Introduction to Digital Audio

In recent years, digital audio has become increasingly popular. The most common uses of digital audio are currently Compact Discs and Digital Audio Tapes. DATs are replacing analog tapes for professional audio use, just like CDs have replaced LPs for personal use.

Digital vs. Analog

Both CDs and DATs record numbers instead of analog signals. For example, a standard cassette tape records sound by magnetizing a tape. When the sound being recorded gets louder, the tape recorder writes a stronger magnetic field to the tape. When the sound gets softer, the tape player writes a softer magnetic field onto the tape. A DAT recorder, on the other hand, records numbers. For loud sounds, it writes a large number; for soft sounds, it writes a smaller number.

There are several reasons why numbers are better to record than analog signals (such as the magnetic signal on cassette tapes). For starters, it is much simpler to edit digital sound. Using a computer program like Studio 16, it is easy to move parts of sound around or insert one sound into the middle of another. In the analog world this is accomplished by cutting and splicing tape. Another advantage, and the reason the music industry is concerned about DAT, is that when you copy digital audio you always get a perfect copy. Remember that digital sound is just numbers and is manipulated like any other data in your computer. When you copy a disk with your computer, you get an exact copy of the data. On the other hand, every time you copy a magnetic tape, you add a little distortion or "tape hiss".

Converting Analog to Digital

So how do you turn natural analog sound into numbers? You need a sound digitizer like the AD516 or AD1012. The AD516 and AD1012 measure and record the amplitude of a sound. Amplitude is the loudness of a sound signal at an exact moment in time. The process of measuring and recording is referred to as "taking a sample". To digitize a sound, the AD516 (or AD1012) takes a series of samples. It takes a sample, allows a certain amount of time pass, takes another sample, allows the same amount of time pass, takes a sample, etc. As the samples are taken, loud sounds are recorded as larger numbers and quiet sounds are represented by smaller numbers. The amount of time that passes between samples is referred to as the period. Assume the period is 1/44,100 of a second. By inverting the period you can calculate the resulting sampling rate. The inverse of 1/44,100 is 44,100. The sampling rate is 44,100Hz.

