# APOGEE ELECTRONICS CORP.

## PORTABLE REFERENCE
## ANALOG TO DIGITAL CONVERTER

# AD-500
# AD-500E

# OPERATION MANUAL

## WARNING

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

Important - To insure that the complete system (including this peripheral) is capable of complying with the FCC requirements, it is recommended that the user make sure that the individual equipment of the complete system has a label with one of the following statements.
"This equipment has been tested with a Class A Computing Device and has been found to comply with Part 15 of FCC Rules."
-or-
"This equipment complies with the requirements in Part 15 of FCC Rules for a Class A Computing Device."
-or equivalent.

CAUTION
Any changes or modifications not expressly approved by Apogee Electronics Corp. could void your authority to operate this equipment under the FCC rules.

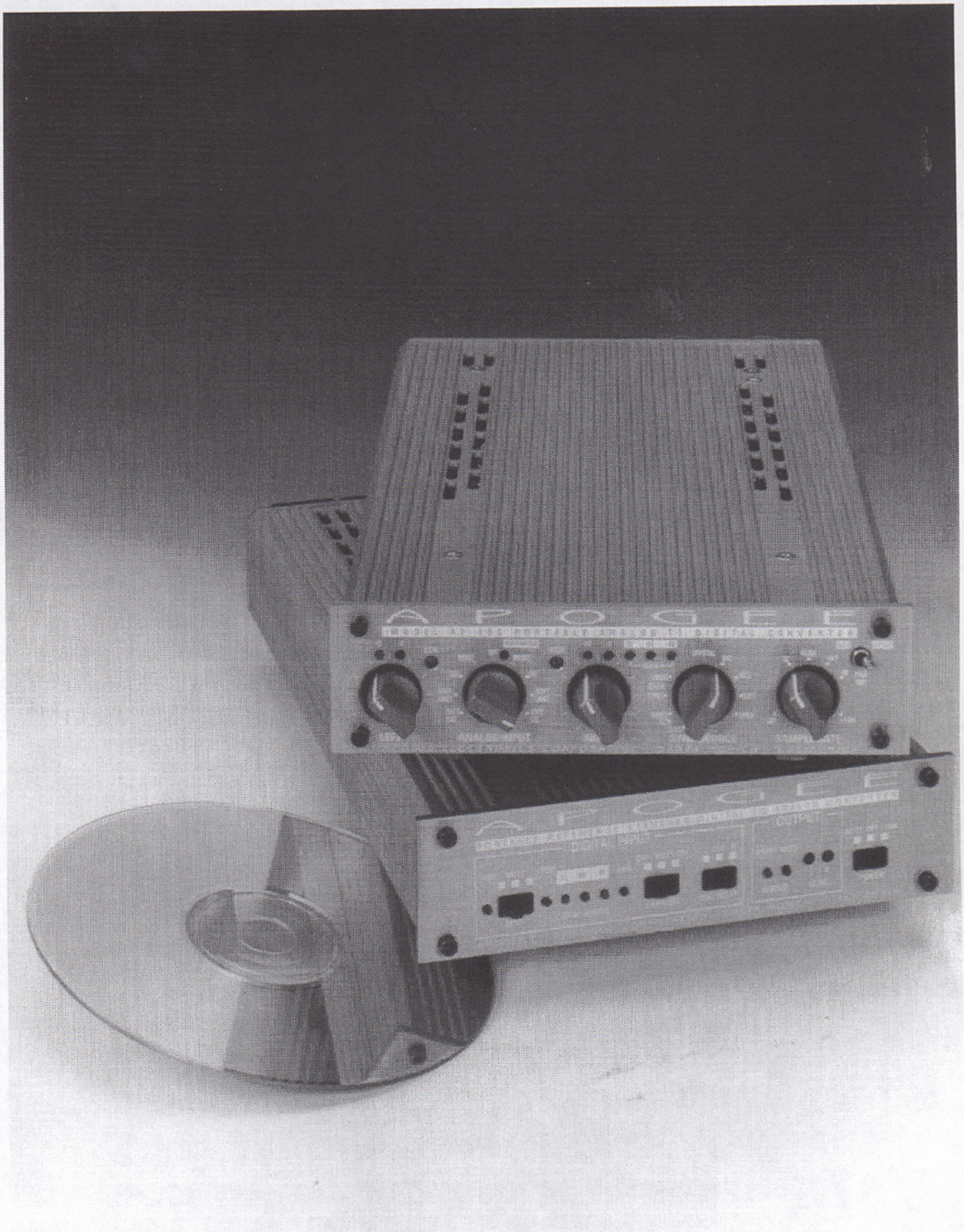
## CONFIDENTIAL



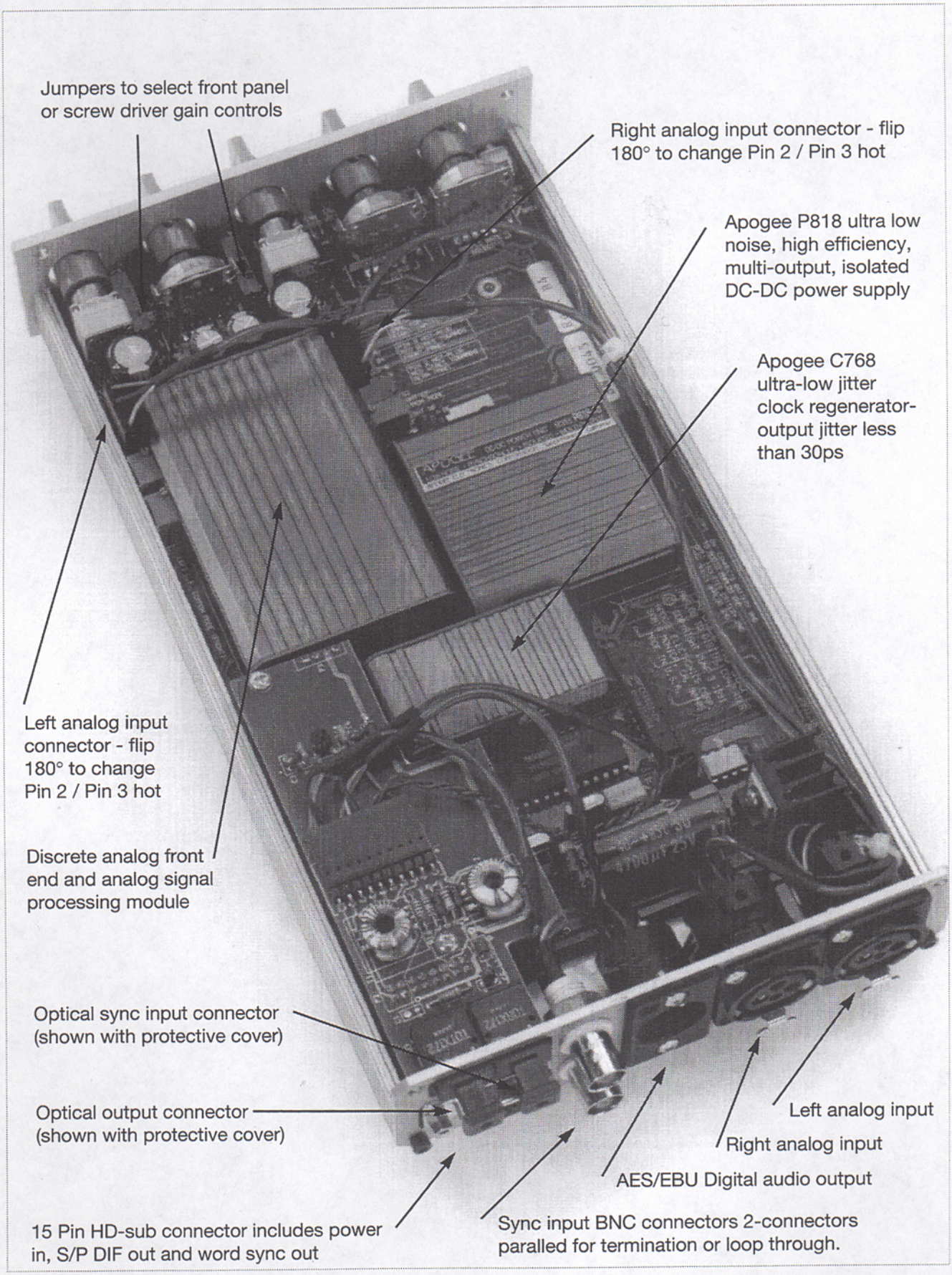
## OWNER'S RECORD

The serial number is located on the top right hand corner of the rear panel of the unit. We suggest you record the serial number in the space provided below. Refer to it whenever you call an authorized APOGEE repair facility or the manufacturer. Make sure that you return your completed warranty card immediately!

Model No. AD-500 Serial No. _____ Purchase Date _____




Apogee AD-500 and companion DA-1000 Portable Reference Digital to Analog Converter.




Apogee AD-500 with bottom cover removed showing leaded component side of main printed circut board. Surface mounted components are on the other side.

## SECTION I

# APOGEE AD-500 PORTABLE REFERENCE ANALOG TO DIGITAL CONVERTER

### SPECIFICATIONS

| | |
|---|---|
| QUANTIZATION | 18 Bits/Sample |
| FREQUENCY RESPONSE | 20Hz-10KHz +/-0.025dB<br>10KHz-20KHz +/-0.025 -0.1dB |
| TOTAL HARMONIC DISTORTION PLUS NOISE | -94dB Typically @ 1KHz<br>(@ 48KHZ sampling; 0.1dB below full scale) |
| SIGNAL TO NOISE RATIO | Typically -95.5dB |
| CROSSTALK | Typically better than 90dB @ 1KHz |
| EMPHASIS | 50uS/15uS selectable on/off |
| EMPHASIS INDICATOR | Green LED indicates Emphasis selected |
| SOFT LIMIT THRESHOLD | -1.5dB below digital output full scale<br>selectable on/off |
| SOFT SATURATE THRESHOLD | -12dB below digital output full scale<br>selectable on/off |
| METERING THRESHOLDS | Red indicates1.5dB below full scale (includes peak hold function)<br>Amber indicates 12dB below full scale (includes peak hold function) |
| COMMON MODE REJECTION | Typically better than 90dB@100Hz<br>Typically better than 70dB @10KHz |
| EXTERNAL SAMPLING RATE RANGE | Any frequency from 32KHz to 54KHz via External Sync Input |
| INTERNAL SAMPLING RATE | 32KHz, 44.056KHz, 44.1KHz or 48KHz |
| INTERNAL SAMPLING RATE ACCURACY | +/- 10 PPM |
| SAMPLING RATE INDICATOR | Amber LED's indicate output sampling rate range for 32KHz, 44KHz, and 48KHz |
| INTERNAL CLOCK JITTER | Typically 30 picoseconds RMS |
| NOMINAL DC POWER INPUT | 12VDC @ 1200mA |
| INPUT VOLTAGE RANGE | +11.5 to +15 Volts DC |
| INPUT DROPOUT VOLTAGE | 11.0 Volts DC |
| WEIGHT | 1.3Kg (2 lbs 14 oz) |
| DIMENSIONS | L=27.30 x W=14.12 x H=3.96 cm<br>(L=10.75 x W=5.56 x H=1.56 in) |
| OPERATING TEMPERATURE | 0 C to 40 C (32 F to 104 F) |

*Note: The AD–500 will work with any well regulated 12V DC Power source with an output current of 1200 mA of greater. We recommend using linear type power supplies . Direct connection to external 12VDC lead acid or nicad batteries will provide convenient portable operation.*

### INPUTS

**ANALOG INPUTS** (two 3 pin female XLR connectors on rear panel)
+4dBu nominal input level @ 20K ohms balanced (10K ohms unbalanced)
Maximum input peak level (front panel gain controls at minimum, fully counterclockwise)
+28dBu balanced, +24dBu unbalanced
Minimum input peak level (front panel gain controls at maximum, fully clockwise)
-0.5dBu balanced, +1.5dBu unbalanced
*Note: the above maximum and minimum represent the input level to acheive maximum digital output level.*

SEE NEXT PAGE

**SYNC INPUTS** (Two male BNC connectors on rear panel)
BNC's are paralleled for convenient looping or termination (75 ohm terminator supplied)
BNC's will accept either balanced or unbalanced inputs
*The following signals will be accepted:*
*ANALOG VIDEO*
Black burst/Composite Sync/Composite Video (525line/59.94Hz; 525line/60Hz; 625line/50Hz)(input bridged by > 5K ohms)
*WORD SYNC (WC)*
32KHz to 54KHz Input Sampling Rates
TTL levels (input bridged by > 5K ohms)
RS422 levels (input bridged by > 5K ohms)
*DIGITAL AUDIO SYNC*
32KHz to 54KHz Input Sampling Rates
AES/EBU Format (automatically terminated at 110 ohms)
AES/EBU Format (input bridged by > 5K ohms)
S/P DIF Format (input bridged by > 5K ohms) (BNC to RCA adapter supplied)
*OPTICAL SYNC* (Optical input connector on rear panel)
32KHz to 54KHz Input Sampling Rates
S/P DIF or AES/EBU Optical Format

## OUTPUTS

**WORD SYNC OUT**(15 Pin HD sub connector on rear panel)
32KHz to 54KHz Output Sampling Rate
Balanced - RS422 Compatible
Unbalanced - TTL Compatible

**AES OUTPUT**(Male XLR connector on rear panel)
32KHz to 54KHz Output Sampling Rate
AES/EBU Format selectable on front panel power switch

**S/P DIF OUTPUT**(15 pin HD sub connector on rear panel)
32KHz to 54KHz Output Sampling Rate
S/P DIF Format selectable on front panel power switch

**OPTICAL OUTPUT**(Optical output connector on rear panel)
32KHz to 54KHz Output Sampling Rate
S/P DIF or AES/EBU Format selectable on front panel power switch

## SUPPLIED ACCESSORIES

Operation Manual, warranty card, male BNC to female RCA adapter, BNC 75 ohm terminator, 3/32 hex wrench, a10-32 x 7/16 screw for rack mounting, six miniature programming jumpers and four spare rubber feet.

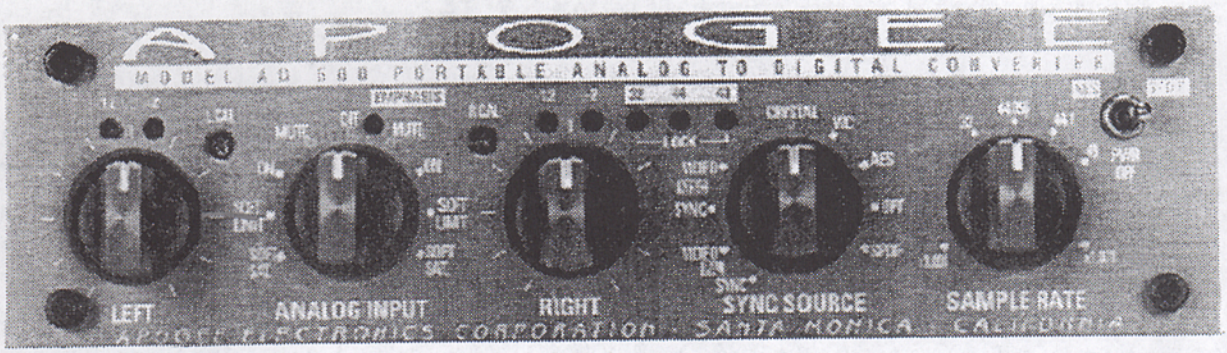
## OPTIONAL ACCESSORIES

APOGEE Model TT-1200/AD is a compact table top power supply for AD-500 accepting 110 Volts AC @ 60Hz and providing12V DC regulated output @ 1200mA. Includes 15 pin HD subconnector with two coaxial cables with female BNC connectors for Word Clock and S/P DIF digital audio output.

APOGEE Model PS-1000 is a rack mountable dual worldwide power source for the AD-500 with selectable100, 120, 220, and 240 Volts AC and 50/60Hz providing dual 11.7 Volts DC regulated outputs @ 1500mA each. Unit is 1/3 rack size and matches style and finish of the AD-500. Power is distributed by two 15 pin HD sub connectors on rear panel.

APOGEE Model RM-1000 is a rack mountable carrier frame capable of holding up to three AD-500, DA-1000E or PS-1000 in a 1U EIA space.

# SECTION II




Congratulations for choosing Apogee's AD–500 Portable Reference Analog to Digital Converter. You have chosen a unique product with many powerful features that will provide years of valuable service. The AD–500 is much more than just an analog to digital converter. It is a powerful production tool with maximum flexibility for a wide range of applications.

## FEATURES

The AD–500 is a general purpose stereo Analog to Digital Converter that combines a high quality discrete analog 'front end' with Delta Sigma Conversion Technology. This combination provides unmatched sonic performance with full 18 bit resolution optimized for all 16 bit applications such as Digital Audio Tape recorders(DAT), Disc-based audio workstations, and CD mastering.

ANALOG INPUT CIRCUITRY-

The AD–500 features our proprietary balanced discrete front end with no feedback, yet still delivers better than 0.001% Total Harmonic Distortion plus Noise. The unit features gold plated XLR input connectors that will accept input levels from below consumer level up to +27dBu. The common mode rejection is typically 100dB which surpasses even the finest transformers, and provides very stable performance over a broad temperature range. Also incorporated prior to any active circuitry, is a passive RF filter to roll off any outside interference, without the typical intermodulation distortion byproducts, from active circuitry.

GAIN CONTROLS-

Two levels of input gain control provide maximum flexibility in gain calibration. The output of the discrete front end can go to either the multi-turn trim pots, the conductive plastic front panel pots or both via the selectable jumpers inside the unit. The two recessed multi-turn pots (screwdriver adjustment) can locate the variable pots to any specified reference location on their scale or operate independently as tamper proof gain trims.

INPUT CONTROL-

The input selector is a nine position switch providing broad input flexibility to the user. When the switch is in the center OFF position, the digital output still delivers a 'digital black' condition (all 0's) used in many mastering and video applications. Rotating the switch counter-clockwise (Pre-Emphasis OFF), MUTE/CAL mutes the input and automatically calibrates the A/D converter. Next, ON is the normal straight thru analog to digital converter process. The next two positions provide the user with additional creative control over the program material. First, when less headroom is required, SOFT LIMIT can be used as a peak limiter. Typical peak limiters are very abrupt and can spread unwanted harmonics. With the AD–500, once you pass the threshold, it gently removes the peaks by rounding them off, making the difference very difficult to hear. The result is 'hotter' sounding program material. Next is SOFT SATURATE. This position starts a progressive compression of the audio sooner (the last 12dB), and its effect mimics progressive analog

tape saturation which gives that 'fatter' analog sound(ie, drum squashing, gun shots, etc.) Some people call this their 'Analog machine in a Digital box' position. Moving clockwise from the OFF position are all the same positions as above, but with Pre-Emphasis set to on.

FILTERS-

High performance passive anti-aliasing filters are set between the discrete analog front end and the A/D converter. These direct coupled filters remove the 'digital harshness', provide better stereo imaging, more open and 'airy' top end, and give a tighter bass with extended low frequencies.

