The SoundSpace™ con
by Advent

Faisant suite à votre demande téléphonique da
ce jour, voulez-vous trouvez ci-joint une
notice en français, pour le Sound Space Control

SENNHEISER

ADVENT

Avec les compliments
de la Maison Brandt Frères

DIVISION HAUTE-FIDELITÉ
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The SoundSpace™ control by Advent

The last real frontier in sound reproduction is the ability to change your living room, electronically, into the kind of space where music sounds best—a good-sized space where music has room to expand and reverberate, and where the right spatial proportions and right combination of sound reflection and absorption produce rich, warm, and clear acoustics.

The SoundSpace control by Advent is a new electronic product that allows you to transform the sound in your living room into what you might hear in a whole range of good listening spaces of varying sizes and acoustics. It uses the most sophisticated technology ever applied to home audio.

The SoundSpace control makes a dramatic difference in the way music sounds in your living room—a greater difference than anything you can experience by changing or improving conventional stereo components. It provides a three-dimensional spaciousness that can't be achieved with tone controls, equalizers, reflective loudspeakers or added amplifier power. It enhances the sound of all music, including the many rock and other recordings where the only original listening space you can bring home into your living room is the one in the heads of the musicians, producer, and engineers.

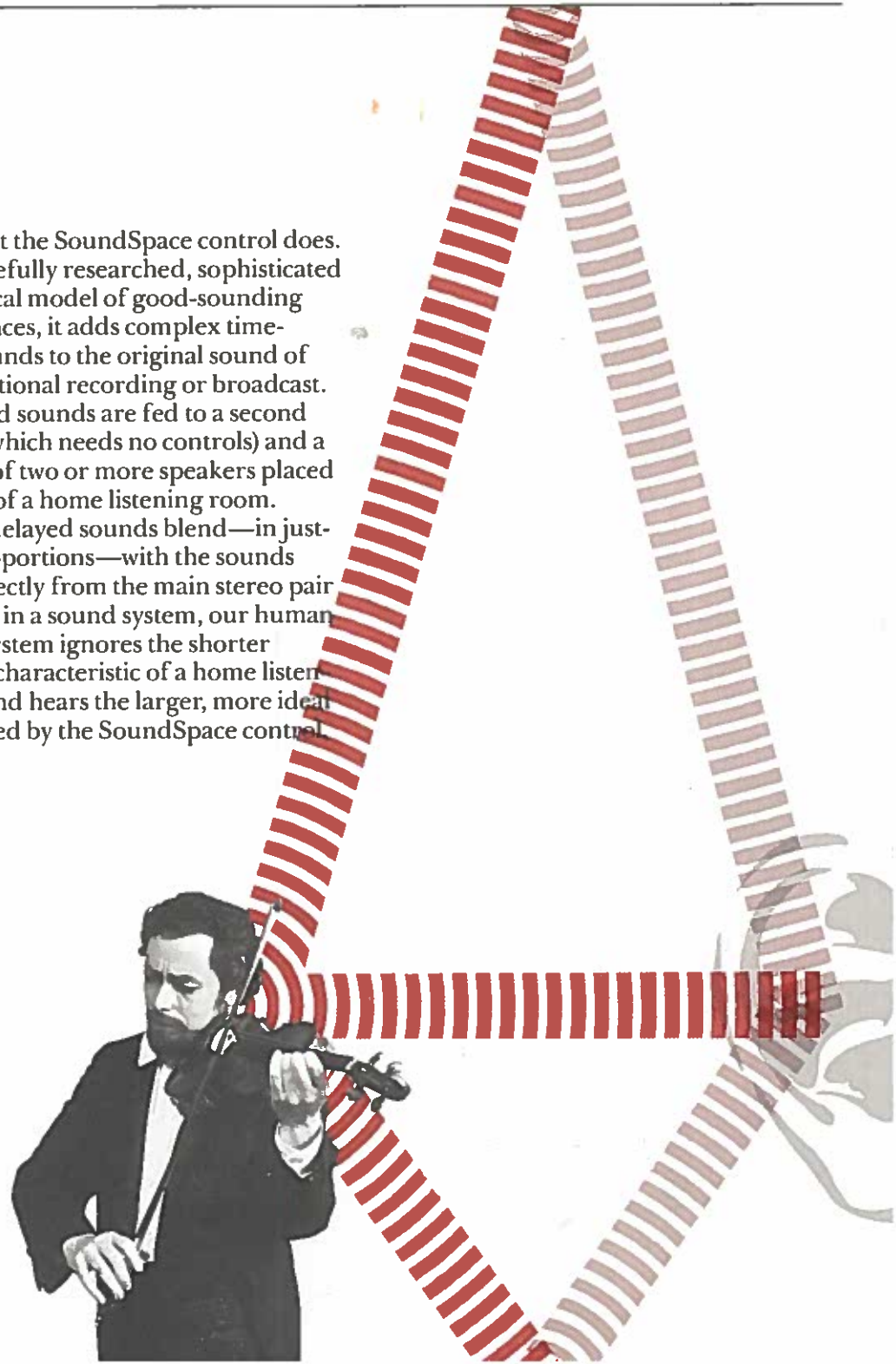
What it does

At a live performance in a good-sized listening space, sound reaches you both directly from the performers and indirectly by way of a number of delayed reflections from all of the surfaces of the listening space. The amount of delay in the arrival of the indirect sounds, and the way in which they are reflected, absorbed, and combined by the surfaces of the hall (and the people in it) produce the total acoustic experience.

When you listen to a stereo system at home, the sonic delays and reflections of the large listening space are replaced by the ones characteristic of your listening room. The delays are much shorter, and the mixture of reverberant sounds is more limited and less satisfying.