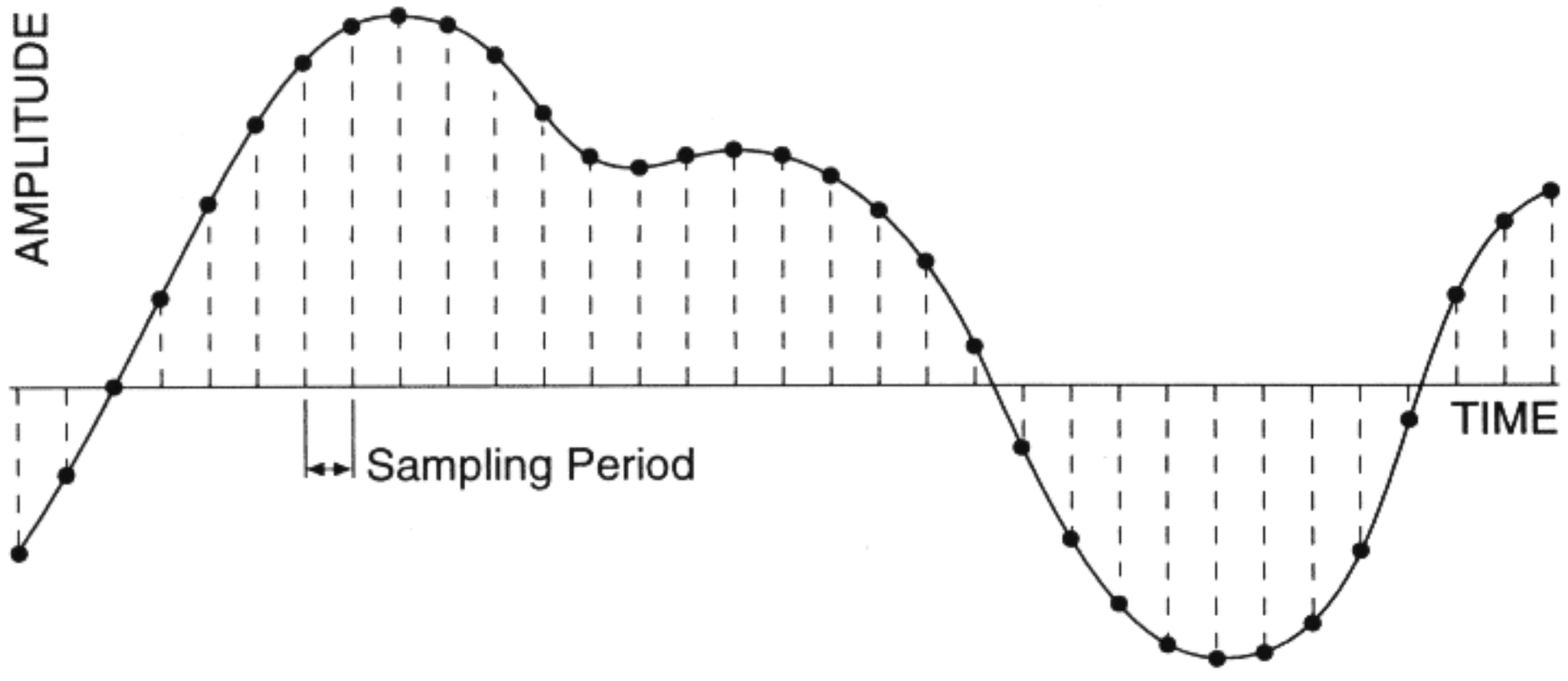

Figure 1-1. Digital Audio Diagram

There is a direct relationship between sampling rate and the maximum frequency you can record. This relationship, called the "Nyquist theorem", states that the maximum frequency you can record is equal to half the sampling rate. So, if you sample at 10,000Hz, all frequencies up to 5,000Hz are recorded accurately. Frequencies over 5,000Hz will introduce distortion into the sound. This distortion is called "aliasing".

Compact Discs always play back at 44,100Hz. This gives CDs a maximum frequency range of 22,000Hz which is outside or on the limits of most people's hearing ability.

The second parameter that determines digital sound quality is the maximum sample value. If we let silence be recorded as zero, what value does the loudest possible sound have? This value is the maximum sample value. Sound will oscillate above and below zero by this amount. Using the Amiga's internal 8 bit sound, the maximum sample value is 127. Thus all sounds are recorded as numbers between 127 and -127, with zero being silence. For comparison, the AD1012 has a range of +2,048 to -2,048, Obviously this gives the AD1012 much better sound quality than the Amiga's internal sound. Note that the sixteen bit AD516 has an even larger range of +32,767 to -32,767.

The final thing to notice about digital sound is that it uses quite a bit of memory. Since each AD516 and AD1012 sample takes two bytes, a sampling rate of 44,100 samples per second means that every second of sound is going to take exactly 88,200 bytes. This works out to 5.05 megabytes per minute or 12 seconds per megabyte.

Differences Between 8,12 and 16 Bit Audio

Digital sound systems generally fall into three different categories: 8, 12, and 16 bit. A small discussion of each class follows. A common reference is given (i.e., "8 bit sounds like an AM radio") as well as the theoretical Signal-to-Noise Ratio (SNR). Keep in mind that the SNR given is the theoretical maximum for a pure sine wave. Practical systems never match this number. However, one aspect of the quality of a real world system is how closely its SNR comes to the theoretical maximum.

8 Bit

The Amiga's internal sound format and SunRize's 'Perfect Sound' are 8 bit. A common use for 8 bit digital audio is long distance phone calls. Phone calls are often digitized with 8 bits of resolution at the switching station for broadcast via satellite or fiber optic cable. Eight bit audio has a theoretical maximum SNR of -48dBs and its sound quality is often compared to AM Radio.

12 Bit

The AD1012 card is 12 bit. Twelve bit audio is also used in many popular music synthesizers. It has a theoretical maximum SNR of -72dBs. Its quality is comparable to a high quality reel-to-reel tape deck or FM radio.

16 Bit

The AD516 card from SunRize is 16 bit. Compact Disk players and DATs are also 16 bits. Sixteen bit digital audio has a theoretical maximum SNR of -96dBs. Its quality is equivalent to a CD player.

Decibels

In audio systems the common measurement of volume is the Decibel (dB). Studio 16 volumes are also specified in dBs. Decibels are a logarithmic scale used to more accurately represent how the ear hears volume changes. Zero dB means no gain. Attenuation are negative, and amplifications are positive.

For example:

-12dB	is equivalent to 25% volume
-6dB	is equivalent to 50% volume
0dB	is equivalent to 100% volume
+6dB	is equivalent to 200% volume

These ratios are determined by the following equation:

dB = -20 log (gain)

example: -6 = -20 log (0.5)

Installation

Hardware Installation

The following installation instructions are the same for the AD516 and the AD1012. Both audio cards plug into a free Zorro slot in an Amiga 2000, 3000 or 4000. Installing the card is relatively easy. However, if you prefer, your local Amiga dealer can install it for you.

