

1.0 INTRODUCTION

Since its introduction in 1975, the Aphex Aural Exciter [®] has rapidly become a standard in the recording and broadcast industries. It has been used on thousands of albums, movies, broadcast productions, commercials and concerts. Aural Exciters are on the air on the top AM & FM stations throughout the U.S.A and the rest of the world. They have also found countless applications in sound reinforcement, paging & P.A. systems, tape duplicating and background music systems. In short, the Aural Exciter can benefit any audio application.

Whatever the final usage, the Aural Exciter will provide:

- * Increased presence and clarity - Program material sounds bright and real again.
- * Increased intelligibility - Vocal articulation is much clearer, easier to hear and understand.
- * Enhanced stereo imaging - The sound seems to "open up," giving greater separation and detail making speaker placement less critical, while still being totally mono compatible.
- * Greater perceived loudness - without adding any extra power. Does not trigger limiters or compressors.
- * Reduced listener fatigue - Increased penetration at lower SPL and distortion levels.
- * No decoding needed - Aural Excitement is a single ended process. Once it is encoded into the material it stays, even through succeeding processes and generations of tape copies.
- * Perceived enhancement even greater on poor quality reproduction systems or poor listening environments.
- * Aural Excitement is completely mono compatible, with no phasing or notching problems.
- * Because it is actually CREATING a new overtone series, the Aural Exciter adds an amazing brightness to drum machines and synthesizers that are limited by their digital sampling rates to a mediocre top end.

1.1 What is Aural Excitement?

By now you are probably wondering how the Aural Exciter can

do all these things, and why it is necessary in the first place.

The answer is that the audio recording and reproduction process is far from perfect, even under the best of conditions. Every step of the way from the original microphone, through countless tape and electronic stages, to the final amplifier and loudspeaker, something gets lost. What's lost is presence and realism. The sound just doesn't sound real and live any longer. The parts that disappear are the harmonics, the tiny fragile parts of the audio that give a sound its character and definition among other sounds.

Other types of processors such as equalizers, expanders or reverb and delay cannot restore this realism because they only work on what's left of the original signal, often increasing noise and distortion in the process. Equalizers, in particular, are most commonly compared to the Aural Exciter due to the apparent "boost" in mid and high frequencies. But equalization is a static, fixed process, while the Exciter is dynamic, constantly changing with the program. Also, no equalizer can boost what is no longer there.

The Aural Exciter actually re-creates the missing material, and adds it back in the form of a very small cue signal that creates a psychoacoustic difference in the subconscious part of the listener's brain. Because of this, the enhancement signal can be very small, and adds virtually no power to the audio signal. It is easily recorded and reproduced, even by low quality systems and is not affected by normal acoustic problems. These factors make the Aural Exciter a powerful tool in any audio application.

Detractors claim that the Aural Exciter generates "distortion". Technically, any device that changes audio (such as a compressor, equalizer, reverb or delay) can be said produce "distortion". What is important is to understand the difference between a wanted change (an effect), and an UNwanted change (loss of signal quality).

What the Aural Exciter does generate are harmonics that are musically and dynamically related to the original signal. The result is a completely controllable, pleasant sounding enhancement very different from other static operating devices.

Properly used, the Aphex Aural Exciter can be regarded as a harmonic equalizer. However, unlike an ordinary equalizer, the boosted information is not at the same frequency as the input signal. Consequently this new low level information does not merely add amplitude to an existing signal and does not eat up headroom in the already restricted, pre-emphasized high end.

1.2 Brief Psychoacoustics

The term "psychoacoustics" is the latest buzzword in the

audio field. It refers to our psychological interpretation of what we hear, as opposed to the mechanics of hearing.

With the exception of the Fletcher-Munson required compensation for non-linearity of our hearing (loudness controls), modern audio and electronic processing methods tend to ignore the entire receiving portion of what must be considered a two-part system. In the meantime, science is providing us with an increasingly better picture of how the aural processes function.

