTORS

The output connectors are located on the rear panel. There are two output connectors per channel, one 1/4" TRS phone type and one XLR-3M type.

Refer to Appendix A for more information on the proper wiring of balanced and unbalanced lines.

### 3.6 OPERATING LEVEL SWITCH

Between the input and output jacks are located the Operating Level switches. These switches set the nominal operating level for all of the input and output jacks simultaneously to either -10dBV or +4dBu. You should select the position that most closely matches your signal level.

In the event that you are not familiar with the operating levels of the equipment in your system, you should consult the manuals for each device so that proper gain structures are maintained. Too high an output (+4dBu) connected to a device requiring lower input levels (-10dBV) can result in clipping of the input stage and gener-

## Installation & Interfacing

ating distortion. In the reverse situation, connecting a -10dBV output to a +4dBu input will tend to increase the noise floor, thus degrading the systems signal-to-noise ratio.

In general, most entry level "home studio" equipment operates at -10dBV as it is assumed that the user will likely intermix home hi-fi equipment, such as cassette decks and CD players. Most professional recording gear and live sound equipment operates at +4dBu.

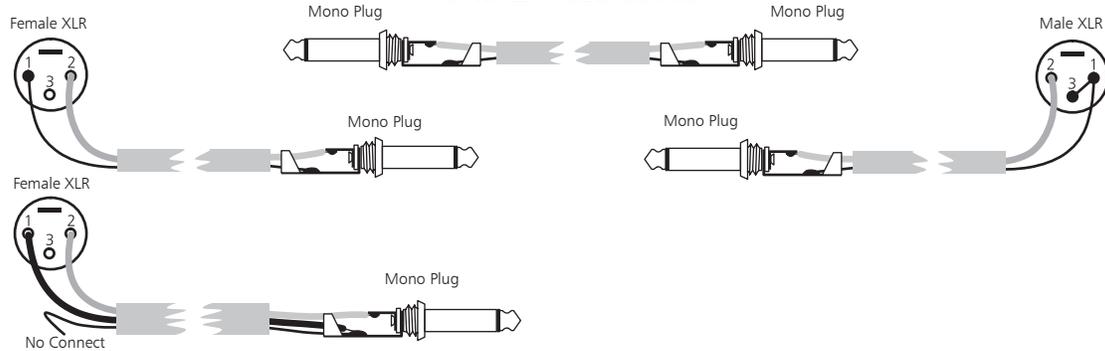
### WIRING DIAGRAMS

Throughout this manual we use TS and TRS as abbreviations. Here is a complete definition: TS refers to the Tip-Sleeve or "mono" 2-conductor type and TRS refers to Tip-Ring-Sleeve or "stereo" 3 conductor type 1/4" phone connectors. This applies to jacks (female connectors) and plugs (male connectors).

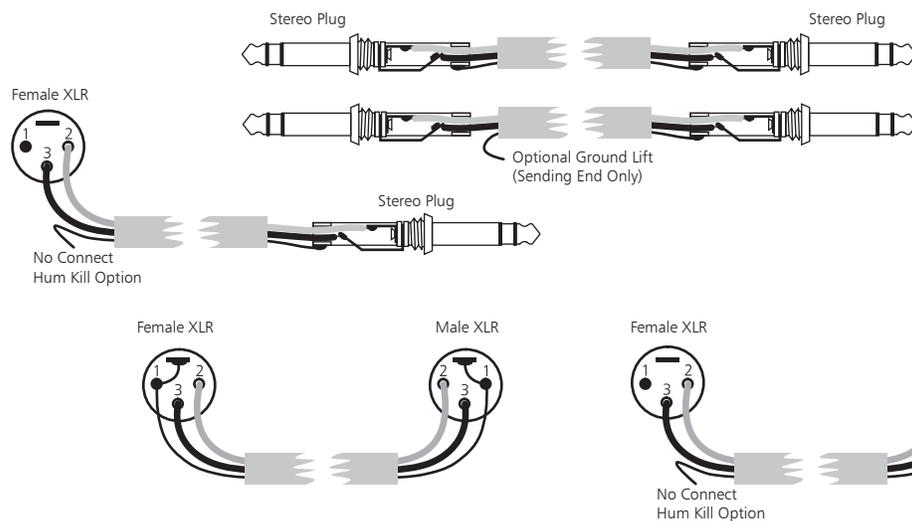
**Note:** We recommend using only conventional 1/4" phone plugs with the Model 204. Professional patch bay cords using brass PJ055 telephone type plugs are designed to a different standard and will not make full contact with the Model 204 phone jacks.

When it comes to wiring, one picture is worth a thousand words. The following illustrations show all the different ways you will probably ever need to hook up your equipment. You typically will have little trouble using professional manufactured cables, but you may wish to make your own. In case of hum, buzz, or noise troubles, check your cables against these diagrams for correctness. You may benefit from isolating the shield wire at the sending end (never the receiving end) if you experience hum using balanced cables.

#### UNBALANCED Cables



#### BALANCED Cables



## 4.0 Controls & Indicators

### 4.1 FRONT PANEL VIEW



### 4.2 BIG BOTTOM TUNE CONTROL



This control lets you optimize the bass enhancement frequency band. Where this is set depends upon your sound system and the type of music being played. Typically, 12:00 is a universal position. However, you may want to experiment with other settings. The range is from 50Hz to 190Hz. At center, you are tuned to about 110Hz.

### 4.3 BIG BOTTOM DRIVE CONTROL & INDICATOR



This needs to be set at a point where the processor receives the optimum level required for Big Bottom to work effectively. To find the optimum level, turn the control clockwise until the green L.E.D. at the right of the Drive control pulses on the bass peaks. Longer and brighter pulsation means a longer bass sustain is being created. You will find a range of settings that yields very musical and powerful bass.

If the green L.E.D. doesn't pulse by the time you reach 2 o'clock, check the Operating Level switches on the back panel and make sure they are set properly. It's possible that you have set the Operating Level switch to +4dBu and you have a -10dBV input. On the other hand, if the green L. E.D. is pulsing strongly at settings as low as 9 or 10 o'clock, you probably have a +4dBu input level with the operating level of the 204 switched to -10dBV. That can cause overload distortion.

### 4.3 BIG BOTTOM MIX CONTROL



This control adjusts the amount of Big Bottom enhancement being added to the original signal. The lower the setting, the subtler the effect until there is no effect at all. The higher the setting, the more dramatic the effect.

One of the benefits of the Big Bottom is that it can increase the bass power without greatly increasing the peak output level. That means that loudspeakers and amplifiers will not be overdriven even though the bass has been extended and increased in power. Extreme settings of the Big Bottom Mix control, however, will increase the peak output level significantly, so we recommend staying within some reasonable limits.

Generally, the best results are found between the 9 and 2 o'clock settings. Try working the Big Bass Tune, Drive, and Mix controls when maximizing the bass enhancement.

## Controls & Indicators

### 4.4 AURAL EXCITER TUNE CONTROL



The Aural Exciter Tune control adjusts the corner frequency of the high pass filter, thus setting the range of frequencies being enhanced by the Aural Exciter. The range of the corner frequency is 800Hz (fully counter clockwise) and 6kHz (fully clockwise). The 12 o'clock setting is approximately 3kHz. As the tune control is adjusted clockwise, less and less mid-frequency enhancement will take place.

Refer to the Tune Control With Frequency Markings in section 5.4.

### 4.5 AURAL EXCITER HARMONICS CONTROL



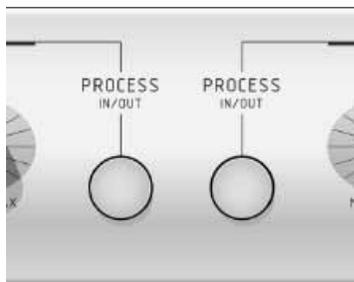
This control adjusts the amount of harmonics being generated by the exciter. It controls the texture and detail of the effect. The MIN position is generally considered NORMAL, and is useful for voices and total mixes. The MAX position is most useful on specific tracks, especially percussive instruments, horns, guitars and digital instruments. The higher settings provide more of an "edge" to a track or instrument and can sometimes make all the difference between just an OK track or one that really cooks.

### 4.6 AURAL EXCITER MIX CONTROL



This control varies the amount of enhancement mixed back into the original signal, from the sidechain. Maximum effect is achieved when the control is set fully clockwise. No effect is audible when the control is turned completely counter clockwise.

### 4.7 PROCESS IN/OUT BUTTONS



These lighted Process In/Out buttons allow you to turn the enhancement for each channel on and off individually. The IN position turns all processing on and sends Aural Exciter and Big Bottom enhancement to the outputs. The buttons glow green when processing is on. They are dark when processing is off. When processing is off, only the unmodified signal passes through to the outputs. Switching the button back and forth offers a quick A/B comparison, allowing you to hear the enhancements from the 204 in your program content.