Install the Card

1. Turn off your computer.
2. Unplug the mouse, keyboard, monitor and power cables.
3. Remove the screws securing the case. On the A4000 there are 2 screws in the back, top-left and top-right corners. For the A2000 and A3000, look for 2 screws on each side and 1 in the back, top-center.
4. Carefully slide the case off the computer. For more information on removing your Amiga's case, see your Amiga's Manual.
5. Identify the Zorro slots in your computer by referring to your Amiga's Manual. Zorro slots are also referred to as "Amiga 100 pin expansion slots". (Note that any slot in the computer that the AD516 or AD1012 will fit into is a Zorro slot.)
6. Choose a Zorro slot to receive the card and remove its cover plate (back bracket).
7. Ground yourself by touching your Amiga's metal power supply case. This will remove any static charge built up on your body.
8. Remove the AD516 or AD1012 card from its anti-static bag and plug it into the free Zorro slot.

NOTE When the card is installed properly, only a small amount of the gold connector will show. If the slot has never been used, it may take a lot of effort to push the card in. A gentle rocking motion is usually best.

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9. Screw the card's bracket into the Amiga with the screw you removed from the cover plate.
10. Replace the case and secure it with the screws removed earlier.

Setting Jumpers

AD516 has one jumper. It is indicated by JP1 on the pc board. The AD1012 has two jumpers - indicated by JP1 and JP2. All jumpers are set at the factory and shouldn't need changing.

AD516	JP1 should be set to 6. It selects interrupt 2 or 6.
AD1012	JP1 should be set to 6. It selects interrupt 2 or 6. JP2 should be in place for normal operation.

Connecting Audio and SMPTE

All five jacks are "consumer line level" unbalanced connections. They should be connected to an appropriate source using standard RCA patch cables. For example, connect the left and right "Line Out" on your CD player to the "L - IN" and "R- IN" on the AD516.

Many professional Video Tape Recorders (VTRs) use "balanced" type connections. These will typically have the three pin XLR connectors. If your equipment uses these connectors, you will need to use XLR-to-RCA adapters. These are available at electronics stores.

The notations on the AD516's and AD1012's brackets follow:

