SONY

DVP-S9000ES

DVD-Video/CD/SACD Player

Technical Notes

The standard prices shown in this catalog consumption tax and expenses of transportation, installation, connection and adjustment.

New Generation Prestige DVD Player, DVP-S9000ES
Now opening a new field in playing back DVD of extremely pure images and high quality sounds

For videophiles, equipment reviewers and consumer electronics professionals, the launch of a new, top-of-the-line Sony DVD player is always an occasion. In 1997, Sony's original DVP-S7000 was acclaimed as the "Reference Standard." In 1998, the second-generation DVP-S7700 took DVD playback to a new level of accuracy. Now the Sony DVP-S9000ES DVD-Video/CD/SACD player redefines the category. The player is a comprehensive redesign that represents three significant firsts:

- The world's first DVD player with 525P outputs based on **Fast and Pure Cinema Detection.**
- The world's first DVD-Video player to incorporate true **Super Audio Compact Disc playback.**
- The first DVD player to join **Sony's ES Series,** the Elevated Standard in audio reproduction and now video reproduction.

In addition, the player represents significant refinements in MPEG image processing, optical transport, construction and craftsmanship.

This booklet serves as an introduction to the technology of the DVP-S9000ES, presenting advances that promise to shape the development of DVD players for years to come.

SACD/DVD Player

DVP-S9000ES

INDEX

A Major New Opportunity

In 1997, Sony's original DVP-S7000 helped launch the DVD-Video format and was quickly acclaimed as the "Reference Standard." In 1998, the second-generation DVP-S7700 took DVD playback to a new level of accuracy. Of course, both players were designed to maximize performance with the huge universe of televisions using 525-line interlace scanning.

In the mean time, TV stations have launched the era of Digital Television (DTV) broadcasting. High Definition satellite broadcasting has become a commercial reality. In response, Sony and others have introduced a growing population of televisions with higher scanning frequencies, capable of better than 525-line interlace scanning.

Some of these new televisions offer progressive scan or 525P inputs, which can accept 525P output from a DVD player. And 525P outputs have quickly been promoted as a must-have feature in high-end DVD players. They promise reproduction that's even more detailed, more natural, more film-like.

However, there are important differences in how DVD players process the 525P signal. Circuitry varies greatly in sophistication and cost. To appreciate the technology behind these differences, readers need a firm understanding of progressive versus interlace scanning, film versus video origination, 3-2 pulldown and 3-2 reverse conversion. This section reviews these basic issues.

Progressive and Interlace Scan

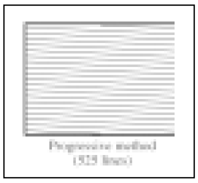

Fig. 1: Progressive scanning creates the picture by illuminating each line from top to bottom until all scanning lines in the frame are completed.

In video, what appears to be a continuously moving image is actually a series of discrete still pictures, called **frames.** On the typical direct-view television, each frame is created on the picture tube by an electron beam that moves from the left edge of the screen to the right, illuminating one **scanning line** at a time. The American EIA television system uses 525 total scanning lines per frame.

Due to bandwidth limitations from the early years of television, the NTSC system was designed to capture 30 frames per second. The natural way to display these images would be to show the scanning lines in sequence, an approach called **progressive scanning.** 525-line progressive scanning at 30 frames per second is abbreviated 525/30P or simply **525P.** Unfortunately, 525/30P creates flicker: the image visibly darkens between frames. In addition, capturing images at 525/30P yields unsatisfactory results in fast-paced action like live sports.

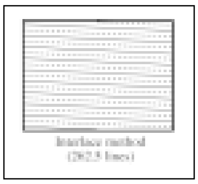

Fig. 2: Interlace scanning divides the frame into two "fields." The first field presents the odd-numbered scanning lines (1, 3, 5, etc.). The second field presents the even numbered lines.

For these reasons, the early television engineers developed a solution called **interlace scanning.** Instead of capturing and displaying all 525 lines in their numerical sequence, the NTSC system divides the image into two fields. The "A" field contains the odd-numbered scanning lines (1, 3, 5, etc.) and lasts 1/60 second. The "B" field contains the even numbered lines and lasts 1/60 second. This system can be abbreviated 525/60i or simply 525i (when discussing the line rate) or 60i (when discussing the picture rate). The 525i solution is a compromise that doubles the picture rate but halves the vertical resolution at any given instant. While it is a compromise, the 525i system is highly effective, an elegant engineering solution that has helped make television an essential part of entertainment.

In the early days of television, when 12-inch diagonal screens were commonly used in living rooms, halving the vertical resolution was not a practical concern. But in today's environment of 61-inch diagonal projection systems, the illusion of a continuous picture on the screen begins to fall apart, especially when you sit close to the screen. Individual scanning lines become visible and the compromise in vertical resolution becomes an annoyance. That's why many of today's finest big screen televisions have the ability to input and display 525P at 60 frames per second (525/60P). When carefully executed, 525/60P can achieve fluid, lifelike fast motion, along with breathtaking image detail. The 525/60P system is also superb for resolving fine print on the screen — one reason why 525/60P is the basis of the popular VGA computer display standard.

Film and Video Origination

Movie film is conventionally shot and displayed at 24 frames per second. In the camera, the entire frame of film is exposed at one time. In the theater, the entire frame is projected at one time. Unfortunately, projecting at the native film rate of 24 frames per second creates flicker. That's why movie projectors use a special shutter to display each frame twice, creating the effect of 48 frames per second.

Theatrical release movies aren't the only programs that are originally captured at 24 frames per second on motion picture film. The following is a snapshot of common industry practice:

Genre	Typical Origination
Theatrical release movies	24P film
Made for TV movies	24P film
Hour-long primetime dramas	24P film
Music videos	24P film
Network commercials	24P film
Sitcoms	Either
Documentaries	Either
Network news magazines	Either
Live concerts	60i video
Wildlife/natural history	60i video
Reality-based shows	60i video
Do-it-yourself series	60i video
Soap operas	60i video
News	60i video
Talk shows	60i video
Sports	60i video
Local Commercials	60i video

Of course, the choice of film or video ultimately depends on individual production budgets and artistic intent. And important variations occur. A growing number of theatrical releases are shot on video. And Sony's latest HDCAM® high definition video equipment can capture images at 24 frames per second progressive scan – 24P.

Film-to-Video Transfer and 3-2 Pulldown

We've seen that much of television broadcasting starts out as movie film at 24 frames per second. This means not only has it been converted from film to video, it's been converted from 24P to 60i. A machine called a telecine performs both conversions. Simple arithmetic says that 60÷24 = 2.5. This means that each film frame must convert to an average of 2.5 video fields. A process called 3-2 pulldown performs this conversion. The first film frame is converted to three video fields. The next film frame is converted to two video fields. The next film frame is converted to three video fields, and so on. We get a pattern of 3-2-3-2-3-2 etc, from which 3-2 pulldown gets its name. This pattern averages out to 2.5 video fields for every film frame. The telecine converts a film frame to three video fields by repeating the first field. For example, the first video field may consist of odd scanning lines, the second field consists of even scanning lines and the third field consists of the same odd scanning lines as the first.

Film and Video on DVD

In order to fit a feature-length film onto a CD-sized disc, the DVD format employs MPEG-2 digital compression. And one important trick of this compression is to make an important distinction between footage originally shot on video and footage originally shot on film. As you would expect, DVD stores video footage in its native 60i form. But you might be surprised to learn that most DVDs shot on film store the images at film's native rate of 24 frames per second!

Like material shot on video, the typical DVD shot on film is encoded from 60i videotape. But in the DVD authoring process, logic circuits in the majority of high-quality MPEG encoders detect the telltale pattern of 3-2-3-2 in the incoming video fields, the so-called **3-2 cadence.** Since repeated fields would waste precious disc space, the DVD eliminates them and replaces them with First **Field Repeat Flags (FFRFs)** to tell the player which fields to repeat. The remaining fields are reassembled back into their original frames and encoded onto the DVD in progressive scan at 525/24P. This system is 20% more space-efficient than 60i. It's an important advantage because it enables DVDs to hold films that are 20% longer. Or DVDs can encode each frame with a 20% more bits, for even better picture quality.

The 24P encoding of film-originated DVDs means that 3-2 pulldown must be performed in the DVD player before the picture can be displayed on a conventional television. The exact pattern of 3-2 pulldown can have a subtle effect on the rendering of motion. So it's important that the DVD reproduce the 3-2 pulldown cadence of the original master videotape. That's where the FFRFs come in. They identify each field to be repeated as part of a "3."

3-2 Reverse Conversion

The 525/24P encoding of film-originated material has a special property. In conventional 525/60i video, each "B" field represents a slice of time 1/60th second after the corresponding "A" field. To the extent that objects in the frame are moving, the two fields won't match and aren't well-suited for direct output in progressive scan.