**Note:** This is not a hard wired bypass. The audio still passes through the input and output stages but enhancement sidechains are turned off.

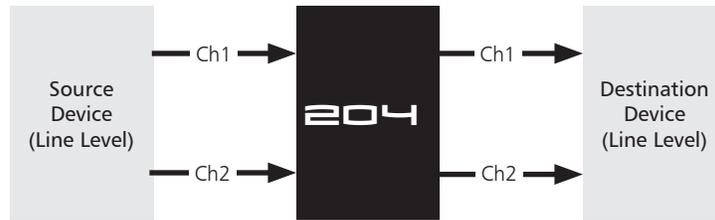
## 5.0 Operation & Applications

### 5.1 IN-LINE PATCHES

The Model 204 has two independent channels. Each channel contains one Big Bottom circuit and one Aural Exciter circuit. Each channel may be used on completely different input signals. When the 204 is used on a stereo mix, match the settings of the controls on each channel.

The Model 204 is typically used as an in-line device, see illustration below.

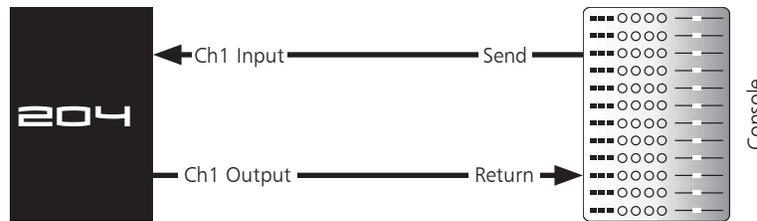
USING A 204 IN AN IN-LINE CONFIGURATION



### 5.2 CONSOLE INSERT PATCHES

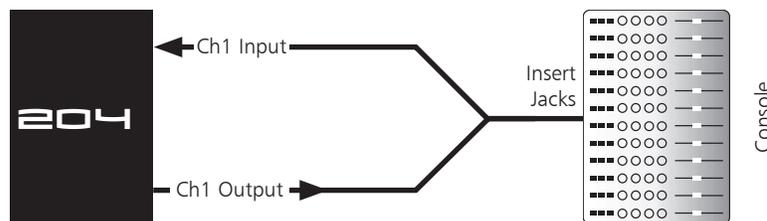
The Model 204 can also be hooked-up (in-line) through a mixing console's Input Channel Inserts or Buss Inserts in one of two ways, as seen in the following two diagrams. One of the two types of hook-ups will be specified by the console manufacturer.

USING A CONSOLE'S INSERT WITH SEPARATE JACKS



The following example is a hook-up that has become very popular particularly among manufacturers of lower to mid priced consoles. The cable required for this hook-up is a special Insert Cable of the TRS type.

USING A CONSOLE WITH A SINGLE (TRS) INSERT JACK

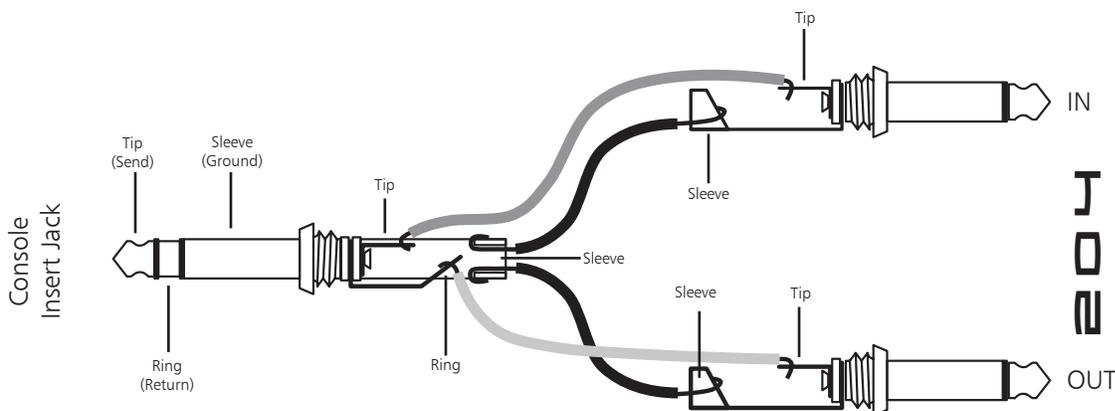


Insert Cables are more than ordinary "Y" cables. The single (TRS) side can accept a signal coming from two directions when placed in a specially designed Insert jack on a console. The "Y" section is hooked up into the Model 204 through the respective input and output jacks.

See the detailed drawing of an Insert Cable on the next page.

## Operation & Applications

### WIRING A TRS INSERT CABLE

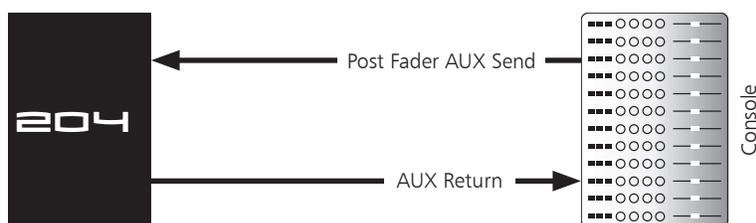


Note: Some manufacturers reverse the Tip and Sleeve connections, where the Tip is Return and the Sleeve is Send. This would mean that IN becomes OUT and OUT becomes IN when referring to the previous drawing. Be sure to check the owner’s manual of your console.

### 5.3 EFFECTS LOOP PATCHES

As we stated early on, the Model 204 was primarily designed as an in-line device. However, if you choose to use it in an effects loop, keep in mind that the signal being received back into the console is **not pure effects**. The return is a mix of effects and the original sound. Because of this we recommend that you put the Mix controls of both the Aural Exciter and the Big Bottom on the maximum setting (fully clockwise) when using the 204 in an Effects Loop. Because very little Aural Excitement goes a long way, it is possible to get very good results from this type of set-up.

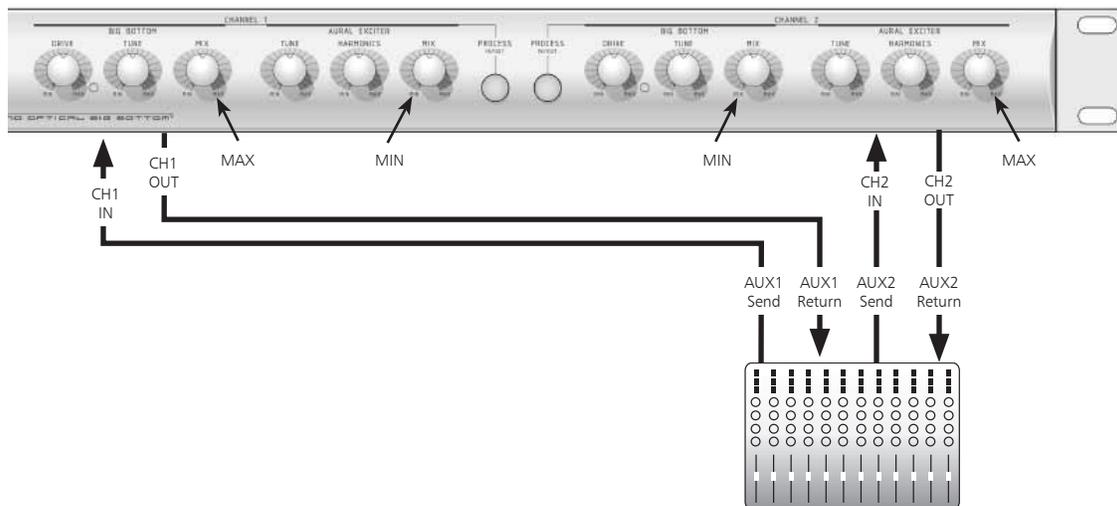
#### USING A 204 IN AN EFFECTS LOOP



5.3 EFFECTS LOOP PATCHES (cont.)

SEPARATING THE AURAL EXCITER & BIG BOTTOM EFFECTS

The following illustrates how you can use Big Bottom and Aural Exciter separately on different effects sends. Let's assign Effects (or AUX) Send 1 to the Aural Exciter and Effects (or AUX) Send 2 to Big Bottom. Now turn the Aural Exciter MIX control all the way up (completely clockwise) and turn the Big Bottom Mix all the way off (fully counter clockwise) on channel 1 of the 204. To set channel 2 up for Big Bottom processing, turn the Big Bottom Mix control all the way up (fully clockwise) and the Aural Exciter MIX all the way off (counter clockwise).



5.4 OPTIMIZING AURAL EXCITER EFFECTS

There are two independent channels, each containing one Aural Exciter circuit. Each channel may be used on completely different signals.

The front panel provides two identical sets of controls for two separate channels. The Tune control adjusts the corner frequency of the high pass filter and the Mix control varies the amount of Aural Exciter enhancement that is mixed with the unmodified signal.

