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YAMAHA DSP-A1000 DIGITAL SOUND-FIELD PROCESSING AMPLIFIER

Manufacturer's Specifications

Audio Section

Power Output per Channel, 20 Hz to 20 kHz: Main and center channels, 80 watts into 8 ohms or 100 watts into 6 ohms; front and rear effects channels, 25 watts into 8 ohms or 30 watts into 6 ohms.

Rated THD: Main and center channels, 0.015%; front and rear effects channels, 0.05%.

Dynamic Headroom: Main channels, 2.1 dB into 8 ohms or 2.0 dB into 6 ohms.

Damping Factor: Main channels, 120.

Frequency Response: Phono, RIAA ±0.5 dB; high level, 20 Hz to 20 kHz, ±1.0 dB.

S/N: Phono, 86 dB; high level, 96 dB.

Residual Noise, A-Weighted: 150 μV.

Input Sensitivity: Phono, 2.5 mV; high level, 150 mV; center and main in, 1.0 V.

Maximum Phono Input at 1 kHz: 140 mV.

Maximum Output, Preamp Out: 3.0 V.

Headphone Output Level: 0.25 V at 1 kHz, for 8-ohm load.

Tone Control Range: Bass, ±10 dB at 50 Hz; treble, ±10 dB at 20 kHz; bass extension, +7 dB at 70 Hz.

Muting: −20 dB.

Video Section

Composite Video Signal Level: 1.0 V peak to peak, 75 ohms.

S-Video Signal Level: Luminance, 1.0 V peak to peak; chroma, 0.286 V peak to peak.

Maximum Composite Video Input Level: 1.5 V peak to peak.

S/N: 50 dB.

Frequency Response: 5 Hz to 10 MHz, +0, −3.0 dB.

General Specifications

Power Requirements: 120 V, 60 Hz, 400 watts.

Dimensions: 17⅛ in. W × 6 11/16 in. H × 18 7/16 in. D (43.5 cm × 17 cm × 46.85 cm).

Weight: 44 lbs. (20 kg).

Price: $1,499.

Company Address: 6722 Orangethorpe Ave., Buena Park, Cal. 90620.

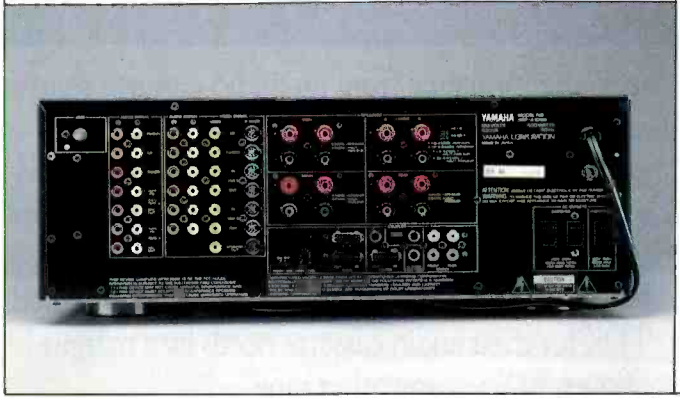
For literature, circle No. 90

Back in 1986, Yamaha introduced what was probably the very first home digital sound-field processor, the DSP-1. Yamaha's engineers had measured the acoustical characteristics of a wide variety of concert halls and other establishments where music was performed. Then, using digital signal processing and large-scale integrated circuits, they stored these characteristics in their first sound-field processor so that the environments could be duplicated in a home listening room. Yamaha's newest processor, the DSP-A1000, combines the company's latest digital processor circuitry with a seven-channel integrated audio/video amplifier. As I quickly learned, it also employs the most sophisticated digital sound-field processing and home theater surround-sound circuitry Yamaha has ever offered. The DSP-A1000 features 12 different sound-field programs and 23 variations, including separate modes for general and adventure movies. Utilizing a combination of digital processing and digital Dolby Pro-Logic to create a "70mm Movie Theater" setting, this all-in-one unit provides separate sets of information for foreground voices, special effects, and music and surround channels. In the seven-channel mode, dialog and front action are fixed at the video screen, while the effects are enhanced in the four available surround channels. A conventional Pro-Logic five-channel configuration is possible, as are four-channel arrangements (substituting a "phantom" channel for the preferred center-channel speaker) and even minimal three-channel installations.