SAMPLE RATE-

An accurate 10 PPM internal crystal provides sample rates of 32, 44.056, 44.1 and 48 KHz. Unlike other A/D converters, the AD–500 provides a broad range of sync source inputs with continuous sampling coverage between 32KHz and 54KHz making it well suited for all vari-speed applications. It also has ability to multiply or divide the incoming sync by 1.001 for added flexibility. (1.001 is the ratio between CD's and NTSC video)

SYNC SOURCES-

The AD–500 has a very broad sync capability via the ground isolated BNC connectors (with additional loop thru). Sync is selected via the front panel SYNC-SOURCE SELECTOR SWITCH. Sync sources capabilities includes: CRYSTAL (selects the internal crystal reference from the sample rate switch); WORD CLOCK (locks to any external clock from 32 to 54KHz, including full vari-speed operation); AES/EBU,S/P DIF (a 75 ohm terminator is used with a BNC to RCA adapter, both of which are supplied); VIDEO and SYNC (NTSC [525line/59.94Hz], Monochrome [525line/60Hz], PAL [625line/50Hz] are provided).

METERING-

A simple but very effective LED metering system has been incorporated that indicates levels of 12 and 2 dB below converter clipping and is designed to be used with the hosts' metering.

DIGITAL OUTPUTS-

A separate transformer isolated AES/EBU output is provided on the rear of the unit. Also provided is a fiber optic output connector. S/P DIF and WORD CLOCK outputs are available on the HD sub connector. Additionally, the WORD CLOCK output is driven by the internal Low Jitter Clock via a high speed opto isolated driver.

LOW JITTER CLOCK-

The C768 ultra Low Jitter Slaving Clock references to an external clock source and provides a 'flywheel' effect by smoothing out short term timing irregularities or jitter. This low jitter slaving clock locks in a predictable and very accurate phase relationship with the incoming reference. The result is superior sonic imaging with excellent soundstage detail.

# SECTION III

## A. UNPACKING

Your AD-500 is packed in a foam lined shipping container. Be sure to save the container for any future shipments of the unit.

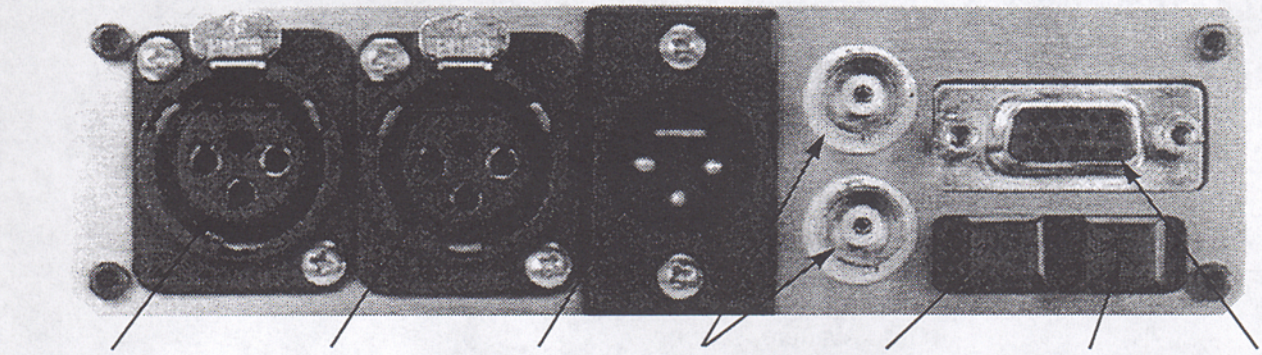
ACCESSORIES

The following accessories are shipped with the AD-500.

1 x Operation Manual
1 x Warranty Card
1 x Male BNC to Female RCA Adapter
1 x Male BNC 75 ohm Terminator
1 x 3/32 Hex Wrench
1 x 10-32 x 7/16 Mounting screw for rack mount
6 x Miniature programming jumpers
4 x Spare rubber feet

NOTE: Power supplies and associated cables are shipped on separate order

# B. GETTING STARTED QUICKLY




A quick guide to using your AD–500 Portable Reference Analog to Digital Converter

Your AD–500 is shipped from Apogee ready to go. It has spent at least two days 'burning in'. This burn-in procedure involves powered operation at elevated temperatures to isolate units that would possibly fail due to infant mortality.

We recommend you read the entire manual before using your AD–500. If you are anxious to get started you will find the operation is intuitive. We suggest you take the following steps--

**1-** Connect your left and right analog inputs to the rear panel XLR connectors. The inputs are left and right as you look at the rear panel. The input polarity is pin 3 hot, balance or unbalanced. If your input is wired for pin 2 hot you need to consult the manual under the section Analog Audio Inputs in the Operations Section.

**2-** Connect the male 15 pin power connector to the rear panel.

**3-** Connect the digital output from either the AES/EBU male XLR connector on the rear panel or the optical output connector on the right (when viewing the rear panel). If you plan the use the S/P DIF output you need to be sure you have the S/P DIF adapter cable attached to the rear 15 pin HD sub connector(available from Apogee).

**4-** Select the front panel power switch to AES or S/P DIF depending on the chosen output format. When AES is selected, all outputs transmit the AES/EBU format from the appropriate connector at the correct level and impedance. Selecting S/P DIF transmits the S/P DIF consumer type output from the same connector.

**5-** Adjust the left and right gain knobs to flash the amber '-12' LED's without flashing the red '-2' LED's.

**6-** Select the input rotary selector switch to ON. Emphasis is selected with the 'ON' position to the right and no Emphasis in the 'ON' to the left.

**7-** Select the SYNC SOURCE to CRYSTAL.

**8-** Select the SAMPLE RATE.

**9-** Your AD-500 will now be outputting digital audio.

# C. INSTALLATION

Your AD-500 is designed for free standing or rack mount operation.

The AD-500 features a high performance analog input stage consisting of many discrete bipolar and FET transistors. This front end circuitry runs in a special Class 'A' configuration with no feedback. Class 'A' circuitry is normally relatively power hungry and the addition of a 60 volt power supply causes this analog circuitry to generate several watts of heat. Most of the heat generated by the AD-500 is in the analog circuitry.

It is important to allow for adequate ventilation as the AD-500 is internally very densely packed with electronics. The AD-500 typically generates 14 watts of heat and unless adequate ventilation is provided it will get hot to the touch. It is normal for the AD-500 to run warm.

When used in a free standing mode, make sure it is sitting on its rubber feet (spares provided in accessory kit) and the cooling slots on the bottom are not obstructed. Operate on a clear flat surface free of sheets of paper that may restrict natural cooling.

For rack mounted operation, check that the APOGEE rack mount adapter is not tightly sandwiched between other items in the rack so as to restrict adequate ventilation.

# D. OPERATION

## Understanding Analog Audio versus Digital Audio

Sound is transmitted through air as movement of individual molecules of air. A microphone turns this movement of air into a changing voltage which represents the air movement. This changing voltage is called an analog of the air movement. Sound analogs can also be mechanical, such as a phonograph groove, electrical current, magnetic field, optical energy, or any continuously varying representation.

Digital audio uses numbers to represent sound. These numbers have to be big enough to accurately capture the smallest and biggest details in sounds. The same numbers also need to be changed fast enough so our ear is not aware of them stepping by. You are probably aware that cartoons consist of a sequence of individual drawings that change fast enough to give the illusion of motion. If we slow the sequence of drawings down, the image starts to flicker like the old movies and motion becomes jerky.

To fool our eyes into seeing fluid motion, the images need to change from one to the next at around 25 per second. There are some motion picture systems such as the one from Showscan in Culver City, CA that increase the rate to 60 per second, resulting in an amazingly grain-less and fluid motion.

The frozen visual images of individual movie frames are analogous to the individual numbers of digital audio. Our ear doesn't get fooled into thinking that these numbers sound real until they change at around 32,000 times a second. The individual numbers are called "samples" and represent audio in narrow slivers of time. The rate these frozen slices of audio change is called the sample rate.

A sample rate of 32,000 is used in digital broadcasting applications. Compact discs use a 44,100 sample rate. You will often see these sample rates represented as KHz or Kilo Hertz (K = One Thousand; Hz = Cycles per second). A 44.1 sample rate is 44.1 KHz or 44,100. The most popular fixed sample rates are 32 KHz,44.056 KHz, 44.1 KHz, and 48 KHz. In digital multi–track applications, the sample rate can be varied plus or minus 12.5% to allow special effects such as overdubbing in a different key for a vocalist to sing in a comfortable range. The multi–track fixed sample rates are normally 44.1 and 48 KHz giving a vari-speed range of 44.1 minus 12.5% to 48 plus 12.5%, i.e. 38.58 KHz to 54KHz. Apogee's AD–500 locks to any sampling rate from below 32 KHz to beyond 54 KHz.

Although the digital audio samples are changing very quickly, it is still very important that the spaces of time between them are the same. Jitter is the measure of how closely the samples arrive to the ideal time for each sample. An analogy would be catching the 5:00 PM bus home from work. It would be unusual to expect it to arrive at exactly 5:00 PM and not unreasonable to expect it to be a few minutes early or late. The imperfect arrival time from day to day is called time jitter and could be measured in minutes early or late.

Time jitter in digital audio is the same idea. Instead of the arrival time of every day for the bus, the samples come along every 0.0000227 seconds (22.7 microseconds) for the compact disc sampling rate, and the jitter is measured in nano or pico seconds. A nanosecond is 0.000000001 seconds or one thousandth of one millionth of a second. As a point of reference, light travels about one foot in a nanosecond. A picosecond is one thousand times smaller than a nanosecond.

<u>What do all these impossibly small numbers mean to me, and why should I care?</u>

Jitter of just a few nanoseconds can compromise digital audio performance. If you close your eyes while listening to a well recorded piece of digital music, the instruments are usually positioned across the imaginary sound stage at specific locations. This soundstage has both width and depth defined by many different subtle imaging cues. As we add jitter to the conversion process, causing some samples to arrive a little early and others late, the soundstage tends to become fuzzy or less focused. Instruments that were precisely located are less sharply defined.

Louder, high frequency sounds are first to be affected by jitter. These high pitched sounds carry the fine sound detail that contain subtle cues that help us locate the source of sounds. Tiny echoes and decaying reverberation tails are blurred, and high harmonics are less sharply localized.

It takes a lot of jitter to affect mid range sounds. Even more jitter is needed to affect the bass which causes the high harmonics of these sounds to be affected first.

Jitter also comes in different flavors. Some is totally random in nature and some contain energy clumped at specific frequencies. To avoid the negatives effects of jitter when making analog to digital recordings, ultra precise timing is a must. Ideally the timing circuitry or clock would go through a jitter cleaning final filter before reading the critical conversion section.

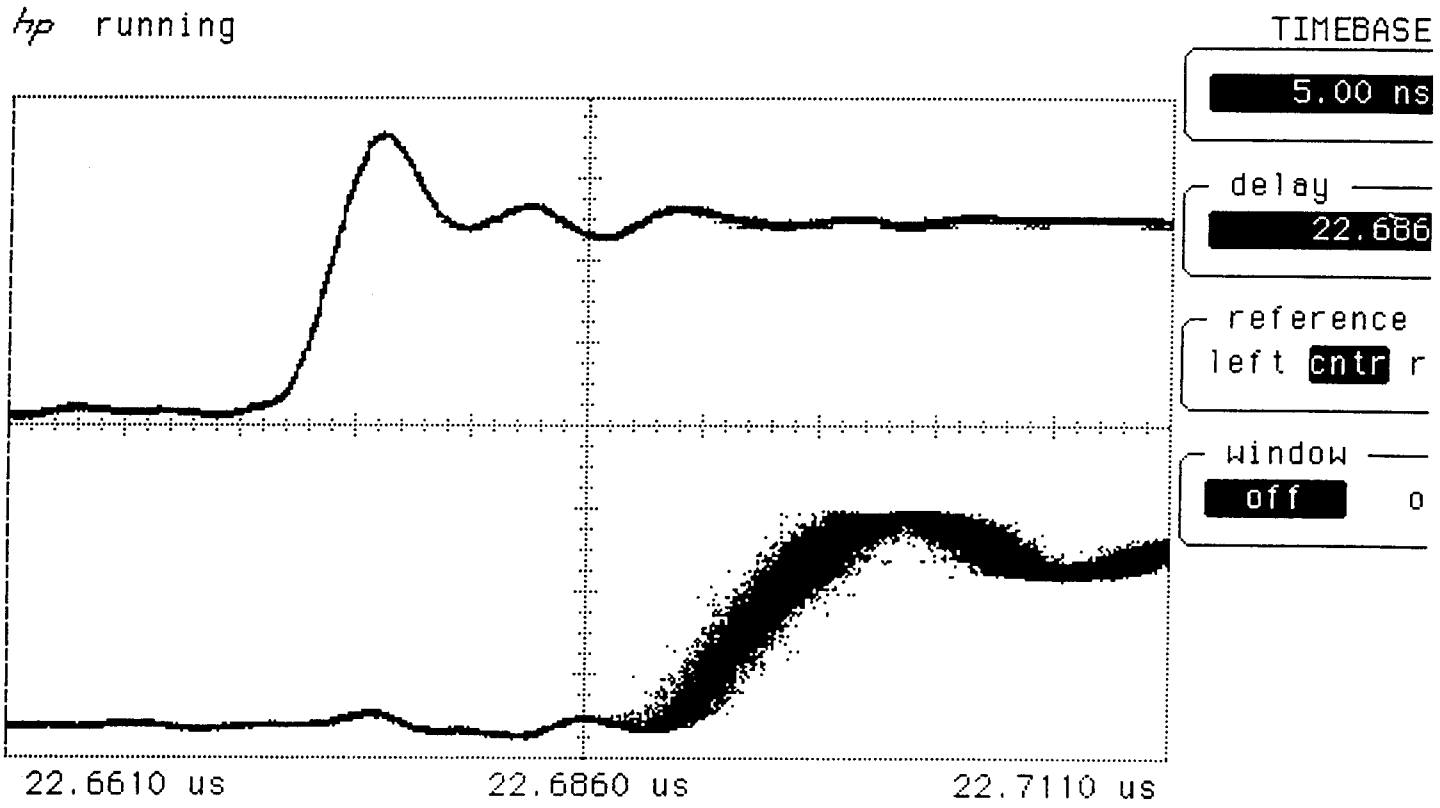
CLEANING UP TIMING JITTER

The AD–500 incorporates Apogee's C768 low jitter clock regenerator (patent pending). Apogee has spent several years in the investigation and research into the effects of jitter and the development of what is required to minimize audible consequences in digital audio equipment.

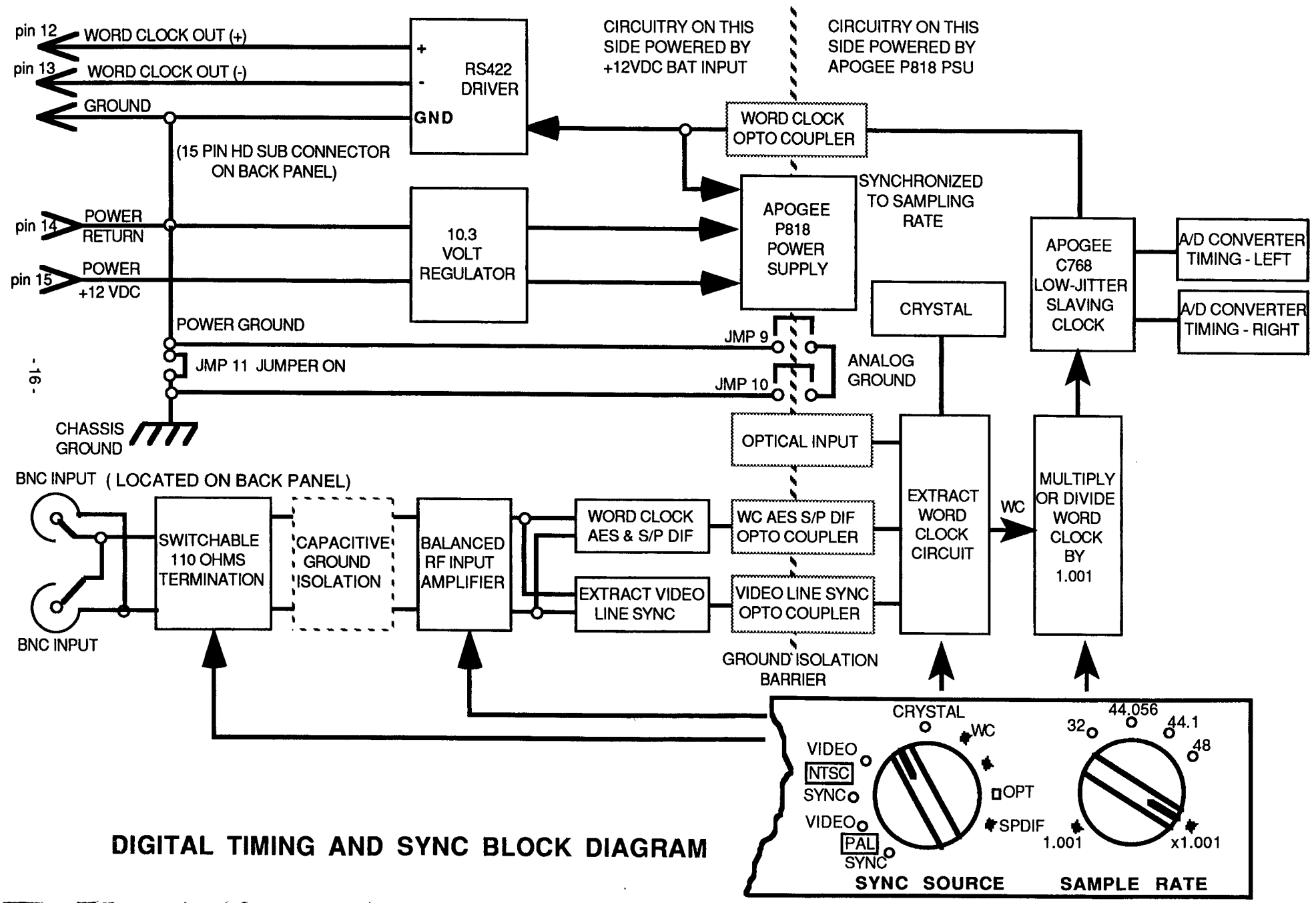
Apogee's model C384 low jitter clock was the first product to address the jitter problem over three years ago. The next generation C768 far surpasses the original C384, which stimulated the digital audio industry's awareness of jitter.

The C768 takes in erratic or jittery timing signals and puts out a family of cleansed, ultra pure timing signals. When the AD–500 locks to normally jittery external timing reference such as word clock, AES, S/P DIF, optical or video Inputs, the C768 delivers optimum analog to digital conversion for uncompromising sonic results.

When you hear audiophiles and professional users talk of various digital audio interconnects compromising the sound quality, it is not the interconnect that is to blame but rather the various sources of jitter. The compromised sound quality is due to the analog to digital or digital to analog converters inability to recover clean, stable timing under the influence of embedded jitter. Sources of jitter embedded in the digital data are due to inherent properties of the interconnect in addition to the transmitted changing digital information such as varying subcode data and audio program content. Apogee C768 low jitter clock eliminates these criticisms.