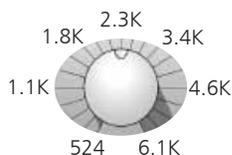
Experiment with the Aural Exciter controls to hear how each one enhances the original audio signal:

1. Make sure the Process Switch is IN.
2. Put the Aural Exciter Mix control on maximum, fully clockwise, to make it easy to hear the effect as it changes.
3. Vary the Tune control and listen for the frequency range that's being enhanced. The Tune control can be used to enhance a particular instrument so it stands out in the mix.
4. Go between MIN and MAX Harmonics and listen for the change in harmonics being added to the original audio signal.
5. After your experimental tour, set the Mix control to taste. Keep in mind that a little Aural Exciter goes a long way.

After a while you'll get a sense of where you like your Tune setting when using the Aural Exciter on individual tracks. The following chart can be used as a guideline for finding specific frequencies of commonly used musical instruments and voices.

## Operation & Applications

When the Aural Exciter is used on individual tracks it's best not to overprocess exactly the same range frequencies with the tune control during the final mix. If you already processed individual tracks with a 204 try starting the final mix with the Tune control turned fully clockwise which is approximately 6kHz You should get a spacious, three-dimensional mix with an open "airy" quality.

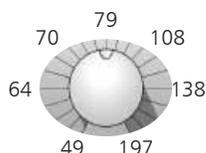


AURAL EXCITER TUNE CONTROL FREQUENCY POINTS

### 5.5 OPTIMIZING BIG BOTTOM EFFECTS

There are two independent channels, each containing one Big Bottom circuit. Each channel may be use on completely different signals. Two identical sets of controls are provided.

The Drive control needs to be set at a point where the processor receives the optimum level required for Big Bottom to work effectively. The Mix control adjusts the amount of Big Bottom enhancement being added to the unmodified signal. The Tune control sets the frequency below which the bass enhancement effects are generated.



BIG BOTTOM TUNE CONTROL FREQUENCY POINTS

Next to the Drive control is a green L.E.D. indicator. When the Operating Level (+4/-10) switch on the rear panel is set correctly and the Drive control is properly set up for nominal processing, this L.E.D. will illuminate brightly on bass peaks.

#### BIG BOTTOM EXPERIMENTING

1. Make sure the Process Switch is IN.
2. Set the Tune and Mix controls to 12:00.
3. Vary the Drive control and listen to how the bass can be made to hang over, or sustain, longer. Start by adjusting the Drive control until the green L.E.D. just flashes on bass peaks, then advance the Drive incrementally.
4. Vary the Mix control and listen for how subtle or dramatic you can make the effect.
5. Vary the Tune control to find what point gives you the most powerful or most pleasing effect.

### 5.6 RECORDING: TRACKING AND MIXING

The Aural Exciter restores presence and clarity, improving transient response of individual tracks or whole mixes. Increased harmonic detail enables specific instruments to stand out in the mix, offering a more "live" or spacious sound. Imaging is improved with an open "airy" quality.

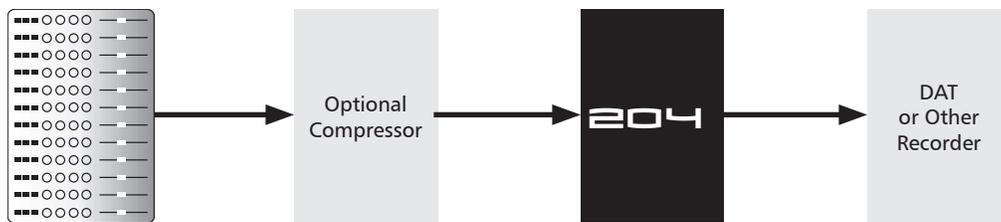
Any instrument, such as a guitar, processed through the Aural Exciter circuit will have greater penetration, crispness and clarity. Specific instruments pop out in the mix, giving the instrument its own sonic identity without raising the volume of the instrument in the mix.

Using Big Bottom on bass instruments tightens the sound, allowing individual notes to be more articulated and recognizable. Big Bottom provides more feeling, resembling a “live” sound.

In the recording studio, post production suite or similar environment, post processing of previously recorded sound tracks can restore lost vibrancy and realism, even to the extent of saving dialog or sound effects which were thought to be unusable. Instruments and vocals can be made to stand out in the mix without substantially increasing the mix levels or using equalization.

The Aural Exciter is especially useful in creating the perception of high frequencies and greater dynamics with pre-processing, bringing more presence and clarity to the final product.

The Model 204 should be hooked up between a compressor like the Aphex 208 Easyrider Automatic Compressor and any equalization. Use the Aural Exciter in place of equalization whenever possible, as shown below.

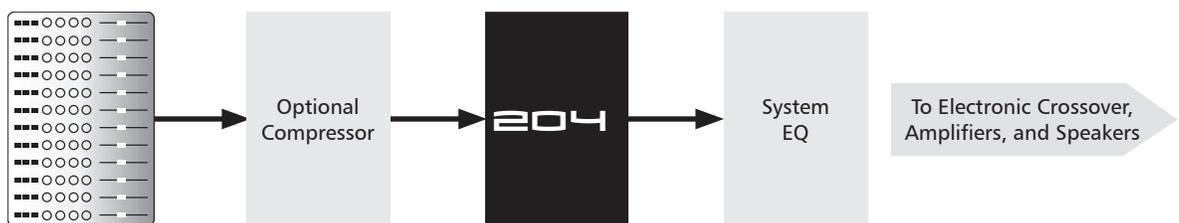


**5.7 LIVE CONCERTS & SOUND REINFORCEMENT**

The Aural Exciter adds intelligibility without increasing levels, even with speaker systems that have reduced bandwidth. It does this through higher harmonics generation which improves vocal articulation through a sound system. Audio that is processed by the Aural Exciter will more easily penetrate noisy and reverberant environments by adding brightness and clarity through the addition of harmonics rather than increasing gain of frequency fundamentals which may lead to feedback. Any voice or instrument individually processed with the Aural Exciter circuit will have greater crispness and clarity allowing them to pop out in the mix with its own sonic identity.

Big Bottom inexpensively increases the bass capacity of any sound system. It is as though you’ve added subwoofers to the system. If you already have subwoofers you’ll think the number of subs in the system was increased.

Equalizers are commonly used for tone control, elimination of feedback, and compensation for both system and room deficiencies. In some cases the Aural Exciter can replace certain functions of outboard equalizers because of the uniqueness of the Aural Exciter process. The Model 204 can be placed before or after the equalizer in the audio chain, depending on how you want to use the Model 204 in conjunction with equalization. For room equalization, we recommend placing the Model 204 before the equalizer, as shown in the illustration below. For recording and other applications, we recommend equalizing first, followed by the Aural Exciter.



## Operation & Applications

If you use a compressor for smoothing out dynamics it should go into the audio chain before the Model 204. If you are using a limiter for system protection it should be the last thing in the audio chain before amplification.

**Note:** The previous illustration depicts an in-line audio path. Most mixing consoles offer Master Bus Inserts for processing.

### 5.8 STAGE MONITORS

Stage monitors are a necessity for performers but can be a source of problems for the sound engineer. For instance, in rock concert settings the existing high levels on stage are fighting the effectiveness of the stage monitors. The most common example is when the lead singer yells at you to give him more level in his monitors because he can't hear himself over the wall of guitar amplifiers. The volume that is required from the stage monitors is high enough that you're usually on the edge of feedback.

Another situation is acoustic music performances such as folk or bluegrass. In this instance there is no problem with a high stage level. However, you have instruments that by nature have a low acoustical output that require high amounts of gain to reproduce them through PA and stage monitor systems. In this situation, you're typically on the edge of feedback especially as the number of mics increase.

In both of these examples you are trying to get more gain out of the stage monitors than the limiting factor of feedback will allow. The Aural Exciter will give you a perceived increase in volume without putting your system into feedback. Put an Aural Exciter in line when the system is stable yet close to the point of feedback. The Aural Exciter may be the most viable option under these conditions.

There are two types of monitor systems in use. The simplest and least expensive method is a foldback monitor system. Only one console is used for mixing both the "front of house" P.A. and the stage monitors. To use a Model 204 in a foldback monitor system, patch directly into the 204 from the line level monitor output on the console. The Model 204 should always come before equalization and then on to the amplifier and speakers.

The other method is known as on-stage monitor mixing. In this scenario, a separate mixing console is placed on stage to mix the stage monitors. This is prevalent in larger, more sophisticated performance settings where there is typically many monitor mixes. Since we are dealing with a separate console, in most cases you'll have a choice of using a buss insert or patching "in-line".

Refer to section 5.1 and 5.2 for patching instructions.

### 5.9 GUITAR, BASS & KEYBOARD RIGS

The sampling rates of digital devices such as synthesizers, drum machines, samplers etc. limit the instruments bandwidth and resolution. They have no high end beyond a fixed point and can sound lifeless. Use of the Aural Exciter dramatically improves their overall sound by creating additional overtones, literally doubling the bandwidth.