The fixed sound fields are not limited to use with video sources. For music-only enjoyment, three different concert hall settings are provided (with two variations apiece)—as well as a church environment, two types of rock concert environments, and modes for disco, jazz, and stadium. Audio/video DSP programs include "Concert Video," "TV Theater," "Movie Theater," and, of course, the normal and enhanced modes of Dolby Pro-Logic.

The two main amplifiers and the single center-channel amp are designed to deliver 80 watts per channel into 8-ohm loads; the four effects channels provide 25 watts each into 8 ohms. (Part of the DSP-A1000's substantial weight of 44 pounds is attributable to the massive transformer employed in its power supply and to the anti-vibration, anti-resonance chassis.) In addition to supplying high power levels, this unit incorporates 10 audio and five video inputs with S-video as well as composite video jacks. Front-panel auxiliary terminals (including another S-video terminal) are provided so that you can connect the outputs of a camcorder without having to access the rear panel of this amplifier. A motor-driven input selector can be operated at the front panel or via the learning-capable remote control supplied with the DSP-A1000. A separate record-out selector lets you send any signal to "VCR 1" or "Tape 1" while another program is being heard or viewed.

A blank overlay lets users label the remote's programmable keys with whatever legends they want.



The DSP-A1000 includes a digital test-tone generator for DSP and Dolby Pro-Logic, five-band center-channel equalization, three center-channel modes (normal, wide, and phantom), and normal and three-channel Pro-Logic modes. Information that appears on the multi-function display on the front panel can also be superimposed on the screen of your TV monitor, if it's connected to the Yamaha's rear-panel "Monitor" output jack. Additional features of this amplifier include bass and treble tone controls, a preamp-out/main-in jack set, a subwoofer output terminal with a low-pass filter, dynamic "Bass Extension" (which I'll discuss later), audio muting for the main and effects channels, and a front-panel headphone jack.

Control Layout

The upper half of the all-black front panel houses the main power switch, a "Tape 2 Monitor" switch, the rotary source selector, and the master volume control (which is calibrated in dB from full volume, "0," past −80 to "−∞"). The centrally positioned LCD display area shows selected program names and parameters, information about other various settings and adjustments, and activation of the Pro-Logic and sound-field processor circuits.

The DSP-A1000 has more sophisticated sound-field processing than Yamaha's original DSP unit, plus seven amplifier channels.

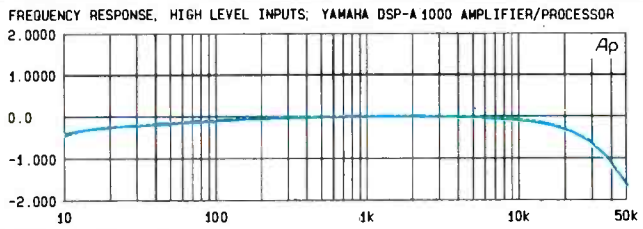


Fig. 1—Frequency response of main channels, for line input signal.

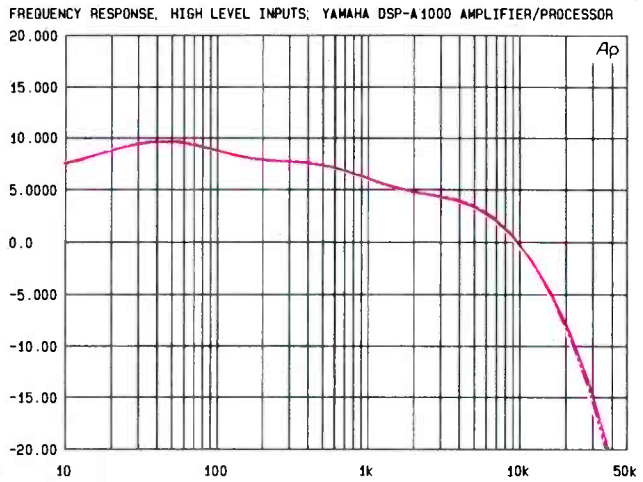


Fig. 2—Frequency response of effects channels in "Concert Hall 2" mode, for line input signal. Curves have been smoothed to eliminate time-delay effects; see text.