In contrast, 525/24P film-originated DVD is inherently progressive and is perfectly suited to progressive scan display. Ironically, today's MPEG decoder chips automatically convert the 525/24P progressive DVD into 525/60i interlaced video. There's no way to "tap into" the chips and extract the progressive signal. Additional processing is required to convert the 525/60i interlaced signal into a 525/60P progressive signal for output to a compatible television. The required process is called **3-2 reverse conversion.** Because the process operates on a digital signal in the digital domain, it can result in a super high-quality video source that promises to be the ideal complement to high-end, big-screen televisions with 525P inputs.

Unfortunately, not every DVD player with 525P outputs fully delivers on the promise. Concerns such as flicker, motion artifacts and 3-2 cadence glitches can visibly degrade the viewing experience. As later sections will show, the Sony DVP-S9000ES represents a thorough engineering solution — one that realizes the full potential of progressive scanning.

Realizing the Potential of 525P

Progressive scan 525P outputs have been promoted as a must-have feature in high-end DVD players. But not all progressive-scan outputs are created equal. Sony, a leader in progressive scanning equipment for broadcasting and movie production, understands the limitations of conventional designs. And Sony engineers were determined to overcome those limitations. The result is Sony's exclusive Precision Cinema Detection — the key to even higher performance in 525P reproduction.

Sony's Fast and Pure Cinema Detection.
A thorough solution to the engineering challenges of 525P output, Sony's Fast and Pure Cinema Detection incorporates four significant advances:

1. High accuracy film detection with FFRF.
2. Dedicated microprocessor for motion detecting.
3. Separate 3-2 reverse conversion algorithms for video and film-originated DVDs.
4. Full 3-2 reverse conversion.

Together, these advances enable the Sony DVP-S9000ES to deliver more consistent, more satisfying, more seamless 525P output with a wider variety of discs. Flicker, motion artifacts and 3-2 cadence glitches are controlled. The visibility of scanning lines is minimized. Connect the DVP-S9000ES to a 525P-compatible television, monitor or projector and prepare to be amazed. You'll approach the full glory of high definition picture quality — from today's standard DVDs!

High Accuracy Film Detection with FFRF

Smooth 525P output depends on proper 3-2 reverse conversion. To accomplish this, the player must accurately reconstruct the 3-2 cadence of the original master videotape. The key to achieving this is the sequence of First Field Repeat Flags (FFRFs) on the DVD. Most DVDs contain a complete set of FFRFs. But inconsistencies in videotape editing, MPEG encoding and DVD authoring can result in irregularity in the FFRF signal. As reviewers have already noticed, this can cause even highly regarded players to stumble, producing visible motion artifacts.

Sony's DVP-S9000ES overcomes the problem. The player performs high-speed detection of missing flags, with flag look-ahead and non-contiguous point detection. The player then reconstructs missing flags, for smooth, uninterrupted playback of DVD movies.

Dedicated Microprocessor with Motion Detection

The FFRF signal is designed to be present in all film-originated DVDs — and absent from all video-originated DVDs. Yet even in the most extreme case, where a film-originated DVD contains no FFRFs at all, Sony's dedicated microprocessor with motion detection can elicit full performance. The microprocessor can judge the correlation between fields very accurately, supplementing the FFRF detection system. As a result, the Sony DVP-S9000ES can read and reproduce even this worst-case disc in beautiful, stable 525P.

Separate Algorithms for Video and Film Originated DVDs

"A" and "B" fields originated on film represent a single slice of time and have no motion between them. "A" and "B" fields originated on video represent different slices of time and can have significant motion. For this reason, film and video require substantially different algorithms in Interlace-to-Progressive conversion. Conversion of film-originated DVDs can use relatively simple de-interlacing. Conversion of video-originated DVDs requires a more complex motion-adaptive algorithm.

The correct application of the video algorithm requires the precise identification of motion between pairs of video fields. The DVP-S9000ES accomplishes this with the motion detection microprocessor. It uses the external graphics memory of the I-to-P conversion circuit to read pixel-level motion of each field at high speed. Then the microprocessor instantly selects the appropriate conversion algorithm for video, for film or for still scenes with no motion.

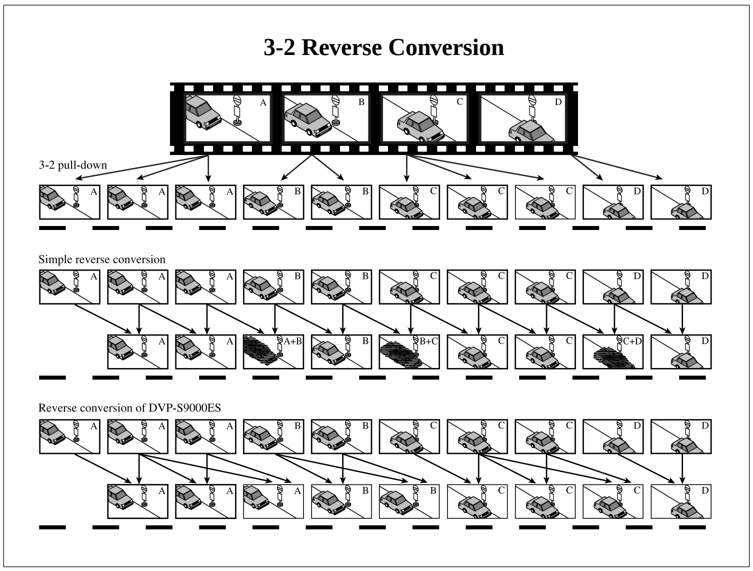

Fig. 3: At the top are the original film frames, showing a car moving down the street. Next comes the original 3-2 pulldown. Simple frame memory reverse conversion results in a motion blur every time fields from different film frames are combined. (This occurs for two out of every five frames — or 40% of the time!) Sony's DVP-S9000ES, bottom, uses full 3-2 reverse conversion, to preserve the integrity of the original film frames.

High-quality Progressive Output from Film

One potential way to cut corners in 525P output is to adopt relatively inexpensive **frame memory.** However, simple frame memory systems can expose the signal to motion blur on two out of every five frames. This becomes clear when we review the 3-2 pulldown process. In simple frame memory reverse conversion, the player combines the present field with the previous one — no matter what cinema frame it came from. If the previous field came from the same cinema frame, all is well and a good 525P picture results. But if the previous field came from the previous cinema frame — an event that occurs regularly on two out of every five frames — then images that were captured 1/30 second apart will be artificially combined on the television screen. The result will be a blur of any moving objects in the video picture. Such motion artifacts would be completely unacceptable in the design program of the DVP-S9000ES. That's why the player undergoes the full 3-2 reverse conversion process.

Achieving 525P: DVD Player vs. Television

Many televisions capable of 525P have internal line doubling or scaling circuitry capable of converting conventional 525i inputs into 525P display. Sony's own such circuits include the Digital Reality Creation™ (DRC™) and DRC Multi-Function (DRC-MF) systems. With seemingly similar capabilities in both the DVD player and the television, it's only natural to ask which is preferable. In most cases the 525P output of the DVD player will provide superior results. There are two reasons.

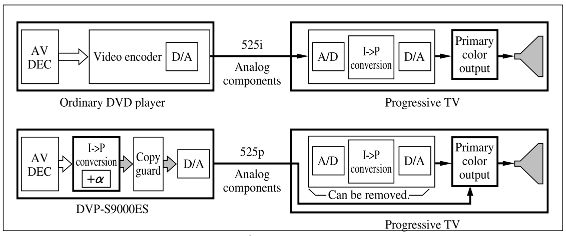

Fig. 4: Allowing the television to transform the signal to 525P (top) exposes the signal to the losses entailed in additional D/A and A/D conversions. Performing the conversion in the DVP-S9000ES (bottom) simplifies the signal path for an image with lower noise and lower distortion.

First, only the DVD player can perform the transformation on the DVD's digital signal in the digital domain. The alternative is to convert the signal to analog, transfer this analog signal to the television, reconvert the signal back to digital and perform 525P conversion. This exposes the signal to the losses and distortions of an additional analog-to-digital and digital-to-analog conversion. So the DVD player has a natural advantage.

Second, when designed properly, DVD player will observe the correct 3-2 inverse conversion, respecting the integrity of the original film frames. The overwhelming majority of outboard devices are not sophisticated enough to detect and maintain this integrity. Here again, a well-designed DVD player surpasses most outboard devices.

High Performance MPEG Image Processor

Sony's progressive scanning outputs represent a new benchmark in home video performance. But Sony's design goals for the DVP-S9000ES required even more. Sony built a new MPEG Image Processor to undertake three crucial functions:

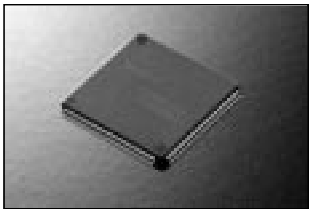
Photo 1: Sony's MPEG Image Processor LSI performs three important functions to optimize image quality.

1. Motion Adaptive Field Noise Reduction.
2. Block Noise Reduction.
3. Clear Frame Still Image Performance.

Motion Adaptive Field Noise Reproduction

Data compressed formats such as DVD are susceptible to noise. In the video signal, noise appears as tiny flecks or specks of unwanted color. Typically, the circuits that reduce noise also suppress fine picture detail. Viewers are asked to sacrifice the ultimate in resolution for the ultimate in low noise picture clarity.

