SONY

SCD-1 & SCD-777ES

Super Audio CD/CD Players

Technical Background

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1. Introduction.

Super Audio Compact Disc represents a quantum leap in sound quality. Its Direct Stream Digital® (DSD) encoding gives music a freshness and presence unmatched by any other audio technology. To demonstrate this new format to the fullest, Sony has built two landmark components: the SCD-1 and SCD-777ES Super Audio CD™/CD players.

In creating these players, Sony discarded many preconceived notions about digital audio and digital music reproduction. We had to invent new approaches, build new architectures and produce entirely new Large-Scale Integrated (LSI) circuits. It was to explain these accomplishments that Sony created this white paper.

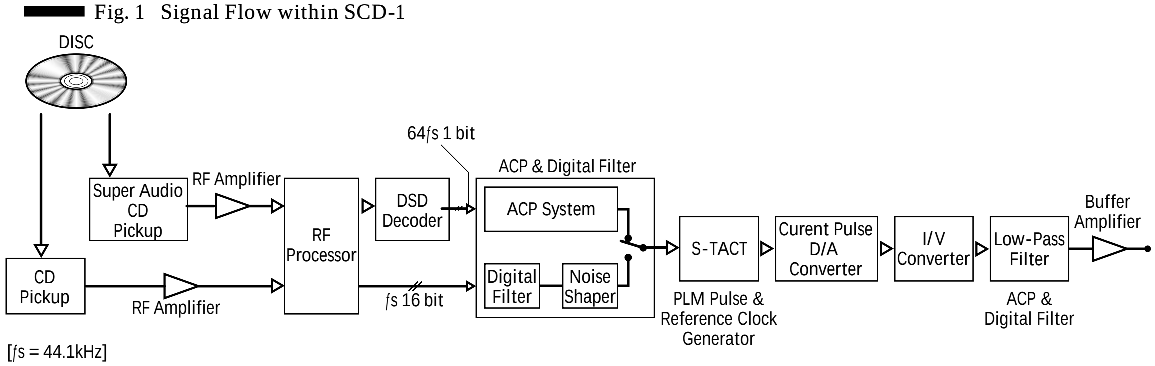
2. Technology.

2.1. Overview.

When Compact Disc players were new, audiophiles had to learn the new language of laser pickups, digital filters, D/A converters and analog output filters. SACD has a comparable language all its own. But SACD players are also CD players. So there are two signal paths inside the player. At some stages, SACD and CD signals receive exactly the same treatment. At others, there are dedicated circuits strictly for one type of disc or the other. Here's a brief overview of which stage does what.

1. **Dual Discrete Optical pickup.** Incorporates two separate pickups, one optimized for SACD, the other dedicated to CD.
2. **RF Processor.** For both types of disc, this circuit performs clock signal extraction, synchronization, demodulation and error correction.
3. **DSD Decoder**. For SACD only. Authenticates the SACD invisible watermark, separates text from music and forms the left and right DSD pulse trains.
4. **ACP System.** For SACD only. Controls the influence of switching distortion.
5. **VC24 Digital Filter.** For CD only. A supremely advanced version of the familiar 8x oversampling digital filter.
6. **S-TACT System.** For SACD and CD. Suppresses time-base errors for jitter-free performance.
7. **Current Pulse D/A Converter.** For SACD and CD. Supremely accurate conversion from 1-bit digital to analog.
8. **Low Pass Filter.** For SACD and CD. A General Impedance Circuit (GIC) stage for superb bandwidth and sound quality.
9. **Buffer Amplifier.** For SACD and CD. Discrete output circuitry for maximum signal integrity.

Fig. 1 Signal Flow within SCD-1



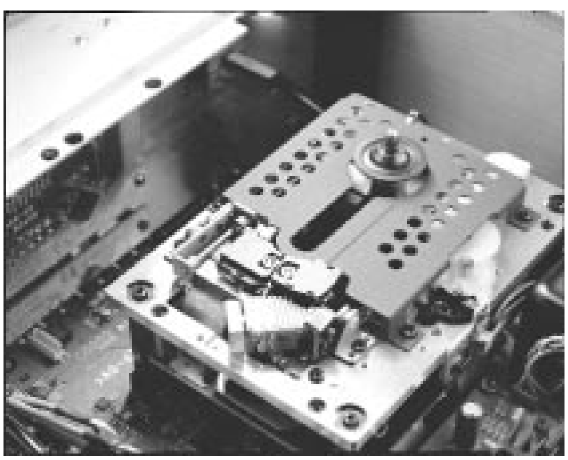
The SCD-1 and SCD-777ES incorporate circuitry to handle both Compact Disc and Super Audio Compact Disc signals.

2.2. Fixed Pickup Mechanism.

Optical playback systems require motor servos, tracking servos and focus servos to maintain accurate playback. Unfortunately, the laser output is extremely low in level—making it extremely sensitive to radiated noise. That includes noise induced from the servo currents!

While servo currents obviously can't be eliminated, they can be isolated, controlled and reduced by Sony's Fixed Pickup Mechanism. It creates a quiet environment for clear, low-noise signal readout.