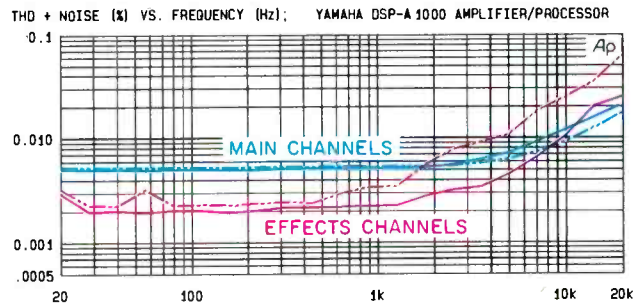


Fig. 3—THD + N vs. frequency for main and effects outputs at rated output into 8-ohm loads, for left channels (solid curves) and right channels (dashed curves).

Lowering a swing-down hinged panel reveals additional controls. These include an "Input Trim" control that adjusts input levels of each program source and also adjusts items selected by an adjacent "Set Menu" switch. That switch in turn brings up five different items for adjustment: "Pro Logic Mode," "Center Mode," center graphic equalizer, "Sub Woofer Level," and "Color" of the TV picture background (when no video signal is being applied to the connected TV monitor). A "Program" switch sequentially selects the sound-field processing programs, while an "Effect" switch turns effects speaker channels on or off. Other controls normally hidden by the swing-down panel are the stereo headphone jack; a "Bass Extension" switch; bass, treble, and balance controls; a "Rec Out" selector, and a set of audio and video auxiliary input jacks, including an S-video connector.

In addition to duplicating almost all of the control functions found on the front panel, the supplied infrared remote offers buttons that adjust rear- and center-channel levels relative to main-channel levels, change on-screen display parameters, and operate such other compatible Yamaha components as a CD or LaserDisc player, a tuner, and a tape deck. The remote can, in fact, be "taught" to control components from other manufacturers as well. Each key can learn two different functions, selected by flipping a switch from memory "1" to "2." Memory "1" is preprogrammed with functions that are called out on the panel, though it can be reprogrammed by the user. Memory "2" is empty, ready for user programming, and a blank template is supplied for personalized labelling.

When I turned the unit around to make my connections, it was easy to understand why the DSP-A1000 had to be more than 6½ inches high: The rear panel is crammed full of jacks and speaker terminals. There are seven pairs of RCA jacks for audio-only program sources, the 24 RCA or S-video jacks needed for routing two VCRs and inputting a LaserDisc and a DBS TV feed, and a monitor output in both RCA and S-video. The panel has some *eight* sets of speaker output terminals (two main, four effects, and two center), a subwoofer output jack (for use with powered subwoofers or with a separate amplifier), and four "Effect" output jacks (for those who prefer to use separate amplifiers for surround channels instead of the built-in amplifiers). There are also jacks for interconnection of the preamp and power amp sections, in/out jacks for the center channel, and a "Mono" output jack (which Yamaha explains is for fill between widely spaced speakers in large rooms). A small "Main Level" rotary control adjusts the line output level at the "Main Out" jacks. A "Front Mix" switch allows effects signals to be blended into the main outputs for systems that do not use front effects speakers. A center-speaker impedance-matching switch, three a.c. convenience outlets (two switched, one unswitched), and a ground terminal complete the rear-panel layout.

Measurements

My first objective in measuring this complex product in the lab was to determine the basic performance of its amplifier channels. Figure 1 shows the frequency response of the main-channel amplifiers. Attenuation was about 0.3

Sound fields ranged from a concert hall just right for Mozart to film theater environments with the sweep to match adventure movies.