*The above printout is taken from a very high speed digital oscilloscope.The bottom trace shows the timing jitter in an optical ( consumer ) digital audio link .The top trace shows the recovered timing after the jittery input has passed through Apogees exclusive C768 low jitter clock.This `jitter cleaning' module is taking an already low 4-5 nano-seconds peak to peak input jitter and reducing it to below the oscilloscopes 100 pico-seconds resolution.This cleansed output is better than 30 pico-seconds RMS and represents an improvement of over 50 times.*




## DIGITAL TIMING AND SYNC BLOCK DIAGRAM

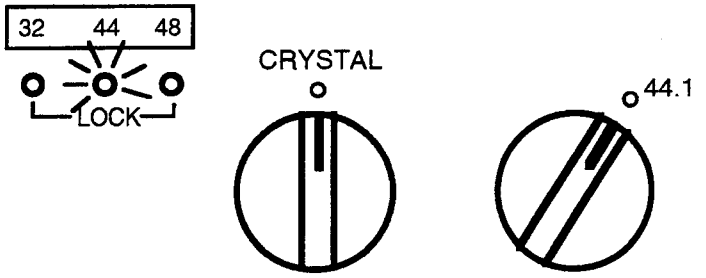
# TIMING AND THE AD-500

A- SELECTING SYNC SOURCE AND SAMPLING RATE

When recording digitally, you need to select an appropriate sample rate either independent of other equipment or locked to an external reference. The AD–500 is very flexible with very accurate internally generated sampling rates and its ability to lock to a wide range of external sync sources. The AD–500 can also act as a stand-alone sync generator.

B- SELECTING THE INTERNAL CRYSTAL SYNC SOURCE

A 'crystal' is a thin piece of quartz cut very precisely to mechanical vibrate at a very accurate frequency in an electrical circuit. The crystal inside the AD–500 vibrates within plus or minus ten parts in a million(PPM) of the specified frequency.
When the sync source is selected to crystal (o), the sample rate switch is active in any of the sample rate positions marked with the solid dot (●). Illumination of the appropriate sample rate LED indicates lock.




The above switch positions select a 44.1KHz sampling rate locked to the internal crystal reference. Illumination of the 44 LED indicates lock.

C- SELECTING AN EXTERNAL SYNC SOURCE

A video signal is often used as a reference for locking a number of different pieces of audio and/or video equipment together. The video is usually a very accurate sync reference and conveniently ties sound to picture. The AD-500's video sync source input is very flexible and incorporates APOGEE's proprietary '1.001' circuitry to accurately generate all the popular sampling rates. 1.001 is the ratio between the frequency of a NTSC color signal and the original monochrome standard. *NOTE:When engineers in the USA first developed the NTSC color television system they found interference problems using the same frequencies as the monochrome system they were replacing. The solution was to slightly shift the color video frequency by 0.1%. This is the 1.001 ratio.*

When Compact Disc's(CD's) were developed, a reliable method to store the digital audio data in preparation for making the CD was necessary. The solution was to use a video cassette recorder to store the wide bandwidth information. A sampling rate of 44.1KHz was chosen to conveniently pack the digital audio data on the U-matic video cassette in the form of a video signal. The video signal chosen was the NTSC monochrome standard of 525 lines/60 frames per second (525/60). This CD 44.1KHz sampling rate is not compatible with a NTSC color video signal(525/59.94Hz). In fact, 44.1KHz is 1.001 times higher than the 44.056 sampling rate that would be compatible with NTSC video. Therefore to lock a 44.1KHz sampling rate to NTSC video requires multiplying the NTSC reference by 1.001.

Digital video machines (D-1, D-2) use 48KHz sampling locked to NTSC video or PAL video.

F-1 type systems use 44.056Hz sampling in NTSC versions and 44.1KHz sampling in PAL versions.

1.001 example- In a music video application, a picture running at 59.94 FPS has to sync with a CD sound track running at 60 FPS(44.1KHz sampling rate).

D- CLOCK ACCURACY

In video applications it is important to match sound and picture. If sound and picture are not synchronized they will drift depending on the difference between the two timing references. Timing accuracy is measured in parts per million (PPM) difference from the ideal. Accuracy for various sources can be gauged by the time it takes for two devices to drift one frame out of sync. The approximate times below assumes worst case conditions (one reference fast, the other slow) and a frame period of 33 msec.

TIMING ACCURACY VS. DRIFT

1 ppm = 4.6 hours (approximate)
10 ppm = 25.25 minutes (approximate)
100 ppm = 2.5 minutes (approximate)

COMMON TIMING ACCURACY STANDARDS

NTSC sync generators hold to 3 ppm
PAL sync generators hold to 1 ppm.
AES/EBU digital audio holds to 10 ppm.
Consumer digital audio holds to 50 ppm.

## E- VIDEO LEVELS

A video signal contains picture information in a sequence of thin lines and additional timing information to synchronize (SYNC) the lines into a complete picture. The total video signal is represented as 1 volt peak to peak(Pk-Pk) when driving into a 75 ohm load. The picture part uses 0.7V pk-pk and the sync uses the remaining 0.3V pk-pk.

If the video signal is to be used just for sync purposes, a black picture can be used which consists of only the 0.3V pk-pk part.

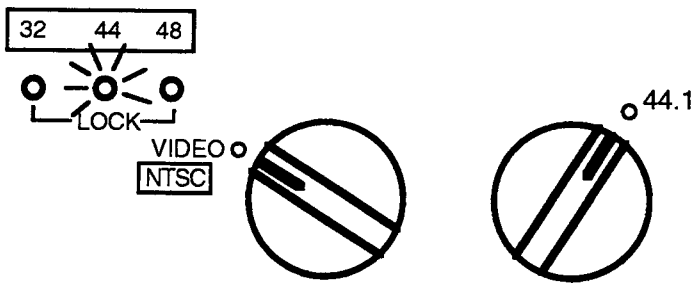
Video sync information can also be distributed as a 4 volts pk-pk signal into 75 ohms for NTSC and 2 volts pk-pk into 75 ohms for PAL.

In the AD-500, the three different video standards supported are NTSC (525line/59.94Hz), PAL (625line/50Hz), and monochrome (525line/60Hz). In each of these standards the input can be video, black video and the higher level, sync.

## F- LOCKING TO A NTSC VIDEO SYNC SOURCE

Connect the video reference to one of the BNC connectors on the rear panel and terminate with the supplied 75 ohm terminator on the other BNC. The terminator is not necessary if looping to another device and the last device in the chain is terminated with 75 ohms. *NOTE: The video must be correctly terminated for proper AD-500 Sync operation.*

Select NTSC video on the sync source selector and choose the sample rate with the sample rate selector. Illumination of the appropriate sample rate LED indicates sample rate lock to the external video source.




**SYNC SOURCE** **SAMPLE RATE**

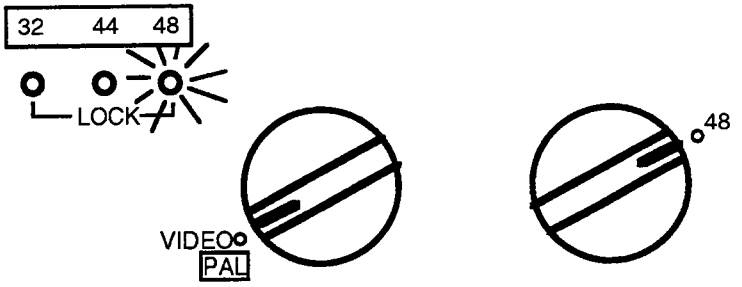
The above example indicates selector positions for NTSC video level sync source and 44.1KHz sampling rate.

Illumination of the 44 LED indicates lock.

## G- LOCKING TO A PAL VIDEO SYNC SOURCE

Connect the video reference to one of the BNC connectors on the rear panel and terminate with the supplied 75 ohm terminator on the other BNC. The terminator is not necessary if looping to another device and the last device in the chain is terminated with 75 ohms. *NOTE: The video must be correctly terminated for proper AD-500 Sync operation.*

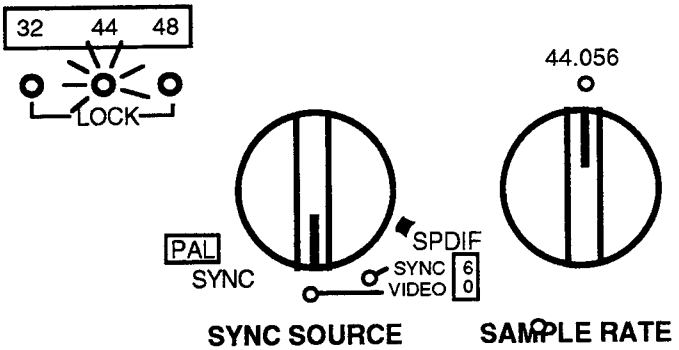
Select PAL video on the sync source selector and choose the sample rate with the sample rate selector. Illumination of the appropriate sample rate LED indicates sample rate lock to the external video source.




The above example indicates selector positions for PAL video sync source and 48KHz sampling rate. Illumination of the 48 LED indicates lock.

H- SPECIAL VIDEO SYNC FACILITIES

The AD-500 has two additional sync source selector positions. These two positions generate the four output sampling rates from a monochrome video sync source. Monochrome refers to 525 line/60 Hz video.




The above selector settings deliver a 44.056 sampling rate locked to a 525/60(monochrome) video source. Illumination of the 44 LED indicates lock.
*NOTE: The term monochrome in this application refers to 525/60 . 525/60 can be color video.*

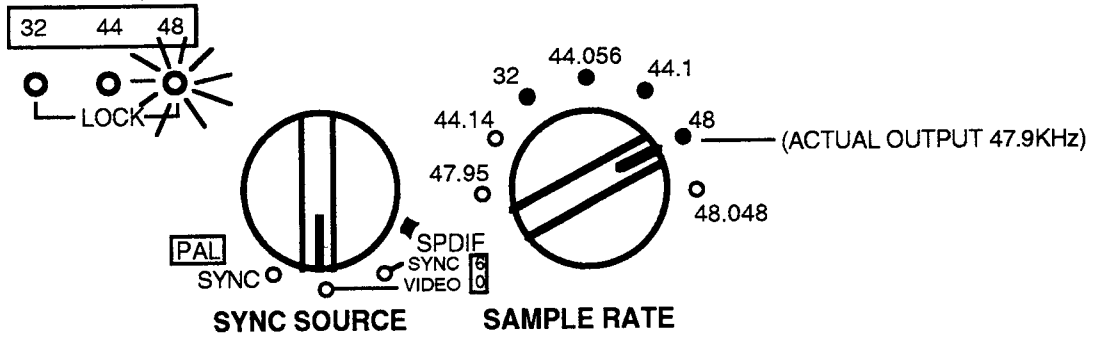
I- SPECIAL SAMPLING RATES

*FILM VARIENT CRYSTAL SYNC FREQUENCIES*

For all of our clients in the film industry who have requested additional sample frequencies that are available while using crystal sync. The additional sample frequencies are 44.144 KHz, 47.952 KHz and 48.048 KHz. These are the "standard" sample frequencies with the 1.001 ratio built in. The most common useage will be to perform a DAT field recording at 48.048 KHz which will pull down to a sample frequency of 48 KHz during the telecine process.

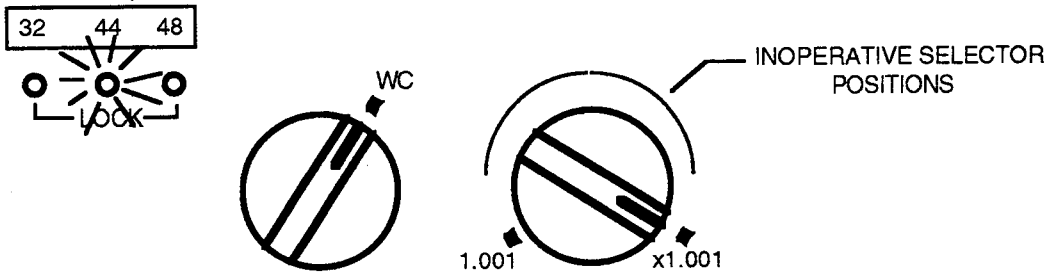
*47.952KHz LOCKED TO NTSC*

In some high definition television applications (HDTV), it is necessary to generate 47.952KHz locked to a NTSC sync source. Selecting monochrome (525/60) video or sync while inputting NTSC(525/59.94) video or sync gives some useful sampling rates for special applications. With selectors set to the above positions; a NTSC video input, the 48KHz position outputs 47.952KHz(48/1.001) Illumination of the 48 LED indicates lock.



J- LOCKING TO EXTERNAL WORD SYNC INPUTS

The AD-500 locks to external word sync inputs(also known as Word Clock- WC). In this sync source mode all but two sample rate selector positions are inoperative and the AD-500 outputs the same frequency as the sync input. The active sample rate switch positions provide the unique ability to increase or decrease the input sampling rate by a 1.001 ratio.




**SYNC SOURCE** **SAMPLE RATE**

Utilizing the above settings, any WC(Word Sync) input will be multiplied by 1.001. For example a 44.056KHz WC input will deliver 44.1KHz locked to the input. Illumination of the 44 LED indicates lock.

The x1.001 and divide by 1.001 positions are marked with a square which corresponds to the square on the WC, AES, OPT AND S/P DIF sync source positions. AD-500 users tell us this feature has saved the day in situations where the wrong sample rate was used.

K- AES SYNC INPUTS

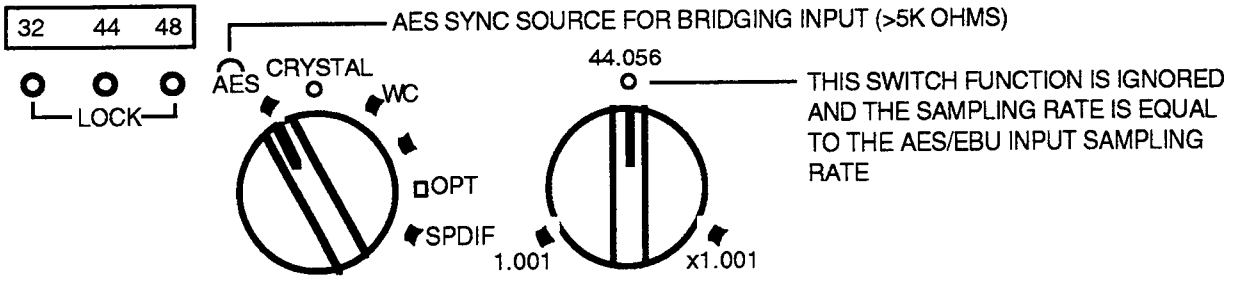
Selecting the AES sync source position enables the AD-500 to lock to any AES/EBU digital audio source. No audio information is transferred. The sync information is extracted form the AES/EBU data stream.

The only sample rate selector positions active are the x1.001 and divide by 1.001.(Marked with square) Any other switch positions are ignored. The 1.001 positions function as described in the WC section above. The labeled AES position terminates the input automatically with 110 ohms for correct line termination without the need for an external BNC terminator.

In addition to the labeled AES selector position, there is an additional unlabeled AES selector position. The unlabeled AES position (next to the crystal position at 12 o'clock) selects an AES/EBU bridging input to permit looping multiple AD-500 with the same AES/EBU input, without overloading the AES/EBU signal. The last AD-500 in the chain needs to be terminated, normally by using the labeled AES sync source position.

The circles on the sync source selector relate only to the circles on the sample rate selector.

The squares on the sync source selector relate only to the squares on the sample rate selector.



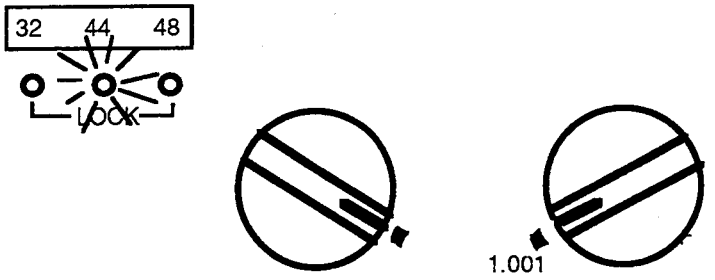

**SYNC SOURCE** **SAMPLE RATE**

The above example shows the sync source selected to the unlabeled AES sync source position which selects an AES/EBU sync source but does not terminate it with the normal 110 ohms. Note the sample rate switch is set to 44.056 and is ignored. Depending on the input sampling rate, the appropriate LED will illuminate to indicate lock.

L- S/P DIF SYNC INPUT

Selecting the S/P DIF sync source position enables the AD-500 to lock to S/P DIF digital audio sources. No audio information is transferred. The sync information is extracted from the S/P DIF data stream. Apply the S/P DIF input signal to the BNC utilizing the supplied male BNC to female RCA adapter. If not looping signal through to another unit, terminate the other BNC connector with the supplied terminator. If looping the signal to other devices, the last unit in the chain should be terminated with 75 ohms.

The only sample rate selector positions active are the x1.001 and divided by 1.001(marked with square). Any other switch positions are ignored. The 1.001 positions function as described in the WC section above.



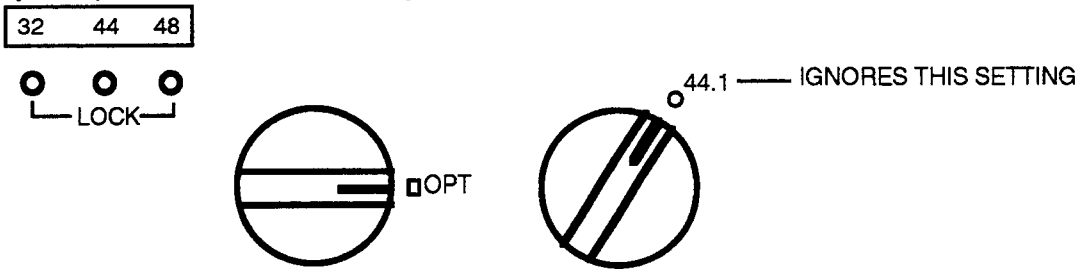

**SYNC SOURCE** **SAMPLE RATE**

Utilizing the above settings, the sync source selector is selected to S/P DIF inputs and the sample rate selector is set to 1.001. This will divide the incoming S/P DIF input sampling rate by 1.001.

For example, a 44.1KHz input would output a 44.056 sample rate perfectly locked. Illumination of 44 LED indicates lock.

M- OPTICAL SYNC INPUT

The optical sync source comes in via the optical cable input connector located on the rear panel. For higher sampling rates, this input is somewhat sensitive to internal grounding. Usually the best grounding arrangement for the optical input isn't always optimum from an audio standpoint. The optical sync input is typically used very infrequently, so it should not pose a problem. If you do intend to use it we suggest you experiment with the various grounding jumpers as described in the section on grounding.




**SYNC SOURCE** **SAMPLE RATE**

The above example shows the sync source selected to the optical sync input. The sampling rate will be the same as the optical sampling rate with the sample rate switch ignored. Illumination of the appropriate LED will indicate lock.