It is helpful to remember that all sound perceived appears only by courtesy of the brain. Taking into account some of the known peculiarities of psychoacoustics allows interesting improvements in electronic sound processing, the Aphex method being a good example.

This is a fairly new field with much yet to be discovered, but we do know that most of the factors that affect our interpretation of what we hear are incredibly small, such as the minute cues that let us tell left from right in a stereo image. There are also minute cues which our subconscious mind interprets as "presence" or "realness". It is these missing cues that the Aphex Aural Exciter re-creates and adds back to the main signal to change the way you PERCEIVE what you hear.

The Aphex enhancement signal involves frequency dependent phase shift and amplitude dependent harmonic generation. The phase shift, or delay which is too short to be perceived as an echo or reverb, is perceived as an increase in impulse or transient duration, which make the signal seem louder. The phase shifted signal also "beats" slightly against the main signal, simulating what happens to sound in a normal ambient situation (reflections), but without causing phase cancellation or "phasing".

The harmonics generated are derived from the main signal and are, therefore, musically related. The natural harmonics or overtones are the most likely to be lost. The louder the fundamental produced by an instrument or voice, the greater the overtones. The Aphex Aural Exciter generates harmonics in the same manner. The harmonic structure of each sound or instrument is thus strengthened, allowing it to stand out from others. The increased harmonic structure also creates the illusion of a much fuller, brighter top end to your sound. You will swear there is at least 10 dB of treble boost, but a spectrum analyzer would show less than 1 or 2 dB.

1.3 How It Works

It is possible to "encode" electronically processed sound with supplementary directional information that will tend to widen the perceived image and increase presence. This information is generated by the Aphex Aural Exciter and is mixed

with the main signal as a low level subcarrier. The brain, acting as a "de-coder", compares the main signal and the sub-carrier as a differential function. The result is increased spatiality and presence.

As can be seen in the block diagram (Fig.1) the main audio signal passes to the Aural Exciter unchanged. The processing is done in an outside loop called a sidechain. This sidechain taps off the main signal, and sends the audio through a highpass filter. This filter may be tuneable. It removes unneeded low frequency material and creates the necessary frequency dependent phase shift. The filter output is then fed to the next stage the harmonics generator via the drive control. This is where the musically related harmonics are generated and mixed with high-passed information. This complex material then goes through the mix pot where a small portion (typically 20 dB below) is added to the main signal. Although this amount of information is so small it shouldn't even be heard, the listener perceives a significant increase in mid and high frequency energy.

2.0 FUNCTIONAL DESCRIPTION

The Aural Exciter functions as an extremely transparent input and output buffer, with signal processing occurring externally, in a side chain. The product of the side chain is then mixed into the main signal, to create the desired enhancement. All controls affect this side chain only, not the main audio signal, so carefully produced program material is left uncolored, except as desired.

2.1 I/O Circuits

The input to the Aphex II is a true instrumentation amp for excellent common-mode noise rejection and truly balanced loading of the signal source. For those that absolutely need it, a Jensen nickel-core transformer is available as an option. This input stage is jumper selectable to operate at various input levels, from -10 to +8 dBm while maintaining 20dB headroom.

The Broadcast units additionally feature an RF "doghouse" assembly with RFL filtering for additional RF rejection on the inputs and outputs. The Broadcast models feature barrier strip I/O with a jumper selectable 600 ohm load on the input. The Studio units have standard 3-pin XLR connectors on input and output, with 1/4" jacks on the sidechain access.

The output of the Aphex II is a servo-balanced transformerless type that may be operated balanced or single-ended with no adjustment or loss of signal level. Like the input, jumpers select the desired output operating level to match any system. A Jensen transformer is also an option here. Early Aphex IIs used a dedicated balanced or single-ended output stage, that cannot be operated interchangeably. These can be recognized by having only two output transistors per channel, instead of the four TO-220s in the newer circuits.

2.2 The Filter

The sidechain begins with a two-pole tuneable highpass filter, the corner frequency adjustable from 600Hz to 6kHz. This filter is used to determine where the enhancement will begin, from the lower midrange of a male voice to the upper end of cymbals. It also eliminates the unneeded low frequencies from the enhancement circuit. The shape of this filter is adjustable with the DAMPING control to vary the slope, and thereby the amount of material passed by the filter. (See Fig.).