Many designs attempt to overcome this limitation by comparing the pictures from several video fields at once. Pixels that correlate from one field to the next are considered accurate. Pixels that vary are considered noisy. This method performs beautifully as long as the images are still. But because different fields can capture the image at different times, the noise reduction system can easily misinterpret movement as noise. When this happens, the noise reduction circuit can create ghost images, unwanted motion artifacts that may be more annoying than the original noise. In the past, Sony has overcome this by exempting areas of screen movement from noise reduction. Of course, this allows some video noise to reach the television — another compromise.

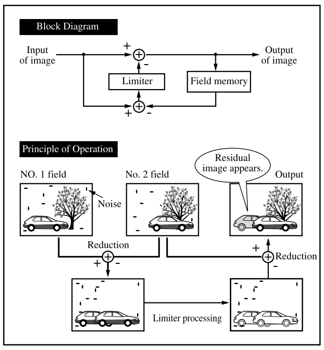

Fig. 5: Conventional digital noise reduction assumes that any difference between two fields is video noise. This effectively reduces the background noise, but can create new problems. In this example, the movement of the car is interpreted as noise, resulting in an unwanted ghost image — a motion artifact behind the car.

Sony's Motion Adaptive Field Noise Reduction uses new technology to overcome the old compromises. Thanks to the new circuit, the DVP-S9000ES can achieve very high signal-to-noise ratio, very high resolution and very accurate motion — all at the same time!

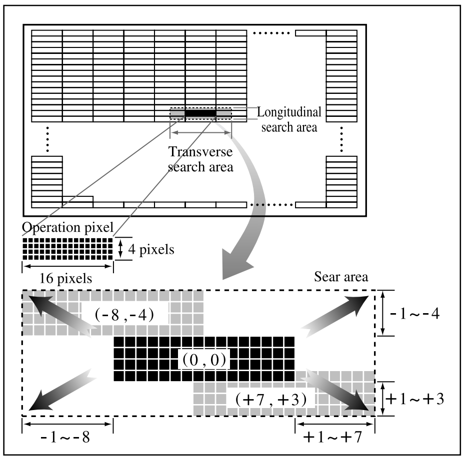

Fig. 6: Sony analyzes the video fields for movement by dividing the fields into blocks that are 4 pixels high by 16 pixels wide. When big changes are detected between two fields, Sony's MPEG Image Processor determines that there is screen movement. The system attempts to match the block across a search window that extends four pixels up, three pixels down, eight pixels to the left and seven to the right.

To overcome motion artifacts, the Sony design actively analyzes the fields for movement. The system divides the image into blocks of 4 pixels high by 16 pixels wide. This specific rectangular shape is based on the understanding that most movement in video images is horizontal. In blocks where no large changes are detected between fields, the system applies conventional noise reduction.

When large changes are detected between fields, the system automatically searches for block movement. The search "window" is 11 pixels high by 31 pixels wide.

By finding matches for blocks that have moved, Sony's Motion Adaptive Field Noise Reduction makes it possible to apply noise to areas of screen movement, in addition to the still background. The system compares data from the two fields by a mathematical method called the **Hadamard transform.** Noise, in the form of

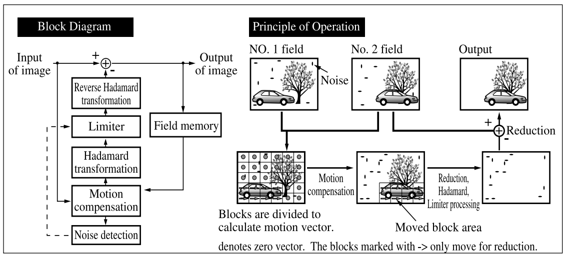

Fig. 7: Sony's Motion Adaptive Field noise reduction identifies and suppresses noise across the entire screen area — in moving parts of the picture as well as the motionless background. The process uses advanced motion detection and a Hadamard transform to suppress noise without sacrificing detail or generating motion artifacts.

differential luminance (Y) signals, is analyzed in blocks one pixel high by 8 pixels wide. The Hadamard transform converts the noise into an easily processed frequency distribution. To reduce errors, eight operations are performed for each pixel. The average of the eight values is then used. A limiter is then used to extract noise from the converted signals. Than a reverse Hadamard transform generates an error-correction signal that is added to the video signal to suppress noise.

In addition, Sony's Motion Adaptive Field Noise Reduction performs the same process for noise in the color difference channels, C_B and C_R. Since luminance and color difference signals are separately processed, their noise reduction can be individually optimized.
The mathematics of this noise reduction process may be complex, but the results are easy to appreciate. The circuit accomplishes three formerly elusive goals simultaneously:

1. Clean noise-free images on both moving portions and still portions of the screen.
2. The full resolution of the DVD.
3. Clear and natural image movement, without ghosting or other motion artifacts.

Block Noise Reduction

Another characteristic limitation of MPEG-2 compression is **block noise.** This is the tendency for delicately shaded picture areas to be rendered as solid rectangles of color. Instead of a continuous contour of color on the cheek of an actress, fading softly into shadow, you see subtle squares of approximately correct color. Block noise is most apparent at the edges where squares meet. This effect is also called **mosquito wings**, because it can appear as subtle discoloration in tiny slices of the picture and just as quickly disappear.

Sony's MPEG Image Processor mounts a sophisticated, comprehensive attack on block noise. The aim of Sony's system is to identify those areas of subtle gradation of tone — the areas most prone to block noise — analyze the gradations and reconstruct the abrupt steps of tone as more linear, more gradual slopes.

The principal challenge here is to distinguish legitimate steps in the picture tone (signal) from the unwanted, artificial steps (block noise). This separation of wanted and unwanted steps is made easier because the block borders area always at the same places on the screen. Their location is a fixed attribute of the MPEG-2 compression used in the DVD format.

The DVD format divides the screen into 2,700 blocks (90 horizontal by 30 vertical). Each block measures 8 pixels horizontal by 8 pixels vertical. They're shown as vertical rectangles because of interlace scanning. To judge for block noise, the MPEG Image Processor establishes the three pixels to the left and right of the border as the **Vertical Correlation Coefficient Area.** A larger area, extending five pixels to the left and right of the border is the **Activity Calculation Area.**

Small, random-seeming changes at the border are determined to be legitimate variations in the signal. These are not changed. Moderate changes arranged in a line along block borders are determined to be block noise and are corrected. However, when the image hardly changes within five pixels of the border and undergoes a big change right at the border, this is considered to be a legitimate edge in the picture, and it passes uncorrected.

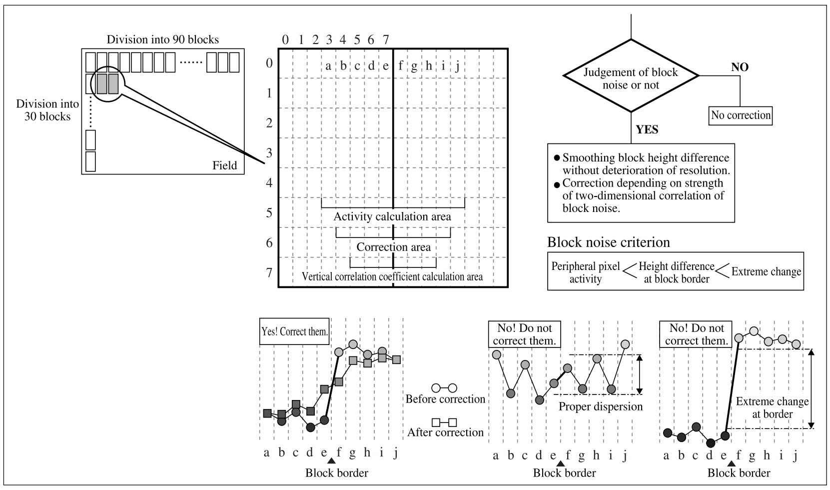

Fig. 8: Detection and correction of block noise. On the left is the DVD block structure. In the center, a pair of blocks, showing the Activity Calculation Area. Across the bottom are sample readings. The first is a step characteristic of block noise, which gets corrected to a gradual slope. In the center are random variations, which are passed uncorrected. On the right is a large step characteristic of a legitimate picture edge. This also passes uncorrected.

After detecting block noise, Sony's MPEG Image Processor must determine the appropriate corrective action. The correction area extends four pixels on either side of the border. Correction consists of smoothing the step of block noise into a more natural, gradual slope.