What's needed to bring home the acoustic depth and richness of the good live listening experience—and to add the dimensions of that experience to studio-produced recordings—is an electronic way to "dissolve the walls" of the home listening room and to present the reflections that reverberate, blend and die down as they would in larger listening spaces with good acoustic characteristics.

That is what the SoundSpace control does. Using a carefully researched, sophisticated mathematical model of good-sounding acoustic spaces, it adds complex time-delayed sounds to the original sound of any conventional recording or broadcast. The delayed sounds are fed to a second amplifier (which needs no controls) and a second set of two or more speakers placed to the rear of a home listening room. When the delayed sounds blend—in just-audible proportions—with the sounds coming directly from the main stereo pair of speakers in a sound system, our human ear-brain system ignores the shorter reflections characteristic of a home listening room and hears the larger, more ideal space created by the SoundSpace control.



The SoundSpace control is designed to do its job with great precision on its part and great ease on yours. In the accuracy, effectiveness, and ease of its operation, it is like no other product, past or present.

The SoundSpace control automatically makes countless choices for you. It puts you, for instance, in the theoretical "best seat" in any space you create, sets the aspect ratio of the space, and sets a "stage depth" appropriate to the size of the listening space. It makes the many thousands of calculations related to basic acoustics (including matters like coefficients of reflection and delay amplitudes) with no need for computations by the listener. Taking over all the complexities of modeling acoustic space, the SoundSpace control lets you make the the two most important choices for creating the kind of listening space you want: its size and reverberation characteristics.

You choose the size of the space you want to create with a simple control that can produce any of 100 acoustic sizes in less than five seconds. The sizes are visually displayed on a "Size Index" digital readout next to the controls. (Typical settings are 20-35 for a small club, 30-60 for theaters, 50-80 for concert halls, and 70-99 for cathedrals.)

After you choose the size of the space, you select its reverberation characteristics with a continuously variable control that lets you produce anything from a "dry" or "dead" space to a "live," highly reverberant one.