Typical laser transports mimic the design of LP turntables. The spindle, disc and motor are fixed in position. The laser acts like a phono cartridge, tracking across the radius of the disc. The Fixed Pickup Mechanism changes everything. To isolate servo voltages from the laser pickups, the pickups themselves are fixed, rigidly bolted onto a subchassis. While the pickups remain stationary, the disc and turntable move horizontally to accomplish tracking. As a result, the system achieves extremely precise tracking—with extremely low induced servo current noise.



Sony's Fixed Pickup Mechanism
suppresses servo-induced noise.

This Fixed Pickup design—first used in Sony's critically-acclaimed CDP-XA7ES Compact Disc player—has been further refined by highly advanced sub-assemblies:

- **Spindle motor.** Made of die-cast aluminum for high rigidity. The stator (stationary side) includes a sapphire bearing. The rotor (rotating side) features a ruby ball that fits into the sapphire bearing. This combination makes for incredibly smooth rotation — and reduced motor servo current. It also reduces wear at the contact point.
- **Base plate.** The drive mechanism is mounted to a solid aluminum plate, 6 mm (1/4 inch) thick. The spindle cutout is reinforced with an extra plate for added rigidity. Special openings suppress vibration, to reduce servo currents further still.
- **Floating suspension.** The entire mechanical block floats on four rubber dampers, mounted on four chassis pillars. The design combines high rigidity with superb isolation from chassis-borne vibration.
- **Disc stabilizer.** The disc is held onto the spindle by a massive brass stabilizer that the user places over the center hub. This dampens extraneous motion and helps create a high-precision rotating system.

The die-cast aluminum spindle motor is highly rigid.

A unique ruby rotor ball bearing minimizes
friction and servo current.

2.3. Dual Discrete™ Optical Pickup.

Compact Disc requires a laser wavelength of 780 nm. SACD uses 650 nm. Compact Disc requires an objective lens numerical aperture (NA) of 0.45. SACD requires 0.60. Instead of trying to compromise these requirements, or switch lenses or lasers, Sony employs two separate optical pickups. One is dedicated to CD while the other is optimized for SACD. So you get ideal tracking for both types of disc.

2.4. Servo DSP LSI.

Super Audio Compact Disc has half the spacing between tracks (track pitch) of CD. The pits themselves are also half as long. As a result, SACD requires absolute precision in playback. That's why the SCD-1 and SCD-777ES employ an exclusive Sony Digital Signal Processor (DSP) to control spindle motor, tracking and focus servos. The DSP maintains superb precision for extremely stable signal readout.

2.5. RF Processor LSI.

As the optical pickup reads the disc signals, an RF amp located inside the mechanical block amplifies them. This amplified RF signal is sent to the RF processor, located on the main circuit board.

The RF processor chip is responsible for clock signal extraction, synchronization, demodulation and error correction. Both the servo DSP and RF processor are Sony Large-Scale Integrated (LSI) circuits. Large Scale Integration makes for smaller circuit boards—and reduced signal exposure to hum and noise.

2.6. DSD™ Decoder.

The RF processor extracts the data contained on the disc, without interpreting, analyzing or reading it. Organizing the data into left and right pulse streams is the job of the DSD decoder. Another 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.

2.7. ACP System.

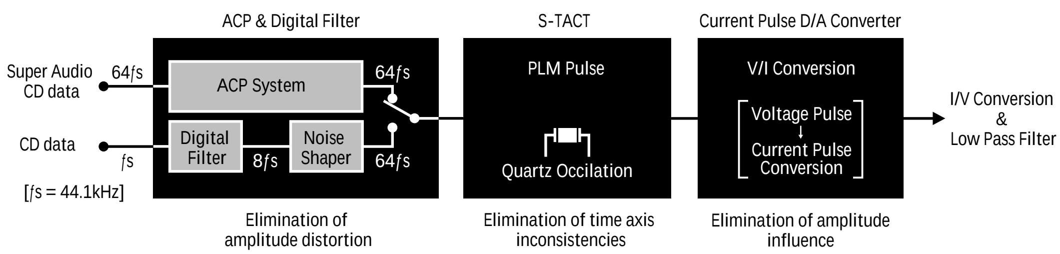
In principle, it is possible to convert the Direct Stream Digital signal into analog with nothing more than a low-pass filter. In practice, the DSD signal benefits from some highly specialized processing. To preserve the maximum accuracy of the DSD pulses, our design program identified two basic goals:

* Amplitude axis precision

* Time axis precision

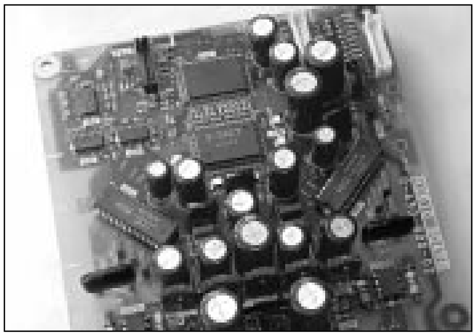
Sony's Accurate Complementary Pulse Density Modulation (ACP) system and Current Pulse D/A Converter meet the first goal. The second goal is achieved by Sony's Synchronous Time Accuracy Controller (S-TACT).

