APPENDIX A
DIGITAL RECORDING CONCEPTS

Analog Recording Basics

Digital recording works very differently from analog recording. With analog recording, tape containing millions of tiny magnetizable particles move past a record head. The magnetic field around this head fluctuates according to the audio signal present at the tape recorder's input. These fluctuations permanently rearrange the particles on the tape to form a pattern that is analogous to the original audio signal.

On playback, the patterns on tape are read by a separate playback head (or from the record head, set up to read instead of record signals) that converts the magnetic fluctuations back into an audio signal.

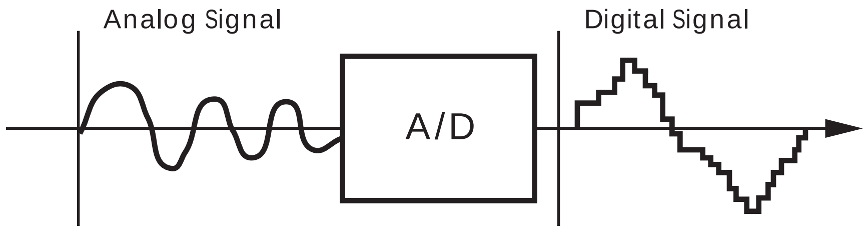
The biggest problem with analog recording is that the tape itself alters the sound originally recorded on tape. Tape hiss is one problem; it superimposes a low-level rushing noise onto the audio signal. Although there are ways to minimize noise, such as noise reduction circuitry, this colors the sound in the process of masking the noise.

Tape's frequency response is also an issue. Tape has a hard time "absorbing" higher frequencies, which can dullen the sound. Moving tape faster allows the heads to magnetize more particles and extends the high frequency response, but the tradeoff is increased tape costs, and heftier transports to move bigger reels of tape.

Digital Recording Basics

With digital recording, the technology is similar — tape moves past a record head, and plays back through a playback head. However, the signal recorded on tape is very different.

Audio signals entering each channel of the LX20 first pass through an analog-to-digital (A/D) converter, a device that takes 48,000 samples or "snapshots" of the signal level every second[1]. Each sample is assigned a specific numeric value that corresponds to its level.



[1] 48,000 samples are taken per second at a sampling rate of 48 kHz; 44,100 samples are taken per second at a sampling rate of 44.1 kHz.

These numbers, which represent coded audio, are then converted into an audio signal that can be recorded on tape. Fortunately, recording a number on tape doesn't degrade the signal.

During playback, a digital-to-analog (D/A) converter reads the numbers from tape and outputs a corresponding level. This creates a "stairstep" reconstruction of the original signal, which is close to (but not exactly) the same as the original signal. To complete the process, a low pass filter smooths this stairstep signal. The result is natural-sounding audio that sounds virtually unchanged from what was originally recorded.

Digital audio requires lots of numbers to represent an analog version of the same sound. Analog signals may require at least 20kHz frequency response to reproduce audio faithfully. Digital signals for the same 20 kHz audio requires a frequency response of several million Hertz. Due to the way individual numbers are transmitted, digital audio requires a wide bandwidth recording medium[2].

The Advantages of 20-Bit Recording

Just as the sample rate determines the frequency response of any digital system, the word length (or quantization) determines its dynamic range (or signal-to-noise). The four extra bits of ADAT Type II recording offer a potential of over 120 dB dynamic range, while 16-bit linear systems' maximum potential is 98 dB.

Another advantage is the lower distortion of 20-bit encoding. With over a million different values (as opposed to 65,536 values in 16-bit), the A/D converters capture a much more detailed signal.

So why not go to 24-bit? The increased potential of 24-bit encoding is overshadowed by the technical limitations of the converters themselves, not to mention dynamic range limitations of the analog microphones or other equipment being recorded. The incremental improvement is, unfortunately, mostly lost in the real-world limitations on electronic design such as thermal noise, interference etc.

If your application is extremely critical, it is possible to record at 24-bit resolution on your ADAT-LX20 using external adapters (i.e., the Rane PAQRAT or the Yamaha 02R). This method takes the "extra" bits and records them on higher tracks, so you won't get eight tracks without using more recorders and adapters.

Why S-VHS?

S-VHS recording technology offers more than enough bandwidth to record eight tracks of digital audio. S-VHS tapes are built to higher standards than standard VHS tapes, and can take the tape shuttling required by professional audio applications. S-VHS tape cassettes are also inexpensive compared to reel-to-reel tape, readily available, compact, and easy to transport and store.

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[2].Bandwidth is a measure of the lowest to highest frequency a signal path can handle.