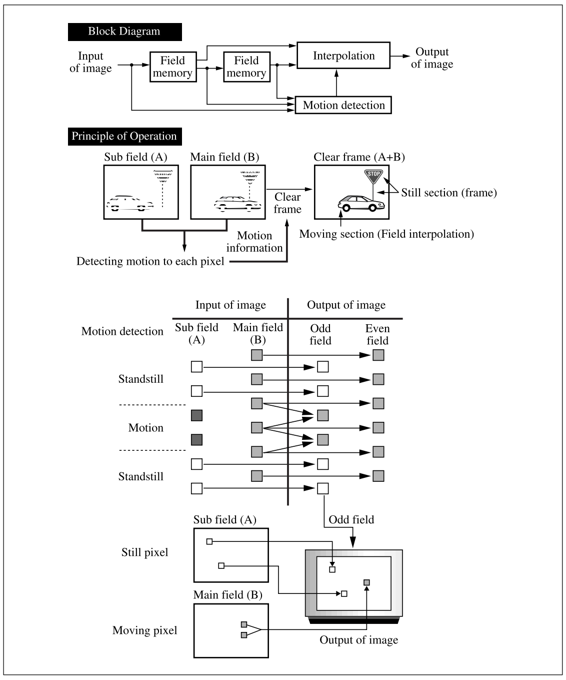

Fig. 9: Thanks to motion detection, the Block Noise Reduction circuit "knows" when a car is approaching the edge of a block and does not try to correct the picture edge.

For even greater sophistication, the Block Noise Reduction system takes advantage of the same motion detection engine as described above for Field Noise Reduction. In essence, the motion detector tells the Block Noise Reduction circuit, "a car is approaching the block edge." When the car arrives, the Block Noise Reduction system already knows that it's a legitimate picture edge and will pass it through without correction.
While we have described Block Noise Reduction for the vertical block edges, the system works equally well for horizontal block edges. The result is a comprehensive solution to even subtle picture errors caused by block noise. Images are clearer and more natural. The subtle gradations captured by today's best cinematographers are rendered with a greater precision and care. The soft shadows that define a cheekbone, a fold of cloth or a footprint in the sand come through with effortless clarity.

You can match the operation of Block Noise Reduction to the condition of each DVD. An on-screen menu offers eight settings, ranging from 0 (off) to 7 (maximum).

Clear Frame Still Image Performance

The third and final function of Sony's MPEG Image Processor is Clear Frame. As many disappointed VHS users already know, when you hit the Pause button on a VCR, you see only the information for a single field. Much of the vertical resolution is lost. DVD players can perform far better in still mode, because DVD can present both fields together to represent the entire video frame.

However, as we discovered in the discussion of 525P outputs, the parameters of film-originated DVDs are quite different from those of video-originated DVDs.

- **Film-originated DVDs** do best with frame pause, because both video fields represent the same slice of time. The two fields blend together perfectly for a full-resolution still image.

- **Video-originated DVDs** capture two fields that represent different slices of time, 1/60 second apart. To accommodate this, DVD players have offered a choice between frame pause or field pause. Frame pause maximizes vertical resolution, but blurs whatever motion may be present in the image. Field pause gets rid of motion blur, but sacrifices vertical resolution, just like a VCR.

Now with the Clear Frame system of Sony's DVP-S9000ES, you no longer need to choose. Because the MPEG Image Processor already has comprehensive motion detection circuitry, the player already "knows" which portions of a video-originated scene have motion. So the player applies high-resolution frame pause for all

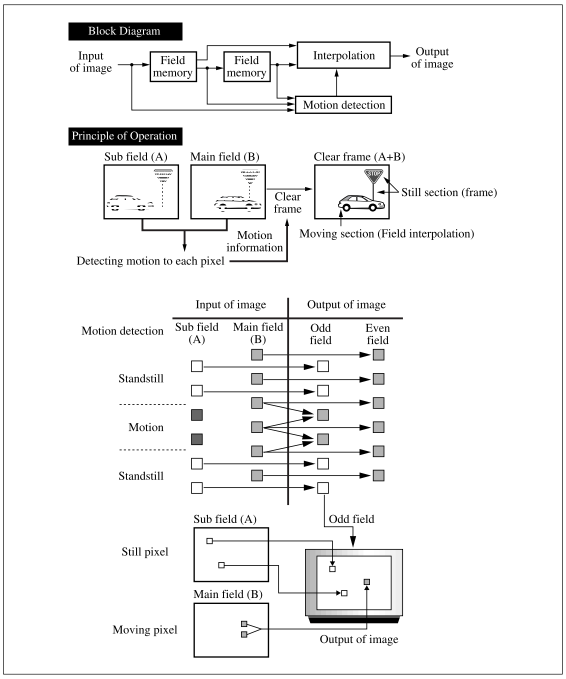

Fig. 10: Sony's Clear Frame system delivers superior still images of video-originated DVDs. Moving areas, like the car are reproduced in motion-stopping field pause. But motionless areas, like the stop sign are reproduced in the full resolution of frame pause. So you see far higher pause mode resolution!

the motionless areas of your picture, while it applies motion-stopping field pause to areas of movement. Clear Frame is simple, automatic and easy to appreciate. It's a major improvement in freeze frame technology.

High Precision Video Equalizer

The video equalizer of the DVP-S9000ES enables users to fine-tune performance to match their monitors and viewing conditions. The equalizer is controlled via on-screen display and offers unusually fine adjustment:

Picture	+/- 20 steps
Brightness	+/- 20 steps
Color Balance	+/- 20 steps
Hue	+/- 20 steps
Horizontal Sharpness	+/- 20 steps
Vertical Sharpness	+/- 20 steps
Block Noise Reduction	stages 0 to 7
Luminance (Y) Noise Reduction	stages 0 to 7
Chrominance (C_B, C_R) Noise Reduction	stages 0 to 7
Chroma Delay	2 stages

"Below Black" Reproduction with Graphical Gamma Adjustment

The DVD format dictates specific quantization for specific brightness levels. For example, full black corresponds to a quantization of 16 while full white corresponds to 235. However, demand has grown for adjustment that matches the DVD player output to the characteristics of your display. Direct-view CRTs, plasma panels, CRT projectors and LCD projectors each have specific needs. For example, LCD projectors are subject to "black float" and can benefit from a calibration "below black." CRT direct view televisions tend to loose dark detail when viewed in brightly-lit rooms.

Historically, gamma adjustment has matched the grayscale of a video camera to the general transfer characteristics of CRTs. Sony's Graphical Gamma Adjustment matches the grayscale performance of the player to the specific transfer characteristics of your display. Used with a commercially available calibration disc, the Graphical Gamma Adjustment can achieve ideal reproduction.

The system enables you to make adjustments to gamma much like a graphic equalizer adjusts audio frequency response. As with an audio equalizer, aggressive adjustment can yield unnatural results. The controls are best used to make gamma curves that are smooth and subtle. Sony's control offers eight points of correction, each with 8-bit precision. And you can always return the gamma controls to the industry-standard "flat" state by selecting "RESET" on the on-screen display.

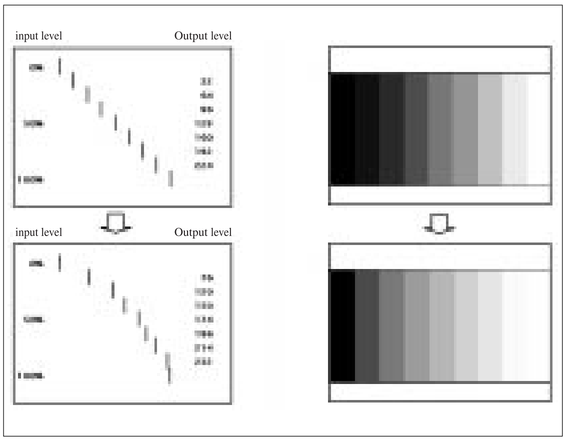

Fig. 11: Graphical Gamma adjustment is like an eight-band graphic equalizer for grayscale and black level.

Custom Memory / Playback Memory

Many of the video equalizer adjustments exist to tailor performance for individual DVDs. That's why the DVP-S9000ES can store your favorite settings for instant recall. Custom Memory lets you store five standard settings for different movie studios, different DVD genres or different types of display. Playback Memory stores your fine-tuned adjustments for up to 300 discs. Each time you insert one of the 300 discs, the player will automatically recall your specific hand-tailored adjustments.

Video Clock and Video Data TBC

The master clock resides in the Audio section. But instead of passively receiving the external clock signal, the video circuit regenerates its own 27 MHz reference clock with its own quartz crystal. This reference is distributed to every digital video circuit. So timing errors and their consequent distortions are kept to a bare minimum. Images achieve maximum stability and minimum jitter.

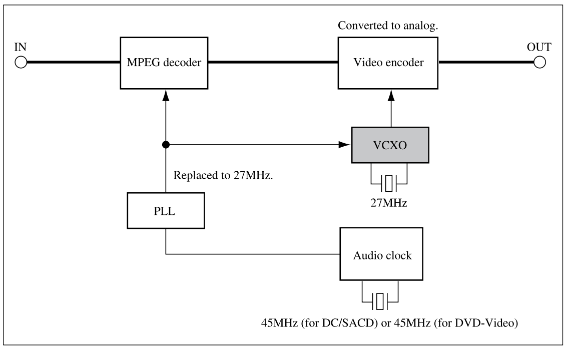

Fig.12: A dedicated 27 MHz quartz crystal oscillator regenerates a super-clean video-only reference clock.