Fig. 3 D/A Converter System



The entire conversion system is optimized for precision on the amplitude axis and the time axis.

The first element in this reproduction system is ACP. Sony designed ACP to overcome one practical limitation in decoding the Direct Stream Digital pulse train. In the ideal world, DSD pulses would be square, with crisp, vertical leading edges, flat tops, flat bottoms and vertical trailing edges.



Sony LSIs include the VC24 Digital Filter, S-TACT system and Current Pulse D/A Converter.

The real world is a different place. In reality, at the MegaHertz speeds of DSD encoding, ICs permit some switching distortion. Leading and trailing edges become slightly slanted. Tops and bottoms begin with a switching glitch.

These distortions would be easy to correct in later processing—except for one problem. The distortion only occurs at the transitions from 1 to 0 or 0 to 1. When digital 1s occur in succession, there is no switching—and no switching distortion. The same is true for a string of digital 0s. This uneven distribution makes switching distortion difficult to suppress.

Fig. 4 Ideal Pulse Signal and DSD Signal

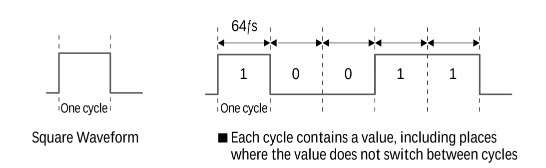


Fig. 5 Actual IC Pulse Output and DSD Signal

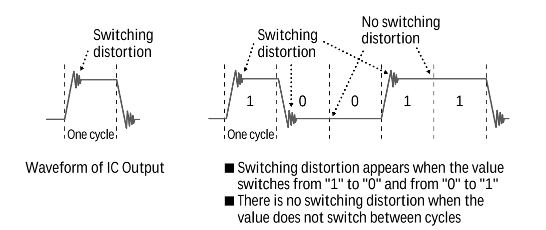


Fig. 6 Ideal ACP Pulse Signal

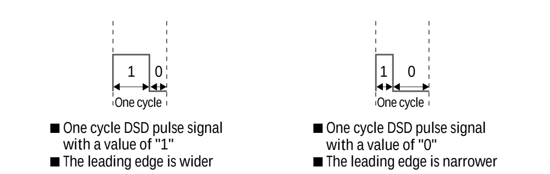
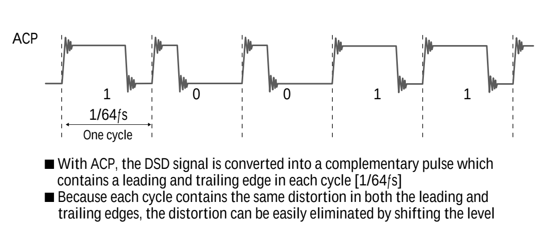


Fig. 7 DSD Signal with ACP Processing



Sony solves the problem with Accurate Complementary Pulse Density Modulation. ACP represents each digital 1 as wide 1 followed by a narrow 0. ACP represents each digital 0 as a narrow 1 followed by a wide 0. In this way, every sample includes both a 1 and 0. So every sample has the same minimal switching distortion. As a result, the distortion is easy to remove in subsequent processing.

The ACP system establishes extraordinary precision on the amplitude axis, a crucial factor in the audio performance of the SCD-1 and SCD-777ES players.