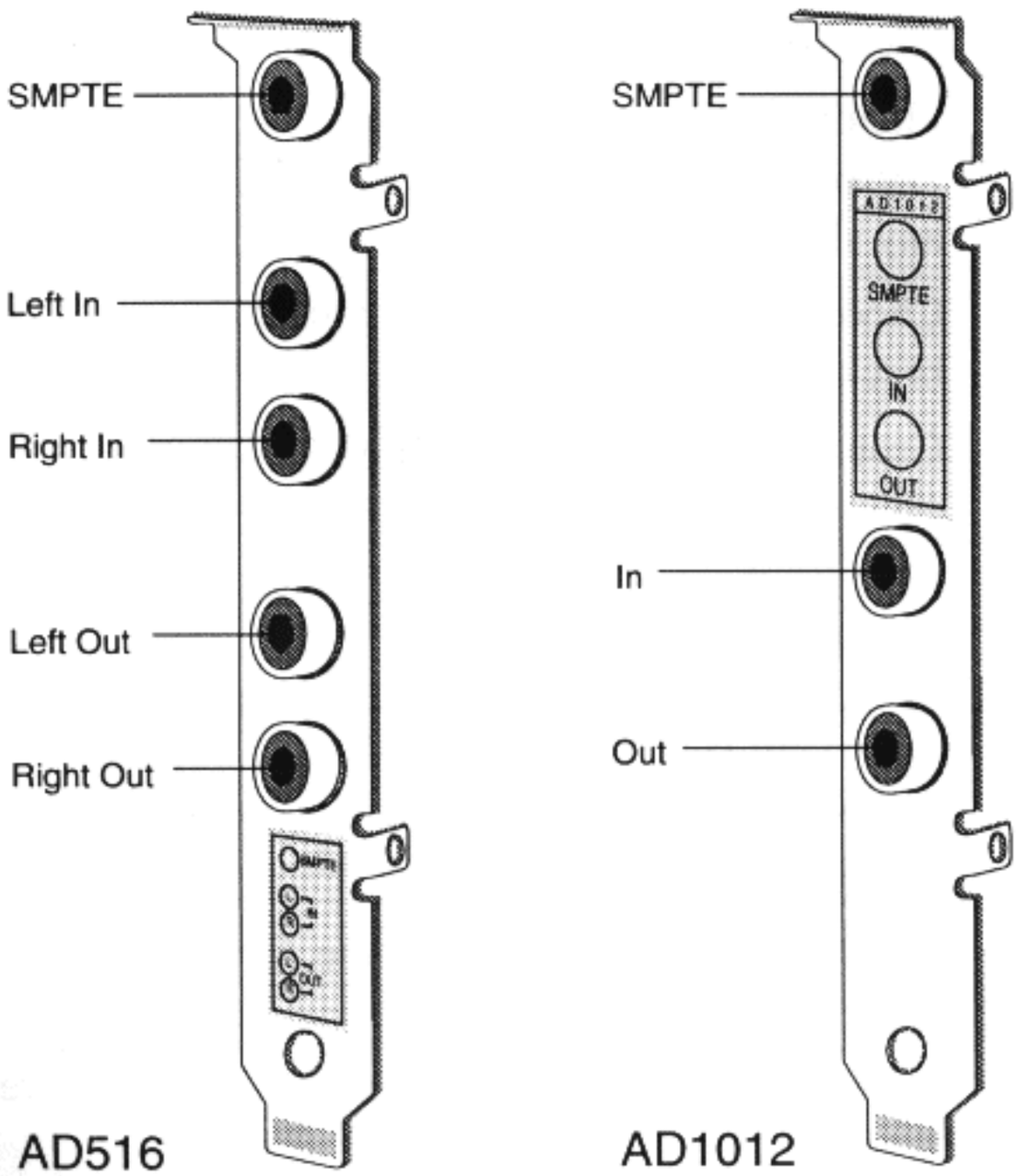

Figure 2-1. Bracket Labels

AD516

The AD516 card has five RCA jacks: SMPTE (LTC) In, Left and Right Audio In, and Left and Right Audio Out.

AD1012

The AD1012, a monophonic card, has the same SMPTE LTC input as the AD516. Its Audio In and Out are standard unbalanced RCA connectors.

SMPTE Sources

Although Studio 16 doesn't require an external SMPTE source to run, it is enhanced by its addition. If your deck has a dedicated LTC SMPTE track, simply connect it to the AD516's or AD1012's SMPTE In. If your VTR does not have a dedicated SMPTE track, you should record LTC time code to an unused audio track on video tape. This process is referred to as "striping a tape". This will allow you to use one of the Audio output jacks on your deck as a source for SMPTE time code. For more information on time code and striping tapes, see Chapter 5 -SMPTE.

If your deck uses VITC SMPTE, the SMPTE out on your deck may require a VITC-to-LTC translator. The AD516 and AD1012 do not read "vertical interval time code" (VITC) directly. See Appendix C - Third Party Sources for a supplier of VITC-to-LTC translators. For information on time code see Chapter 5 - SMPTE.

The AD516 and AD1012 SMPTE reader is designed to handle normal speed variations due to tape motor variance. It is not designed to read time code in fast forward modes.

Software Installation

Install Studio 16 On a Hard Drive

1. Turn on your computer and wait for WorkBench to finish loading.
2. Insert the Studio 16 **Disk 1** into a floppy drive.
3. Double click the **Studio16_1** disk icon.
4. Double click the **Read_Me** icon. The Read_Me file contains updated information that is not included in this manual. It may contain information related to installation. You can close the Read_Me file after reading it. The Installation Utility will copy it onto your hard disk for future reference.