54 MHz Video D/A Converter

One natural consequence of supplying both progressive and interlaced video outputs is the need to provide both progressive and interlaced video D/A converters. DVP-S9000ES is equipped with both video D/A coverters, one for interlace output and the other for progressive output. The DVP-S9000ES progressive D/A converter was developed in cooperation with Analog Devices Corp., the same company that built the 32-bit SHARC processor in Sony's TA-E9000ES A/V digital preamplifier.

This is a Large Scale Integrated circuit (LSI) of remarkable processing power. Sony's previous designs converted the DVD's 8-bit video samples with 10 bits of precision. This current LSI raises the standard of performance with 12-bit conversion for the luminance (Y) signal and 11-bit conversion for each of the color difference signals (C_B and C_R). Higher word lengths enable four times the fine gradations in the luminance channel, and twice as many gradations in each of the color channels. So you get a more accurate rendition of colors and gray scale from the deepest black to the brightest highlights.

In addition, the converter employs video oversampling similar to the oversampling near universal in audio CD players. To capture 13.5 MHz signals, the luminance channel uses a 27 MHz sampling frequency. The D/A conversion uses 2x oversampling system to bring this to 54 MHz. In a similar process, each chrominance channel gets 4x oversampling. The C_B and C_R sampling frequency of 13.5 MHz is quadrupled to 54 MHz. As in CD players, this method makes quantization noise easier to filter out, with more linear amplitude frequency response within the passband and superb suppression of noise outside the passband. As incorporated in the Analog Devices Super Sub Alias Filter™ design, this achieves better signal-to-noise ratio and superb frequency response, taking DVD 4:2:2 D/A converters into the realm of 8:8:8 performance.

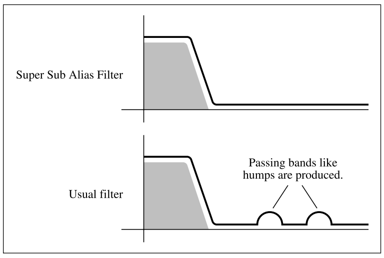

Fig. 13: The Super Sub Sampling Alias Filter (top) controls the noise of alias signals (bumps on bottom).

Optimized Video Filters

Separate video filters for progressive and interlaced outputs help achieve wide bandwidth, high resolution and minimum out-of-band noise.

High-Speed Video Buffers

The interlaced output must pass 6.75 MHz, while the progressive output must achieve twice that frequency — 13.5 MHz. Since bandwidth equates to resolution, the DVP-S9000ES is equipped with high-speed video buffer amplifiers that are more than equal to the task. These circuits can pass 325 MHz without loss. As such, the buffer amps are prepared to drive capacitive cable runs, while minimizing such distortions.

Output Capacitor-Less (OCL) Coupling

In typical audio and video design, an output capacitor prevents the accidental passing of DC offset voltage from one component to the next. However, the mere presence of the output capacitor can affect the audio frequency response and literally tinge the television picture with unwanted shading. And these effects are beyond the adjustment of your television's video adjustments. Sony's answer is a rigorous design that controls DC offset voltages from the start. You get reliable operation without performance-robbing output capacitors.

Carefully Selected Parts

More than a labor of technology, the DVP-S9000ES represents the enthusiasm that Sony engineers share with high-end videophiles. That's why the player incorporates a variety of carefully selected resistors, inductors, semiconductors and capacitors. Each plays a specific role in maximizing video performance.

- **Low Distortion Film Capacitors.** While electrolytic capacitors are suitable to power supply filtering, film capacitors are especially proficient for sound and picture. Many of these low-distortion capacitors contribute to the Many of these low-distortion capacitors contribute to the outstanding performance of the DVP-S9000ES.

- **Oversized output resistors.** Output resistors determine the impedance of the analog output circuits. Most designers avoid large resistors. But Sony incorporates large resistors of uncommonly tight tolerances. This contributes to the high slew rates required for wideband audio and video.

- **Output Signal Relay.** To simplify connections to your television, the DVP-S9000ES uses a common set of component video terminals for both progressive and interlaced output. Naturally, this requires output switching. While common designs use semiconductor switches, Sony employs a high-quality mechanical relay. It's a more expensive design that delivers more positive connections, lower resistance and lower noise across the switch. Progressive and interlaced output can be selected via on-screen menus or via back panel switch.

Wide Pitch Component Output

Sony engineers even anticipated the videophile-grade output cables likely to be used with the DVP-S9000ES. For this reason, the engineers deliberately spaced the $Y/C_B/C_R$ output jacks further apart than common practice, the better to accommodate extra-fat cables and plugs!

Photo 2: Widely spaced $Y/C_B/C_R$ output jacks accommodate even extra-fat videophile connectors.

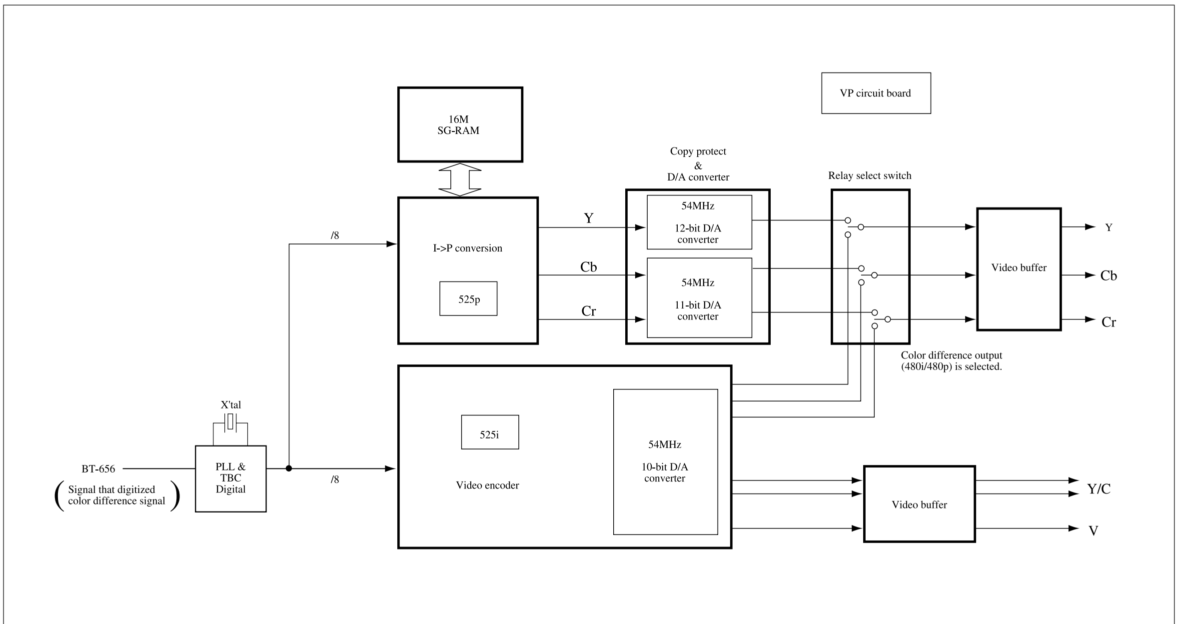

Fig. 14: Overview of the video processing circuit board.

A Listening Experience Beyond All Expectations

The DVP-S9000ES is more than just a cutting edge Sony DVD-Video player. It's a Sony high fidelity component of the first order. This is the very first DVD player to be part of Sony's acclaimed ES Series, the Elevated Standard in audio/video. It incorporates circuits, topology and features carefully designed to maximize DVD-Video sound tracks, Compact Discs and Super Audio Compact Discs.

Super Audio Compact Disc:

Because there's So Much More to Hear ™

The Compact Disc was an important accomplishment in music reproduction. But over the years, discerning listeners have demanded even more. That's why Sony and Philips, the inventors of CD, have created the new Super Audio Compact Disc (SACD). Thanks to a revolutionary technology called Direct Stream Digital(tm) (DSD(r)) encoding, this is the highest quality stereo sound source available today.

- **Fidelity.** With DSD encoding, SACD can capture more of the original sound source. The SACD format offers frequency response to 100 kHz and a theoretical dynamic range of 120 dB. But specifications alone cannot express the DSD advantage. DSD one-bit encoding strips away entire classes of distortion that have always characterized PCM. The DSD system provides nothing less than a quantum leap in music resolution.

- **Simplicity.** To audiophiles, purity has always meant simplicity. So with SACD, there's no option for music to be recorded at anything less than the highest possible resolution. There's also no option for lossy compression of any kind. And you'll never experience stereo derived from a computerized fold-down. SACD is about music, pure and simple.

- **Capacity.** As a stereo music carrier, the Super Audio Compact Disc can hold over six times the data of Compact Disc. Some SACDs have enough room for both a two-channel mix and a multi-channel version of the same music, not to mention text and graphics.