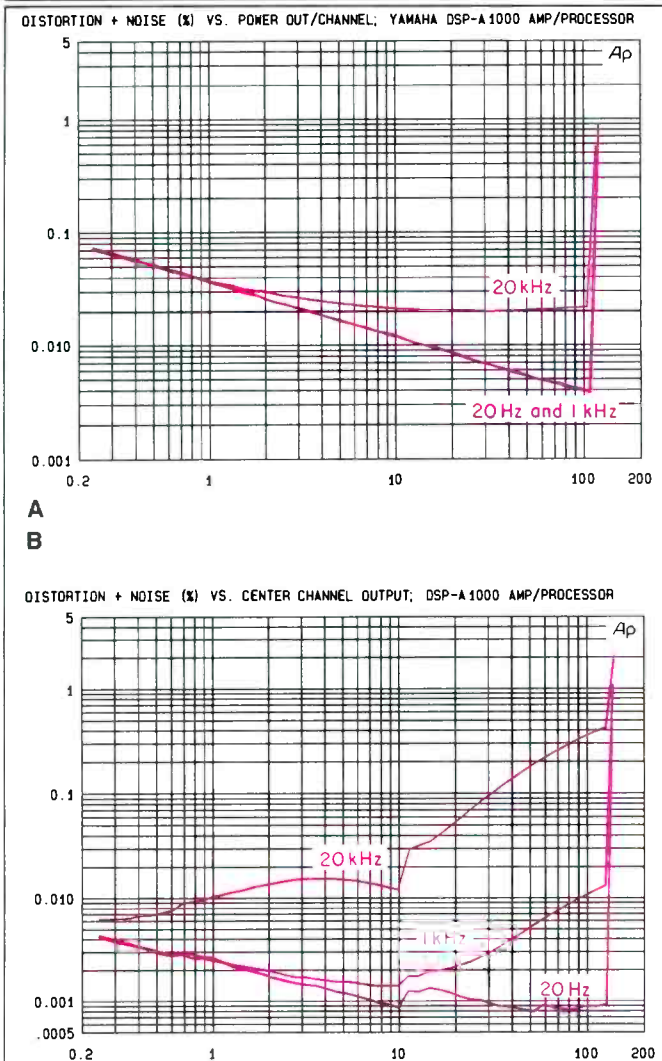


Fig. 4—THD + N vs. power output per channel into 8-ohm loads for main channels (A) and center channel (B).

dB at 20 Hz and 0.4 dB at 20 kHz. Those favoring wideband response for amplifiers will be delighted to note that even at 50 kHz, response was down less than 2.0 dB.

It is virtually impossible to measure the frequency response of surround or sound-field effects channels by the usual sweep methods. That's because the time delays built into such processors cause the resulting response curve to look like a closely spaced series of peaks and nulls as the measurement device tries to read the level of a frequency that has yet to arrive or one that has already passed. Thanks to a smoothing function of my Audio Precision test system, however, it is possible to average out the peaks and valleys. A typical response curve, shown in Fig. 2, was subjected to several passes of this smoothing process. It is presented only as a single example of the type of response that is generally available at the effects-channel outputs, where high frequencies are deliberately rolled off (much as they are in sounds reflected from walls and other surfaces of a concert hall). I could have plotted more of these effects response curves by using several, if not all, of the sound fields offered by the DSP-A1000, and each would have been slightly different. I chose not to do this simply because judging sound-field simulations is accomplished far better through extensive listening tests. I will discuss those tests a bit later.