2.8. Synchronous Time Accuracy Controller (S-TACT).

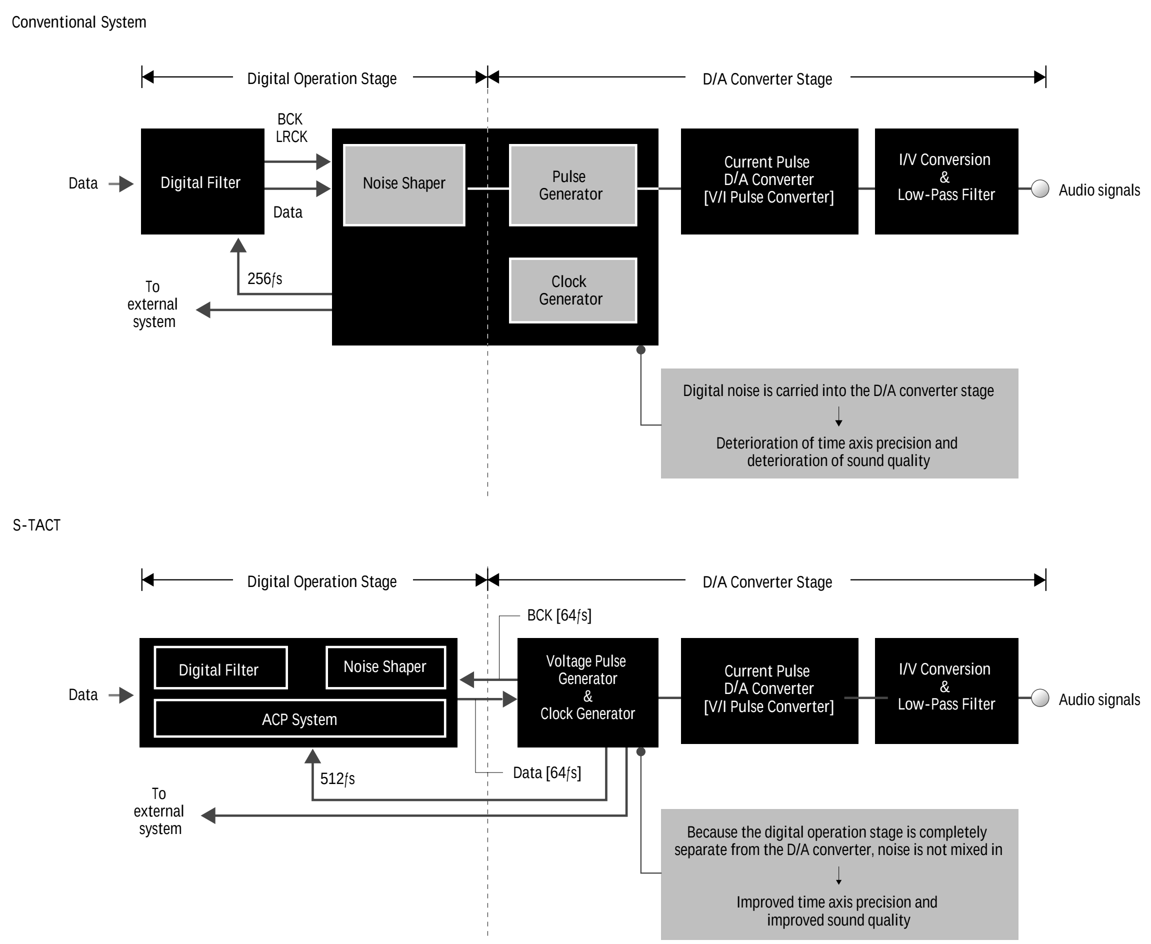
From the early days of digital audio, it was obvious that amplitude errors would equal distortion. Less obvious, but equally true was that time-base errors could also distort the analog waveform. For this reason, the SCD-1 and SCD-777ES have Sony's most comprehensive defense against time-base errors.

All digital playback circuits incorporate quartz crystal oscillators to regenerate precisely timed pulses. But not all circuits achieve the full precision of the quartz crystal. A major cause of time-base error is digital noise, introduced through the clock generator's power supply. For example, the digital filter, noise shaper and ACP systems all have high-speed IC circuitry, handling digital words up to 50 bits long—at clock speeds up to 8 times the sampling frequency of Super Audio Compact Disc.

Conventional circuits place the clock generator on the same IC chip as high-speed digital operations. The arrangement is efficient, but it exposes the clock generator to high levels of digital noise through the power supply voltage. The result is distortion of the clock signal—jitter.

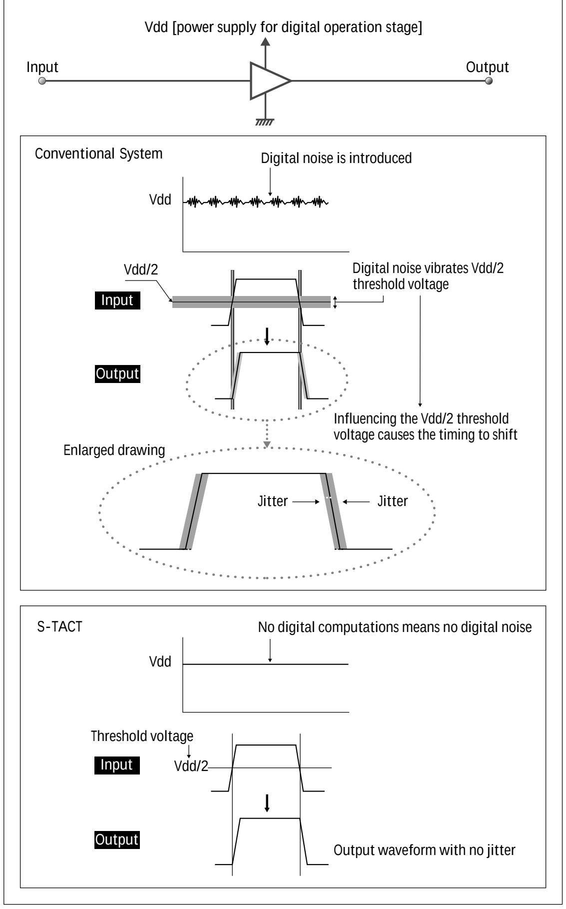
Sony's Synchronous Time Accuracy Controller (S-TACT) resolves the problem by isolating clock generation and voltage pulse generation on their own IC. Removed from high-speed digital operations, the S-TACT circuit draws clean, noise-free power. This means that digital pulses approach full quartz accuracy. Jitter—and jitter-induced distortion—are dramatically reduced.

Fig. 8 Comparison of Conventional System and S-TACT



Conventional circuits place the clock generator on the same chip as high-speed digital operations—exposing the clock pulses to harmful noise. Sony's S-TACT circuit isolates the clock generator from digital noise.

Fig. 9 Comparison of Jitter in Conventional System and S-TACT



Digital noise in the power supply (Vdd) causes the time base errors called jitter. The S-TACT design suppresses the noise, to suppress jitter.