	CD	**SACD (single layer)**
Disc diameter	12 cm	12 cm
Disc thickness	1.2 mm	1.2 mm
Playback side	Single	Single
Coding System	16-bit linear PCM encoding	1-bit DSD encoding
Sampling Frequency	44,100 Hz	2,822,400 Hz
Disc data capacity	680 MB	4.7 GB
Disc minimum pit length	0.83 micrometers	0.40 micrometers
Disc track pitch	1.60 micrometers	0.74 micrometers
Laser wavelength	780nm	650nm
Lens numerical aperture (NA)	0.45	0.60
Playback frequency range (theoretical)	DC — 20,000 Hz	DC — >100,000 Hz
Dynamic range (theoretical)	96 dB (audible range)	More than 120 dB (audible range)
Maximum playback time	Approx. 74 min. (stereo)	Approx. 110 min. (stereo) Approx. 74 min. (multi-channel and stereo)
Additional functions	Text, graphics	Text, graphics, video

- **Security.** Pirated copies of discs threaten music companies, producers and musicians alike. In addition, consumers need protection from fraudulent, unauthorized copies. That's why authorized SACDs are identified by both visible and invisible watermarks. The visible watermark is a faint image on the signal side of the disc, made possible by Pit Signal Processing (PSP) technology. Missing or corrupted watermarks warn consumers of unauthorized discs. Invisible watermarks authenticate the discs prior to playback. If the SACD player cannot read the watermark, the SACD will not play.

- **Compatibility.** Music enthusiasts have already made a substantial commitment to their CD collections. To protect this investment, every SACD player performs superbly with the more than 13 billion audio Compact Discs currently in existence. And the SACD format also includes a hybrid disc option that will play back beautifully in any home, car and portable CD player made since 1982.

- **Three types of discs**. With the SACD format, music companies can offer three different types of discs. The single-layer disc can store a full album of high-resolution music. A dual-layer disc provides nearly twice the playing time. There's even a hybrid disc that contains both a high density music layer and a standard density CD layer for compatibility with over 700 million CD players, worldwide.

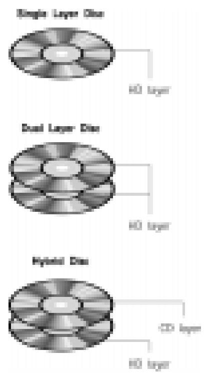

Fig. 16: 3 Types of Disc

- **The Music.** SACD has triggered an outpouring of music, both reissued and new, from the world's preeminent artists. Jazz greats like Dave Brubeck, Miles Davis, Herbie Hancock, Milt Jackson, Wynton Marsalis and Oscar Peterson. Classical virtuosos like Emanuel Ax, Glenn Gould, Yo-Yo Ma and Isaac Stern. With the world's finest orchestras under the batons of Leonard Bernstein, Eugene Ormandy, Wolfgang Sawallisch and Bruno Walter. These performances were singular events. Now captured on SACD, these titles gloriously demonstrate music the way it should be.

Direct Stream Digital™ Encoding:

A Foundation for the Future

For nearly 30 years, digital audio has been based upon Pulse Code Modulation (PCM) technology — and nobody knows PCM better than Sony. We've used it to develop everything from Compact Disc and DAT to professional DASH recorders and digital mixing consoles. But to achieve a truly fundamental breakthrough in music reproduction, Sony has invented a truly amazing audio technology: Direct Stream Digital (DSD) encoding. DSD encoding is destined to serve as the foundation for digital audio in the future.

Simplifying the Signal Path

Even the most advanced PCM record/playback systems require decimation and interpolation filters that can cause problems, including requantization noise, passband ripple and ringing. These degradations can smear musical overtones, muddy the soundstage and compromise overall transparency. A radically simpler approach, Direct Stream Digital processing eliminates these problems by eliminating the filters! It enables a 1-bit signal to be recorded directly.

Beyond Comparison

Direct Stream Digital processing is dramatically different, even when compared to the most sophisticated PCM technology. This 1-bit system encodes music at an astonishing 2,822,400 samples per second. The result is more than just superb frequency response and dynamic range. You'll hear the inner detail of choral ensembles. The reverberation trailing from a guitar chord. And the acoustic space surrounding the instruments. With DSD technology, you hear every nuance of sound reproduced with incredible ease and clarity.

The Digital Equivalent of Straight Wire with Gain

The DSD analog-to-digital converter produces a one-bit pulse train that appears remarkably analog. In this manner, DSD encoding combines the advantages of digital recording with the well-regarded characteristics of analog sound. For recording artists, producers and engineers, DSD technology is a

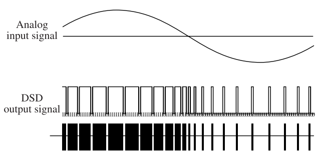

Fig.16: The Direct Stream Digital pulse train "looks" remarkably like the analog waveform it represents. More pulses point up as the wave goes positive and down as the wave goes negative.

Overview of DSD Circuitry

priceless new tool. For audiophiles, it's a major step closer to pure music.

Not surprisingly the DVP-S9000ES audio section makes extensive use of technologies originally developed for the world's first SACD player, the Sony SCD-1. Here are the highlights.

1. **RF Processor.** For all types of disc, including DVD, this circuit performs clock signal extraction, synchronization, demodulation and error correction.
2. **DSD Decoder.** For SACD only. Authenticates the SACD invisible watermark, separates text from music and forms the left and right DSD pulse trains.
3. **ACP System.** For SACD only. Controls the influence of switching distortion.
4. **VC24 Plus Digital Filter.** For CD only. A supremely advanced version of the familiar 8x oversampling digital filter.
5. **Current Pulse D/A Converter.** For SACD and CD. Supremely accurate conversion from 1-bit digital to analog.
6. **Low Pass Filter.** The SACD analog low pass filter helps deliver frequency response to 100,000 Hz, unprecedented in a home audio source component.

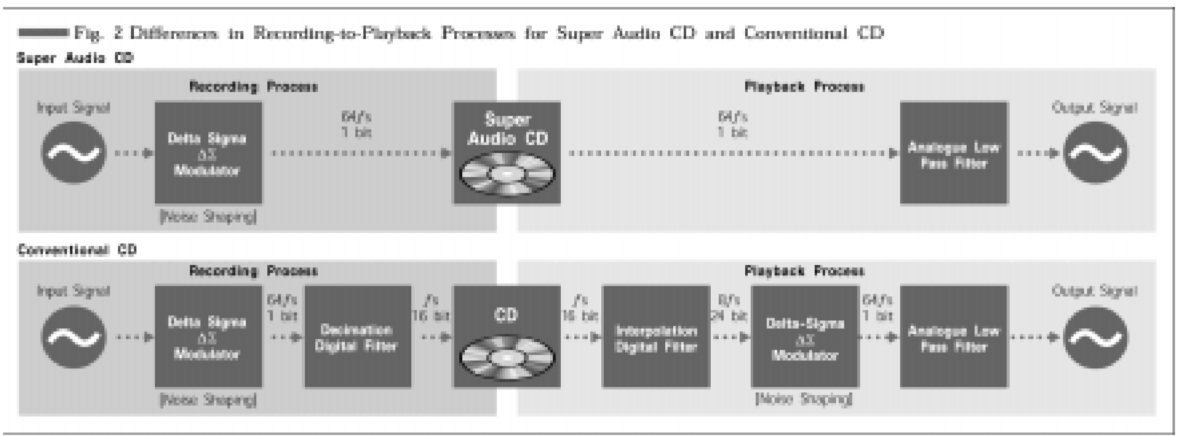

Fig. 15: In high-end audio, simplest is best. And compared to conventional PCM, the new DSD system is far simpler.

fs: 44.1kHz

DSD Decorder

Organizing the data into left and right pulse streams is the job of the DSD decoder. A Sony-built LSI, the DSD decoder first reads the invisible watermark — a key anti-piracy feature — and then decodes the incoming data. Data on the disc originate as alternating bursts of left-channel and right-channel information. Buffer memory and master clock sync enable the bursts to be output as two continuous, simultaneous streams. The DSD decoder also reads sub code data, including text and Table of Contents information such as track number and playing time.

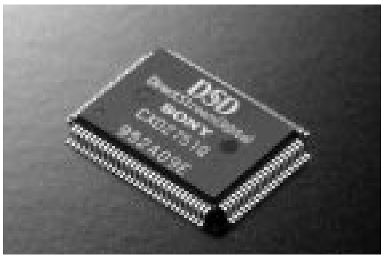

Photo 3: The heart to SACD reproduction, Sony's DSD decoding LSI.

To preserve the maximum accuracy of the DSD pulses, our design program identified two basic goals:

- Amplitude axis precision
- Time axis precision

Sony's Accurate Complementary Pulse Density Modulation (ACP) system and Current Pulse D/A Converter meet the first goal. Sony's new pulse generator in VC24 achieve the second goal.

ACP System

The Megahertz switching speeds of DSD decoding have an unfortunate byproduct, switching glitches, rough irregularities in the DSD pulse train. Sony's Accurate Complementary Pulse Density Modulation (ACP) overcomes this by converting the DSD pulses. Instead of encoding 1 as a pulse and 0 as the absence of a pulse, ACP represents each digital 1 as wide 1 followed by a narrow 0. And ACP represents each digital 0 as a narrow 1 followed by a wide 0. In this way, ACP effectively converts the data from pulse height (sensitive to glitches) to pulse width (insensitive to glitches). So glitches are not passed along to subsequent circuitry.