Any instrument, such as a guitar, processed through the Aural Exciter circuit gives the instrument its own sonic identity without raising the volume of the instrument in the mix. Musicians can include the 204 into their instrument rigs and process the sound they want before it reaches the sound mixer.

**5.10 NIGHTCLUBS AND DISCOS**

The Model 204 is great for smaller sound systems with a limited dynamic range and frequency response. You'll be surprised how much more bottom end you'll have without adding more speakers and amplifiers. No matter how good the sound system is, adding the Model 204 will improve clarity and intelligibility without increasing levels.

Big Bottom inexpensively increases the bass capacity of any sound system. It is as though you've added subwoofers to the system. If you already have subwoofers you'll think the number of subs in the system was increased.

It's also important to remember that when EQ's are introduced into the playback system they can cause ear fatigue and speaker damage. The overuse of EQ in nightclub and disco applications is commonplace. Use the Aural Exciter in place of an EQ in these applications and music seems louder and clearer, even at low levels, saving both your ears and speakers from harm.

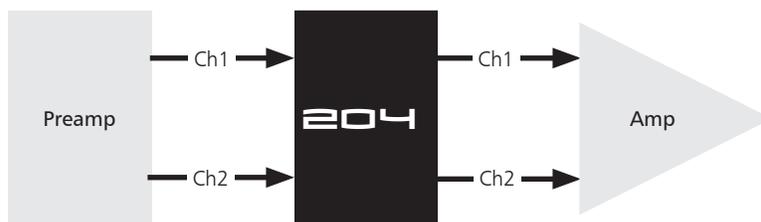
**5.11 KARAOKE & STEREO SYSTEMS**

The Model 204 is a perfect complement to Karaoke systems. In a small club situation, often the sound system and the microphones have a limited dynamic range and frequency response. Big Bottom will help tighten and increase bass. Aural Exciter helps overdubbed vocals become more intelligible and clearer in the mix. The 204 can give Karaoke performers that big "recording studio" sound that audiences want to hear.

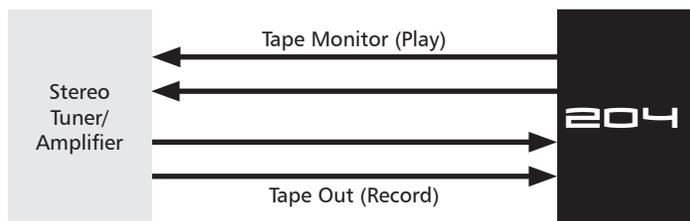
The two channels in most Karaoke and consumer grade equipment are marked left (L) and right (R), rather than one (1) and two (2). Regardless of these markings, the Model 204 can be used as a stereo component. Just make sure to match the settings of the controls on each channel for best results.

You can replace outboard EQ's in home stereo systems with the Model 204. Big Bottom increases the "punch" of the bass and the Aural Exciter "pops" vocals, guitars and keyboards out front in the mix.

USING A 204 WITH SEPARATE PREAMP AND AMPLIFIER



USING A 204 STEREO RECEIVER



## Operation & Applications

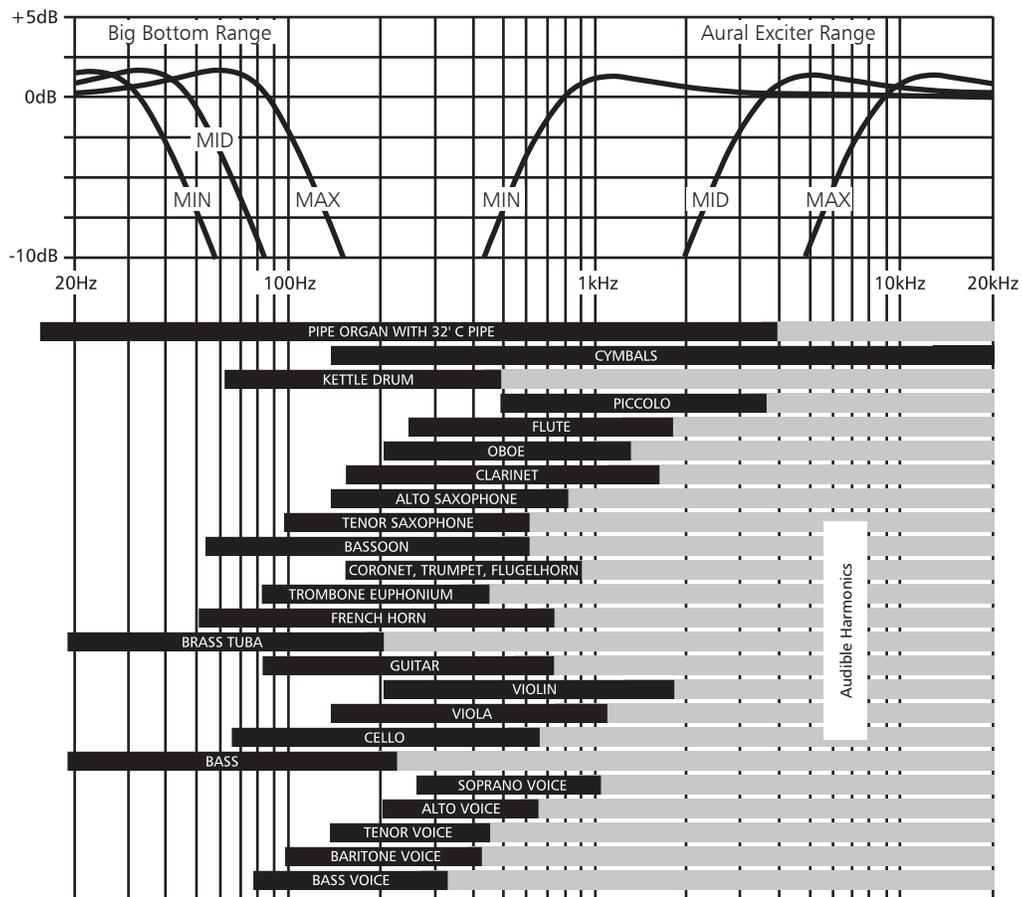
### 5.12 TAPE DUPLICATING

Tape copies actually sound better and brighter than the original if they are first processed by the Aural Exciter. Moreover, there is no generation loss! Chances of tape saturation are minimized as there is little high end boost, which is common in other enhancers.

The Model 204 may be used to "pre-process" recording to anticipate the audio degradation in the medium or during subsequent reproduction. Much of the detail added by the Model 204's Aural Exciter will survive filtering and distortion of the reproduction equipment, and provide a better quality audio playback.

Bit-rate reduced (data compressed) digital audio tracks sound flat and lifeless in comparison to the original. The Model 204 will bring these tracks back to life without unmasking the compression artifacts.

RELATING THE FREQUENCY RANGES OF THE BIG BOTTOM AND AURAL EXCITER TO THE FUNDAMENTALS AND HARMONICS OF SOUND



## 6.0 Warranty & Service

### 6.1 Limited Warranty

**PERIOD**

One year from date of purchase

**SCOPE**

All defects in workmanship and materials. The following are not covered:

- a. Voltage conversions
- b. Units on which the serial number has been defaced, modified, or removed
- c. Damage or deterioration:
  - 1. Resulting from installation and/or removal of the unit.
  - 2. Resulting from accident, misuse, abuse, neglect, unauthorized product modification or failure to follow instructions contained in the User's Manual.
  - 3. Resulting from repair or attempted repair by anyone not authorized by Aphex Systems.
  - 4. Occurring from shipping (claims must be presented to shipper).

**WHO IS PROTECTED**

This warranty will be enforceable by the original purchaser and by any subsequent owner(s) during the warranty period, so long as a copy of the original Bill of Sale is submitted whenever warranty service is required.

**WHAT WE WILL PAY FOR**

We will pay for all labor and material expenses for covered items. We will pay return shipping charges if the repairs are covered by the warranty.

**LIMITATION OF WARRANTY**

No warranty is made, either expressed or implied, as to the merchantability and fitness for any particular purpose. Any and all warranties are limited to the duration of the warranty stated above.

**EXCLUSION OF CERTAIN DAMAGES**

Aphex Systems' liability for any defective unit is limited to the repair or replacement of said unit, at our option, and shall not include damages of any other kind, whether incidental, consequential, or otherwise.

Some States do not allow limitations on how long an implied warranty lasts and/or do not allow the exclusion or limitation of incidental or consequential damages, so the above limitations and exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from State to State.