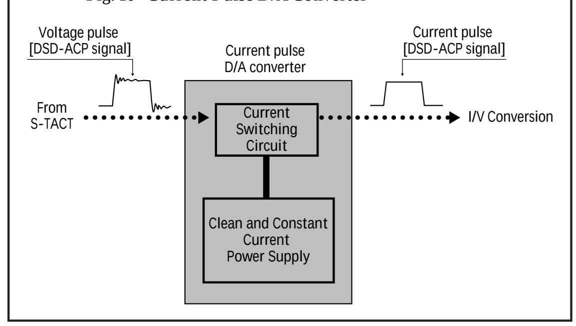
2.9. Current Pulse D/A Converter.

S-TACT effectively cleans time-base errors out of the pulse train. The final step before filtering is to clean up amplitude errors. The ACP circuit does not eliminate amplitude errors, it simply distributes them evenly through every DSD sampling period. The actual suppression of amplitude errors is handled by the Current Pulse D/A converter.

A familiar feature of high-end Sony CD players, the Current Pulse D/A 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. The high-speed switching distortions of earlier stages are finally cleaned out of the signal.

The resulting waveform is close to perfect. The pulse timing approaches full quartz accuracy, thanks to S-TACT. The pulse heights are remarkably even, thanks to the Current Pulse D/A. The only remaining process in the digital domain is a simple Current-to-Voltage conversion (I/V).

Fig. 10 Current Pulse D/A Converter

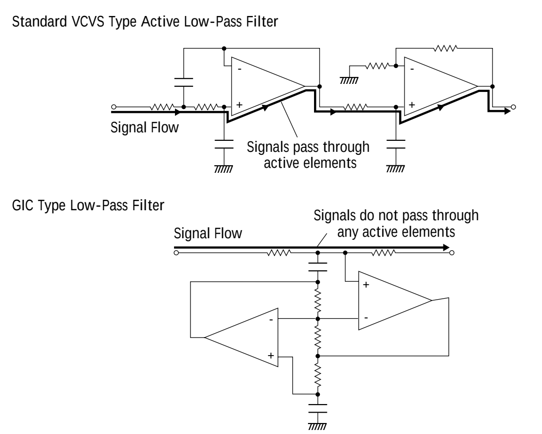


Thanks to a constant current source, Sony's Current Pulse D/A Converter ensures high precision on the amplitude axis.

2.10. Low-Pass Filter.

After I/V conversion, a simple low-pass filter is all that's required to produce an analog output. Conventional low-pass filters use transistors, op amps or other active circuit elements in the signal path. Because Sony was intent on preserving the simplest possible signal path, we chose a different design. Our General Impedance Circuit (GIC) low-pass filter positions the active circuit elements outside the signal path, to preserve the integrity of the original sound.

Fig. 11 GIC Type Low-Pass Filter

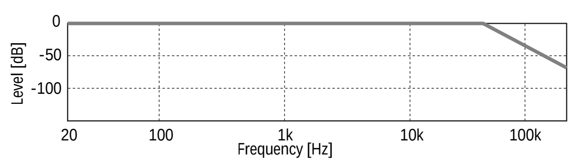


The GIC low-pass filter takes transistors, op amps and other active circuit elements out of the signal path.

Super Audio Compact Discs can have frequency response to 100,000 Hz. As such, the cut-off frequency and characteristics of the low-pass filter have a direct impact on the audio specifications—and sound quality—of the player. Refining the sound means balancing the various design goals: flat amplitude response, maximum high-frequency extension, low noise, optimum phase characteristics and suitability with downstream audio equipment.

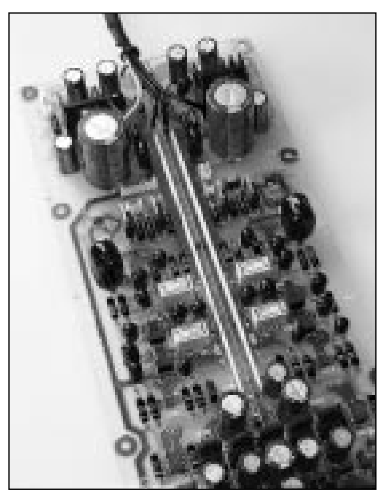
The GIC circuit of the Sony SCD-1 and SCD-777ES take all these factors into account. Frequency response is flat to 50,000 Hz (some two and a half times the response of a CD player). Above 50,000 Hz, response begins to roll off slowly. The result is smooth, open, non-fatiguing sound with exceptional definition and dynamics.

Fig. 12 Characteristics of Low-Pass Filter Used in SCD-1



Sony's filter design achieves flat response to 50,000 Hz.

The GIC filter is followed by a discrete component buffer amp, for optimum coupling to a preamplifier.



Analog circuit with GIC low-pass filter.

2.11. VC24 Digital Filter.

We have just described the SACD playback process from laser to analog output. However, the SCD-1 and SCD-777ES are also CD players. Compact Discs get the benefit of most of the technologies we have mentioned (servo DSP, RF processor, S-TACT, Current Pulse D/A Converter and GIC low-pass filter). However, exclusive to CD playback is Sony's VC24 Digital Filter. The design gets its name from 24-bit processing and Variable Coefficient design.