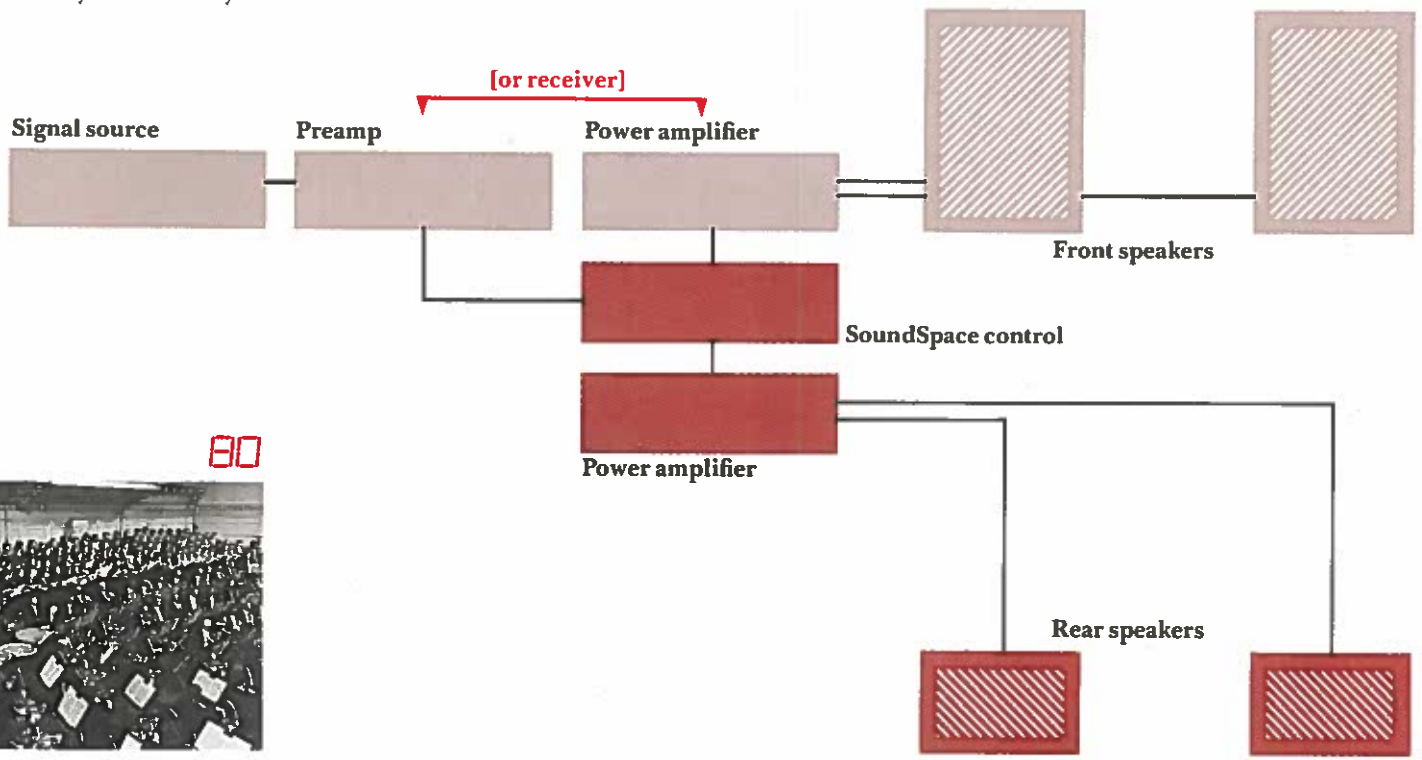
In addition to its flexibility and the ease and precision of its operation, the SoundSpace control offers the sound quality of a highest-fidelity product. It has very low noise and distortion (less than 0.1%) and very wide dynamic range (80 dB). Unlike earlier time-delay units, it provides full-bandwidth operation. Undelayed high-frequency information (in amounts adjustable by a treble control) can be mixed with the delayed material to help reproduce the immediacy of the live listening experience. A bass control for the rear speakers helps create the best match with your own listening environment. And a simple, three-position set-and-forget level switch (with an LED display that indicates normal operating levels in green and overload in red) lets you match the SoundSpace control to the rest of your equipment in a few seconds.

The delayed sounds created by the SoundSpace control are meant to be heard over speakers placed to the sides or rear of your listening room, preferably at or above ear level. Any good speaker, ultra-wide-range or not, will produce excellent results as a rear speaker with the SoundSpace control. A pair of good small speakers, such as Advent/3's, are fine choices, since their size makes it easy to place them in the best-sounding locations.