On the next page is a matrix drawing which indicates all input formats accepted showing sampling rates, selector positions, signal levels and connector types.

| SYNC INPUT | CONNECTOR TYPE | INPUT IMPEDANCE | TERMINATOR REQUIRED | NOMINAL INPUT LEVEL WITH TERMINATION | SYNC INPUT SWITCH POSITION | SAMPLE RATE OUTPUT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 32 | [illegible] | 44.1 | 48 | SAME AS INPUT | INPUT X 1.001 | INPUT DIVIDE 1.001 |
| NTSC VIDEO 525/59.94 | 2 x BNC in parallel balanced | >5K ohms | 75 ohm BNC | 1 volt Pk-Pk | [NTSC] VIDEO | ● | ● | ● | ● | | | |
| NTSC SYNC 525/59.94 | 2 x BNC in parallel balanced | >5K ohms | 75 ohm BNC | 4 volts Pk-Pk | [NTSC] SYNC | ● | ● | ● | ● | | | |
| PAL VIDEO 625/50 | 2 x BNC in parallel balanced | >5K ohms | 75 ohm BNC | 1 volt Pk-Pk | [PAL] VIDEO | ● | ● | ● | ● | | | |
| PAL SYNC 625/50 | 2 x BNC in parallel balanced | >5K ohms | 75 ohm BNC | 2 volts Pk-Pk | [PAL] SYNC | ● | ● | ● | ● | | | |
| MONO-CHROME VIDEO | 2 x BNC in parallel balanced | >5K ohms | 75 ohm BNC | 1 volts Pk-Pk | UNLABELED position next to [PAL] SYNC | ● | ● | ● | ● | | | |
| MONO-CHROME SYNC | 2 x BNC in parallel balanced | >5K ohms | 75 ohm BNC | 4 volts Pk-Pk | UNLABELED position next to ■ SPDIF | ● | ● | ● | ● | | | |
| WORD SYNC (W.C.) | 2 x BNC in parallel balanced | >5K ohms | 75 ohm BNC | TTL or RS-422 | WC | | | | | ■ | ■ | ■ |
| AES/EBU | 2 x BNC in parallel balanced | 110 ohms | none | 5 volt Pk-Pk | AES | | | | | ■ | ■ | ■ |
| AES/EBU | 2 x BNC in parallel balanced | >5K ohms | none | 5 volt Pk-Pk | UNLABELED position next to 'CRYSTAL' | | | | | ■ | ■ | ■ |
| S/P DIF | 2 x BNC in parallel balanced | >5K ohms | 75 ohm BNC | 0.5 volt Pk-P | SPDIF | | | | | ■ | ■ | ■ |
| OPTICAL | Rear Panel Optical Input | N/A | N/A | N/A | OPT | | | | | ■ | ■ | ■ |

# ANALOG AUDIO INPUTS

Viewing the rear panel of the AD-500, the gold plated female XLR connector on the left is the left (or A) analog audio input. The XLR on the right is the right (or B) analog audio input.

A- PIN 3 HOT

The AD-500 is set up for pin 3 hot as shipped. A positive going voltage into pin 3 will produce a digital audio output of the correct polarity. Pin 3 hot is not the accepted worldwide standard but appears to be the most popular convention in the United States.

B- PIN 2 HOT

Changing the input for pin 2 hot to output the correct digital audio polarity requires removing the bottom cover and rotating J2 and J3 by 180 degrees. The instructions for removing the bottom cover are located in the Service Information - CASE DISASSEMBLY section. The polarity instructions are printed next to J2 and J3. Also review WIRING INSTRUCTIONS FOR ADDITIONAL RIGHT AND LEFT INPUTS section for detailed diagrams.

Pin 3 Hot - Plug red wires towards front panel
Pin 2 Hot - Plug red wires towards rear panel

C- INPUT FEATURES

Internally, the left and right inputs are both dual inputs (with only one of each brought to the rear panel). The additional left and right inputs can be accessed to mix additional inputs. See next page for Analog Input Block Diagram.

*Tech Note:*

*Each input pair behaves as an active combining stage with none of the disadvantages of traditional op–amp designs such as increasing noise gain with added inputs.*

*Input signals first encounter a passive radio frequency filter (no transistors or op–amps). Active filters have a limited range beyond which they can no longer effectively filter out higher frequencies. Audio signals mixed with radio frequency interference can result in a form of distortion called intermodulation distortion with active filters.*

*The input assumes the source impedance (from the unit driving the AD–500)will be less than 600 ohms and probably more like output impedances of 50 to 100 ohms. In the very unlikely event of using higher source impedances such as from some consumer and musical instrument sources, the frequency response at the very highest frequencies will increasingly be rolled off gradually with increasing source impedance. Professional audio equipment output impedance is almost always less than 100 ohms.*

*INPUT IMPEDANCE*

*Each side of a balanced input encounters a RF filter and then what appears to be a purely resistive input to ground of 10 K ohms. This makes the input impedance greater than 20 K ohms for balanced inputs and greater than 10 K ohms for unbalanced inputs. This is considered to be a bridging input because it sits like a bridge over the output driving it without any significant loading effect. This permits any low impedance output to drive many such bridging inputs.*

*Each input is referenced to ground which results in minimum cross–talk or interference from one input pair to another.*

D- ACCESSING THE SECOND LEFT AND RIGHT INPUTS (INPUTS B)

The AD–500 features a very unusual input stage. Internally there is a gold plated connector with six input pins to provide two balanced inputs for the left channel (J3) and a second connector for two balanced inputs for the right channel (J2). Both input pairs have a pin for each shield, and each (+) and (-) input.

towards Front Panel

towards Back Panel

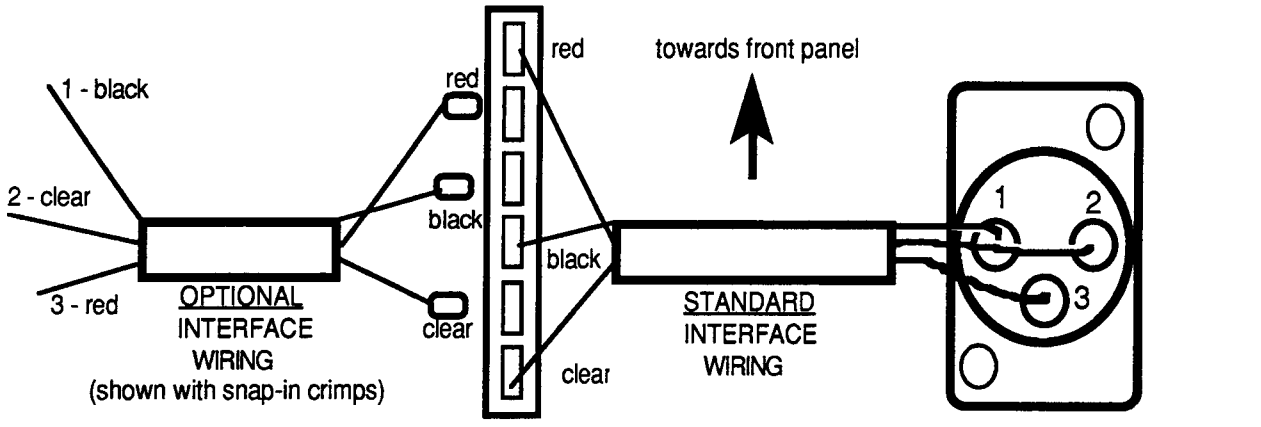
| **J3** Left Channel | WIRE COLOR | **J2** Right Channel |
|---|---|---|
| Input A (+) | RED | Input A (+) |
| Input B (+) | RED | Input B (+) |
| Shield A | BLACK | Shield A |
| Shield B | BLACK | Shield B |
| Input B (-) | CLEAR | Input B (-) |
| Input A (-) | CLEAR | Input A (-) |

Pin 3 HOT – Plug red wires towards front panel
Pin 2 HOT – Plug red wires towards rear panel
Inputs A – Left and right are wired to the rear panel, 3 pin gold plated XLR connectors.
Inputs B – Left and right are not wired to any external input connectors.

The second left and right inputs are provided for any users who may take advantage of some of the special input capabilities.

E- WIRING INSTRUCTIONS FOR ADDITIONAL RIGHT AND LEFT INPUTS

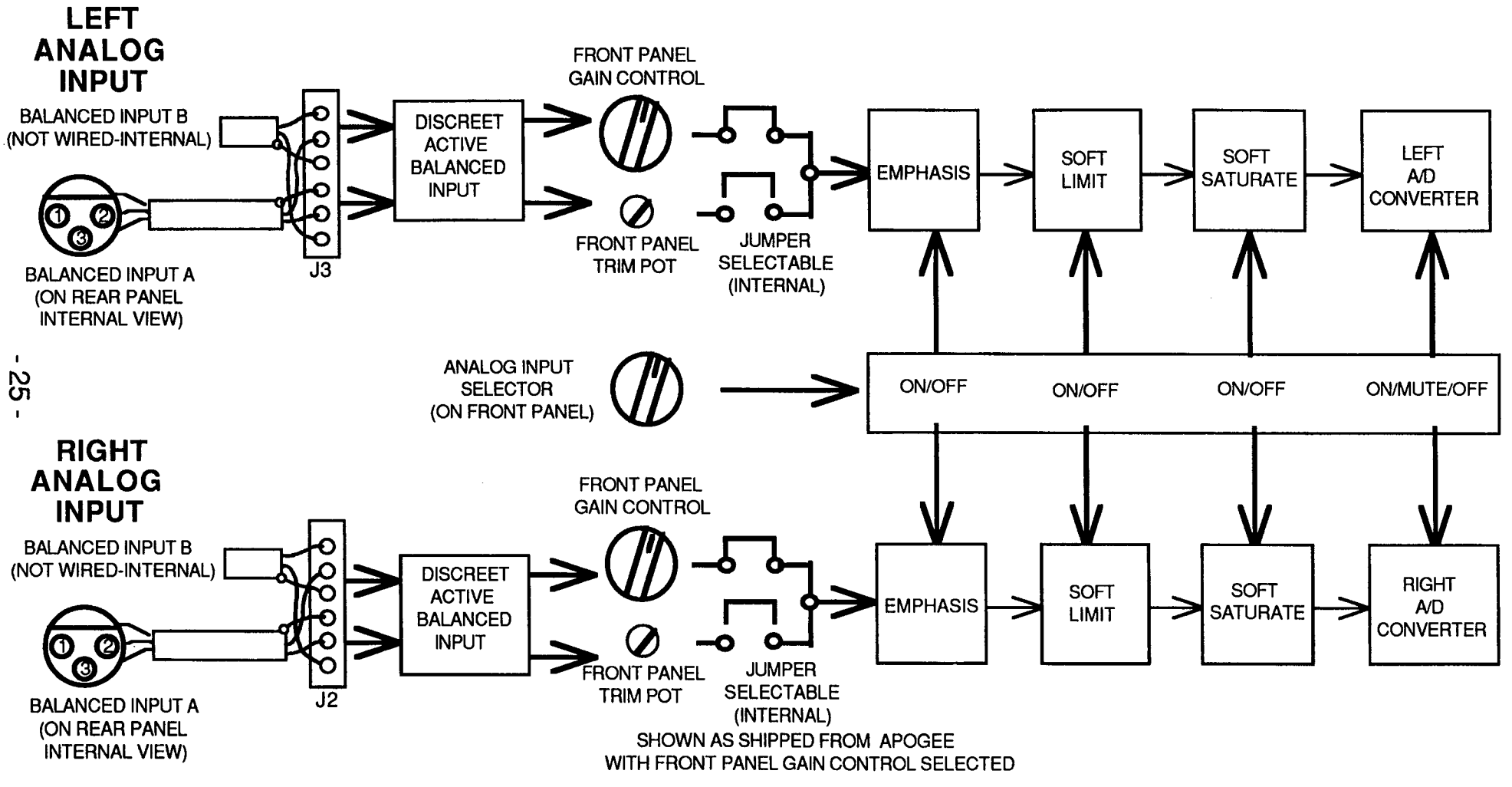
Replace the rear panel gold plated XLR input connector with an appropriate multi pin alternative. Use shielded balanced cable similar to the Apogee provided cable harness to the A inputs.




J2 for Right Channel
J3 for Left Channel
Shown with Pin 3 wired HOT

XLR INPUT CONNECTOR
(ON BACK PANEL)

| | | |
|---|---|---|
| pin 1 | black | shield |
| pin 2 | clear | input A (-) |
| pin 3 | red | input A (+) |






SEE WIRING INSTRUCTIONS FOR ADDITIONAL RIGHT AND LEFT INPUTS
LOCATED IN ANALOG AUDIO INPUTS SECTION FOR J2 AND J3 WIRING

**ANALOG INPUT BLOCK DIAGRAM**

We suggest you use the following manufacturers of cable and contacts which are in use for the analog inputs for the AD-500.

CABLE – Mogami, P/N 2944–07. Neglex cable, purple.

Available from:

Marshall Electronics
P.O. Box 2027
Culver City, CA 90230
USA
Tel. (310) 390–6608

CONTACTS – Amp Modu Mt. Connectors
Amp P/N 102128–1 (bulk packaging)
Digi–Key P/N A3004

Available from:

Digi–Key Corp.
701 Brooks Ave. South
Thief River Falls, MN 56701–0677
USA
Tel. 800–344–4539
Fax. 218–681–3380

## F- INPUT GAIN CONTROLS

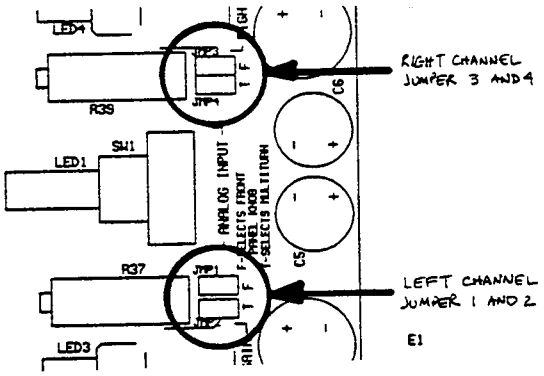
Your AD-500 is supplied with very flexible gain control permitting a wide range of input levels. Internally there are two jumpers on each input (see diagram below) to select:

a) purple front panel rotary gain control (F jumper Left and Right)

b) screwdriver adjust front panel multi-turn gain control (T jumper Left and Right)

c) both of the above, a) and b)

These jumpers are accessed by removing the bottom cover - see instructions under Service Information- CASE DISASSEMBLY section.




When you select both gain controls, the multi–turn pot can be used to trim the purple rotary pot to a specific front panel calibration line.

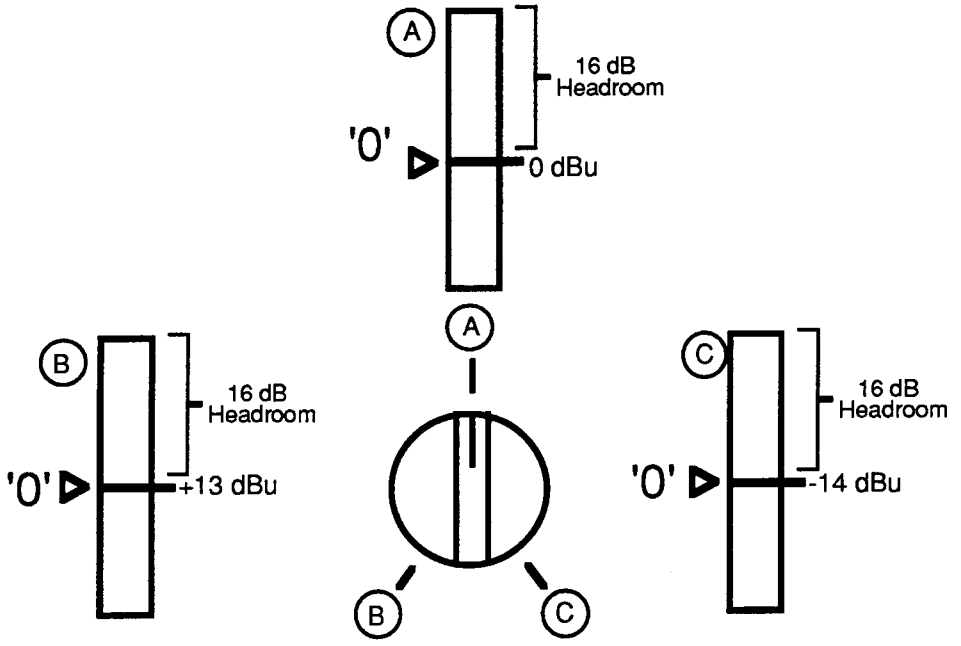
The following should help give you a feel of the gain structure. With a balanced input and the front purple gain controls jumper selected (jumper F internally).

Placing the pots at:

A) the 12 o'clock position with an input of 0 dBu will give a 16.5 dB headroom in the digital audio output.

B) the minimum position with an input of +13 dBu will give a 16 dB headroom in the digital audio output.

C) the maximum position with an input of -14 dBu will give a 16 dB headroom in the digital audio output.




F- BALANCED OR UNBALANCED INPUTS

The AD-500 input will accept both balanced and unbalanced inputs. No internal jumper selectors are required. The maximum input level is +28 dBu balanced and +24 dBu unbalanced. This is the level which will produce a full scale digital output with the gain pots at their minimum position.

G- COMMON MODE REJECTION

Common Mode Rejection is a measure of how well an input ignores interference picked up on pin 2 and 3 together.

The AD-500 discrete input stage features excellent common mode rejection. With a well balanced input, the common mode rejection at 100 Hz is typically better than 90 dB and at 10 KHz is typically better than 70 dB. (Reference Settings: +15 dBu input signal and -0.5dB f.s. digital audio output)This common mode performance assures quiet performance in the presence of external noise and interference.

H- ANALOG INPUT STAGE & TOTAL HARMONIC DISTORTION AND NOISE (THD+N)

Analog circuitry is often judged by how little distortion and noise it adds to an input. The entire analog section of the AD-500 typically has total harmonic distortion + noise performance better than 0.001% with the soft limit and soft saturate selector switched out.

I- THD+N ANALOG INPUT TO DIGITAL OUTPUT

With a full scale digital output, the total harmonic distortion + noise (THD+N) of the digital output is typically better than 0.002%. This figure improves even further as the input level is reduced.

-10 dB F.S. = 0.0016% THD+N REF FULL SCALE
-60 dB F.S. = 0.0016% THD+N REF FULL SCALE
-90 dB F.S. = 0.0016% THD+N REF FULL SCALE

J- HEADROOM

A hotter sounding compact disc can be the difference between having a hit or being forgotten. A hotter sounding CD means not wasting headroom.

In analog recording we define a nominal operating level and allow enough headroom above to avoid clipping the analog circuitry. This nominal level is usually referred to as 'zero' for the 0dB calibration on analog meters. The analog zero usually represents a nominal +4 dBu output level, i.e. when the meter indicates 0 it is really putting out a level of +4 dBu.