### 6.2 SERVICE INFORMATION

If it becomes necessary to return this unit for repair, you must first contact Aphex Systems, Ltd. for a Return Authorization (RMA number), which will need to be included with your shipment for proper identification. If available, repack this unit in its original carton and packing material. Otherwise, pack the equipment in a strong carton containing at least 2 inches of padding on all sides. Be sure the unit cannot shift around inside the carton. Include a letter explaining the symptoms and/or defect(s). Be sure to reference the RMA number in your letter and mark the RMA number on the outside of the carton. If you believe the problem should be covered under the terms of the warranty, you must also include proof of purchase. Insure your shipment and send it to:

Aphex Systems, Ltd.  
11068 Randall Street  
Sun Valley, CA. 91352  
PH: (818) 767-2929 FAX: (818) 767 -2641

## 7.0 Appendices

### Appendix A: Balanced and Unbalanced Lines and Operating Levels

Interfacing all types of equipment with balanced and unbalanced lines and can sometimes be troublesome. First you have to somehow connect balanced to unbalanced and then you have to deal with different levels. This tutorial will teach you about the principles of balanced and unbalanced lines, wiring standards, and how to effectively interface them.

#### Standards

Professional audio equipment usually comes equipped with inputs and outputs that are balanced using 3-pin XLR connectors and sometimes 1/4 inch phone jacks as well. This equipment most often is designed to operate at +4dBu, a professional industry standard. That translates to a magnitude of 1.23 volts RMS (Root-Mean-Squared).

Consumer gear has unbalanced I/O as standard, usually on RCA jacks. The normal operating signal level follows the IHF (Institute of High Fidelity) standard of -10dBV, or 0.316 volts (316mV) RMS. Converting to dBu dimensions, this works out to be the same as -7.79dBu. There is therefore a difference of 11.79dB between pro and consumer operating levels.

#### Grounding

There is the notion that some kind of earthly "ground" exists out there that sinks all the noise and acts as some kind of a shield. You see wires connected to ground rods and water pipes that are supposed to get a good ground. This is not a correct interpretation of grounding from an audio standpoint. Proper grounding of equipment and wiring is important and you will gain a better understanding of that as you read along.

#### Balanced -vs- Unbalanced

Every audio signal is connected through a circuit. The circuit must contain two conductors to create a complete return path. In other words, a signal voltage is conducted to a piece of equipment by injecting a current into a wire. That current has flow through to the destination through the wire and return back to the source through another wire. Since audio is an alternating voltage, swinging through negative and positive polarity, the current through the two conductors changes direction each alternate half cycle. Which wire is the source and which is the return alternates accordingly. In this regard, balanced and unbalanced lines are the same. They both need two conductors.

What makes a system unbalanced is when one of the wires is formed into a tube that wraps around the other conductor, without touching it, such that the outer conductor can be said to "shield" the inner conductor. This describes all of the coaxial cable used for video, cable-TV and radio as well as most of the high fidelity audio cables.

#### Balancing

If both conductors are identical insulated wires that are twisted together, then they form a balanced line. This describes telephone lines, microphone cables, and most professional audio cables. Typical balanced cables include an additional shield wrap around the twisted pair, but this is not strictly required for balanced lines to work properly.

Many people, because they have more experience with unbalanced wiring, think that balanced is confusing. Believe it or not, balanced lines are really easier to understand than unbalanced. There is no grounding issue with balanced, and the way it works is perfectly natural and simple. Balancing naturally rejects hum and noise and eliminates all sorts of complications in interfacing.

Balanced transmission works something like this. Your balanced input stage looks at the two wires and detects only the potential (voltage) difference between them. Anything that is the same on the two wires (for all practical purposes as seen measuring from ground) is called a common mode signal and is cancelled out by the differential amplifier. Figure 1 illustrates how the hum is induced into both wires equally and therefore is cancelled out.

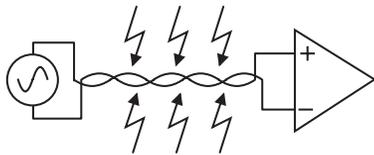


Figure 1 Balanced Line Model

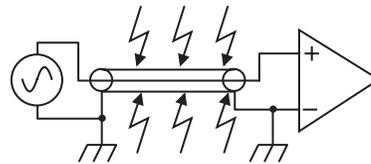


Figure 2 Unbalanced Line Model

It can be seen that the signal generator driving the twisted pair will cause a difference between the wires, and that signal will be readily picked up by the differential input stage. One of the beauties of the balanced line is that it is completely independent from ground. Nothing is connected to ground at all, nor does it care about ground. Nevertheless, most professional cable has an overall shield wrap that is intended to be connected somehow to ground. You may well ask why, and the answer is less than glorious. Simply, nothing is perfect, not even balanced cable. Under some circumstances the shield can overcome extreme interference problems that can't be adequately rejected by the twisted pair alone. Things like 2-way radios, television transmitters, and light dimmers can induce very heavy interference that may be reduced by shielding. You are going to find virtually all balanced cables include a shield so you need to deal with it, even if it is not actually needed. That subject will be addressed a little later.

**Unbalancing**

Unbalanced wiring works a little differently. Figure 2 shows the basic plan. In this case, the wires are not twisted, they are coaxial. The unbalanced input stage is somewhat like the balanced input stage because amplifies a difference signal, but this time it is the difference between two non-symmetrical conductors. To make things even less symmetrical, the outer conductor is connected to ground at both ends. The principle is that the outer shield conductor shields the inner conductor from induced noises. This can only work well if the cable is relatively short and the ground at each end of the cable is somewhat equal, i.e., there is no "grounding difference" that can cause current to flow through the shield conductor. Grounding difference is a serious problem in studios, because often the equipment grounds are connected to power outlet grounds, and there can be a significant difference of ac voltage between alternating wall outlet grounds. For this reason, unbalanced systems can sometimes never be made hum free, and just changing one piece of equipment in a studio can cause hum to appear somewhere else. When you are using unbalanced gear, it is a very good procedure to power all your equipment from one large power isolation transformer. At the very least, make sure all equipment is powered together off the same distribution panel circuit (same circuit breaker).

## Appendices

### Appendix B: Dealing With Grounds and Hum

#### Ground Loops

Many people equate this term with hum, and that's just about the bottom line of it. If you have a ground sensitive system, like unbalanced audio equipment for example, then hum will result from ground currents that flow from the ac power system. It is sometimes very difficult to isolate and stop ground currents between unbalanced equipment, but it is quite easy to clean up balanced gear. That's why pro gear is always balanced! The cost of balancing is that of more expensive connectors, cable, and electronics but the cost is worth it when you depend on your audio quality. That's why the Model 204 is equipped with a fully balanced I/O. Now that we've sold you on only using really expensive pro gear, lets show you how to get away with the really cheap stuff! At least from the standpoint of killing ground hum.

A ground loop is an ac current that has become routed through your audio ground system. The current comes mainly from ground potential differences that exist between different wall outlets that return to opposite phases at the power distribution panel. Secondly, however, many pieces of equipment contain line filters and transformers that leak a small amount of ac power into the chassis and ground return.

You may once have had the experience of getting zapped by touching two pieces of gear at the same time. That illustrated the ground loop effect - - straight through you! No matter what you do, you may not be able to prevent some of your equipment from generating ground currents. The most likely culprits are digital products because they use switching power supplies that require heavy line filters to prevent conducted EMI from going out of the box. Filters so employed very often take the ground leakage current right up to the UL safety limits. Although it won't kill you, that is a lot of ground loop current for audio cables to handle.

There are basically three ways to attack the problem of a ground loop. First is to eliminate it from its source, and the second is to re-route it through another path. The third is to balance out your unbalanced audio interfaces.

#### Identify the Sources

A good way to identify grounding problems is to use a multimeter to check the ac voltage between the chassis of your various gear when no audio cables are hooked up and all gear is plugged in and switched on. Just start touching the two probes to the metal chassis of different pieces of gear. Ideally, you should always see zero volts. Warning! You may see as much as the whole line voltage between two different chassis! It does happen. This voltage between chassis will be responsible for your ground loop problems. If you find there is more than about 1 volt between equipment grounds, you should start looking for a remedy.

#### Commonize the Power

Try plugging all of your equipment into the same outlet strip. Get one that has enough outlets in one strip or string more than one together. Of course, you need to make sure you don't overload the one ac circuit your strip is plugged into. If the load is too great for one circuit, use a second or third circuit that is tapped off the same 120 volt phase in your distribution panel. That means all outlets should be on odd or even numbered circuit breakers. That's because, as you go down the column, the circuit breakers tap into alternating legs of your incoming electric power. Be sure you're always on the same leg. You can tell you're on the same leg by measuring the ac voltage between the hot slots of the different outlets you've chosen. It should be very low or zero. That will remedy 50 percent of the cases.

#### Check the Cord Polarity

For products that have 2-wire power cords, try reversing one of the power cords in the socket. That may reduce the ground current generated by the internal electronics of the offending gear.