The filter's 24-bit process is 2 bits more powerful than Sony's previous best. But this actually understates the case. The new filter also conducts twice as many operation steps and performs direct oversampling with three additional bits. When viewed in terms of operation steps, two bits yields 2^2 or 4 times as many steps, twice the operations yields 2 times the number of steps, and 3 bits yields 2^3 or 8 times as many steps. All told, the VC24 filter handles 4 x 2 x 8 = 64 times as many steps as Sony's previous best.

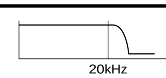
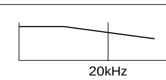
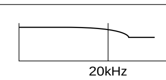
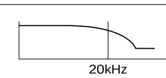
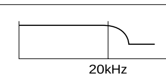
Since the launch of Compact Disc, each new digital filter has had a fixed filtering coefficient. It's been designed at the factory and offered to home listeners with no user controls. Sony's Variable Coefficient digital filter is a dramatic departure. The VC24 actually offers five distinct settings, representing different filter coefficients, different filtering methods and different objectives in reproduced sound.

- **Std.** The standard setting meets the classic digital filter objectives of the steepest possible roll off above 20 kHz, with the greatest possible suppression of ultrasonic noise.
- **df-1.** This setting incorporates smoothing interpolation. Conventional 8x oversampling uses three cascaded stages of 2x oversampling. In contrast, df-1 performs the full 8x oversampling process in a single pass. The result is smoother processing and clearer sound.
- **df-2.** This setting maximizes the digital word length. In each stage, it adjusts the word length of the input number to match the noise shaper in the next stage. This eliminates all non-linear portions in the computation process and suppresses quantization noise.
- **df-3.** This is an all-new 224-order design with an even number of filters. Unlike conventional, odd-number filters, the original data samples are retained as-is, without alteration by the oversampling process. Frequency response is flat to 17 kHz, while noise suppression at 26 kHz is 80 dB.
- **df-4.** An enhanced version of df-2, this setting increases the computation word length by four bits, increases the filter degree twofold and employs an even-number filter. Frequency response is flat to 18 kHz, with a gain at 20 kHz.

Table 1 Comparison of the VC24 and Previous VC Digital Filters

Category	VC24	Previous VC
Number of operation steps [steps/44.1kHz]	512	256
Operation data word length	24 bit	22 bit
Coefficient word length [Direct 8 times oversampling filter]	16 bit [±2.0]	13 bit [±2.0]
Maximum number of orders [Direct 8 times oversampling filter]	224	112
Maximum number of orders [Direct 4 times oversampling filter]	112	56
Coefficient word length [3-stage cascade 8 times oversampling filter]	27 bit [±2.0]	27 bit [±2.0]
Maximum number of orders [3-stage cascade 8 times oversampling filter]	171 + 35 + 19	171 + 35 + 19
Maximum number of orders [2-stage cascade 4 times oversampling filter]	171 + 35	131 + 27

Table 2 Positions for 24-bit VC Digital Filter

Position	Filter type	Cut-off characteristics
STD standard	Sharp roll off	
df-1 [No. 1 Clear]	Slow roll off	
df-2 [No. 2 Plain]	Slow roll off	
df-3 [No. 3 Fine]	Slow roll off	
df-4 [No. 4 Silky]	Slow roll off	

3. Construction.

3.1. Circuit Board Layout.

After paying such meticulous attention to the composition, design and execution of each circuit, Sony was equally careful in the physical arrangement of circuits in the chassis.

The main circuit board—which includes the DSP servo LSI, RF processing LSI and system control—is positioned directly underneath the fixed pickup drive assembly. This was a design challenge. For example, it required a hole in the circuit board to accommodate a support post. But this configuration reduces signal runs from the laser pickups, reducing exposure to possible interference.

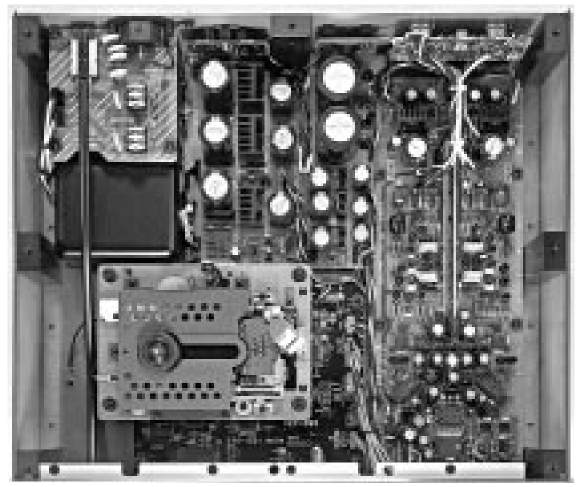
The main circuit board itself follows Sony's "digital minimum" design, with key components as closely concentrated as possible. To accomplish the goal, Sony designed the printed circuit pattern in 4 layers. And then applied surface-mount LSIs and small-scale chips on both sides of the board. As a result, a phenomenal amount of circuitry fits comfortably on a single, small board.

Concentrating the main circuit board and placing it under the mechanism leaves ample space in the chassis for the two circuits that need "spreading out." The power supply and the audio circuit board.