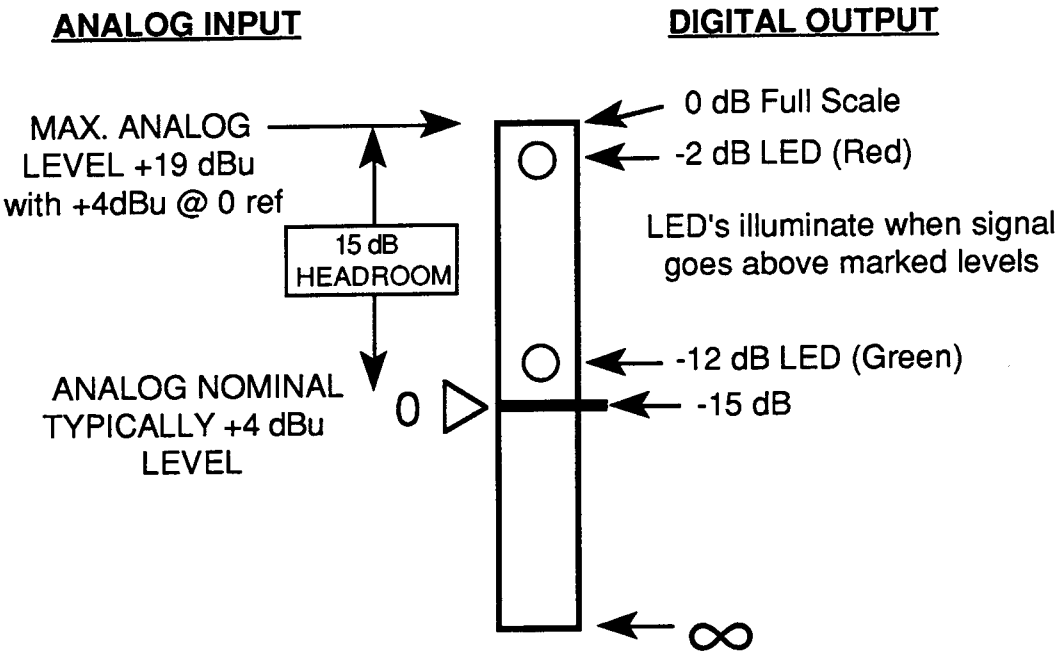
With digital audio, a precise distortion or clipping point is known. This is the point where we run out of numbers to represent the analog input. This maximum positive or negative level is often called an

'over' due to the popular labeling of digital meters. The 'over' indicators illuminate when a digital maximum is reached, usually for a total of more than 3 samples in a row.
*NOTE: Some DAT recorders such as the Panasonic 3700 and 3900, indicate 'overs' with analog inputs, but do not indicate them with digital inputs such as from the AD-500.*

In digital audio we must decide on how much headroom we want above our nominal level (the zero from analog world) before we hit a dreaded "over" or digital clip. The aim is to use as much of the dynamic range as possible. Any wasted headroom means we are closer to the noise floor than necessary.

We require more or less headroom, depending on the material being recorded. Mastering engineers typically choose 12 or 14 dB headroom over their nominal input level because they usually have their dynamics tightly controlled. In tracking situations 15 and 16 dB are the most popular with some users going as high as 18 and 20 dB. The headroom of analog inputs or some DAT recorders are often fixed, such as at 18 dB for the Panasonic 3700 and 3900. When using the AD–500, the headroom is easily adjusted with the front panel controls (purple knobs), or front panel multi–turn pots, or a combination of both.

Just to confuse you even further, digital audio levels are often referred to the maximum level (or full scale, f.s.). Zero dB full scale is a maximum level when referring to digital levels. With 16dB headroom, the nominal level would be then sitting down at -16dB referenced to full scale (f.s.)
*NOTE:dBu is a dB measurement relative to the voltage developed by 1 milliwatt into 600 ohms, which is 0.775 volts RMS or 0dBm. The dBu is a more modern measurement of output level because of todays' input stages are mostly insensitive to loading impedance.*



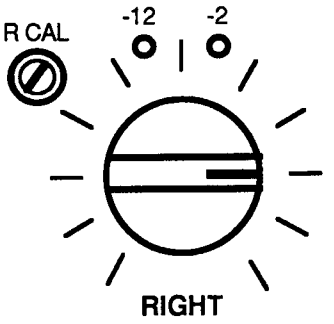

EXAMPLE: COMPARISION OF ANALOG INPUT TO DIGITAL OUTPUT WITH 15dB HEADROOM AND +4 dBu REFERENCE

K- METERING

The front panel metering LED's indicate when the AD–500 input signals are peaking in a comfortable range. They are designed to be used in conjunction with the meters of the hosts' system such as DAT, workstation, etc.

* The GREEN LED indicates when the input signal is 12 dB below full scale digital out.
* The RED LED indicates when the input signal is 1.5 dB below full scale digital out.

*This zero dB indication should not be confused with the zero level used in analog meters.*




The above indentifies the location of the -12 dB and -2 dB LED indicators for the right channel.

L- CALIBRATION OF HEADROOM

Before use, we recommend calibration of your setup. By adjusting the gain controls you can calibrate the AD-500 for your specific application and chosen headroom. (Review INPUTS GAIN CONTROL section)

A. Set up a reference oscillator from your mixing console or analog source to output your chosen analog 'zero' level. In music recording studios this is usually +4dBu output level when the meter indicates zero.

B. Next decide what headroom you need for your particular project. (Using 15dB for our example:)

C. Feed the analog zero into the AD-500 and monitor the meters on the host processor.

D. Adjust the input gain controls on the AD-500 to indicate -15dB relative to full scale digital output on the meters.

The above assumes that your meters are calibrated to 0dB full scale digital output.

K- EMPHASIS

Emphasis is often treated as a holdover from the early days of digital audio. Recording an audio signal with emphasis passes the analog signal through a special filter which boosts the high frequency sounds while leaving the low frequency sounds below 1KHz alone.

Audio signals in general tend to decay in level as the frequency is increased, this is especially true of classical music. Rock and roll is an exception and tends to have a lot of high frequency energy by way of direct inputs, hi-hats, cymbals, etc. By rolling off the high frequencies on playback we apply de-emphasis, which reverses the effect with a high frequency rolloff. The net result is an improved noise floor at higher frequencies.

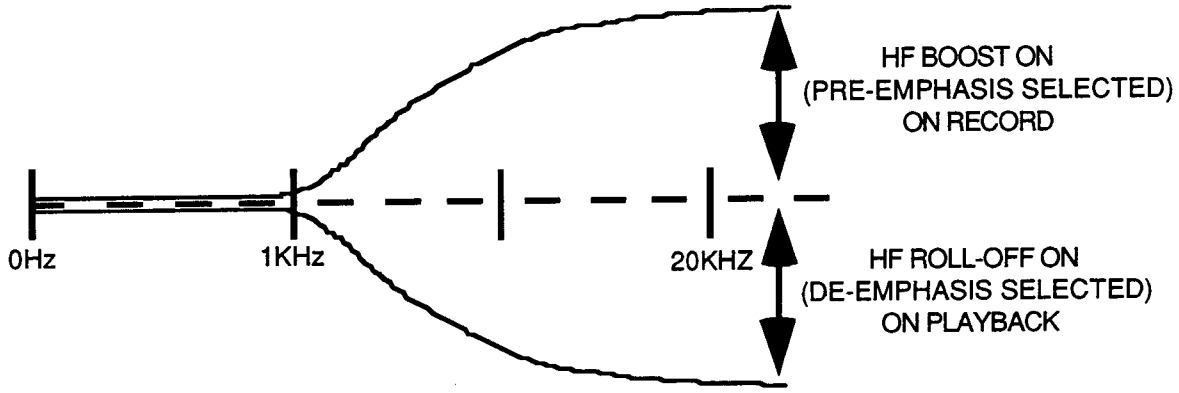
Ten different people will have 10 different opinions on emphasis. In general emphasis is a dying trend with its main use coming from the classical recording area. A number of recent model CD players produced in Japan don't support emphasis, resulting in lots of highs when playing back an emphasized program.

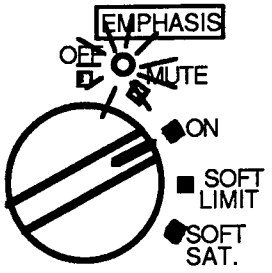
One of the main reasons for using emphasis was the F1 format which was the predecessor to DAT . The F1 or (EIAJ) processor took in analog signals and outputted digital audio in the form of a video signal. This video signal was then recorded on inexpensive video recorders such as VHS and, at the time BETA. The F1 format applied pre-emphasis all the time. Although the F1 and its relatives (Sony 501, 601, 701, etc.) were designed as consumer machines, they were extensively used as professional recorders which resulted in a lot of pre-emhasized masters.

Many of todays masters are made by way of DAT whcih in general does not offer the emphasis option.

50/15uS emphasis descibes the shape of the pre-emphasis high frequency boost on record. The reciprocal de-emphasis high frequency cut is applied on playback. The AD-500 only supports the 50/15uS standard of pre-emphasis.

To record with emphasis select the analog input selector to the right half of the selector invoking emphasis on the labeled function.



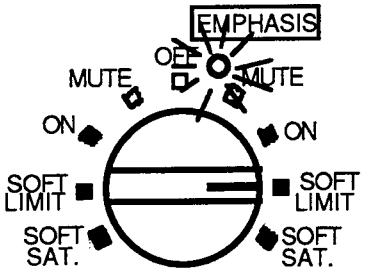

**ANALOG INPUT**

In the above example, emphasis will be applied to inputs. The green LED will be illuminated to indicate emphasis is being applied. The LED metering is post-emphasis and will indicate any loss of headroom, due to the boosted high frequency of emphasis.

N- DYNAMICS CONTROL - SOFT LIMIT FUNCTION

Short transients can clip analog to digital converters and can produce unwanted harmonics (nasty sounds). Typical peak limiters used to remove short transients are very abrupt and spread unwanted harmonics. If these short transients are removed without hard clipping, the average recording level can be raised by several dB with little or no sonic penalty.(ie. your ear doesn't miss the short transients if you don't overdo it and remove them cleanly)

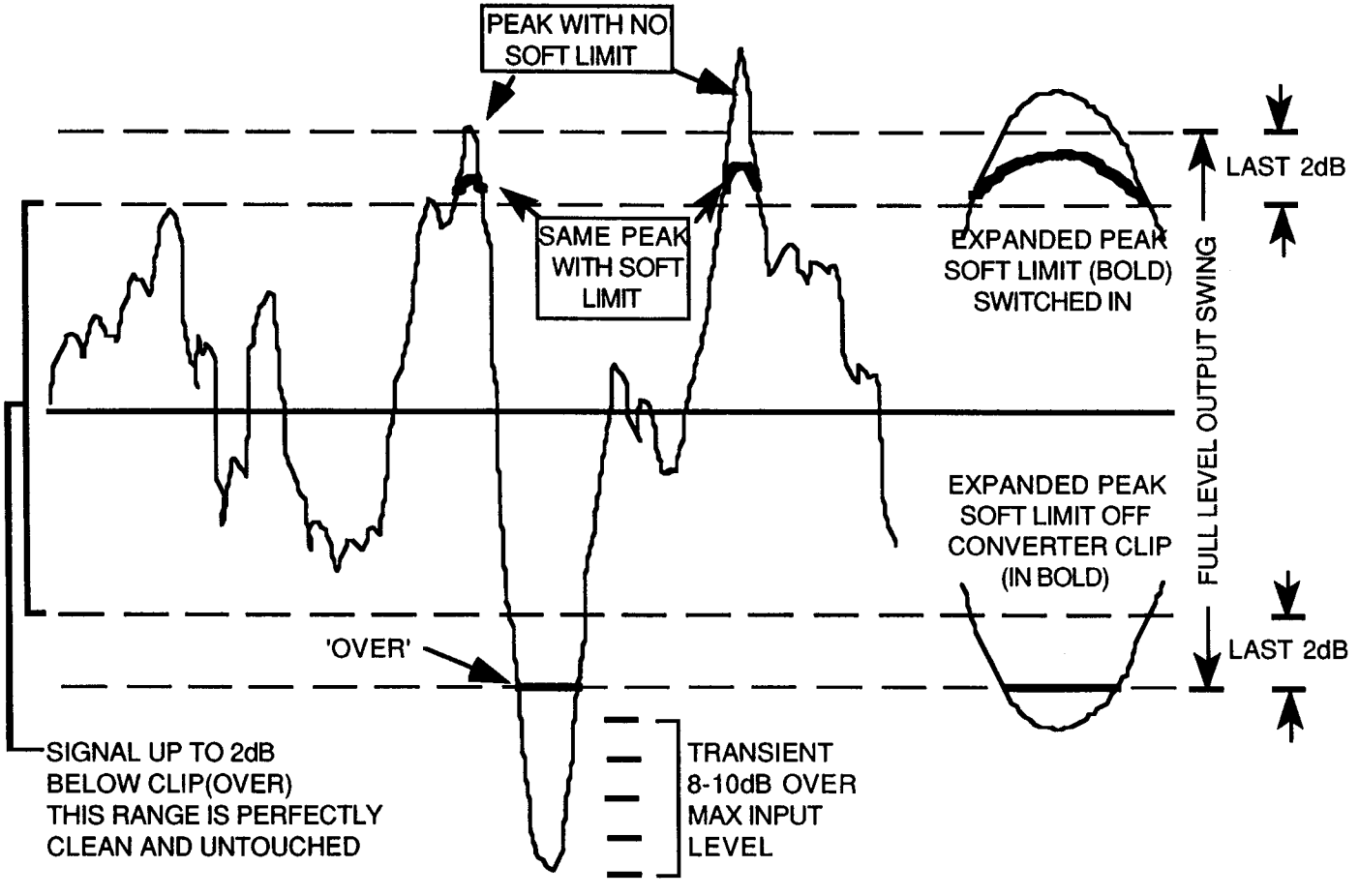
The AD-500 has our exclusive peak limiter (**Soft Limit**). Soft Limit does not make a hard, sharp edge clip as you would get if the converter was over–driven. Instead, once you pass the threshold, it rounds off any peaks in a manner that makes thier removal difficult to hear.. These sharp peaks do not usually affect the sound quality if they are cleanly removed and you also get none of the typical limiter/compressor byproducts such as pumping and breathing. Depending on the material being recorded, the threshold of audibility will vary. This is best found by experimentation. Just a few dB increase in average level can result in more powerful, hotter sounding CD's without fear of leaving a trail of 'overs'. (See next page for detailed diagram of effects of Soft Limit Function)




**ANALOG INPUT**

The above selector settings will insert the Soft Limit function (Also note that emphasis is selected and the LED illuminates indicating emphasis on.)

SHORT TRANSIENTS THAT WOULD NORMALLY CAUSE OVERS
ARE CONTROLLED WITH A GENTLE ROUNDING WITH SOFT LIMIT




**DETAILED EFFECTS OF SOFT LIMIT FUNCTION**

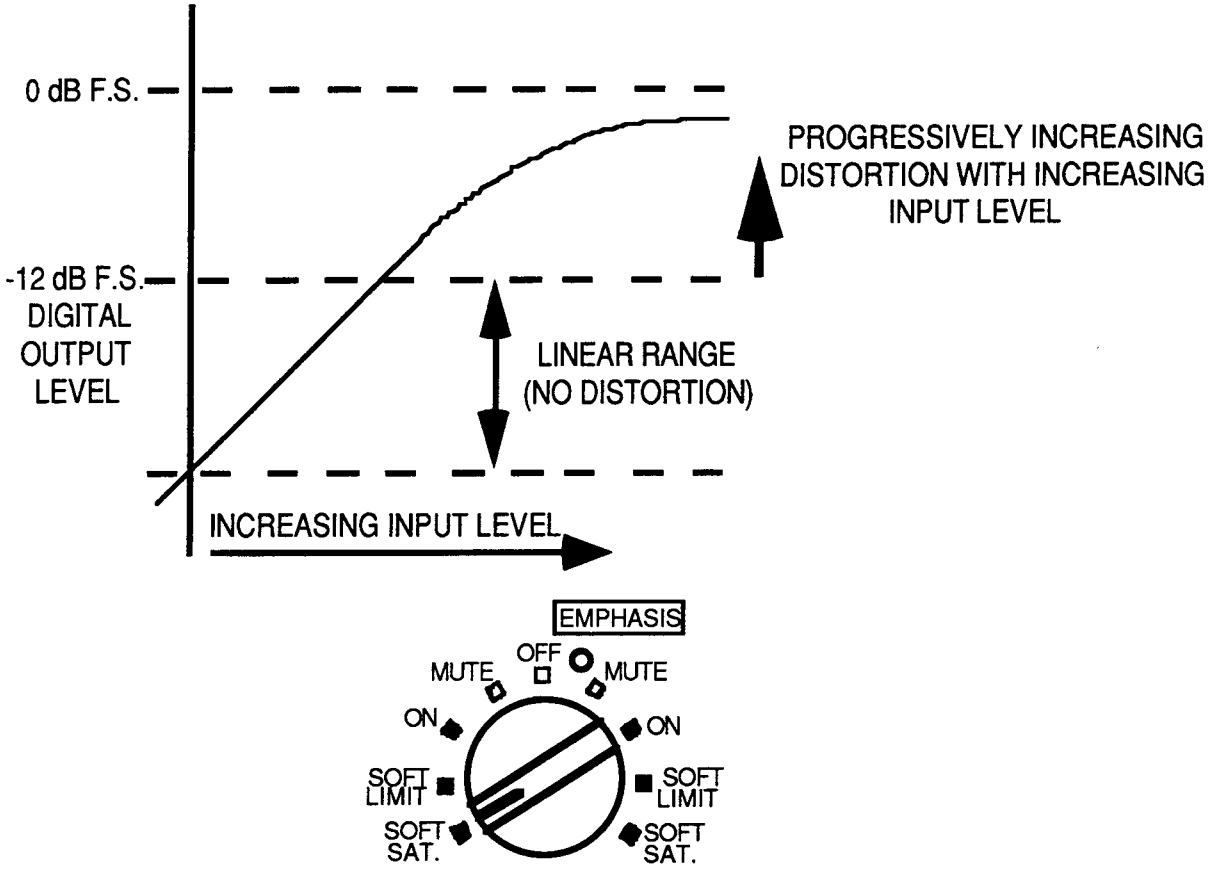
## 0- DYNAMICS CONTROL - SOFT SATURATE

When analog tape is overdriven, it does not go into immediate and heavy distortion like digital audio overdriven. Analog tape reaches a point where the output no longer reflects the input. This is called tape saturation and is due to the magnetic material in the tape going into a nonlinear range. The effect of this gradually increasing distortion can be used to advantage in adding 'character' to musical instruments and effects by adding pleasant sounding harmonic distortion when the tape is 'pushed' into this range.

The key to tape saturation is the distortion consists of harmonics which compliment the original sound. This allows us to 'fatten up' drum sounds and instruments like bass guitar or effects like gunshots for picture. Digital audio, on the other hand, reaches it distortion point very abruptly and the nature of the distortion isedgy and abrasive. The distortion usually consists of odd harmonics and is best avoided. One of the criticisms of digital audio is the lack of analog tapes' gradually increasing distortion that is often used to good effect, especially in tracking applications.

The AD-500 mimics this distortion with the soft saturate function. The soft saturate function starts to kick in around 12 dB below full digital output level. The first few dB into it are quite mild. The harder you drive into the range above -12 dB f.s. digital output, the more radical the effect. It is very difficult to get anywhere near 0 dB f.s.- so you should allow a few dB on top when using this effect. Its best to go by sound rather than meter indication as the last few dB are heavily compressed.

CAUTION- The soft saturate feature is designed for tracking applications and <u>does not</u> lend itself to mixdown or mastering applications.

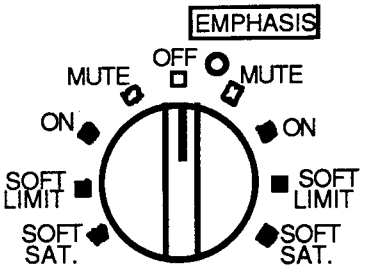



**ANALOG INPUT**

The above selector settings will insert the Soft Saturate function (Also note that emphasis is not selected and the LED will not illuminate.)

P- MUTE AND OFF ANALOG INPUT SELECTOR POSITIONS

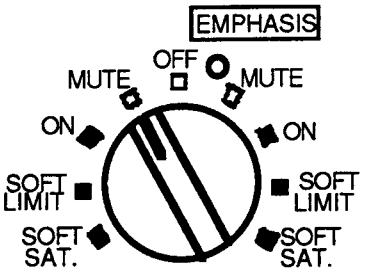
When the analog input selector is switched to OFF, the outputs of the AD-500 transmit what is known as 'audio black' in either AES or S/P DIF formats. This is a signal which corresponds to zero level input. Word Clock is still available at the 15 pin sub connector on rear panel. The analog to digital convertor is turned off and will not pass audio. Also the analog and digital sections of the convertor are in power down status. The LOCK indicator lights will not illuminate.