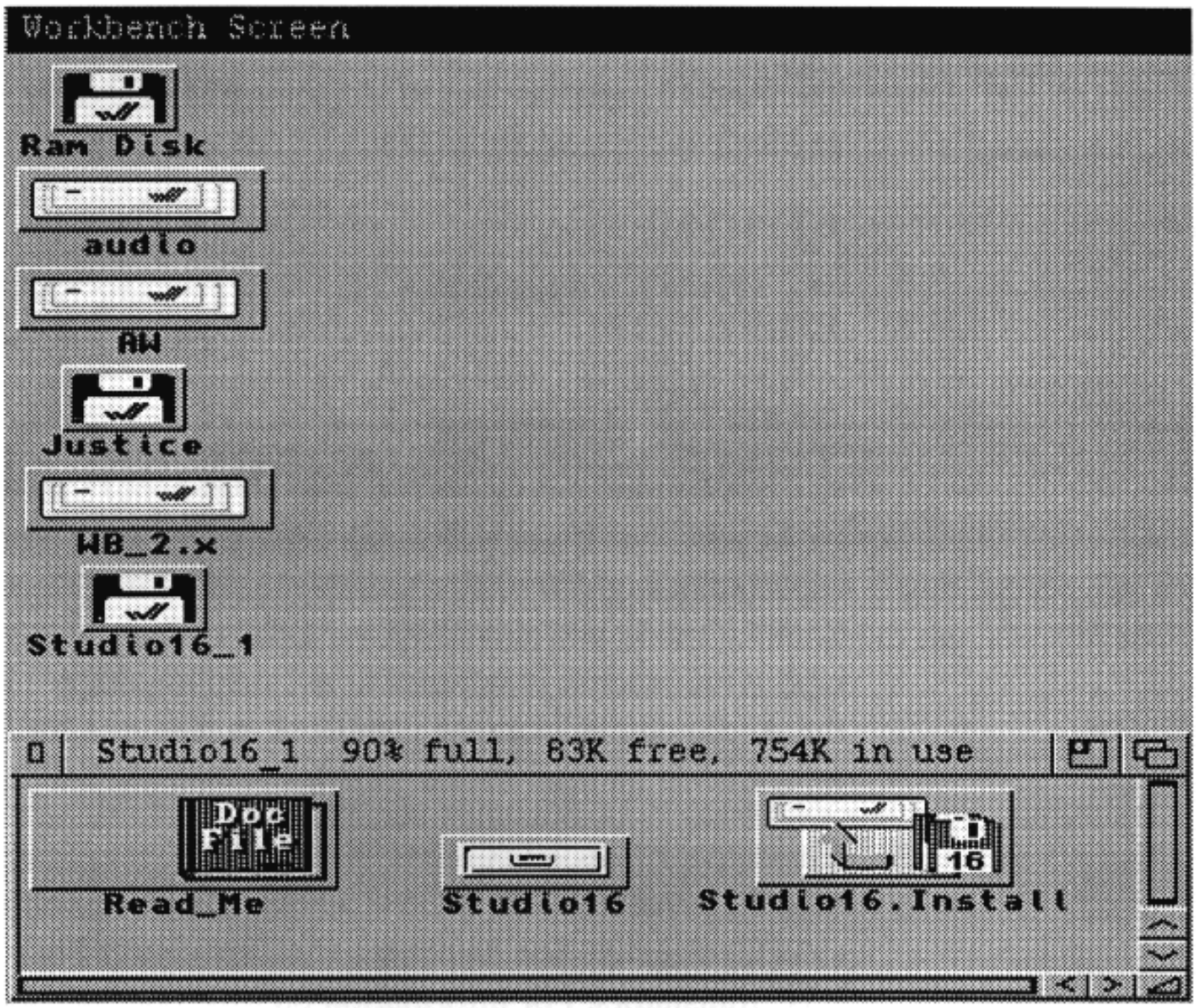

Figure 2-2. Studio 16 Disk 1

5. Double click the **Studio16. Install** icon.
6. The installation utility will run.

NOTE The installation utility is equipped with on line help for your convenience.

7. Before the installation begins, it requests your level of Amiga knowledge. Select your level of knowledge, then click **Proceed**.

   Novice Users are only required to select a directory on which to install Studio 16, all other actions are automatic. **Intermediate Users** have the added option of selecting that a log file be sent to a printer, or file. **Experienced Users** must indicate the preceding as well as having to confirm an assign statement.

8. A notice will appear with the following statement "I have found 1 AD516, is this correct?" Click **Yes** to proceed. However, if the system does not locate your AD516 or AD1012, exit the install utility by clicking **No**. Then, turn off your computer and re-seat the audio card in its slot or in a different slot, before trying the installation utility again. Refer to the preceding Hardware Installation section for more information on installing the hardware.