Figure 3 shows THD + N versus frequency for the main and surround channels. Plotting this for the main channels was easy. At a regulated output level of 80 watts per channel, with both main channels driven, THD + N for all but the highest frequencies is well below the 0.015% specified by Yamaha—and is as low as 0.005% or thereabouts at low and middle frequencies. Measuring the power output capability of the effects speakers (front or rear) was not that easy. As a first attempt, I simply selected one of the DSP modes ("Concert Hall 2") and attempted to plot power output versus distortion for various test frequencies. Much to my surprise, apparent THD + N was well above the published specification. After conferring with some of the folks at Yamaha, I realized that what I was seeing were the time-delayed reverberant signals adding to the THD + N figures. I learned that the only way to isolate the effects amplifier channels from the DSP programs (in other words, to measure these channels simply as straightforward power amplifiers) was to insert RCA plugs into the effects output jacks. This effectively cut the connection between the DSP section and the power amplifier channels used for the front and rear effects speakers. Then I had to inject my generator signals directly to the amplifier inputs located on one of the p.c. boards. This, of course, meant taking the cover off the unit, which may have added a bit of noise or hum to the readings for the effects channels shown in Fig. 3. Even so, these readings were now well below specification for the rated output of 25 watts per channel. In fact, only near 20 kHz does THD + N creep above the 0.05% mark; over most of the spectrum, the readings range between 0.002% and 0.02%. Tests were made with two channels driven simultaneously, and results were about the same for front and rear effects amplifier channels.

Figure 4A is a plot of THD + N versus power output for the main channels. At 100 watts per channel, THD + N for 1-kHz and 20-Hz signals was even lower, around 0.0042%, proving that part of the earlier reading of 0.005% at 80 watts was due to noise rather than harmonic distortion. Figure 4A also reveals that maximum power output before clipping was actually more than 100 watts, even for the 20-kHz test frequency.

Center-channel distortion at rated power output of 80 watts, with a single 8-ohm load connected, was even lower than the THD of the main channels at most frequencies (Fig. 4B). It was less than 0.001% at 20 Hz and about 0.008% at 1 kHz, but it increased to about 0.28% at 20 kHz.

Particularly spectacular for movie playback is the "70mm Adventure" submode, which combines DSP with Dolby Pro-Logic.

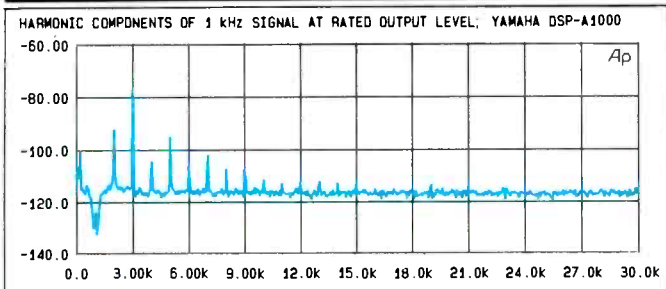


Fig. 5—Spectrum analysis of harmonics of 1-kHz main-channel signal at 80 watts per channel into 8 ohms. Curve shown is averaged result of 16 acquisitions, to reduce displayed noise and improve display of coherent signals.

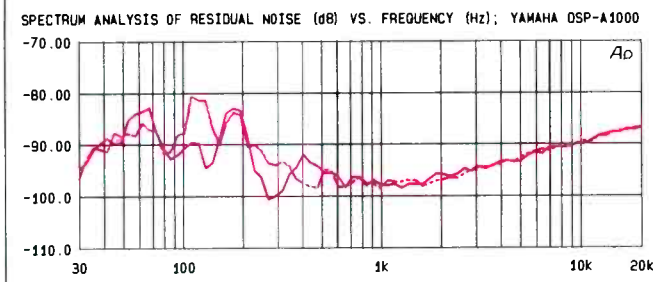


Fig. 6—Spectrum analysis of main-channel residual noise for 1-watt output with 500-mV line-level input.

To further differentiate residual noise from actual harmonic distortion, I ran a spectrum analysis of the distortion products for 80 watts per channel at the main amplifier outputs (Fig. 5). The major (and only significant) harmonic distortion component visible is the third harmonic of the 1-kHz fundamental, and that harmonic is down about 79 dB relative to the 0-dB fundamental, equivalent to a THD value of 0.0112%.

Dynamic headroom for the main channels of this amplifier was 2.0 dB, which means that for short-term musical crescendos, the main channels of the DSP-A1000 could deliver nearly 130 watts per channel before clipping. Damping factor for the main amplifier channels measured 125. Input sensitivity for the high-level inputs was 16 mV for 1 watt output; phono input sensitivity for 1 watt output was 0.27 mV. Maximum phono input level at 1 kHz before clipping measured 145 mV. High-level input signal-to-noise ratio, using a 500-mV input and adjusting the master volume control to produce 1 watt into 8-ohm loads, was an excellent 80.4 dB. For the phono inputs, using a standard 5-mV input at 1 kHz and adjusting gain once more for 1 watt of output, S/N measured 77.7 dB for the left channel and 75.2 dB for the right channel.