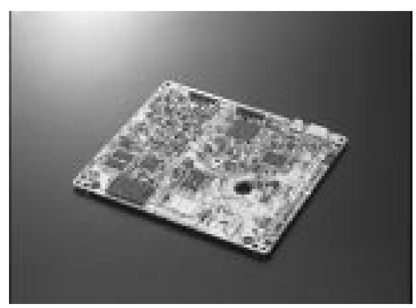
Since the audio circuit board includes so many components that determine sound quality, Sony paid extra attention to its layout and construction. This is a double-sided glass epoxy board with a bus bar and symmetrical left/right layout.

The digital LSIs, including VC24, S-TACT and Current Pulse D/A Converter, are all surface-mount components. And they're all concentrated near the front of the chassis, for minimum radiation of digital noise. The analog buffer amp uses integrated-lead discrete components. These are widely spaced, for minimum mutual interference.

Voltage for the analog stage is provided by a discrete left and right power supply secondaries, located directly on the audio circuit board. Separate left and right 3-layer bus bars help minimize power supply impedance. To optimize grounding, the audio output terminals are connected to the audio circuit board using a thick copper plate.



SCD-1 Internal structure



SCD-1 Main circuit board (top)

SCD-1 Main circuit board (bottom)

3.2. Power Supply Block.

The SCD-1 and SCD-777ES power supplies were designed to minimize interference and maximize the stability and purity of voltage. A remote power switch, for example, minimizes intertwining of the primary AC wiring—restricting it to a short run at the back of the unit. Separate power transformers for analog and digital sections limit mutual interference through the supply.

Sony uses two large R-Core transformers to minimize magnetic flux leakage, mechanical vibration and acoustic noise. On the SCD-1, vibration is further suppressed by resin-sealed cases for both transformers.

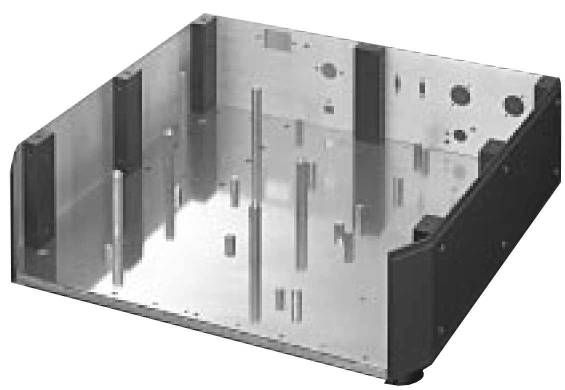
The analog audio power supply secondary (capacitors and diodes) is mounted on the audio circuit board to minimize impedance. Essential parts, including electrolytic capacitors, were carefully selected for sound quality.

Power supply block

3.3. Base Pillar (BP) Construction.

Given Direct Stream Digital encoding's ability to resolve even the most subtle musical information, the SCD-1 and SCD-777ES were designed to restrict even the most subtle forms of distortion. Microphonics—unwanted voltages caused by the physical vibration of wires and component parts—have been suppressed by thoroughgoing anti-resonant construction.

For this purpose, Sony has developed a new anti-vibration design: the Base Pillar (BP) chassis. The base consists of two 5-mm (0.2-inch) thick metal plates that combine to form a massive 10-mm (0.4-inch) thick platform. On this base, Sony has mounted seven high-carbon cast iron pillars, two 4.5-mm (0.2-inch) sidewalls and a 5-mm top plate. It's no exaggeration to call this chassis "massive." The SCD-1 weighs some 26.5 kg (over 58 lbs.) while the SCD-777ES weighs 25 kg (55 lbs.).



BP Chassis Construction

By choosing intrinsically rigid materials, Sony constructed a simple, but very stable chassis. The chassis design is also extremely open, enabling the ideal layout of each subassembly: mechanism, power supply, main board and audio board.

3.4. Insulator Feet.

To prevent shelf-borne vibration from entering the chassis, Sony's eccentric 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.

The SCD-1 is distinguished by sophisticated 5-piece insulator feet. The upper foot is made of a high-carbon cast iron that offers high attenuation. The lower foot is made of brass. These two halves meet at a pinpoint contact, carefully designed to block the propagation of vibration. Finally, the pinpoint itself is surrounded by a gel shaped damper to reduce even trace resonances.

3.5. Slide-Top Loading Panel.

The loading door at the top of the chassis is a jewel of mechanical engineering. It glides on concealed guide rails. The panel rises slightly as it opens—and lowers to its original height when it closes.

The motor cover and floating mechanism are insulated against noise and vibration. The disc housing is treated with an anti-vibration coating. A high-carbon textile with a Teflon® coating ensures sound insulation and high reliability. The main axle for the slide mechanism is made of stainless material, while the bearing is made of solid brass.

4. Operation.

4.1. Disc Type Selection.

The SCD-1 and SCD-777ES automatically recognize CDs and SACDs and commence playback. By selecting the disc type in advance, users can bypass the recognition step and go directly to playback. Manual selection is also useful for hybrid SACDs, which contain both high-density and standard CD layers.

4.2. Digital Output.

Two types of digital output are available for CD playback: coaxial and optical. To minimize radiation interference, these outputs can be switched off by a front panel control. There is no digital output during SACD playback.