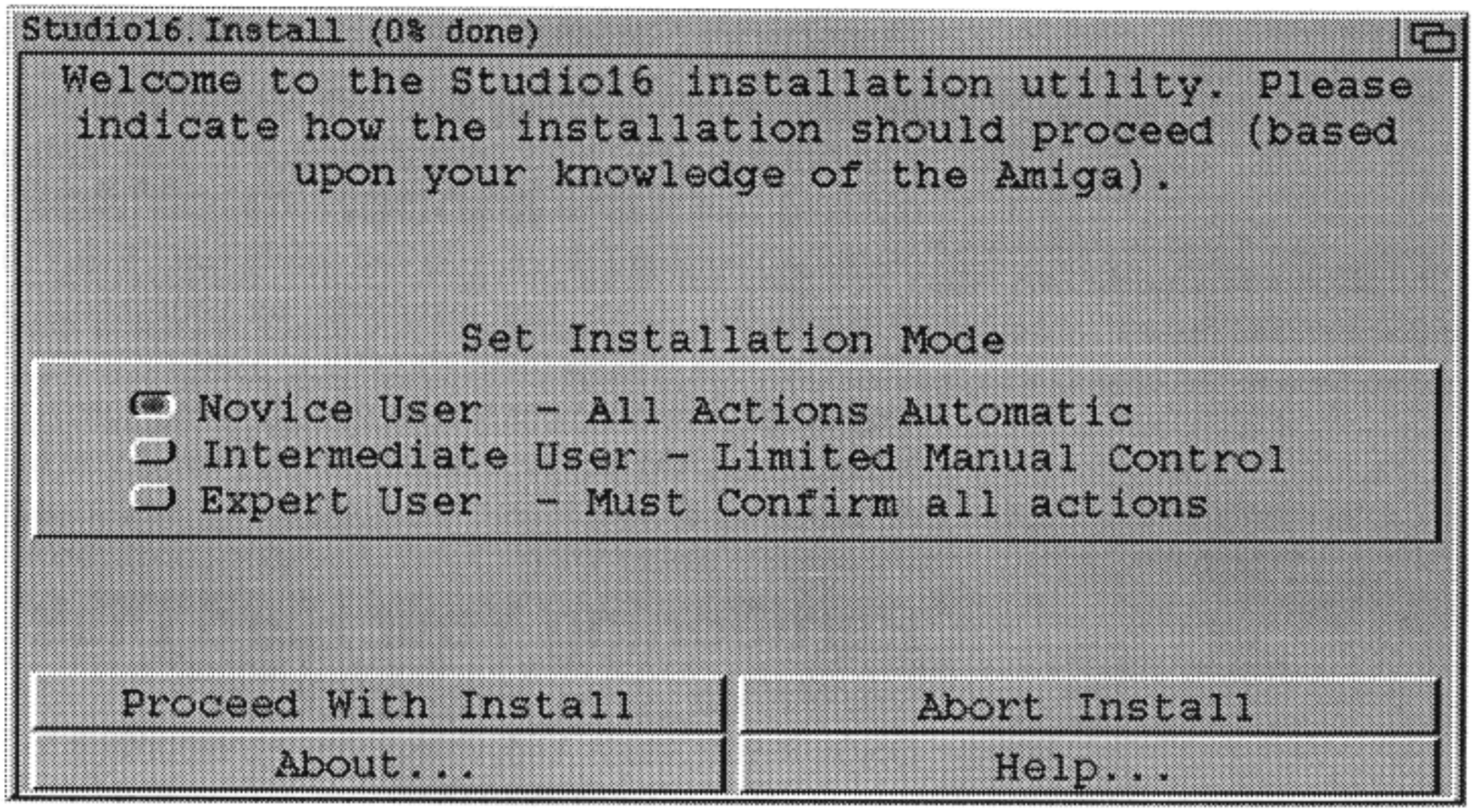

Figure 2-3. Studio 16's Installation Utility

9. Select the hard drive or partition to put the Studio 16 program on. Your available Amiga DOS devices will appear in the upper window. Click one of the names to select the device, then click **Proceed.** (You do not have to use the same path that you intend to use for your audio files.) For more information on the file requester click the **Help...** button.
10. The installation utility will create a directory called 'Studio16_3' and copy the appropriate files into it. In addition, your s: and libs: directories will be altered. And a log file will be created unless you have indicated otherwise. The log file contains all the actions that the installation utility completed during installation.
11. Insert the Studio 16 **Disk 2** when indicated.
12. When the installation is complete a Installation Complete notice will appear, click **Proceed** to close the installation window.
13. Now is a good time too fill out and mail your registration card. The card must be returned to SunRize in order to receive technical support, and software update notices.

Load Studio 16

Studio 16 will run under WorkBench 2.0 and greater. You can load Studio 16 from WorkBench or the Shell.

From WorkBench	Double click the **Studio16_3** directory icon. Double click the **Studio16** program icon.
From the Shell	Change the current directory to **Studio16_3**. Type **Studio16**.