### **Redirect Ground Loops**

Sometimes it just comes down to brute force grounding. That means providing such heavy, low resistance, ground current paths that little current is left to flow through your audio grounds. You can try adding heavy gauge, for example 12 gauge, copper wire from chassis to chassis. You will need to locate a metal screw that solidly binds to the metal chassis of the gear. You may even need to drill a hole through the chassis and install a screw yourself. Equipment in rack shelves can have their chassis grounded to the metal rack frame by a heavy wire and the frame itself can act as a brute force ground. You just have to try everything you can think of. Usually a combination of all these methods will be needed to completely clean up a badly humming audio system.

### **Balance Out the Audio**

Remember, balanced lines are inherently hum free. If you can balance out your unbalanced equipment, you will be able to stop the hum.

### **Pseudo Balancing**

You will find in Table 2 an interconnecting method called Pseudo Balanced. This works when connecting an unbalanced output to a balanced input. This breaks up the ground loop by requiring the shield to be grounded only at one end. For best results always ground the shield only at the receiving end.

### **Level Interface Units**

Aphex manufactures the Model 124 Level Interface box which is designed to electronically convert two unbalanced inputs and outputs two balanced inputs and outputs, and at the same time translate the -10dBV IHF unbalanced levels to the pro +4dBu balanced levels. This cost effectively gives your non-professional unbalanced equipment a fully professional I/O equal to the world's best pro audio gear. Seriously consider putting one of these on each unbalanced piece of gear you use.

### **Avoid Transformers**

The use of balancing transformers is an option, but you will invariably lose audio quality due to transformer limitations. Try everything else first.

## **Appendix C: Wiring Techniques**

A true balanced line should be used wherever your equipment allows. Use "twisted pair" shielded cable. For unbalanced wiring you should use high grade, low capacitance shielded wire for best results. If you have an unbalanced output but have a balanced input, the "pseudo-balanced" configuration may help deal with ground loop hum. This method and others are illustrated in Table 2.

### **CONNECTOR WIRING STANDARDS**

The 3 pin XLR, 1/4" (63.5 mm) TS mono phone and the 1/4" (63.5 mm) TRS stereo phone are the most commonly used line level connectors in pro audio. Less common is the use of the "RCA" phono jack, which is essentially a consumer type connector. The XLR and the TRS are three conductor and are used for balanced connections. The TS and the RCA are two conductor and are used for unbalanced connections.

In addition to the three main contacts on an XLR there is also a grounding lug contact. This lug is connected to the connector's case (shell). In all Aphex products audio ground and chassis ground are one and the same. Aphex products that use XLR connectors tie Pin 1 to the XLR case automatically. **Therefore it is not necessary to use the XLR case-ground lug.** This also makes possible the use of XLR ground drop adapters (see Note 3).

## Appendices

TABLE 1: The following wiring convention is now standardized in 17 countries including the USA. Please note that any equipment that still uses Pin 3 as positive on XLR connectors is not adhering to the standard.

TABLE 1 - BALANCED & UNBALANCED CONNECTOR WIRING STANDARDS		
3-Pin XLR	1/4" TRS Phone	Standard Wiring Convention (Balanced)
Pin-1	Sleeve	Ground/Shield (Earth, Screen)
Pin-2	Tip	Positive (Signal, High, Hot)
Pin-3	Ring	Negative (Signal Reference, Return, Low, Common)
1/4" TS Phone	RCA	Standard Wiring Convention (Unbalanced)
Tip	Center Pin	Positive (Signal)
Sleeve	Shell	Ground/Shield (Signal Reference/Return)

### THE PIN 1 DILEMMA AND HOW IT AFFECTS CABLE SHIELD CONNECTIONS

The three main contacts on an XLR (or TRS) and the accepted wiring assignments shown above are only part of the picture. The standard for terminating ground is Pin 1 (Sleeve). But which ground? It could be connected to audio signal ground or chassis ground depending on the method of grounding used by the equipment manufacturer. In all Aphex products audio ground and chassis ground are one and the same. This is just good, common sense engineering practice (which is what you would expect from us, course). Unfortunately, many products are designed so that the noisy currents from the shield drain into signal ground instead of chassis ground. This practice creates a real problem for end-users. The appropriate overall grounding scheme of an audio system would be a lot easier to predict without this problem<sup>1</sup>.

The standard balanced line wiring recommendation from Aphex Engineering is this: In the majority of cases maximum noise rejection occurs when the shield is connected to the input ground only (especially in locations with high levels of RFI). That means the sending end shield should be left disconnected. **However, if you already have cables with the shield connected at both ends, go ahead and try them out. If you are connecting a fairly simple audio system it may be fine as is.**

**A word on optional shield connections:** Connecting the cable shield of a balanced line at both ends creates unnecessary ground loops which may carry noise and hum currents that can be amplified. Connecting the shield only at the sending end (instead of the receiving end) may exaggerate common mode noises at the receiving input stage. It can actually increase RFI and noise more than having no shield at all. Because of the "Pin 1 Dilemma" (mentioned above) you may be forced, in some situations, to experiment with how the cable shield is connected to ground to eliminate a pesky hum or radio interference problem. It might be good to try XLR ground drop adapters (see Note 3) as a method of trying these conflicting methods out and being able to change easily if necessary.

### IMPEDANCE

Regardless of inaccuracies, it has become more or less standard over the years to refer to balanced lines as low impedance and unbalanced lines as high impedance. The fact is, however, that both balanced and unbalanced lines are operated at low impedance in modern practice owing to the fact that all output stages have become low impedance. A few exceptions might be outputs from passive mixers, instrument pickups, electric guitars and some keyboard synthesizers. It is generally ideal to drive any audio line from a low impedance and receive into a high impedance (generally at a minimum of a 1: 10 ratio - this is called a "bridging" impedance). This

has in fact become modern practice and all balanced inputs are normally running 10K ohms or higher impedance. Because of these developments, it is now no longer as critical to consider impedance when dealing with interfacing pro line level equipment (impedance “matching” is mostly a requirement of the past).

**A word on impedance and interfacing adapters:** If you are connecting between two line level devices and they have different connectors (example: 1/4” phone to XLR or vice-versa), you do not need to use an impedance matching transformer. With very few exceptions you are strictly dealing with a difference in connector types and should only use hard-wired adapters (or cables) for this situation.

**TABLE 2**

Table 2 is a comprehensive guide to line level interfacing. It shows simple block wiring diagrams that apply to all types of audio connectors in use. Use Table 1 to match the contacts in Table 2 to the contacts on the connector you intend to use. For the exact wiring of the connectors used for each Aphex product - use the diagrams in the respective User’s Manuals.

## Appendices

TABLE 2 - - TYPES OF ACTIVE BALANCED INPUT/OUTPUT CIRCUITS & INTERFACE WIRING				
OUTPUT TYPE	WIRING DIAGRAM (Interface from OUTPUT to INPUT)	INPUT TYPE	Resulting Interface METHOD / LEVEL	
1 Unbalanced	<p>Wire: single conductor with a shield (coax style)</p>	Unbalanced	Unbalanced	Unity Gain <sup>2</sup>
2 Unbalanced	<p>Wire: two conductor with a shield (twisted pair)</p>	Balanced	Pseudo Balanced (see Note 4 for Unbalanced wiring)	Unity Gain <sup>2</sup>
3 Voltage Balanced	<p>Wire: two conductor with a shield (twisted pair)</p>	Unbalanced	Unbalanced	6dB Loss <sup>2</sup>
4 Voltage Balanced	<p>Wire: two conductor with a shield (twisted pair)</p>	Balanced	Balanced	Unity Gain <sup>2</sup>
5 Impedance Balanced	<p>Wire: two conductor with a shield (twisted pair)</p>	Unbalanced	Unbalanced	Unity Gain <sup>2</sup>
6 Impedance Balanced	<p>Wire: two conductor with a shield (twisted pair)</p>	Balanced	Balanced	Unity Gain <sup>2</sup>
7 Cross-Coupled Balanced (Aphex Servo Balanced)	<p>Wire: two conductor with a shield (twisted pair)</p>	Unbalanced	Unbalanced	Unity Gain <sup>2</sup>
8 Cross-Coupled Balanced (Aphex Servo Balanced)	<p>Wire: two conductor with a shield (twisted pair)</p>	Balanced	Balanced	Unity Gain <sup>2</sup>

**NOTES**

The following notes are referenced in the text and in Table 2 on the preceding pages.

**Note 1:** ADDITIONAL READING SUGGESTIONS: Sound System Engineering by Don Davis and Carolynn Davis (Howard W. Sams and Co.), Handbook for Sound Engineers (The New Audio Cyclopedia) Edited by Glen Ballou (Howard W. Sams and Co.) and Sound Reinforcement Handbook by Gary Davis and Ralph Jones (Hal Leonard Publishing Corp.).

For more information on the "Pin 1 Dilemma" see the June 1995 issue of the Journal of the AES (Vol.43/No.6, Audio Engineering Society, New York). This issue is dedicated to "Shields & Grounds."