The output of the filter is connected to the side chain access point on the rear of the chassis, so that the user may experiment with additional processing on the effect of the side

chain.

2.3 The Harmonics Generator

The Aphex II uses the 1537A VCA as the heart of the harmonics generating circuit. By creating various control signals in the detector circuit, the 1537A can be made to produce any mixture of pure odd to pure even harmonics of the original, high-passed program. The amount of these harmonics actually produced is dynamically related to the source material, duplicating the way they are naturally produced by a voice or instrument.

2.4 The Limiter

To prevent overly bright or sibilant material from "spitting" or "splashing" there is a limiter on the processing side chain. Threshold and release time can be user adjusted to taste. This limiter in no way affects the main signal, only the enhancement.

Later units, (produced after) use a new Aphex I.C., the Maxi502. This chip processes the audio prior to the harmonics generator. It may make use of the limiter unnecessary. In fact, with the Max chip in use, it may be almost impossible to get the LIMIT light to come on at all.

2.5 Metering

The Aphex II features comprehensive metering showing the status of operation at a glance. A vacuum tube fluorescent meter can be switched to show input, output or enhancement levels, and can read with peak or VU characteristics. Its OVU reference is jumper selectable to match the overall system operating level. LED illuminated legends show which meter functions have been selected, DRIVE level, LIMIT action and PEAK output level (2dB before clipping).

4.0 Installation

4.1 Unpacking

Your Aphex II Aural Exciter was carefully packed at the factory, and the container was carefully designed to protect the unit from rough handling. Nevertheless, we recommend careful examination of the shipping carton and its contents for any sign of damage that may have occurred during shipping. If damage is evident, do not destroy the container or packing material. Immediately notify the carrier for a possible claim for damage. Shipping claims must be made by the consignee.

Each box should contain an Aphex II, an IEC standard power cord, an Owner's Guide, rack mounting screws, and some Aphex promotional material. In addition, broadcast units should contain (2) bypass relays to be plugged into the rear panel.

4.2 Operating Level Set

Before installation, the Aphex II operating level must be set to match the level of the system it will be connected to. The Dyna-Set jumpers allow setting the I/O levels as well as the OVU reference point on the meter. The Aphex II normally comes from the factory set for a +4dBm system (+24dBm clipping). The calibration level is indicated on a tag on the rear panel.

Should the user desire to change the Aphex II's operating levels, it can be done as follows:

1) J201 Input Level select - Set this jumper for the maximum level (clipping) expected from your system, typically 20dB above your OVU point. Fixed options are +21, +24 and +27 dBv. Other options may be accommodated by choosing an appropriate value for R215 and placing the jumper in the * position.

2) J601 Output Level select - This is set to correlate with J201 "Input Level". For earlier units with Single-Ended (unbalanced) transformerless outputs, this must be set to read 6dB higher than the actual intended output level. For example, to get a +21 output level, the jumper must be set to the +27 position.

3) J301 External Reference set - This jumper sets the sidechain input headroom to maximize noise performance at a given operating level. It should be set to match the desired OVU operating level.

4) J801 and 802 Meter Reference - These settings correlate internal clipping and VU settings to match the user's

system. Set them to match the choice of of VU reference. Standard settings are 0, +4 or +8dBv = 0VU.

4.3 Mounting

The Aphex II Aural Exciter occupies two standard rack units of space (3-1/2"). Be sure to allow enough rear clearance for connectors. Mount with the cushioned rack screws provided.

4.4 Connectors

Studio Models - Input and output connections are made with standard XLR type connectors. As both inputs and outputs emulate transformers, either pin2 or pin3 may be used as "high". The same standard should be used at both ends to preserve phase integrity. The Sidechain access points are made with standard 1/4" phone connectors, and are unbalanced.