**ANALOG INPUT**

The above selector setting will not accept any audio input and transmit 'audio black'.

When the MUTE position of the Analog Input selector is switched in, the AD-500 continues to transmit AES or S/P DIF 'audio black'. Word Clock is still available at the 15 pin sub connector on rear panel. The analog to digital converter prepares for calibration mode which corrects for DC offset in the input circuitry. This calibration is initiated when the selector goes to the ON position. The convertor will not pass audio in the MUTE position. Also the analog and digital sections of the converter are in power down status. The LOCK indicator lights will illuminate corresponding to the selected sample rate.




**ANALOG INPUT**

The above selector settings show mute switched on.

When the ON position is selected on the analog input selector, audio passes straight through to the analog to digital converters bypassing the SOFT LIMIT and SOFT SATURATE functions. (See respective sections). Note also that when the slector is turned left, no emphasis is engaged. Emphasis is engaged only when selector is turned to the right. (See section on EMPHASIS)

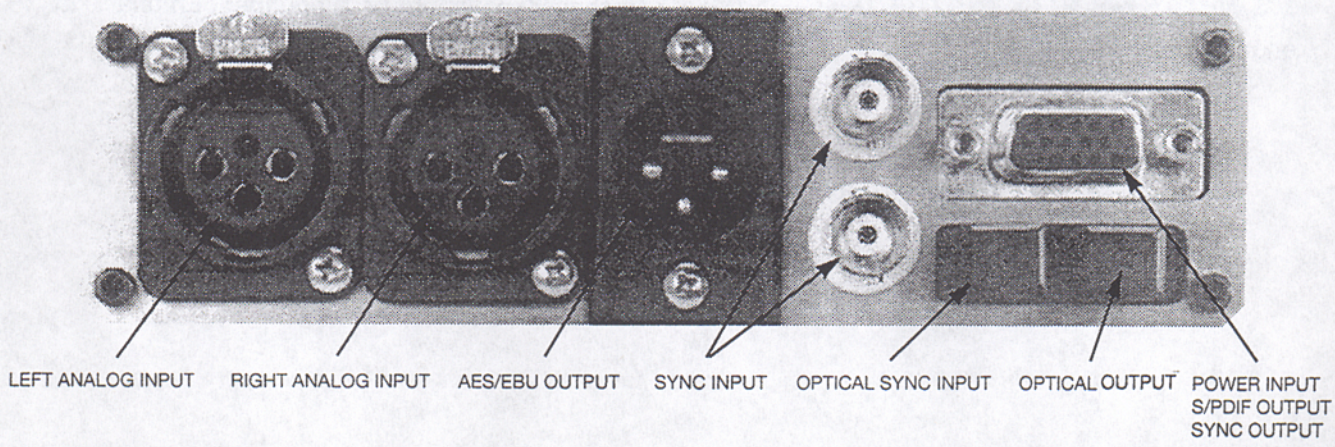
# DIGITAL OUTPUTS

## DIGITAL AUDIO OUTPUT

| SIGNAL OUTPUT | CONNECTOR TYPE | LOAD IMPEDANCE | RATED OUTPUT LEVEL | NO LOAD OUTPUT LEVEL |
|---|---|---|---|---|
| SPDIF OUT | 15 PIN HD SUB | 75 OHMS | 0.5V Pk-Pk | 1.0V.Pk-Pk |
| AES/EBU OUT | XLR MALE | 120 OHMS | 4.4V Pk-Pk | 10V Pk-Pk |
| OPTICAL OUT | EIAJ STANDARD RCZ-6901 (TOSLINK STYLE) | OPTICAL | -15dBm to -21dBm | N/A |

## SYNC (WORD CLOCK) OUTPUT

| SIGNAL OUTPUT | CONNECTOR TYPE | LOAD IMPEDANCE | RATED OUTPUT LEVEL | NO LOAD OUTPUT LEVEL |
|---|---|---|---|---|
| WORD SYNC OUT (unbalanced) | 15 PIN HD SUB | 75 OHMS | TTL LEVEL (3V Pk-Pk) | 3.7V Pk-Pk |
| BALANCED WORD SYNC OUT (RS-422) | 15 PIN HD SUB | 75 OHMS | RS-422 (5.3V Pk-Pk) | 8.5V Pk-Pk |



C- DIGITAL OUTPUTS

The AD-500 outputs a professional format digital audio output on the AES/EBU Male XLR connector. The AD-500 also outputs digital audio in the consumer optical format and consumer coaxial format. (See page 34 for details) The coaxial consumer output is called the S/P DIF format and is available on the 15 pin HD sub connecter on the rear panel via an adapter cable. (See page 37 for wiring and pinout) Please refer to page 8 for optional accessories which include adapters.

A balanced or unbalanced word clock output is also available on the rear panel 15 pin HD sub connector. This output can be used to synchronize a wide variety of other digital audio products. The wiring and pinout for this output is detailed on Pages 36 and 37.

D- DIGITAL AUDIO OUTPUT FORMAT AND SELECTION

The AD-500 features three different digital audio output formats:

AES/EBU- Professional digital audio transmission format.
Transformer isolated balanced line output to a three wire transmission line.
Output Impedance - 110 ohms
Signal amplitude- 4.4 Volts peak to peak into 110 ohms
Sampling Rate Range - 32KHz to 54KHz
Connector- male XLR mounted on rear panel
Pin 1 - Cable shield or ground
Pin 2 - Signal
Pin 3 - Signal
Note: Polarity of pins 2 and 3 is not important. Reversing pins 2 and 3 will not affect the digital audio transmission.

S/P DIF- SONY/PHILLIPS digital interface for consumer applications (standardized as the CP-340 digital audio interface by the EIAJ; Electronic Industries Association of Japan).
Transformer isolated balanced or unbalanced output to a two wire transmission line.
Output impedance- 75 ohms
Signal amplitude -0.5 Volts peak to peak into 75 ohms
Sampling Rate Range - 32KHz to 54KHz
Connector- 15 pin HD sub connector mounted on rear panel
Pin 1 -Signal
Pin 6 -Shell
*(Note:requires adapter to standard female 'RCA' connector.)*

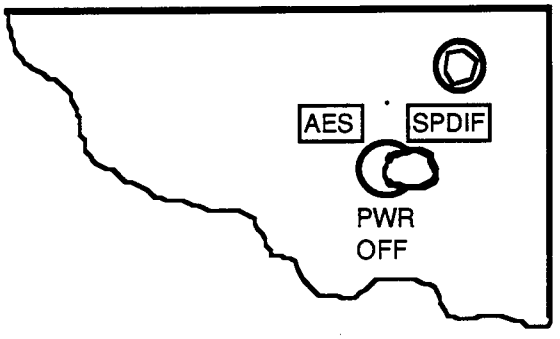
OPTICAL- Digital optical interface standard for consumer applications
Transmitter characteristics:

| | |
|---|---|
| Peak emission wavelength | 660nm +/- 30nm |
| Peak emission power | between -15dBm and -21dBm (when measured at the edge of the reference optical fiber which is connected to the output terminal of the fiber optic transmitter) |

Connector- standard to 'TOSLINK' style optical interconnect.

Your AD-500 takes in analog audio and outputs digital audio in two formats:
a) AES/EBU for professional applications
b) S/P DIF FOR CONSUMER APPLICATIONS

The output format is selected on the front panel power switch




Power Switch shown in S/P DIF position

The front panel power switch is a three position switch located on the front upper right hand corner of the AD-500. The center position selects power off. The other two positions select either AES or S/P DIF output format. The selected output format appears at the AES (male XLR), S/P DIF (15 pin D sub connector, pins 1 and 6) and OPTICAL (optical plug nearest the edge of unit) outputs simultaneously with the appropriate level and impedance. For example, with the front panel switch selected to S/P DIF, the AES, S/P DIF and OPTICAL outputs will output S/P DIF format. The AES output will be 5 volts pk-pk/balanced and the S/P DIF output will be 0.5 volts pk-pk/75 ohm/balanced (will drive balanced and unbalanced loads).

E- CHANNEL STATUS

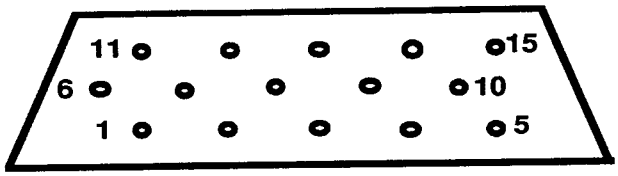
The AES/EBU and S/P DIF formats are very closely related. The main differences are output level, impedance and some differences contained in a repeating train of data packed in with the digital audio. The data are called channel status. This train of information repeats itself a couple of hundred times per second and contains codes to tell digital audio products information such as whether it is AES/EBU or S/P DIF format, sample rate, pre-emphasis applied or not applied, if copying is permitted, etc.

Most of the information transmitted in the channel status is transparent to users. (We have included additional information for your reference) The two main bits of information that may matter are:

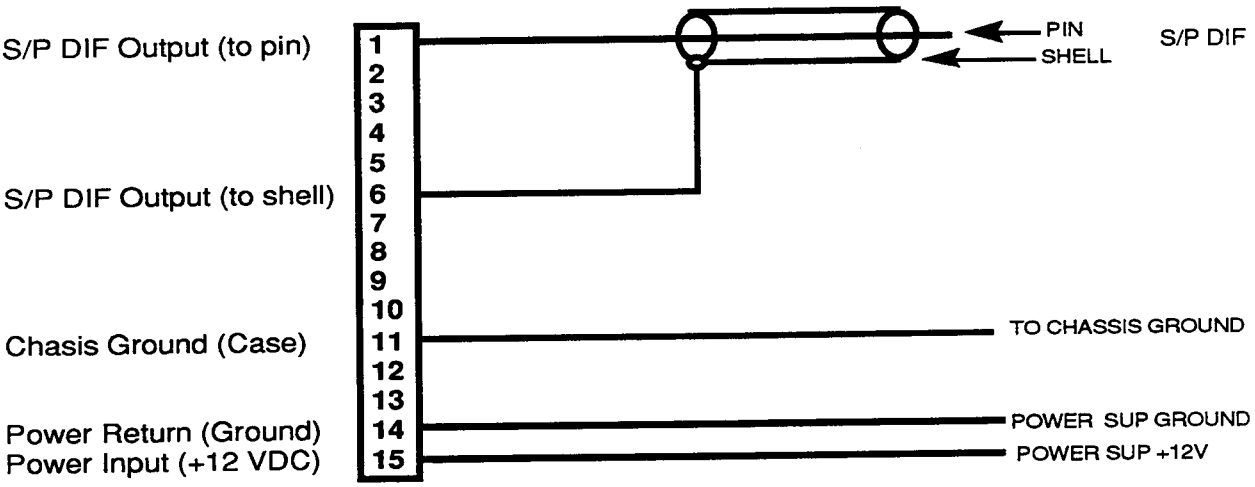
a) The data defining AES/EBU or S/P DIF format.
b) The data defining whether a copy can be made or not.

Quite often, professional and consumer digital audio equipment will ignore much or all of the channel status information, while permitting you to interchange professional and consumer equipment format. If you do drive both S/P DIF and AES/EBU equipment simultaneously and you find problems with one format, try selecting the other format position on the power switch. The reason for this is that some of the equipment may not be checking the status bits. (See next two sections for a more detailed explanation)

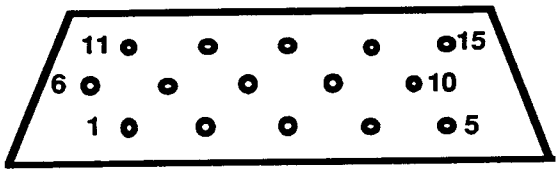
## AD-500 ADAPTER FOR S/P DIF OUT



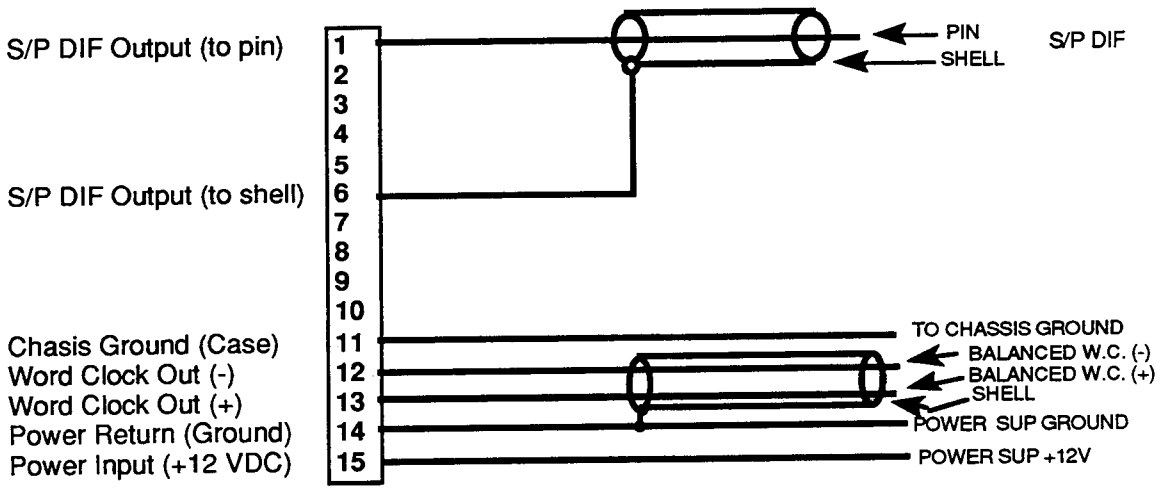

**J1 PINOUTS**
RECEPTACLE-MATING FACE
(located on rear panel)




## AD-500 ADAPTER FOR BALANCED WORD SYNC (WC) OUT

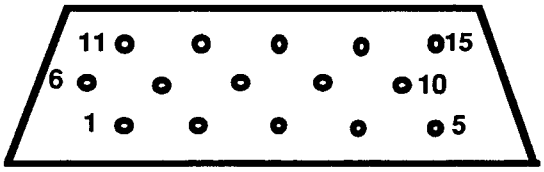



**J1 PINOUTS**
RECEPTACLE-MATING FACE
(mounted on rear panel)

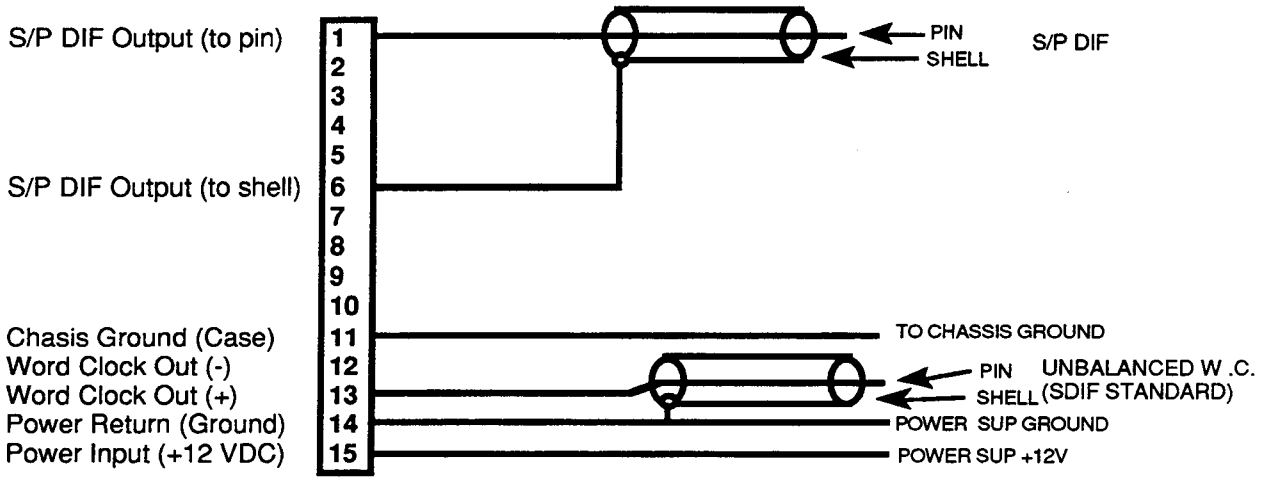


# AD-500 ADAPTER FOR UNBALANCED WORD SYNC(WC) OUT

**COMPATIBLE WITH WORD SYNC FOR SDIF FORMAT**




**J1 PINOUTS**
RECEPTACLE-MATING FACE
(located on rear panel)



# COPY PROTECTION

Consumer digital audio products (S/P DIF digital audio format) include codes in the digital audio output to control copies. Whenever the 'no copy allowed' code is transmitted and receiving devices which are designed to respond are used, then recording (copy) is not permitted.

This is a detailed explanation. Understaning these details is not necessary for most applications. We are including this information for your reference for the unusal situations where you may have trouble interfacing the AD-500 to other equipment. Skip to the COPY PROTECTION-THE PAINLESS VERSION section below for the easy way out.

## A- PROFESSIONAL MODE COPY PROTECT

The AD–500 is a professional analog to digital converter.
In the AES/EBU mode, the AD–500 does not have copying restrictions.

## B- CONSUMER MODE COPY PROTECT

In general, consumer digital audio products give excellent value for the money. When using consumer products for professional applications, the main weaknesses are usually the conversion processes and the inability to synchronize to an external source. The AD–500 allows you to have premium conversion performance and comprehensive synchronizing ability while using inexpensive consumer-oriented transports.

Consumer digital audio products (S/P DIF Digital Audio Format), originally included copy protection via bit 2 only. Whenever the 'no copy allowed' code was transmitted, and receiving devices which were designed to respond were used, recording(copy) would not be permitted.

The AD–500 can be programmed to transmit the 'copy allowed' code in the consumer format. It would be very simple if that was all that was required. Unfortunately, that is not the case.....

## C- SCMS

More recently you have probably noticed the SCMS label on consumer DAT recorders. SCMS stands for serial copy management system (some users referred to it as 'SCUMS'). For the moment, SCMS is the chosen method for copy protecting copyrighted works. DAT recorders with SCMS permit unlimited duplication of the original recording (master) but no duplication of any copies from the original recording.

When consumer oriented digital audio products are interconnected using the standard coaxial cables or optical cables, the SCMS information is transmitted as part of the channel status data train.(See technical note below)

Most problems arise due to incompatibility between the two different methods of duplication control;

A) The original copy protect used in earlier generation consumer equipment
B) The recently standardized SCMS system used in latest generation consumer equipment.

## D- TECHNICAL DESCRIPTION OF S/P DIF COPY PROTECT

Different digital audio products have different category codes transmitted as part of the status information. Category codes describe the digital audio source such as CD, DAT, etc.

The copy protection scheme works by knowing the category code and then utilizing the Copy and L bits to determine if a copy should be allowed (see table below for description and location of copy and L bits). Digital processing of data should pass through the copy and L bits defined by their particular code. If mixing inputs, the highest level of protection of any one of the sources should be passed through. If the copy bit indicates no copy protection (bit 2 = '1'), then multiple copies can be made. If recording audio data to tape or disk, and any source has copy protection asserted, then the L bit must be used to determine whether the data can be recorded.

The L bit determines whether the source is an original (or prerecorded) work, or is a copy of an original work (first generation or higher). The actual meaning of the L bit can only be determined by looking at the category code since certain category codes reverse the meaning.