**Note 2:** TABLE 2: LEVEL CHARACTERISTICS (unity gain verses 6dB loss)

Diagrams 1, 2 and 4 through 8: The effective interface gain will remain at 0dB for all of the interfaces shown.

Diagram 3 Balanced to Unbalanced: This configuration should be used with equipment incorporating a conventional active balanced output stage. Most non-Aphex equipment uses this kind of output stage because of its simplicity and low cost. Therefore, you will find yourself using diagram 3 fairly often when interfacing typical equipment together. In this case, the interface gain will be 50% down, giving a 6dB loss of level. This is because each output driver has fixed gain and supplies only half the balanced output amplitude. You can usually compensate for the loss by adjusting the output level or input level settings on the associated equipment.

**Note 3:** XLR GROUND DROP ADAPTERS A word on using XLR ground drop adapters (and mic cables): A secondary advantage to not using the XLR case lug as a ground is the ability to use barrel style XLR "ground drop" adapters (hard-wired female to male XLR adapters with Pin 1 disconnected). These can be used on one side of the cable to disconnect the ground as discussed earlier. If the case lug is tied to the cable's shield (with or without Pin 1) the cable will still be grounded to the equipment's ground though the XLR ground drop's case. XLR ground drops are useful especially for live sound situations where the same stock of XLR cable may be used for line level patching and/or for patching microphones. The reason is that XLR cables used for microphones should never have the shield disconnected at one end. This is a safety issue for the performing artist - microphones should always be grounded!

**Note 4:** If you have an unbalanced output but have a balanced input, the "pseudo-balanced" configuration may help deal with ground loop hum. However, it is possible to wire this as an unbalanced interface. To wire unbalanced - use a coax cable with a single conductor and a shield, wire as follows: Output (From) - connect the ground contact to the cable shield, connect the positive contact to the positive conductor; Input (To) - connect the ground and the negative contacts to the cable shield, connect the positive contact to the positive conductor. Please note that this in fact occurs by default when plugging an unbalanced cable with a 1/4" TS (Tip-Sleeve) phone plug into a TRS (Tip-Ring-Sleeve) phone jack.

**Note 5:** Some electronically balanced output circuits from other manufacturers exhibit problems when the negative output amplifier is shorted to ground in order to drive an unbalanced load. The grounded output amplifier pumps current onto the ground which may cause distortion or cause the amplifier to fail. When wiring this type of output be careful to leave the negative contact unterminated.

**Note 6:** Shield Option: Connect receiving end only. See text preceding Table 2 titled - THE PIN 1 DILEMMA AND HOW IT AFFECTS CABLE SHIELD CONNECTIONS

**Note 7:** Single-Ended, Impedance-Balanced

**Note 8:** It is possible to wire this as an unbalanced interface. To wire unbalanced - use a coax cable with a single conductor and a shield, wire as follows: Output (From) - connect the ground and the negative contacts to the cable shield, connect the positive contact to the positive conductor; Input (To) - connect the ground contact to the cable shield, connect the positive contact to the positive conductor.

## Appendices

### Appendix D: Back To BASS-ICS

by Marvin Caesar

Think of a sound system with incredible bass. Are you imagining the sound of the bass or are you imagining how the bass would feel? If you are imagining sound, then you are thinking too high in frequency. The bass referred to in this article causes a visceral response.

For those who don't relate to feel (and won't eat quiche), these are bass frequencies lower than 80Hz. Therefore, if your interest is speech only, you should read this article only for a further understanding as to why some full range systems will make you want to dance while others will make you want to run.

Ask any non-professional to listen to a sound system. Reduce the bass, listen, then reduce the high frequencies, return the bass to flat and listen again. The listener will probably decide that listening to the system with attenuated highs is much preferable to listening to the system with attenuated lows.

David J. Holman, a friend of ours and a recording engineer and producer of several platinum albums had this to say about bass: "Bass is the most important thing on a record. Without it you don't have a record. People think bass is just the bass instruments, but it is also the "wood" in an acoustic guitar and the "chest" of a male vocalist. With a good low end, a synthesizer sounds rich and expensive. Without a good low end, it just sounds like more digital nonsense.

Maintaining quality bass over a wide dynamic range is made difficult by subjective human hearing response. As shown in the constant-loudness curves published by Harvey Fletcher and Wilden Munson, the threshold of hearing at the extreme low frequencies requires approximately 60 dB higher sound level than the threshold of hearing at 1kHz. The hearing curves gradually become fairly flat at listening levels around 90dB-SPL, and remain so above that level.

This explains the well-known phenomenon that occurs when playback level is reduced: the bass seems disappear.

Over the years, several methods have been used to overcome this phenomenon. The most common method has been fixed equalization. We're all familiar (maybe too familiar) with the disco smile on graphic equalizers: lowest and highest frequencies pushed up, the midrange sagging. By adding a fixed amount of gain on the low end, this method helps overcome the disappearing bass phenomenon. The problem caused by this added gain, however, may be more serious than those solved.

The principle of superposition is that the motion of electrons in a circuit, or of air around our ears, is single vector sum of all the forces at work. Different electrons don't alternate at different frequencies; of the electrons in the circuit have the same instantaneous potential and direction. Figure 1 shows a high frequency riding on a low frequency. Although frequency is not usually shown this way, this is just the way the superposition works, in a wire or at our eardrums.

Headroom is the range, in decibels, between present operating levels and the crash point, those levels that would damage equipment or distort signal. There is no such thing as infinite headroom,

electronic or acoustic. If the low frequencies are increased in level, even though the boosted frequency band never reaches the crash point, the higher frequency peaks are closer to or exceed the crash point.

As the boosted frequency band gets lower in frequency, this phenomenon gets more pronounced. Imagine adding a direct-current offset into an amplifier, and how quickly this change would send the signal into distortion. Subharmonic generators are sometimes used for bass enhancement. These devices read signals in the mid-bass frequency area and synthesize artificial signals an octave below these signals. The use of subharmonic generators also causes an increase in overload problems, with overloads taking place at higher frequencies.

Many systems are biamplified, triamplified or quad-amplified. Such systems might avoid the peak overload characteristics of wide-band systems, but adding a fixed amount of low frequency gain or increasing subharmonics can cause overload problems within the bass band(s).

Let's ignore overload problems for a moment and look at the sonic effects of these methods. Adding bass boost through equalization or subharmonics might be quite musical when the bass needs the enhancement. These methods, however, have no way of determining when the bass does not need the enhancement and when it does. If the bass content in the source material is sufficient, adding fixed equalization or subharmonics would surely make the output too bottom-heavy.

That brings us to yet another method of bass enhancement: multiband gain control. The signal is divided into frequency bands, and each band is separately processed through an automatic gain control circuit, which narrows the dynamic range in the band. Whether the outputs of the separate compressors are summed again into a single band or sent directly to amplifiers, this method helps keep the bass within a limited time dynamic range, increasing level when the input is low and decreasing level when it is high. The multiband feature reduces spectral intermodulation (one part of the spectrum modulating another), which could be introduced by a simple wide-band device.

Although this method maintains a limited dynamic range, by definition it changes the dynamics of the signal. Thus the sound of the output will depend upon compression ratios, attack and release characteristics and threshold. Depending on how aggressively the signal is being compressed, it may sound totally mashed. Furthermore, if there is far greater gain reduction in one band than in others, the total integrity of the entire mix may be thrown out of balance.

#### A NEW SOLUTION

What to do? Enter Big Bottom (sideways, if it is a narrow doorway).

Aphex's Donn Werrbach, the inventor of the Compellor, the Dominator, and several versions of the Aural Exciter, comes from a broadcasting background. In that competitive industry, each station tries to produce as attention-getting a sound as possible while remaining within legal modulation limits. Given the constraint of extremely limited headroom, Donn searched for a method that would enhance the low frequencies musically and naturally but without vastly increasing peak output.

He found the answer in time, literally and figuratively. He found that by making a copy of incoming low frequency information, delaying it by a set amount, and adding it back as a constant-level enhancement signal, he was able to achieve a dramatic increase in the perception of the bass without a corresponding increase in peak output.

Big Bottom is a relatively simple circuit. The signal is split into two paths. One path goes to the output unmodified, while the other path goes through a frequency shaper, a phase shaper, and finally a dynamics processor. The output of the dynamics processor is then mixed back into the unmodified signal. The results of the time and amplitude relationship between the unmodified signal and the enhancement signal are a dynamically changing frequency response and longer-duration bass frequencies.

Because the output level of the dynamics processor is constant over a wide range of input levels, it varies as a percentage of the mixed output. At lower input levels, when the bass needs the enhancement, the enhanced percentage is reduced. As the input reaches the highest levels, the enhancement signal percentage becomes almost negligible.

At high input levels, the bass is still enhanced because of the longer duration of the bass information. The peak output level, however, is hardly affected, if at all. This is in contrast to fixed equalization or subharmonic generation.

Big Bottom helps maintain the perception of bass when there is low input level, but it does not diminish the dynamics of the bass as the input increases. This is in contrast to compression schemes.