Broadcast models - All connections are made with a standard barrier strip. They are the type with a built-in wire clamp, so crimp-on spade lug connectors are not necessary.

4.5 I/O Considerations

4.5.1 Impedances

The Input impedance to the Aphex II is 50K ohm balanced, 25K ohms unbalanced. This should allow the unit to be easily driven by any other piece of audio gear. In the event the prior equipment is designed to be driving a 600 Ohm load, there will be a large disparity between its output meter and the Aphex II's. On broadcast models, a 600 Ohm load resistor is built in to the input panel, and is easily connected with a supplied strap. Studio Models will need a 600 Ohm resistor to be added across the input drive lines.

The output impedance of the Aphex II is very low (20 Ohms balanced, 10 Ohms unbalanced), and can easily drive almost any load. However, there are some inputs, especially transformer types, that are designed to see a 600 Ohm source impedance. An indication of this would be a non-linear frequency response, emphasizing the low frequencies. The solution is to terminate the output of the Aphex II with 300 Ohm 1/4 Watt resistors in series with each of the balanced output lines.

4.5.2 Balanced vs. Unbalanced Operation

The Aphex II's unique input and output stages may be used balanced or unbalanced at any time without any adjustments or change in gain. The servo-type circuits sense lack of

drive at either pin and automatically compensate. For single-ended use, the user simply grounds the unused terminal on the XLR or barrier strip. IMPORTANT!- do not leave the unused terminal "floating"! When used single ended, the output will now only reach +21dBm. To maintain proper phase, be sure to use identical terminals on input and output. The Aphex II may be easily used to convert single-ended to balanced and vice-versa.

NOTE : The above is not true for earlier models with dedicated single-ended or balanced output stages. These may be identified by having only two power transistors per output stage instead of the four on the newer units. These must be used just the way they came.

4.6 AC LINE CONNECTOR

The Ac mains power is supplied to the unit via an integral receptacle/fuse holder on the rear panel which meets all of the international safety certification requirements. Check to be sure that the unit is configured to match your Ac mains voltage by inspecting the programming tag located in the fuse holder. It works with any IEC power cord for easy replacement, if necessary, and adaptability to any country.

4.6.1 Voltage Selection

The Aphex II can be adapted to to any standard AC mains voltage by simply repositioning the voltage programming card in the fuse receptacle. This is done by the following procedure:

1. Remove the power cord from the chassis receptacle.
2. Slide the clear plastic cover to the left to uncover the fuse compartment.
3. Remove the fuse by prying out with the "fuse pull" lever
4. Pull out the small printed circuit programming tag. The tag has four voltages printed on it - 100, 120, 220 and 240. Orient the tag so the desired voltage is readable on the top left side of the tag, and re-insert the tag in the holder. You should now be able to read the correct mains voltage through the window of the fuse holder.

4.6.2 Fuse selection

Be sure to use the correctly rated fuse for your mains voltage. These fuses are:

100-120V xxxA Slo-Blo 3AG size
220-240V xxxA Slo-Blo #AG size

5.0 CONTROLS

It may help to refer to the block diagram (Fig.1, Section 1) as these controls are explained.

5.1 DRIVE

The DRIVE control adjusts the level to the harmonics producing circuitry. This is the only control where the level is not subjective. To the left of the level meters is a tri-color LED, one for each channel, that light up DRIVE. These LEDs change color from off to Green, to Yellow and finally Red as the level gets higher. The Drive control should be adjusted so the LED is mostly Yellow, hitting Red and Green on high and low peaks while running some typical program material.

5.2 FILTER CONTROLS

5.2.1 Tune

The TUNE control sets the point at which the enhancement begins. As the control is adjusted from 700Hz to 7kHz, the Aphex II will enhance everything from that point on up. This allows you to "aim" the enhancement at the low frequencies in a male voice or the very top edges of a cymbal. Since low frequencies have more energy than the highs, TUNE is slightly interactive with DRIVE, so you may have to go back and trim up the DRIVE after finding your preferred TUNE point.