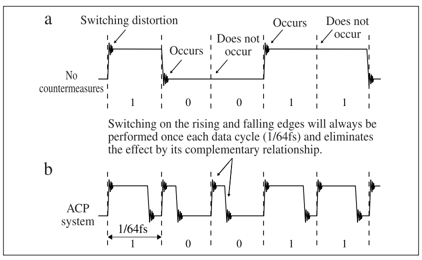

Fig.17: Thanks to Pulse Density Modulation, the ACP system disregards amplitude distortions and switching glitches.

96 kHz / 24-bit capable Current Pulse D/A Converter (for all discs)

Conventional D/A converters generate pulse height from the voltage power supply — a method that can expose the signal to subtle power supply voltage fluctuations. The Current Pulse Converter overcomes this limitation. The design changes the incoming train of voltage pulses to a train of current pulses. Because the circuit incorporates an extremely clean "constant current" source, the pulses emerge with the desired flat tops, flat bottoms and identical height. You get audio output of extraordinarily low distortion. The Current Pulse D/A converter operates for SACD, CD and DVD-Video sound tracks alike. The system supports the highest sound quality in DVD-Video: 96 kHz/24-bit recording.

VC 24 Plus Digital Filter (for DVD-Video and CD)

A conventional digital filter has a fixed filtering coefficient with no user controls. Sony's Variable Coefficient digital filter is a dramatic departure. The VC digital filter actually offers different settings, representing different filter coefficients, different filtering methods and different objectives in reproduced sound.

Separate Low-Pass Filters (for all discs)

After current-to-voltage conversion, a simple low-pass filter is all that's required to produce an analog output. Unlike CD, the SACD cutoff frequency is largely determined by the characteristics of the player's low-pass filter. The DVP-S9000ES low-pass filter has aresponse curve that slowly falls in the vicinity of 50 kHz, enabling usable response out to 100 kHz, some five times higher than previous home audio sources.

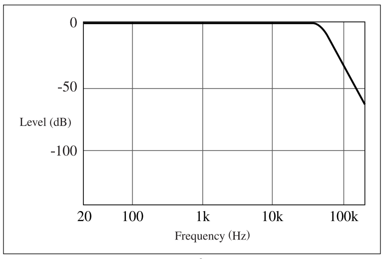

Fig. 18: The Low Pass Filter of the DVP-S9000ES enables usable frequency response to 100 kHz, some five times higher than previous home audio sources.

Two Audio Master Clocks (for all discs)

As an audio/video player, the DVP-S9000ES needs to generate master clock frequencies for audio and video simultaneously. Typical practice deploys a Phase Locked Loop (PLL) circuit to subdivide the video master clock for audio use. However, this exposes the audio signal to unwanted jitter, which can generate audible distortion. That's why the DVP-S9000ES subdivides audio master clock for video use. The SACD and CD master clock runs at 44.1 kHz x 1024 = 45 MHz. The DVD-Video sound track master clock runs at 48 kHz x 1024 = 49 MHz. And the DVD-Video clock for pictures downconverts this via PLL to

27 MHz. For a further reduction in noise, the power supply to any unused clocks is automatically turned off.

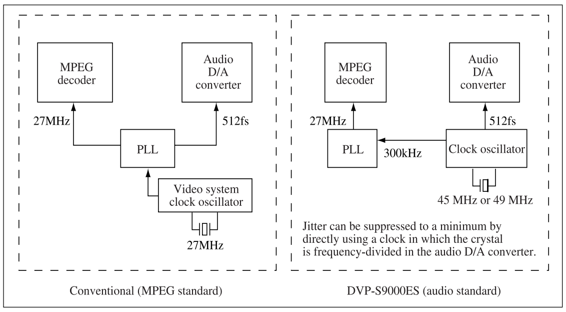

Fig. 19: Contrary to common practice, the DVP-S9000ES subdivides the audio master clock for video, not the other way around.

Audio Direct Output (for all discs)

One potential concern with so many types of circuitry in one chassis is mutual interference. Sony minimizes the possibility of radiated interference with Audio Direct output, a front panel switch that automatically shuts off all Video and Digital outputs. The switch enables the DVP-S9000ES to operate audio-only whenever you desire. Three other power configurations are also offered:

- **Video Off.** Shuts down the video and power circuitry to eliminate its effect on the audio circuitry.
- **Digital Off.** Shuts down the signal.
- **Display Off.** Cuts off power to the fluorescent display panel, for a further reduction in noise.

Jitter-Free 96 kHz / 24-bit Digital Output

The DVP-S9000ES is capable of sending out DVD-Video sound tracks at full 96 kHz/24-bit resolution on discs without copy protection. (Discs with copy protection are limited to 48 kHz/16-bit digital outputs.) To support full 96 kHz/24-bit digital output, the optical output module operates all the way up to 13.2 Mbps. So you can connect with maximum fidelity.

As an added safeguard to signal integrity, the digital output signal is re-synchronized immediately before the coaxial and optical digital outputs. The signal is realigned to the highly accurate master clock at 49 MHz (for DVD-Audio) and 45 MHz (for CD and SACD). This reduces the possibility of distortion-inducing jitter at the digital outputs.

Separate Audio Circuit Board (for all discs)

As a further defense against radiated noise, the audio circuitry is isolated on its own circuit board, shielded by 1.6 mm sheet metal and fed by its own, dedicated power supply secondary, located on the circuit board itself. The board is laid out in classic dual monaural configuration, for enhanced stereo separation and sonic purity. A straight path carries the signal directly from the D/A converter input to the output terminals on the back panel. As an added precaution, extra-thick low-impedance jumper cables eliminate patterning between the main ground of the audio board and the main ground of the digital block.

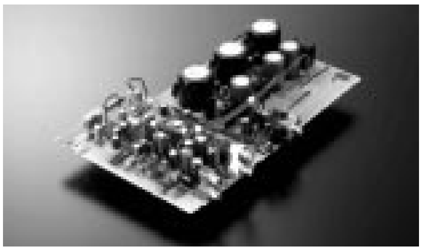

Photo 4: The front and back of the audio circuit board reveal

Twin R-Core Power Transformers (for all discs)

Power transformer cores and windings can vibrate and degrade the sound, radiating 60 Hz hum into nearby audio circuits. That's why Sony shields the audio circuit board. And that's why Sony chose twin R-Core power transformers. The R stands for round. Not only is the core round, it has a cylindrical cross section, enabling the transformer windings to be wrapped without the voids or gaps that permit vibration. This results in far less radiation, far less hum. The core itself is formed from long narrow magnetic steel plates, rolled into shape without gaps that might also generate hum. To further protect the audio stage from interference, one transformer handles video, system control and servo systems while the other specializes in audio alone.

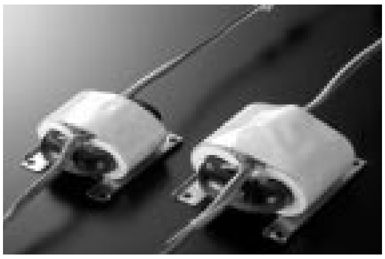

Photo 5: Sony minimizes power transformer hum and noise by incorporating two carefully made R-core power transformers.

Power Supply Configuration (for all discs)

While switching power supplies are common in DVD players, Sony demanded more. We use more traditional series power supplies with the twin transformers followed by rectifiers. Separate power supply secondaries are employed for each stage. And the secondaries are located on the circuit boards they serve: audio, video, system, motor drive and display. In addition, separate regulation is used in the D/A converter, VC 24 Plus, master clock oscillator and digital output buffer blocks. This minimizes even slight opportunities for mutual interference through the power supply.

Audiophile Parts

The same insistence on high-performance parts that marks the video section of the DVP-S9000ES can be found throughout the audio section, as befits a fully qualified member of Sony's ES Series. The parts are selected after undergoing exhaustive testing. For example, the audio circuit board is a glass epoxy design that steadfastly resists deformation. The copper foil traces on the circuit board are twice the normal thickness. Principal parts are secured with through-hole connections. The digital circuit is intentionally compact with the shortest practical leads. High quality electrolytic capacitors are used wherever they can impact sound. Even the AC power line uses gold plating for the minimum in contact resistance. The result is remarkably pure, superbly clean sound.

Build Right

Vibration is the enemy of DVD players for two powerful reasons. First, vibration in the disc or optical pickup triggers unwanted operation in the tracking servos. This can radiate spurious noise throughout the chassis. And this radiation occurs in exactly the wrong place — near the sensitive low-level optical pickup preamplifier. To make matters worse, vibration can also cause subtle distortions in the audio circuitry. Vibration can have tiny "microphonic" effects on capacitor values and point-to-point wiring. While these distortions are not always apparent to the casual listener, Sony's design program required performance without compromise. For all these reasons, the DVP-S9000ES takes advantage of Sony's comprehensive anti-resonant design. It's one more way the player reflects its dual heritage as a top Sony DVD machine and proud member of the ES Series.