The harmonics of the bass frequencies are what subjectively make the bass instruments real and give them punch. Changing the time relationship between the bass frequencies and their harmonics may cause the low end to sound muddy.

Equalization causes a frequency-dependent time shift. So the low end might be louder, but very often the result will be louder mud.

Because the enhancement signal is added to the input signal and does not change the original time relationship between the low frequencies and their harmonics, there is no loss of low-frequency definition. In combination with a dynamic range without limiting, low-frequency definition is particularly important for kick drums and bass guitar.

In the Model 204, Big Bottom has three controls: "tune", "drive" and "mix". Tune sets the range of frequencies that will be enhanced. Drive sets the amount of dynamics processing in the enhancements signal path. The greater the amount of dynamics processing, the longer the duration.. or the persistence, of the low frequencies.

Mix adjusts the amount of enhancement signal mixed into the output. If the input signal is below threshold, the mix control works like a simple equalizer. The higher the mix setting, the greater the equalization effect on the output. Therefore, the drive setting must be appropriate to ensure sufficient processing. For that purpose, there is a green LED next to the drive control. When the LED light flashes on the bass peaks, the signal is at its processing threshold.

Big Bottom can be used on any sound system or storage medium that can reproduce low frequencies (<100Hz). It will increase the

perception of greater bass energy without substantially increasing peak output and without sounding muddy.

If you already recognize the importance of a good low end and the potential costs (electronic, sonic and financial) of achieving that sound with traditional methods, then Big Bottom may be the solution you're looking for.

The Principles of Superposition

Fig. 1  
Linear System  
Audio Waveform  
with Dual Tones

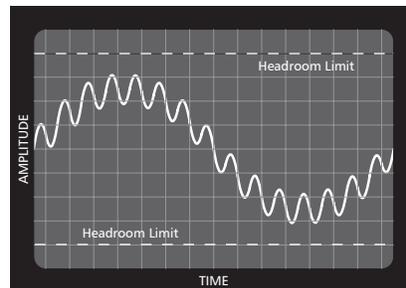


Fig. 2  
Linear System  
Dual Tone  
Spectrum  
Purity

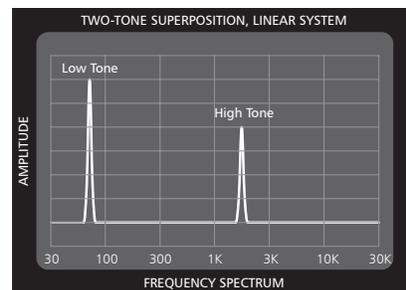


Fig. 3  
Clipped Wave  
From Too Much  
Bass Boost  
(without Big  
Bottom)!

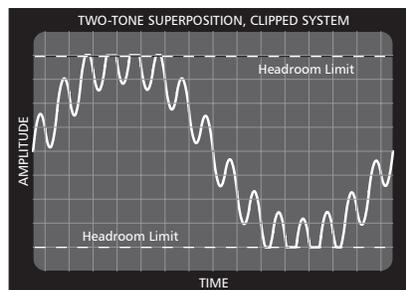
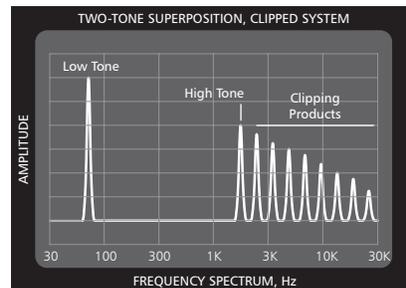


Fig. 4  
Distortion  
Spectrum  
From Clipping  
(without Big  
Bottom)!



## 8.0 Specifications

### 8.1 GENERAL SPECIFICATIONS

OPERATING LEVEL		+4dBu	-10dBV
Switch Setting:			
<b>INPUT</b>			
Connector:	XLR-3F and TRS 1/4" phone jacks	Same	
Type:	Transformerless, active balanced	Same	
Balanced:	40K $\Omega$	40K $\Omega$	
Unbalanced:	20K $\Omega$	20K $\Omega$	
Nominal Level:	+4dBu	-10dBV (-7.8dBu)	
Maximum Level:	+27dBu	+12.5dBV (+14.8dBu)	
CMRR:	>40dB	>40dB	
<b>OUTPUT</b>			
Connector:	XLR-3M and TRS 1/4" phone jack	Same	
Type:	Active Balanced (may be used unbalanced)	Same	
Balanced:	112 $\Omega$	Same	
Unbalanced:	56 $\Omega$	Same	
Nominal Level:	+4dBu	-10dBV (-7.8dBu)	
Maximum Level:	+27dBu Unloaded, +25dBu into 600 $\Omega$	+12.5dBV (+14.8dBu)	
<b>AUDIO</b>			
Frequency Response:	+0.5dB 10Hz-38KHz	Same	
Dynamic Range:	120dB	Same	
Hum and Noise:	-93dBu, unweighted 22Hz-22KHz	Same	
Crosstalk:	10Hz - 22kHz, -79dB	Same	
THD:	10Hz - 22kHz @ max output, .0003%	Same	
IMD:	10Hz - 22kHz 0 max output, .0007%	Same	

**SYSTEM FUNCTIONS** Refer To Sections 3 & 4

### OTHER SPECIFICATIONS

**Power requirements:** Unit is electrically supplied through an agency approved IEC-type detachable primary power cord. The voltage rating and connectorization meet governing standards where units are sold.

**Power Consumption (maximum):** 12 watts

**Dimensions:** 19" W x 1.75" H x 8.25" overall depth (482.6mm W x 445mm H x 209.6mm overall depth); depth behind front panel: 7.5" (190.5mm)

**Net Weight:** Rack-mounted: 6lbs. (2.73kg)

**Shipping Weight:** 9lbs. (4.1kg)

All specifications are subject to change without notice.

## 8.2 ARCHITECTURAL SPECIFICATIONS

### Basic Description

A dual channel electronic device comprising an Aural Exciter® process to enhance and improve the intelligibility and clarity of an audio system and a Big Bottom® process to separately enhance and improve the bass response of an audio system.

### Aural Exciter

The Aural Exciter process shall create the perception of increased presence, clarity and detail without creating significant changes in the actual signal level. It shall do this by generating, in a sidechain, musically and dynamically related harmonics according to a transient discriminating process, and frequency dependent phase shift. The sidechain generated signal shall be then mixed into the output signal.

A Tune control shall be provided for each channel to select the frequency bandwidth of the effect by tuning a high pass filter from approximately 600Hz to approximately 6kHz. A continuously adjustable Harmonics control shall be provided for each channel to set, from MIN to MAX, the amount of harmonics being generated by the Aural Exciter process. A Mix control shall be provided for each channel to control the amount of effect mixed back into the program.

### Big Bottom

The Big Bottom process shall provide a stronger, more powerful bass, increasing sustain and density without substantially increasing the peak output. It shall do this by generating, in a sidechain, a dynamically compressed low frequency sample of the input, with the addition of frequency dependent phase shift. The sidechain generated signal shall be mixed back with the original input signal to generate the enhanced audio output.

A Drive control shall be provided to properly adjust the dynamic compression depending upon the input signal level. A green LED shall be provided to indicate when the optimum setting has been reached. A Mix control shall be provided to adjust the amount of Big Bottom enhancement signal being added to the original signal. A Tune control shall be provided to adjust the range of low audio frequencies that will be enhanced.

### I/O

A Process In/Out Switch for each of the two channels activates and deactivates Aural Exciter and Big Bottom processing simultaneously. The In/Out button shall be lighted to indicate when the processor is IN.

Input and output jacks shall be both XLR and standard 1/4" TRS phone jacks. Each channel shall be capable of operating at either -10dBV or +4dBu. The inputs and outputs shall both be the active balanced type. Frequency Response shall be 10Hz-38kHz, +/-0.5dB. Dynamic Range shall be 108dB. Hum and Noise shall be no greater than -85dBu. THD shall be less than 0.01%.

### Physical Properties

The device shall be packaged in an all metal chassis measuring 19" (482.23mm) wide, 1.75" (44.42mm) high, with an overall depth of 8.25" (210mm). Depth behind the front panel shall be approximately 8" (203mm). The device shall have a net weight of approximately 6lbs. (2.73kg) and is capable of mounting in a standard electronic equipment rack.

### Power

The unit shall have a self contained power supply operating from the ac line. Primary voltage, connectorization and agency listings shall meet the governing standards where units are sold.

## *Patent Notice*

This product is protected under one or more of the following Aphex patents.

4,578,648  
4,633,501  
4,843,626  
4,939,471  
5,115,471  
5,155,769  
5,334,947  
5,359,665  
5,422,602  
5,424,488  
5,450,034  
5,463,695  
5,483,600  
5,485,077  
5,612,612  
5,737,432  
5,848,167  
5,896,458  
5,898,395  
5,930,374