5.2.2 Damping

DAMPING adjusts the shape of the filter, somewhat like varying the slope or bandwidth of an equalizer. More DAMPING smooths out the curve, widening the effective bandwidth. Less DAMPING gives a slight peak at the tuned rolloff point. This will let you emphasize certain voice frequencies more than the whole mix, for example.

5.2.3 Timbre

The most subtle control, TIMBRE varies the spectral quality of the generated harmonics, from pure Evens to pure Odds. The Even harmonics are warm, round and musical. The Odd harmonics are sharper, and will greatly enhance the percussive edges of the signal. Although the Odds are more attention getting, too much may induce listener fatigue, so use sparingly. The setting will depend greatly upon the harmonic structure of the signal. This control will probably be set mostly by "feel", rather than listening.

5.3 LIMITER

Because the generated harmonics are level dependent, high signal peaks may cause "splashiness". To prevent this, the LIMITER is used,

but only on the sidechain drive, not the program material. Next to the DRIVE LED there is a yellow LIMIT LED that will light to indicate the onset of limiting.

Newer units that contain the MAX 1502 circuitry (those made after xx/xx/xx) will seldom require any use of the Limiter, as the sidechain dynamics are already controlled by the new circuit. (See Sec. 2.5)

5.3.1 Threshold

This control sets the threshold at which the limiter operates. Full ccw is the minimum, or lowest threshold, full CCW is the maximum.

5.3.2 T release

This control sets the release time of the limiter. A short release time can be used to prevent "splash" while a longer release;ease time will cause the limiter to act more like a compressor, enabling more of the enhancement to be added back into the program. This will concentrate the brightness effect, but might diminish overall transparency.

5.4 OUTPUT

5.4.1 Mix

The MIX control set the amount of generated enhancement signal that is mixed back into the program. Full CCW is pure source, moving clockwise adds more effect. At the full CW position there is a clickstop, labeled SOLO, which eliminates the dry signal, so the Aural Exciter outputs enhancement signal only. This position would be useful for external mixing in the studio, using the Aural Exciter in an effect send/receive mode. It is also useful for hearing the direct effects of the other controls, and may make it easier for the beginning user to set up the Aphex II.

5.4.2 Level

This control attenuates the output of the Aphex II from unity at the full CW position, to -20dB at full CCW.

5.5 METERING

5.5.1 Meter Ballistics

The meter may be set to operate with either peak or VU characteristics.

5.5.2 Meter Select

This switch selects the meter to read Input level to the Aphex II, Enhancement return level (Ax), or Output level of the unit.

5.6 IN/OUT (PROOF/OPERATE on Broadcast models)

- d) Adjust Ch B VU cal VR861 so Meter barely reads "0".
- e) Switch Meter Ballistics to "PK" and adjust CH B PK cal VR862 as in step d.
- f) Repeat steps b-e for Ch A, using VR851 for VU and VR852 for PK

7.2 GREEN/RED DRIVE INDICATOR CALIBRATION

This adjustment relates only to older models with a two-color display (Red/Green). Newer models with a tri-color (Red/Yellow/Green) Drive display need no adjustment.

This circuit is calibrated to internal levels, and should not need re-adjustment unless an IC in this circuit or a power supply regulator is replaced. Even then, change will be non-critical ($\pm .5\text{dB}$)

7.2.1 Set-up

DRIVE: Full CCW
 TUNE : Full CCW
 DAMPING: Full CCW

7.2.2 Procedure

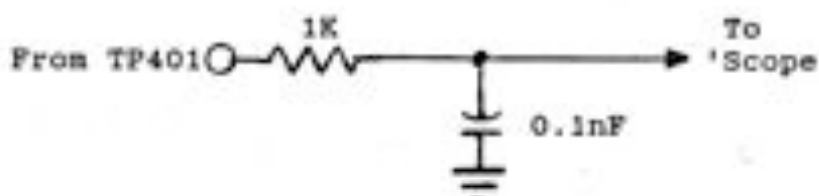
- a) Insert signal at about 0VU, 2kHz into input
- b) Place voltmeter probe at test point TP301
- c) Adjust DRIVE for +6dBv (0.775V) at this point
- d) Adjust threshold trimmer VR901 so DRIVE LED just goes from Green to Red.
- e) Reduce signal about 12dB. LED should go OFF at this point (approximate).