A third-octave spectrum analysis of residual noise of the main-channel outputs versus frequency, with the same reference levels used in the S/N measurement but without A-weighting, is shown in Fig. 6. Note that major contributions, as low as they are, are attributable to the power-supply fundamental frequency and its harmonics. Figure 7 shows the range of the bass and treble tone controls of this integrated amplifier. Also plotted is the response of the "Bass Extension" circuit, which peaks at 70 Hz and then attenuates bass rapidly to avoid amplifier overload. This sort of response will undoubtedly be favored by those who like a solid beat with their rock and pop music as well as by those who want the kind of tummy-rattling bass associated with action movies that have Dolby Surround soundtracks. Figure 8 shows the deviation from standard RIAA playback equalization for signals fed to the phono inputs of the DSP-A1000. Deviation was slightly less than ±0.5 dB for the entire audio spectrum from 20 Hz to 20 kHz.

Listening and Viewing Tests

There are so many ways to set up this sound-field processing A/V amplifier that I was delighted when three of Yamaha's staff volunteered to come to my lab and listening room to make certain I properly explored all aspects of this versatile component. I resisted at first, thinking that they might attempt to do a bit of "brainwashing" to make certain that I said nice things about the product. My fears were ungrounded. Armed with extra speakers, a laser videodisc player, and plenty of cables, the Yamaha crew took over my own home theater installation without in the least upsetting my own entertainment system, other than to use my reference front speakers as the main speakers of the system. To these, they added a center-channel speaker, perched atop my 32-inch reference TV monitor/receiver; a pair of front effects speakers (mounted high, and actually behind what I normally call the "front" speakers, but which they call the "main" speakers to avoid confusion); a pair of rear effects speakers, and a subwoofer. In sum, the installation now included a total of *eight* speakers, seven of which were being driven by the DSP-A1000! (The subwoofer was an active system.) In addition, they hooked up a Yamaha optical disc player so that we would not have to disconnect my own videodisc player from the rest of my system.

What followed can only be described as the most authentic concert hall and movie theater experiences that I have ever enjoyed in my somewhat cramped home theater listening room. Before I tell you about the impact of some of the motion picture excerpts I watched, let me describe what happened when I played a CD of Mozart's 40th Symphony (Telarc CD-80139) by the Prague Chamber Orchestra under the direction of Sir Charles Mackerras. (I felt that this was an appropriate starting point during this 200th-anniversary year of that sublime composer's death.) I began playback using the DSP-A1000's "Concert Hall 1" mode, a European hall

Fitting so many sound fields and amps into one box is a miracle, but the price tag is even more miraculous.

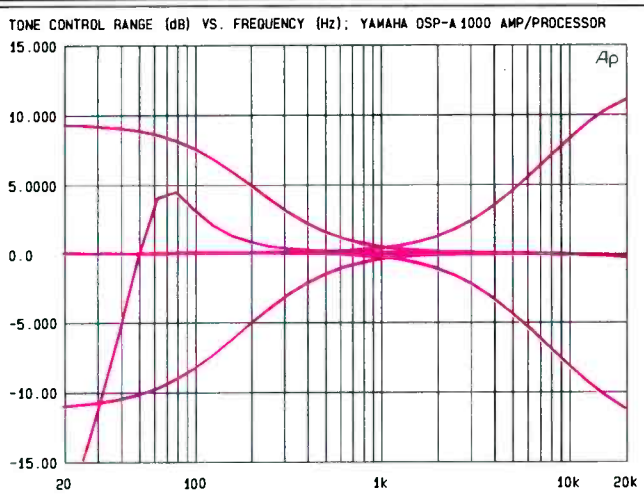


Fig. 7—Bass and treble control range, plus action of "Bass Extension" circuit.