To power the rear speakers, we recommend 15 watts or more per channel. If you listen at ultra-high loudness levels, you may need more power. But our own experiments indicate that modest power can do very well for realistically loud listening in most instances, since the rear speakers are operated at lower levels than a system's main speakers.

For greatest ease of operation, the signals fed to the SoundSpace control should come from a unit—preamp, integrated amp, or receiver—with a *volume-controlled preamp output.* We don't recommend use of the tape-monitor outputs, since the lack of volume control on these outputs means that you would need to readjust the volume control on the SoundSpace control for your rear speakers whenever you changed the listening level of your main speakers.

The amplifier used to power the rear reverberation speakers needs no controls of any kind. But you can use a receiver or integrated amplifier for the rear speakers by connecting the SoundSpace control to its Auxiliary inputs. Once you set its volume at a convenient point, you will not need any of its control functions thereafter. The same applies to using the rear channels of a four-channel amplifier or receiver you might already own. The controls on those channels won't be needed, but there is no reason why the amplifier channels can't be used to power the rear speakers as before.



Time delay is not a new idea. Its potential value has been recognized for many years. But until recently, the technology to make time delay feasible in home audio simply didn't exist. And when the first breakthroughs—the charge-coupled devices and the transfer of some rudimentary digital techniques—came, they barely scratched the surface of time delay's real potential.

To create the sound patterns of good listening spaces, what's needed is an accurate model of the very complex ways in which sound behaves in those spaces. This calls for nothing less than a specialized computer, using state-of-the-art memory and logic circuitry that can recall time delays at essentially random intervals and at several times during the delay cycle. That is what the SoundSpace control achieves. It is a dedicated computer, with circuitry of such sophistication that in the days of vacuum tubes its hardware would have filled an auditorium and required enough power to light up a city block.

By taking advantage of the recent leaps in computer and device technology, the SoundSpace control achieves both the miniaturization and cost-reduction necessary to make time delay a real factor in home audio. A patent-pending technique gives the SoundSpace control the dynamic range needed for full listening satisfaction, and a symmetrical analog-to-digital, digital-to-analog signal conversion process makes distortion vanishingly low.

If you aren't familiar with digital design, the basics of its use in the SoundSpace control begin with the conversion of the continuous audio waveform to a series of on-off, yes-no switching pulses. These digital pulses can then be processed by the SoundSpace control's computer logic circuitry. (For a technical description of that circuitry, see *What goes on inside.)* After the processing, the digital stereo signals are reconverted to an analog waveform to be fed to an amplifier and set of rear speakers.

As we mentioned earlier, the SoundSpace control's accurate handling of this process creates typically less than 0.1% distortion of the original stereo signals. A key element in achieving this level of accuracy in processing audio signals, and the audible clarity it produces, is that the SoundSpace control uses a true 10-bit floating-point analog-to-digital conversion technique that treats every signal sample separately.

The circuitry in the SoundSpace control uses eight random access memory devices (with 4,096 bits each), fifty-seven digital IC's (mostly Schottky MSI TTL logic), fifteen integrated amplifiers (some BiFET), three integrated regulators, nine conventional transistors, twenty-four diodes, eight LEDs and two monolithic numeric LED displays. (The total device count is equivalent to more than 43,000 conventional transistors.)

All of this is incorporated on a double-sided computer-grade circuit board that we believe represents by far the most advanced, space-effective construction to be found in any product for home audio. Looking at the SoundSpace control with its top cover removed will tell you more about its quality and sophistication than we can here. (Our photo tells part of the story, but only part.)