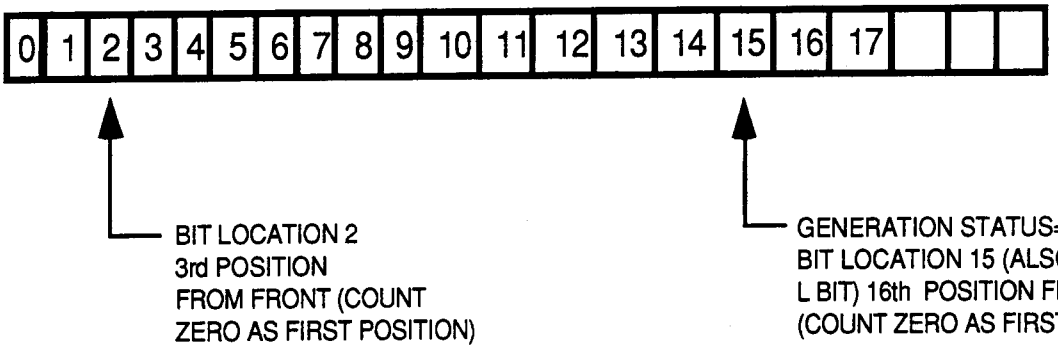
If the category code is CD (1000000) and the copy bit alternates at a 4 to 10 Hz rate, the CD is a

copy of an original work that has copy protection asserted and no recording is permitted. ( The above 3 paragraphs were kindly borrowed from Crystal Semiconducter's explanation of Copy Protection.)

If we look at the information slots making up the train of channel status data, the copy protect system and the SCMS system share the third position from the front. This bit is referred to as the 'copy bit'. The SCMS system also uses the 15th position. This bit is referred to as the 'L bit' or 'generation bit'. To represent the status code, the information slots can be either of two states.

The AD-500 includes internal programming jumpers to let you control the important status information slots in the digital audio output.

The most useful function these jumpers perform is to permit recording to either SCMS or earlier generation non-SCMS consumer equipment. As shipped from Apogee, the AD-500 is set up to enable recording when using an SCMS or non-SCMS equipped consumer recorders. The table below shows how to manipulate the programming jumpers for different options. There are three generations of the AD-500's labeled REV A, REV B, and REV C depending on serial numbers. The jumper positions for REV A and REV B boards is different to REV C boards.




## TABLE FOR PCM OR DAT CATEGORY:

(BIT 15=1 IS ORIGINAL / BIT 15=0 IS DUPLICATION)

| | JP35 | JP36 | BIT2 | BIT15 |
|---|---|---|---|---|
| SCMS COPY PROTECTION DISABLED (DUPLICATION MODE) This is how REV C boards and later REV's are shipped from APOGEE. It should satisfy most requirements with non-SCMS equipped and SCMS equipped devices. If you have trouble we suggest you try JP35 off and JP36 on. Can record. No restrictions. | ON | ON | '1' COPIES ALLOWED | '0' SCMS DUPLI-CATION |
| SCMS COPY PROTECTION ASSERTED (ORIGINAL MODE) Non-SCMS equipment will look at bit 2(copy bit) and see copy protect is asserted. It will not copy unless it happens to ignore bit 2. SCMS equipment can make unlimited duplications because it is an original. Any copies from that original will not be able to be copied. It will record, then that recording cannot be recorded. | OFF | OFF | '0' COPIES NOT ALLOWED | '1' SCMS ORIGINAL |
| SCMS COPY PROTECTION ASSERTED(DUPLICATION MODE) This means you cannot use your AD-500 with any deivces that look at these bits. Do not use this jumper setting! Cannot record. | ON | OFF | '0' COPIES NOT ALLOWED | '0' SCMS DUPLI-CATION |
| SCMS COPY PROTECTION DISABLED(ORIGINAL MODE) Generally allows all devices to make copies. Non-SCMS machines will see copy protect disabled. SCMS machines will see copy protect disabled. Can record. No restrictions. | OFF | ON | '1' COPIES ALLOWED | '1' SCMS ORIGINAL |

## TABLE FOR CD CATEGORY:

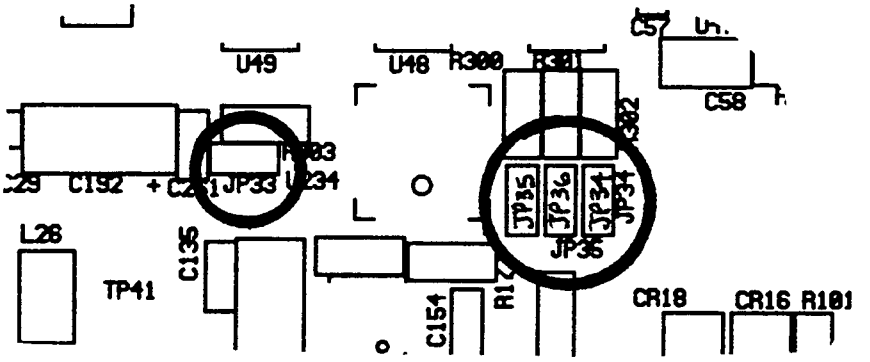
(BIT 15=0 IS ORIGINAL / BIT 15=1 IS DUPLICATION)

| | JP35 | JP36 | BIT2 | BIT15 |
|---|---|---|---|---|
| SCMS COPY PROTECTION DISABLED (DUPLICATION MODE) . It should satisfy most requirements with non-SCMS equipped and SCMS equipped devices. If you have trouble we suggest you try JP35 off and JP36 on. Can record. No restrictions. | OFF | ON | '1' COPIES ALLOWED | '1' SCMS DUPLI-CATION |
| SCMS COPY PROTECTION ASSERTED (ORIGINAL MODE) Non-SCMS equipment will look at bit 2(copy bit) and see copy protect is asserted. It will not copy unless it happens to ignore bit 2. SCMS equipment can make unlimited duplications because it is an original. Any copies from that original will not be able to be copied. It will record, then that recording cannot be recorded. | ON | OFF | '0' COPIES NOT ALLOWED | '0' SCMS ORIGINAL |
| SCMS COPY PROTECTION ASSERTED(DUPLICATION MODE) This means you cannot use your AD-500 with any deivces that look at these bits. Do not use this jumper setting! Cannot record. | OFF | OFF | '0' COPIES NOT ALLOWED | '1' SCMS DUPLI-CATION |
| SCMS COPY PROTECTION DISABLED(ORIGINAL MODE) Generally allows all devices to make copies. Non-SCMS machines will see copy protect disabled. SCMS machines will see copy protect disabled. Can record. No restrictions. | ON | ON | '1' COPIES ALLOWED | '0' SCMS ORIGINAL |

## TABLE FOR GENERAL CATEGORY:

(BIT 15=1 IS ORIGINAL / BIT 15=0 IS DUPLICATION)

| | JP35 | JP36 | BIT2 | BIT15 |
|---|---|---|---|---|
| SCMS COPY PROTECTION ASSERTED(ORIGINAL MODE) When in GENERAL category configuration, JP35 and JP36 settings should not matter. We recommend however, JP35 and JP36 set to OFF. The important thing is that the receiving device connected to the AD-500 should set BIT 2 = 0 (SCMS Copy Protection asserted) and BIT 15 = 1 (Original generation). This would enable you to make 2 generations. The second generation cannot be copied. This setting is standard for receiving equipment. | OFF | OFF | '0' COPIES NOT ALLOWED | '1' SCMS ORIGINAL |




The jumpers controlling the status code for copy protect, SCMS, etc. are tiny jumpers located on the surface mount component side of the main printed circuit board. Follow the instructions in the Disassembly section to remove the main board from the case sections. If you don't have the appropriate surface mount desoldering tools available, use solder wick to desolder any jumpers. Clean off any excess solder on the pads with solder wick. Installing jumpers is the easiest if you put a solder blob on one side of the two pads and using tweezers to hold on to the jumper, solder one side in place. Next solder the other side.

Setting the category code with jumpers JP33 and JP34 tells the receiving device what type of unit is sending the audio information. This category code tells the receiver what some of the subsequence data bits in the status data mean. The AD-500 is shipped from the factory with the jumpers set for DAT category.

| | | | FOR REFERENCE ONLY SETS STATUS BITS TO: | |
|---|---|---|---|---|
| | JP33 | JP34 | BIT 8 | BIT 9 |
| PCM CATEGORY | ON | OFF | 0 | 1 |
| DAT | ON | ON | 1 | 1 |
| CD | OFF | ON | 1 | 0 |
| GENERAL | OFF | OFF | 0 | 0 |

E- REV A AND REV B BOARDS

REV A and REV B serial numbers all preceed 6000. REV A and REV B boards will all function as listed below unless the appropriate control chip has been changed .( U234, 20 pin surface mount 'GAL' chip - 16V8A-25)

The information below describes the function of the jumpers for AES and S/P DIF modes.

In the AES FRONT PANEL POWER SWITCH position jumper JP35 position sets something you will probably never need to access, i.e.

| | JP35 | BIT 9 |
|---|---|---|
| STEREO MODE | ON | 1 |
| NON-STEREO MODE | OFF | 0 |

In the SPDIF FRONT PANEL POWER SWITCH position JP36 sets the original copy protect system bit.

| | JP36 | BIT 2 |
|---|---|---|
| COPY ENABLE-COPY OK | ON | 1 |
| COPYING NOT ALLOWED | OFF | 0 |

REV A and REV B boards can be updated to include SCMS copy enable by replacing U234. Contact Apogee for details. Some new SCMS equipped DAT recorders will still record.

## F- DAT CATEGORY VERSUS GENERAL CATEGORY

The AD-500 is shipped with the S/P DIF output formatted for DAT category. This will work in nearly all situations except for the Sony TCD-D10 Pro. You must set the categroy code to general for it to record. Many DAT machines put out the general code. If you have a problem, we suggest you try the general code category mode.

## G- REV C BOARDS

Serial Number 6XXX or later gives access to SCMS control in addition to origianl protection control.

## H- SOME MACHINES CONVENEINTLY IGNORE COPY PROTECT

Some older DAT recorders don't look at the copy protect information.

Some newer machines such as the Panasonic 3700 and 3900 ignore all copy protect information. These machines will record in any positions of Jumpers JP35 and JP36.

## I- COPY PROTECTION - THE PAINLESS VERSION

Four tiny jumpers soldered on the surface mount side of the main printed ciruit board control the personality the AD-500 presents to the outside world, via its digital output. (See Diagram on Page 42)

Equipment that the AD-500 plugs into looks at this personality and decides if it should record the digital audio of not.

These jumpers are numbered JP33, JP34, JP35 and JP36. It will be a very unusual situation if you have to change these jumpers to the change the personality. The AD-500 is shipped with all four jumpers in place. This tells receiving devices that the AD-500 is a DAT recorder (a schizophrenic lie because its obviosly not) and that its OK to record in as many situations as possible.

If you do run into trouble recording and you have exhasted other possibilities, we suggest you get help from someone with surface mount experience and remove JP35, leaving the remaining three on.

If the recording device still won't accept the input and you still don't want to read the full technicaldescription of copy protect, try removing all four jumpers which gives the AD-500 the personality of limp noodle and no one is afraid of listening to it.

You should have no problems copying with AES/EBU interfaces.

# GROUNDING

The AD-500 can be operated in a wide variety of rack mount and free standing configurations. Grounding and ground loops are a concern in any audio environment. The AD-500 has a very flexible grounding structure designed to enable optimum performance in both standalone situations and rack mount system approaches.

These are three separate and isolated ground systems in the AD-500.

A. Chassis Ground - This ground is connected to pin 11 on the rear 15 pin HD sub connector and ties all the metal chasms components together.

B. Battery Ground - This ground is tied to the incoming 12 volt power (can be battery). Ground on pin 14 of the rear 15 pin HD sub connector. The power supply pre-regulator, sync circuitry and WORD CLOCK out are all tied to this ground.

C. Analog Ground - This ground is tied to the pin 1 pins of the XLR input connectors. This is the audio ground which also ties to some of the digital circuitry such as the analog to digital converters.

If operating in a rack mount environment, it is often important to isolate the chassis ground from the analog ground to avoid ground loops from the various analog inputs through the chassis.

Ground loops can also be caused through the AES output, pin 1 connection to the chassis ground and other devices via their ground connection to the AC ground.

Three grounding jumpers on the main board give control of the grounding connections.

Jumper JMP-9 located next to the DC/DC Power supply P818(the square purple case with the gold label)
ON connects battery ground to audio analog ground
OFF isolates battery ground from audio analog ground
(The AD-500 is normally shipped with JMP-9 in the OFF position)

Jumper JMP-11 located on the rear corner of the main board opposite the 15 pin HD sub connector
ON connects chassis ground to battery ground
OFF isolates chassis ground from the battery ground
(The AD-500 is normally shipped with JMP-11 in the ON position)

Jumper JMP-10 located under the small sub-board over rear 15 pin HD sub connector. Access to JMP-10 is gained
by removing the two mounting screws holding the sub-board and carefully unplugging the entire assembly from the socket below. It is not necessary to remove the wiring harness connector on top of the sub-board. JMP-10 is next to the standoffs closest to the front of the board. Take extra care when replacing the sub-board for correct connector alignments.
ON connects chassis ground to audio analog ground
OFF isolates chassis ground from audio analog ground
(The AD-500 is normally shipped with JMP-10 in the OFF position)

*GROUNDING SIMPLIFIED*

Chassis ground is connected to battery ground. The analog ground is isolated from both battery ground and chassis ground. Please refer to the Digital Timing and Sync Block diagram on page 16 which illustrates the jumper blocks and their shipped configurations.

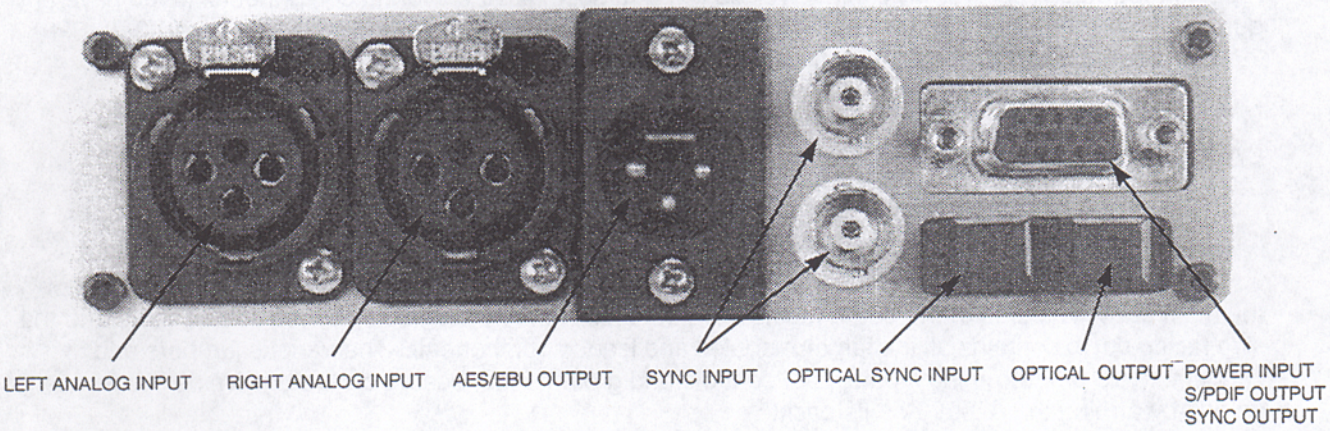
# POWER SUPPLY

The AD-500 is designed to run from a variety of low voltage power sources. These sources can be a 12 volt battery, Apogee table top Power supply (TT-1200/AD), or Apogee dual rack mounted power supply (PS-1000). The nominal 12 Volts DC can vary from +11.5V DC to +15V DC with the ability to withstand short term peaks up to 30V DC.

The power is applied to pin 15 (+) and pin 14 (return) of the 15 pin HD sub connector located on the rear panel. The input voltage then passes through a low dropout regulator with a 10.4 volt output.

The 10.4 volts powers the sync input and output circuitry. The 10.4 volts also drives the special APOGEE model P818 DC/DC Power Supply. The power supply is unique with its six ultra low noise outputs, synchronous operation, 89% efficiency and excellent ground isolation.

There are a total of 14 different regulated power supplies inside of the AD-500.



# E. MAINTENANCE

If the AD-500 is kept in a clean environment free of excess dust, moisture and heat, it will give years of trouble free service. The only components with a limited life are the electrolytic capacitors. The electrolytic capacitors used are of a high quality and will give many thousands of hours service.

The front panel conductive plastic gain controls are sealed and don't require cleaning. If the AD-500 is operated in a dusty or dirty environment, the front panel rotary switches may need cleaning. This is a simple matter and should be referred to a qualified service personnel.

# F. SERVICE INFORMATION

The AD-500 contains no user servicable components. Refer to qualified service personnel for repair or upgrade. Your warranty will be voided if you tamper with the internal components. If you have any questions with regard to the above, please contact APOGEE at (310) 399-2991 by phone or (310) 399-[illegible]65 by FAX, or our local representative in Europe, Charlie Day , The European Office, at 44-296661748 by phone or 44-(0)296661878 by FAX.

CASE DISASSEMBLY

You will need to remove part or all of the case to access the various programming jumpers and connectors that are user programmable.

When you view the AD-500 from the front panel, the main circuit board is held in the top side of the main case. The side of the board facing up is covered with tiny surface mounted components and the side facing down contains all the larger modules and leaded components. The various jumpers and connectors for programming inputs, gain controls and grounds are located on the underside. Access is gained by turning the AD-500 on its back.

REMOVING THE BOTTOM COVER

Turn the AD-500 on its lid to access the screws attaching the bottom cover. Remove the two silver colored phillips head screws in the bottom cover (now facing up). Next remove the top two front panel hex screws with the wrench supplied in the accessories. Remove the two rear top hex screws and slightly loosen the bottom two rear hex screws to ease cover removal. Once the six screws are removed, the cover should easily lift off.Refer to the picture on page 3 to locate internal jumpers.

REMOVING THE MAIN PRINTED CIRCUIT BOARD

The main printed circuit board should be removed by qualified service personel.The only reason to remove the main board would be to gain access to the four jumpers which program the various consumer copy protect modes described starting on page 39.