7.3 DC OFFSET TRIM ON VCA - Harmonics and Limiter function, Sec.400

Once burned in (at the factory) DC offset is seldom a problem. Readjustment will only be necessary if a power supply regulator, IC401, IC402 or IC403 are replaced

7.3.1 Special Equipment Needed

Oscilloscope- 10mV sensitivity minimum
 Shielded Probe
 Noise (lowpass) Filter - An appropriate filter can be made as follows:



7.0 APHEX II CALIBRATION PROCEDURES

The Aphex II Aural Exciter circuitry is extremely stable, and will seldom need any recalibration. However it is good practice to periodically check all studio equipment due to unavoidable aging of parts. Routine maintenance should be scheduled at least once per year, perhaps sooner if equipment is exposed to extremes of temperature or vibration.

Calibration is also advised if the Dyna-Set jumpers have been re-set to a new operating level (See section 4.2)

Calibration procedures given are typical. Calibrate the lower audio board first, then repeat for the upper board (Sec. 7.2 and 7.3)

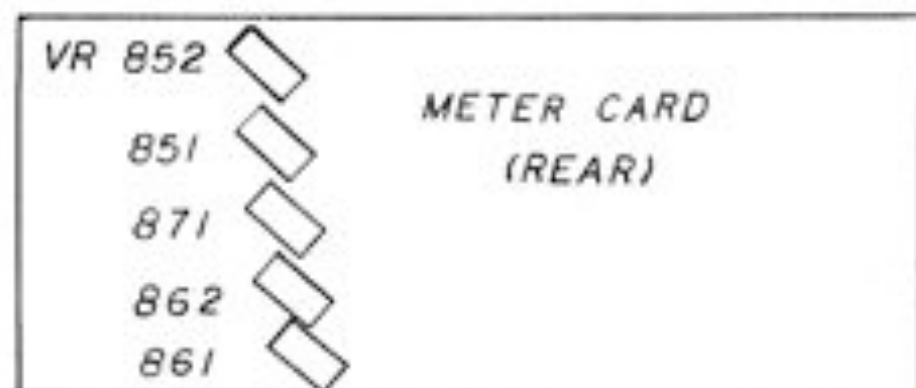
7.1 UNITY GAIN and METER CALIBRATION

Make sure that the test equipment is loaded with the same impedance as the circuit in which the unit is to be used.

7.1.1 Set-Up:

Meter Ballistics: "VU"
 Meter Select: "OUT"
 In/Out (Proof/Operate) "OUT" or "PROOF"
 Output Level: "CAL" (Full CW)
 Mix : Any Position but "Solo"
 All Other Controls : Does Not Matter

Meter Trimmer Locations:



7.1.2 Procedure:

- With no signal adjust meter 0 null trimmer VR871 for no display. This is a "centering" type of adjust.
- Apply signal to CH B at the chosen 0 VU level
- Adjust Output Cal trim VR603 for exactly unity gain. This trimmer is next to the Output level pot.

This switch instantly disables the side chain for instant comparison between processed and unprocessed signal, and also for proof-of-performance tests in broadcasting.

5.7 REAR PANEL CONTROLS AND FEATURES

5.7.1 Phase (Studio models)

This switch allows reversal of the phase(polarity) of the output of the Aphex II. When used in the studio in the solo mode (no dry signal) this allows a subjectively different effect to be created. When using the Aphex II in the standard Mix mode, be sure that both switches are in the 0 position for phase coherency.

5.7.2 Side Chain access

This unbalanced insert point allows other types of processing equipment, such as gates, compressors, equalizers, etc. to be used on the side chain only, to create new and unusual effects.

5.7.3 Remote Mute (Broadcast models)

This allows the enhancement to be muted by an external 5V signal, such as from an automation system. This function duplicates the PROOF/OPERATE switch.