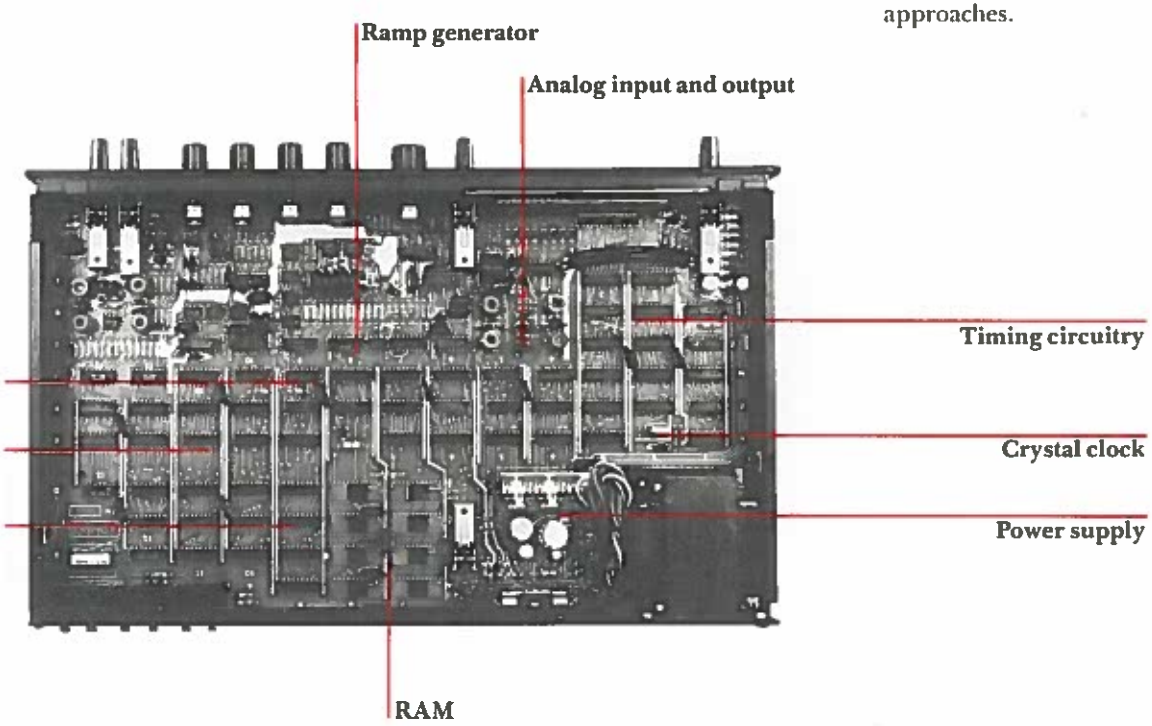
A→D conversion

D→A conversion

Rotating address stack

The Delay Only mode

For use when time-delays only are required (such as for sound reinforcement in a large hall, or special recording effects), a Delay Only switch on the SoundSpace control's rear panel defeats the reverberation-decay action. In the Delay Only mode, the SoundSpace control provides two equal time delays at the rear channel outputs, each with a value that is variable, in one-millisecond steps, up to 100 milliseconds. The two delay channels can be cascaded for a single delay of up to 200 milliseconds. Frequency response of the delayed signal rolls off above 6 kHz.



What goes on inside—a technical description

If you are familiar with digital technology, here is a closer look at what the SoundSpace control does:

Each incoming audio signal passes through a variable gain buffer amplifier and is then filtered into high-and low-pass segments. The low-pass filtered signals are sampled every 62.5 microseconds. Each sample is converted into a 10-bit digital representation using a unique floating point technique which provides 80dB of dynamic range. This technique treats every sample independently, thereby avoiding the hysteresis distortion typical of many forms of delta modulation and related approaches.

Digitization takes place in two discrete operations. First, the sample is sized in 10dB steps, thereby determining the value of two floating point bits (radix root 10). Thereafter, the remainder of the sample is compared with a highly linear ramp and 8 bits of continuous digitization derived. The ten bit representation, comprised of two floating point bits together with 8 continuous bits, is stored in Random Access Memory (RAM) to be recalled when needed by the 10 MHz, crystal-clock-controlled, SoundSpace control Logic.

At the appropriate time, each 10-bit sample is retrieved from memory (its address having been computed by a rotating three-high address stack) and converted into its analog equivalent by an operation which is the precise reciprocal of that by which it was digitized. The symmetric nature of these processes insures that any distortion in either of them is cancelled by the other. Consequently, the SSC produces negligible distortion.

The value the user selects by manipulating the Size control is actually the time delay (in milliseconds) to the longest "early reflection"; this delay is a good index of apparent room size. Given this parameter, the logic within the SoundSpace control is able to calculate precisely when to retrieve each digitized sample and convert it back into audio.