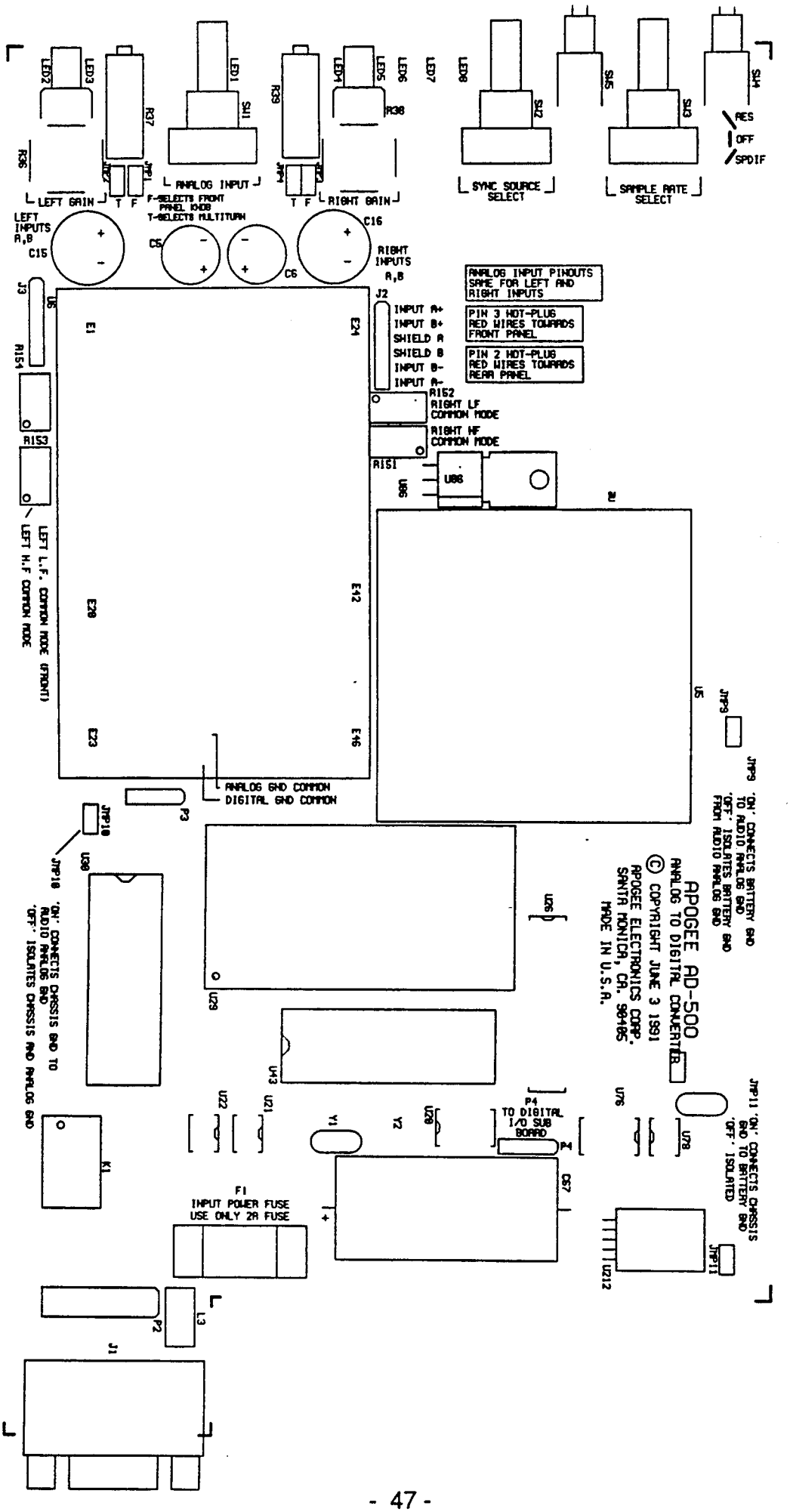
Remove the bottom cover as described above.

Remove the top cover by undoing the five silver colored phillips head screws in the top cover.Next remove the two screws holding the front panel and the two screws holding the rear panel.

Carefully slide the main printed circuit board out of the top cover,towards the rear panel.Take particular care not to damage the two blue common mode adjustment pots located next to the largest purple colored module.These potientometers have very little clearance to the case and will sometimes catch when reinstalling the case.

REMOVING THE DIGITAL INPUT/OUTPUT SUB BOARD

If it is necessary to access Jumper JMP-10 for grounding purposes (described on P 44),you will need to remove the small sub-board mounted over the rear 15 pin D-sub connector This is easily accomplished by removing the two screws holding the board in place and carefully unplugging the 20 pin header from the socket mounted on the main board.Do not confuse this connector with the connector on the top of the sub board which can be left attached by folding the harness to gain access to the jumper.


APOGEE AD-500
ANALOG TO DIGITAL CONVERTER
© COPYRIGHT JUNE 3 1991
APOGEE ELECTRONICS CORP.
SANTA MONICA, CA. 90405
MADE IN U.S.A.
LEFT GAIN
RIGHT GAIN
ANALOG INPUT
SYNC SOURCE SELECT
SAMPLE RATE SELECT
AES
OFF
SPDIF
LEFT INPUTS A,B
RIGHT INPUTS A,B
ANALOG INPUT PINOUTS SAME FOR LEFT AND RIGHT INPUTS
PIN 3 HOT-PLUG RED WIRES TOWARDS FRONT PANEL
PIN 2 HOT-PLUG RED WIRES TOWARDS REAR PANEL
INPUT A+
INPUT B+
SHIELD A
SHIELD B
INPUT B-
INPUT A-
RIGHT LF COMMON MODE
RIGHT HF COMMON MODE
LEFT L.F. COMMON MODE (FRONT)
LEFT H.F COMMON MODE
ANALOG GND COMMON
DIGITAL GND COMMON
TO DIGITAL I/O SUB BOARD
INPUT POWER FUSE
USE ONLY 2A FUSE
JMP9 'ON' CONNECTS BATTERY GND TO AUDIO ANALOG GND 'OFF' ISOLATES BATTERY GND FROM AUDIO ANALOG GND
JMP10 'ON' CONNECTS CHASSIS GND TO AUDIO ANALOG GND 'OFF' ISOLATES CHASSIS AND ANALOG GND
JMP11 'ON' CONNECTS CHASSIS GND TO BATTERY GND 'OFF' ISOLATED

In addition to the various jumpers and connectors you will notice four blue multi-turn trim pots. These trim pots adjust the low frequency and high frequency common mode rejection for the right and left inputs. **DO NOT ADJUST THESE!** These pots should not require re-adjustment. If for some reason they do need to be adjusted, please refer to a qualified service personnel with the correct test equipment. Just a small tweak on these trim pots will throw the common mode right out of adjustment.

## G. WARRANTY

Be sure to return the enclosed warranty card. Apogee will contact you with any manual updates. As enhancements and upgrades are developed, you will be contacted at the warranty registration address. Please address any inquiries to your dealer or direct to Apogee:

APOGEE ELECTRONICS CORPORATION
3145 DONALD DOUGLAS LOOP SOUTH
SANTA MONICA, CA 90405
USA
TEL- (310) 915-1000
FAX- (310) 391-6262

APOGEE ELECTRONICS CORPORATION warrants this product to be free of defects in material and manufacture under normal use for a period of 12 months. The term of this warranty begins on the date of sale to the purchaser. Units returned for warranty repair to APOGEE or an authorized APOGEE warranty repair facility will be repaired or replace at the manufacturer's option, free of charge. All units returned to APOGEE or an authorized APOGEE repair facility must be prepaid, insured and properly packaged. APOGEE reserves the right to update any unit returned for repair. APOGEE reserves the right to change or improve design at any time without prior notice.

This warranty is void if APOGEE determines, in its sole business judgment, the defect to be the result of abuse, neglect, alteration, or attempted repair by unauthorized personnel.

THE WARRANTIES SET FORTH ABOVE ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, AND APOGEE SPECIFICALLY DISCLAIMS ANY AND ALL IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE. THE BUYER ACKNOWLEDGES AND AGREES THAT IN NO EVENT SHALL THE COMPANY BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, OR FOR INJURY, LOSS OR DAMAGE SUSTAINED BY ANY PERSON OR PROPERTY, THAT MAY RESULT FROM THIS PRODUCT FAILING TO OPERATE CORRECTLY AT ANY TIME.

Some states do not allow for the exclusion or limitation of implied warranties or liability for incidental or consequential damages, so the above exclusion may not apply to you. This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

## RMA-RETURN MATERIALS AUTHORIZATION

In the event your AD-500 needs to be upgraded or repaired,it is necessary to contact Apogee prior to shipping,and an RMA (Returned Materials Authorization) number will be assigned.This number will serve as a reference for you and helps facilitate and expedite the return process.Apogee requests that all domestic returns be sent via UPS, and that all international returns ship via Federal Express---unless otherwise authorised in advance.

*Any shipment sent without an RMA number will not be accepted.*

*AD-500 MANUAL REVISION D*
*DECEMBER 15, 1992*
*BRAD SANDERS*
***IF MISTAKES ARE FOUND, PLEASE CONTACT APOGEE ELECTRONICS***

## REVISION LOG

The following pages contain information on the various AD-500 engineering revisions. Most of these are transparent to the user. Some revisions add user enhancements such as the revision starting with REV C, which enables added flexibility when dealing with copy protection. Many revisions are able to be retrofitted to earlier boards. You can determine the Revision level of your unit by checking the serial number printed on the rear panel of your unit against the following list. If you would like to have your unit revised to the highest level available for that PCB, please contact APOGEE.

## COMPARISON OF SERIAL NUMBERS TO REVISION *(last revision of log 12/15/92)*

| MAIN PCB REV # | SERIAL NUMBERS | GAL REV # | EPROM REV # | AI/MODULE REV # |
|---|---|---|---|---|
| REV A4 | 0002,0008 | REV - | REV A1 | REV A |
| REV A5 | 0003,0005,0010,0012 0014,0016,0018 | REV - | REV A1 | REV A |
| REV A5a | 0011,0015 | REV- | REV A1 | REV A |
| REV A5b | 0013 | REV- | REV A1 | REV C3 |
| REV A6 | 0007 | REV - | REV B | REV A |
| REV A7 | 0006 | REV - | REV B | REV A |
| REV A7a | 0009,0017 | REV - | REV B | REV C3 |
| REV B3 | 0020 | REV - | REV A1 | REV B |
| REV B4 | 0021,0023-0026, 0028-0033,0035 0037-0050,0052-0054, 0056-0060 | REV - | REV B | REV B |
| REV B4a | 0019 | REV- | REV B | REV B |
| REV B5 | 0051,0055 | REV - | REV B | REV B |
| REV B5a | 0022,0027,0034,0036 | REV- | REV B | REV B |
| REV C1 | 6001,6002,6004-6007, 6009,6010,6012,6014-6019, 6021-6023,6026-6032,6036-6044, 6046,6048-6057,6059,6061-6065, 6068,6072,6073,6075-6077, 6081,6082,6085,6086,6087 | REV A SCMS | REV C | REV C |
| REV C2 | 6092-6096,7000,7002, 7003,7005,7010,7012, 7013,7016 | REV A SCMS | REV C | REV C2 |

REV C CONTINUED ON NEXT PAGE

| | | | |
|---|---|---|---|
| REV C3 | 6003,6011,6013,6020, 6024,6034,6047,6066, 6069,6079,6080,6084,6088,6098,6099,7001 7009,7017,7019,7024-7027 | REV A SCMS | REV C REV C2 |
| REV C3a | 6003,6008,6025,6033, 6035,6045,6058,6060, 6067,6070,6071,6074,6078,6083,6084,7004, 7006,7011,7014,7020,7030,7037 | REV A SCMS | REV C REV C2 |
| REV C4 | 7008,7018,7021,7022, 7031-7036,7040-7043 7046,7047,7049,7050,7053-7055,7057,7062 | REV A SCMS | REV C REV C3 |
| REV C5 | 0001,0004,6085,6091 6097,7007,7008,7015, 7023,7028,7037-7039,7044,7045,7048,7051, 7052,7056,7058-7061,7063,7065 and up | REV A SCMS | REV C REV C3 |

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**DESCRIPTION OF REVISIONS**

| REV # | DESCRIPTION |
|---|---|
| REV A3 | This includes additional grounding modifications and any necessary changes to basic REV A generation board. C17 and C18 were were replaced by C17A and C17B, C18A and C18B. |
| REV A4 | This increased board filtering. Slightly different grounding scheme is employed. |
| REV A5 & REV B3 | The response time for the sample rate LED's (32,44,48) is decreased. The unit locks to AES, S/P DIF and OPTICAL more quickly. |
| REV A6 & B4 | The internal 28.244MHz crystal is turned off and all three sample rate LED's REV (32,44,48) are illuminated when the SYNC SOURCE selector is not in CRYSTAL. This modification slightly improves THD+N. |
| REV A5b | Capacitors C5 and C6 have been increased(see REV A7,B5,C3 below) and the Analog Input Module is changed to REV C3. |
| REV C1 | The sample rate LED driver circuitry has been modified. Greater flexibility has been added to help deal with copy protection. Synchronization to incoming S/P DIF, AES and WORD CLOCK has been improved. The Soft Limit threshold has been raised slightly to use more of the last dB before hitting an 'over'. (Some users considered the 8-9dB peak absorbing capability excessive and would rarely be used.) |
| REV C2 | Synchronization to all VIDEO sources has been enhanced. |
| REV A7 & REV B5 & REV C3 | Capacitors C5 and C6 (+44V Power supply capacitors) have been changed to a larger value to enhance the low frequency sound accuracy (measured frequency response remains unchanged) |
| REV C4 | Change of the Analog Input Module from REV C2 to REV C3. |
| REV BXa & REV CXa & REV C5 & REV AXa | The timing of the Digital Interface Format Integrated Circuit has been enhanced. |

# ENHANCEMENTS

As we gain more experience manufacturing the AD-500 and listen to customer feedback, we have evolved a number of improvements and optional modifications to enhance flexibility and performance.

To date, there have been three versions of the AD-500 main printed cirucit board. Revision A (REV A) and Revision B (REV B) have serial numbers preceeding the number 6000. Revision C (REV C) all have the serial number 6000 and above.

Please see the enclosed chart to track the revision status of your serial number and review the recommended and optional options. Most of the recommended improvements are free of charge and include items such as upgraded input modules, clocks, etc. These improvements mainly span over the handful of the first units shipped.

## ENHANCEMENTS OF SOFT LIMIT AND LED METERING

As the popularity of mastering to DAT recorders continues to increase, mixing engineers want more control of the final product delivered to their mastering facility of choice.

The Soft Limit function on the AD-500 is proving to be a very popular tool with mixing engineers. In the continuing quest for squeezing the last nano-dB onto compact disk (CD), a number of these engineers have requested the ability to get in and adjust the threshold of the soft limit function.

As originally shipped, the soft limit threshold was set to a point that the digital output would not exceed 0dB ful scale until the transient was 8dB beyond the full scale level with the solft limit switched out. Some engineers thought this was an excessive transients capability and in real world audio mix down situations, just a few dB was necessary. The tradeoff with this high transient capability was wasting the last one dB as a reserve because it would rarely be used. Our solution was to change an internal resistor (R162) which programmed the soft limit threshold. Changing R162 to 18.7K ohms from the original 20K ohms reduced the transient control to 6dB and therefore used more of that last dB.

Some engineers wanted total control, so we have made an option of replacing this fixed resistor with a multi-turn trimmer control mounted on the front panel.

## A. OPTIONAL CONTINUOUS ADJUSTMENT OF SOFT LIMIT THRESHOLD

The addition of a small multi-turn potientometer and a resistor permits continuous adjustment of the solft limit threshold. We suggest you return your AD-500 to Apogee to install this optional enhancement. We are enclosing the following instructions for an approved Apogee service facility to install the components. Installation by a non-approved facility may void your warranty.

## *FOR QUALIFIED SERVICE PERSONNEL ONLY*

Remove the four screws attaching the front panel with the supplied 3/32 hex wrench. Remove the front panel.

### DRILLING FRONT PANEL HOLE FOR SOFT LIMIT SCREW DRIVER ADJUST

Accurately locate the new hole to be drilled in the front panel using the enclosed template. Carefully drill a 0.125 inch diameter (3.2mm) hole in the front panel with a sharp drill bit. Carefully deburr the edges.

### LOCATING AND ATTACHING THE 20K MULTITURN POT

Reattach the front panel to the AD-500 using only the top two front panel hex screws. Remove the two silver colored phillips head screws in the bottom cover and the two bottom rear hex screws holding the bottom cover in position. Remove the bottom cover.

Using tweezers or long nose pliers, hold the 20K multi-turn pot (Bourns 3299x-1-203,20Kohms or equivalent) in position on the main printed circuit board and check the alignment to the center of the hole. The leads should be perpendicular to the main printed circuit board and the screwdriver adjustment stub should be centered in the front panel hole. If the pot needs to be shimmed to raise it above the board, try some different spacers before gluing the pot in place.

Make sure all surfaces are clean and free of oil and grease. Using a cyanoacrylate adhesive (super glue), attach the trimmer in place.

WIRING THE MULTI-TURN TRIMMER TO R162

Remove the front panel. Remove the top cover by undoing the five silver colered phillips head screws in the top cover and two remaining hex screws holding on the rear panel.

Carefully slide the main printed circuit board out of the top cover from the rear to gain access to the surface mount component side.

Identify resistor location R162 and remove.

Solder in 8 inches (20cm) length of 30 gauge teflon coated solid wire to each pad of location R162 and run the other ends through the pad holds for the unused switch position SW5. SW5 is located between the SYNC SOURCE and SAMPLE RATE selectors. (SW2 and SW3)

Solder a 100K ohm resistor between pins 2 and 3 on the 20K trimmer pot.

Solder one of the two wires (it dosnt matter which one) comming from R162 to pin 3 on the 20K pot.

Solder the other wire from R162 to pin 1 on the pot.

The threshold control you have just installed gives very fine control over the soft limit threshold.You will take several turns to see much movement. The adjustment you are making is making a fine adjustment on a control voltage. There is no audio in this circuitry so no special shielding is required.

CHANGING THE RED METER LIGHT TO BETTER INDICATE OVERS

The AD-500 metering is designed to be used in conjunction with the metering of the host system the AD-500 interfaces to.The left and right red LED meter lights are measuring the peak analog level at the last stage before the analog to digital converter.The standard threshold is set so any input that goes beyond 1.5 dB below the maximum digital output level will illuminate the red LED indicator ( marked -2 dB).This threshold is very useful for a basic indication of when you are getting close to clipping the converter.When the soft limit function is selected, the standard red LED indicator is set below the soft limit threshold,which means you have no indication of how hard you are leaning into the soft limiter.This situation can be improved by moving the threshold of the red LED indicator to a point where it will illuminate once the audio is being controlled by the soft limiter.We have chosen a point where you have to hit the soft limiter with 2-3 dB peaks before the red LED will illuminate.This new threshold is set to 0.5 dB below the maximum digital audio output level, which will still give you an indication before you hit an over.As it takes several dB of peak level beyond the soft limit threshold to move the soft limit output peak level by a fraction of a dB,this 0.5dB meter threshold tells you there is still several dB more peak absorbing capability left.

INSTRUCTIONS FOR A QUALIFIED TECHNICIAN TO MOVE THE RED LED THRESHOLD TO -0.5 dB

This modification will usually be performed at the same time that the soft limit threshold adjust is installed.If the case is not already disassembled,follow the instructions above to remove the main printed circuit board to gain access to the surface mount side .Identify the two integrated circuits marked U14 and U 15 (both are LM339).Near by you will find resistors R11,R13,R12 and R35 which set the threshold of the LED metering.

In production model AD-500's to the date of this manual,the red LED threshold is set to -1.5 dB.To change to the 0.5dB threshold,use the resistor values shown in the table below in the right column.

| *RESISTOR LOCATION* | *VALUE FOR STANDARD THRESHOLD* | *VALUE FOR -0.5 dB THRESHOLD* |
|---|---|---|
| R11 | 3.09K ohms 1206 surface mount,1% | 2.94K ohms 1206 size 1% |
| R12 | 3.09K " | 2.94K " |
| R13 | 1.00K " | 1.10K " |
| R35 | 1.00K " | 1.10K " |

CALIBRATING THE AD-500 SOFT LIMIT THRESHOLD USING THRESHOLD ADJUST AND 0.5 dB

There are probably a number of ways to calibrate the soft limit level so you have an idea how much you are into limiting.