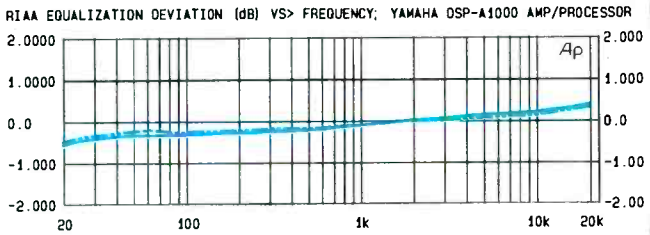


Fig. 8—Deviation from standard RIAA phono equalization.

that was not further identified. The room size seemed to expand to that of a moderately small hall, one that I deemed particularly appropriate for this Mozartean orchestra. When Gary Altunian, National Product Training Manager for Yamaha's audio component line, attempted to impress me with "Concert Hall 2" and "3," I felt that they sounded much too big for this Mozart recording, and he obligingly returned me to the smaller concert hall. I wanted to hear the entire symphony, but in the interests of time, I settled for just the First and Second Movements. I sensed that the Yamaha crew really wanted to get on with some demonstrations of blockbuster films.

The first clips we watched were from *Indiana Jones and the Last Crusade*. The scene in which Sean Connery and Harrison Ford fly (and crash in) a small biplane was first played using Dolby Pro-Logic. It was impressive enough as the heroes' plane was chased by the bad guys in another plane, with sounds streaming overhead and across my expanded home theater environment. Then I used the remote to switch to what Yamaha calls "Dolby Pro-Logic with enhancement," a mode that uses DSP to synthesize phantom images of the multiple effects channels in large movie theaters. Instantly, I was transported to a larger theater, one that made better use of the Dolby Stereo process. The scene now took on new, greater dimensions, with the sounds of the moving aircraft seeming to make smoother transitions from side to side or from front to rear. Finally, I used the remote to select the "Movie Theater" surround mode. There was suddenly an astounding increase in spatial depth. Sounds were coming not only from the actors (via the center channel) and from the space between the screen and my viewing position but also from "behind" the video screen. The contribution of those extra front effects speakers was particularly spectacular during the playback of the same scene in the "70mm Adventure" submode (which combines Dolby Pro-Logic with DSP circuitry); it simply has to be heard to be believed. With dialog at the screen position, sound effects in the near background, and music in the far background, this combination Dolby Pro-Logic/DSP mode truly enveloped me in total surround sound in a way that I had not heard before except in one of the few large motion picture houses remaining in the New York metropolitan area. Certainly, the sonic experience was far superior to the level of sound quality I typically encounter when attending movie theaters that have been subdivided into multiple screening rooms!

The "Movie Theater" mode has a second submode, "70mm General," that is perhaps more appropriate for less dramatic, less adventure-laden films. It was extremely effective with romantic comedies, drama, and what I can best describe as "lower budget" films, but for the greatest impact, give me that "70mm Adventure" mode every time!

I'm indebted to Yamaha's Larry Poor, Marketing Manager for Audio Products; Frank Ricatto, Eastern Regional Manager for Audio Components, and Gary Altunian. The reviewer's task with a product as all-encompassing and elaborate as the DSP-A1000 is not an easy one. I suspect that had it not been for their help, I might have overlooked some of the wonderful surround and sound-field capabilities of this processor/amplifier. As they were packing up the extra speakers and other components they had brought (leaving me the amplifier for further testing on the bench), I could not help but recall the first digital sound-field processor Yamaha introduced five years ago. That unit required the addition of several power amplifiers as well as the required number of speakers. Anyone brave enough to undertake assembly of a home theater or surround sound environment in those days ended up with a rack full of electronics—and a tall rack at that—before even considering the necessary extra speakers. That all of the electronics needed for the variations of Dolby Pro-Logic as well as the 12 programs (for 23 modes) of digital sound-field processing are incorporated in a single "do everything" component can only be regarded as a minor electronics miracle. That such a component carries a price tag actually lower than that of some processor-only components is an even more miraculous achievement.

Leonard Feldman