A single large memory holds discrete information from both left and right input channels, each sample having a distinct address. To implement the acoustic space algorithm, delayed information is purposely mixed, contoured, and multiply delayed in continuously controlled proportion.

Each output channel contains delayed information from its corresponding input blended with signals from prior times and other spatial origins and is, thereby, a precisely formulated time-series corresponding to the sound field in a specific space. The Reverberation control determines the "liveness" of the various modeled surfaces off which sound is being reflected. It varies the amplitude of the recirculation components at the delay-line inputs. (This corresponds to reflection coefficients of actual physical boundaries in auditoriums.) The user quickly learns to adjust the settings of Size and Reverberation to obtain a reproduction of the original performance which emulates reality.

To the carefully processed low-pass signals, the SoundSpace control allows the user to add a measured amount of the high-pass (treble) information present at the input. As discussed by Milner (55th AES Convention), this treble information enhances spatial realism over a wide listening area and minimizes localization shift, thereby producing an acoustic space of uncommon immediacy. The amount of treble to be added is left to the user because it depends, in part, on the acoustics of the listening room.

A final word

The full enjoyment of high-fidelity sound depends both on accuracy in reproducing the sound of musical instruments (like optical and color accuracy in the making of movies and photographs) and on creating the best, most convincing sonic environment for music.

We believe you will find the SoundSpace control uniquely effective in making your living room a "sound theater" that you can vary to suit the music and your tastes. The natural, three-dimensional sonic illusion it creates is far beyond anything you can achieve by buying a closer-to-perfection amplifier, speaker, or what-have-you.

Once you hear that illusion, and have a chance to appreciate the subtle but definite increase in apparent realism, we think you will find it hard to go back to conventional stereo.

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Specifications

Initial delays: Two unequal initial delays, one for each channel, are together continuously variable by the *Size* control. The value of the longer delay, from 1 to 100 milliseconds, is displayed in millisecond steps (less one millisecond) in the *Size Index* window.

Reverberation: The two delayed signals are recirculated and cross-fed to produce multiple incoherent delays that model acoustics of real spaces. Their decay time is determined by the *Reverberation* control, which varies the amplitude of the recirculation components at the delay-line inputs.

Circuit features:
Random access memory (RAM)
Three-high rotating address stack*
Floating point continuous conversion A↔D with uniramp distortion compensation*
10 MHz crystal-controlled clock

Delay Only mode: For public address and professional use, a rear panel switch changes the operation to time delay only, without reverberation. This produces two identical delay paths, each having a delay equal to the value selected plus one millisecond.

Active device technology:
Memory: 32,768 bits of MOS dynamic RAM (4k RAM)
Logic: CMOS; low power Schottky TTL
Analog: High slew rate and BiFET integrated amplifiers

Front channels: Straight wire bypass; unity gain

Rear channels:

Frequency bandwidth: 30–20,000 Hz

Distortion: Less than 0.1% THD for a 1.5V 1 kHz output

Dynamic range and noise: The A↔D conversion employed includes 8 bits of continuous digitization, providing a 50 dB signal/noise ratio, unweighted; the two bits of floating point gain add 30 dB of dynamic range, producing a total dynamic range of 80 dB. Sampling frequency feedthrough is at least 85 dB down from full output.

Input sensitivity/impedance: Three 10 dB steps: 0.3V, 1V, 3V/150k ohms

Output level/impedance: 3V/3.5k ohms maximum

Bass control: Baxandall-type with sliding inflection point, ±5 dB @ 100 Hz

Treble control: Shelves frequencies from 6000–20,000 Hz, infinite cut to +6 dB boost; direct feed from front into rear channels.

Power requirements: 120 VAC nominal (90V–130V) 50/60 Hz, 30 watts. 220 VAC nominal (180V-270V), 50/60 Hz, 30 watts version available outside the U.S.

Accessory outlet (120 VAC version only): 400 watts maximum

Dimensions: 15¾" (40 cm) x 3¼" (8 cm) x 10¾" (27 cm) deep, including knobs and feet

Weight: 10¼ lbs. (4.7 kg)

*Patents applied for