Copper-Plated Frame and Beam Chassis

The first line of defense against vibration is Sony's Frame and Beam (FB) chassis. In this design, the thick, high-strength chassis frame gains additional strength from a horizontal beam. The back panel and main parts use 1.6 mm thick sheet metal while the bottom plate is 2 mm thick. The chassis corners benefit from stiffening boards that add strength and diffuse the natural resonant frequencies. In this way, materials of different shapes and thicknesses combine to suppress vibration. In addition, copper plating on the back panel and bottom help reduce noise by decreasing the ground potential difference.

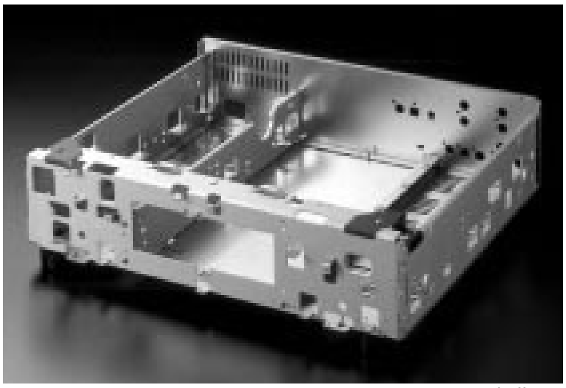

Photo 6: Sony's copper-plated Frame and Beam (FB) is not only strong. Parts of different shapes and thicknesses combine to suppress resonance.

Off Center Insulator Feet

To prevent shelf-borne vibration from entering the chassis, Sony's insulator feet locate the screw hole off center. Varying the radius from screw to perimeter tends to vary the resonant frequency within the foot — diffusing one potential path for vibration.

New Fixed Base Unit Mechanism

The DVP-S9000ES marks the debut of an all-new drive mechanism of unusual design. On a conventional DVD drive, the spindle, drive motor and optical pickup are mounted on a pivoting **base unit.** The pivot is necessary because the base unit needs to drop out of the way when the disc drawer is opening and closing. And it needs to swing back up into playing position once a disc has been loaded. Unfortunately, this pivoting mechanism is an open invitation to vibration and resonance.

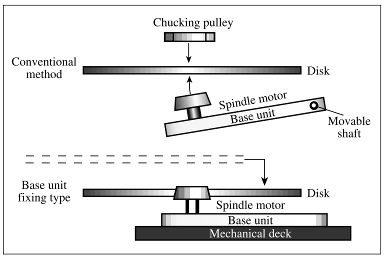

Fig. 20: Conventional DVD players use a pivoting base unit (top), prone to vibration. The Sony DVP-S9000ES uses a rigidly fixed base unit (bottom), minimizing vibration and its consequent distortion.

Sony engineers demanded more. And they developed the fixed base unit mechanism. In the new Sony design, the spindle, motor and optical pickup base unit is rigidly bolted to a sub-chassis, to reduce any possibility of resonance. When you load a disc into the DVP-S9000ES, the disc not only moves laterally into the player, it also descends onto the spindle. Thanks to Sony's new design, the disc is always read in a silent, extremely stable non-resonant environment. Vibration is minimized, along the servo activity vibration can cause. The sensitive RF preamplifier is protected from servo radiation.

Hermetic Shutter

When it carries the disc down to the fixed base unit, the loading tray no longer acts like a door to seal the front-panel loading slot. Sony engineers addressed this by creating a hermetic shutter. It forms an airtight seal to protect the disc and pickup from airborne vibration. Even when the speakers in your room are going full blast, the disc rotates in peace and quiet.

BMC Mechanical Deck

The base unit is mounted on a subchassis called the **mechanical deck.** On the DVP-S9000ES, this is a self-contained box formed of Sony's Bulk Molding Compound (BMC). Long a fixture in Sony anti-resonant design, BMC is carefully formulated for high strength and high internal loss. Like steel, it has the rigidity required for its structural purpose. But unlike steel, BMC steadfastly resists vibration and resonance. BMC consists of calcium carbonate — a principal component of marble — glass fiber reinforcement and unsaturated polyester. The material is subjected to thermosetting and is formed into the mechanical deck floor, walls and ceiling. Even the disc loading tray is made of non-resonant BMC.

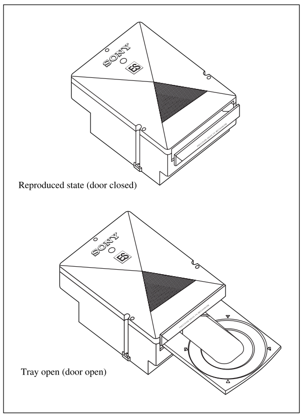

Fig. 21: The mechanical deck is a sealed enclosure, shown here with drawer open & closed

Mechanical Deck Insulators

For further protection, the mechanical deck is insulated from the DVP-S9000ES main chassis via dedicated supports.
A new Digital Signal Processor (DSP) handles 40 million instructions per second (40 MIPS). The result is highly precise control of the optical pickup, for supremely accurate readout of the high-density DVD and SACD signal surface. The new DSP also helps deliver superb high-speed search and special effects playback. And it helps reduce the duration from disc insertion to the start of playback.

High-Speed, High-Precision Servo DSP

This digital controller must speak to such analog devices as the disc drive motor, tilt motor, and thread motor. For this purpose, the system uses 20 MHz Sigma Delta modulation and a highly linear 1-bit D/A converter. The result is 10-bit accuracy in the motor control output voltages.

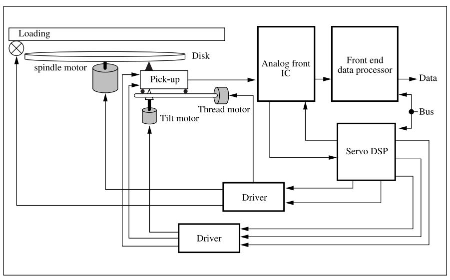

Fig. 22: The drive system uses an uncommonly powerful 40 MIPS DSP, combined with an uncommonly accurate Delta Sigma 1-bit D/A converter.

Performance Meets Refinement

Thoughtful touches and operating refinements make the DVP-S9000ES a pleasure even before playback begins.

- **Thick aluminum front panel.** The DVP-S9000ES has serious, down-to-business styling with a thick, uncluttered aluminum front panel. The fluorescent display window is made of high hardness acrylic resin, especially formulated to resist scratches.
- **Short stroke controls.** Front-panel buttons are designed to respond to the lightest finger contact. Audio feedback in the form of a defeatable beep tone confirms each command.
- **LED/fluorescent display dimmer.** To minimize distraction during movie playback, the front panel fluorescent display can be dimmed. When you dim the display, the player simultaneously dims the front panel LEDs.
- **Control Menu.** With DVD-Video, SACD and CD playback in a single chassis, the DVP-S9000ES is brimming with control options and configuration possibilities. Sony organizes all the options for maximum clarity and presents them on your television screen.
- **Luminescent remote control.** Because owners will be enjoying DVDs with the room lights turned down, the remote control features glow-in-the-dark keys for Play, Stop, Pause and Display.
- **Sound feedback.** Beep tones confirm your selections for both front-panel and remote control commands. If you prefer, the audio feedback can be deactivated.
- **Picture Memory.** Similar to the customizable desktop picture on a PC, the DVP-S9000ES can display different scenes in the Stop mode. These can include favorite video scenes stored in memory, along with jacket pictures from CD Extra discs as well as DVDs.
- **Bit Rate Display.** Users can track the variable bit rate of MPEG-2 compression with on-screen displays of video and audio bit rates.
- **Layer and Pickup Display.** The DVP-S9000ES can show an on-screen graphic representation of your current position on the disc, along with your current layer for dual-layer discs.
- **Custom Parental Controls.** You can password protect the viewing of up to 300 DVDs, restricting playback to PG versions (on compatible discs) or preventing playback altogether.
- **DVD, SACD and CD TEXT™ display.** The DVP-S9000ES provides scrolling front panel display for the text functions of compatible discs.
- **Enviromentally friendly.** To conserve energy, power, consumption in the Standby mode is less than 1 watt. Operation automatically shuts down 30 minutes after Stop. To reduce pollution, the printed circuit boards are halogen-free.

DVP-S9000ES Specifications

Audio Characteristics	
Frequency Response	DVD(PCM 96kHz): 2Hz to 44kHz (-2dB; ±1dB at 44kHz) CD: 2Hz to 20kHz (±0.5dB) SACD: 2Hz to 100kHz (-3dB; ±1dB at50kHz)
Signal-to-noise Ratio	More than 115dB (DVD)
Harmonic Distortion	DVD: Less than 0.0015% CD: Less than 0.002%" SACD: Less than 0.0015%
Dynamic Range	More than 103 dB(DVD/SACD) More than 99 dB(CD)
Wow and Flutter	Beneath the limits of measurement (± 0.001% weighted peak)

General	
Power requirements	220-240V AC, 50/60Hz
Power Consumption	43W(Standby less than 1W)
Dimensions	17 x 5 x 15$^5/_8$" (430 x 126 x 398mm)
Weight	approx 27 lbs., 12 oz. (12.6 kg)


Photo 7: Front panel


Photo 8: Remote control


Photo 9: Rear panel

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