4.3. Balanced Output.

To assure the highest signal integrity at the preamplifier input, the SCD-1 features balanced analog outputs. As featured in professional audio equipment, the balanced outputs use 3-pin XLR connectors with separate conductors for plus, minus and ground.

4.4. Text.

Just as Compact Disc offers a CD TEXT™ option, Super Audio Compact Disc has a reserved area for text. The SCD-1 and SCD-777ES can display information such as disc title, artist name and track title for compatible CDs and SACDs.

4.5. Display.

The SCD-1 and SCD-777ES have segmented displays for track number and time. Because Super Audio Compact Disc titles can have as many as 255 tracks, the players each have a three-digit track number display. A 15-character dot matrix display shows text information, player settings and user warning indications. The Display Mode switch enables users to turn off specific sections or the entire display.

The display window is made of thick acrylic with beveled edges and a half-mirror coating on the inside. This helps give the players a distinctive look.

4.6. Remote Control.

Even the Remote Commander® unit is distinctive. It features a 1-mm aluminum top plate and buttons that depress with a definitive click. The remote duplicates the front panel features and adds track programming, shuffle and repeat (1, all, A-B) as well as 10-key Direct Access™ track selection. Additional controls include cue/review, index search, disc type selection and filter switching.

The remote unit's infrared codes correspond to Sony CD player codes. So most SACD player functions can be operated from the CD player mode of Sony preamplifier and receiver remote controls. To prevent mistaken operation in systems that already include a Sony CD player, the SACD player and remote can be switched to "CD2" mode, engaging a separate set of remote control codes.

5. Features and Specifications.

5.1. SCD-1 Features.

- Plays Super Audio Compact Discs and Compact Discs
- New Direct Stream Digital (DSD) encoding eliminates the distortions of decimation and interpolation filters
- Dual Discrete™ optical block with one laser optimized for SACD, another dedicated to CD
- Twin fixed pickup laser tracking assembly
- Accurate Complementary Pulse Density Modulation (ACP) system for SACD playback
- S-TACT Synchronous Time Accuracy Controller reduces clock noise, minimizes jitter
- 8-output Current Pulse D/A Converter
- General Impedance Circuit (GIC) analog filter
- 24-bit Variable Coefficient digital filter for CD playback
- Super-rigid Base Pillar (BP) construction
- Anti-resonant 10-mm chassis base, 4.5-mm sidewalls and 5-mm top plate
- Die-cast aluminum spindle motor with sapphire and ruby bearings
- Floating suspension transport with rubber dampers and 6-mm base plate
- 5-piece insulator feet with eccentric screw holes, high-carbon cast iron upper foot and brass lower foot
- Motorized slide-top loading
- Brass disc weight
- Aluminum front panel
- Balanced and unbalanced analog outputs
- Two encapsulated R-core power transformers
- Optical and coaxial digital outputs for CD
- Text display for compatible CDs and SACDs
- Remote Commander® wireless remote control

5.2. SCD-777ES Features.

- Plays Super Audio Compact Discs and Compact Discs
- New Direct Stream Digital (DSD) encoding eliminates the distortions of decimation and interpolation filters
- Dual Discrete™ optical block with one laser optimized for SACD, another dedicated to CD
- Twin fixed pickup laser tracking assembly
- Accurate Complementary Pulse Density Modulation (ACP) system for SACD playback
- S-TACT Synchronous Time Accuracy Controller reduces clock noise, minimizes jitter
- 8-output Current Pulse D/A Converter
- General Impedance Circuit (GIC) analog filter
- 24-bit Variable Coefficient digital filter for CD playback
- Super-rigid Base Pillar (BP) construction
- Anti-resonant 10-mm chassis base, 4.5-mm sidewalls and 5-mm top plate
- Die-cast aluminum spindle motor with sapphire and ruby bearings
- Floating suspension transport with rubber dampers and 6-mm base plate
- 4-piece insulator feet with eccentric screw holes
- Motorized slide-top loading
- Brass disc weight
- Aluminum front panel
- Two R-core power transformers
- Optical and coaxial digital outputs for CD
- Text display for compatible CDs and SACDs
- Remote Commander® wireless remote control

5.3. Specifications.

	SCD-1	SCD-777ES
Super Audio Compact Disc		
Frequency Range	2-100,000 Hz	2-100,000 Hz
Frequency Response	2-50,000 HZ (-3 dB)	2-50,000 HZ (-3 dB)
Dynamic Range	More than 105 dB (20-20,000 Hz)	More than 105 dB (20-20,000 Hz)
Total Harmonic Distortion	Less than 0.0012%	Less than 0.0012%
Wow & Flutter	Beneath measurable level (+/-0.001% weighted peak)	Beneath measurable level (+/-0.001% weighted peak)
Compact Disc		
Frequency Response	2-20,000 Hz	2-20,000 Hz
Dynamic Range	More than 100 dB	More than 100 dB
Total Harmonic Distortion	Less than 0.0017%	Less than 0.0017%
Wow & Flutter	Beneath measurable level (+/-0.001% weighted peak)	Beneath measurable level (+/-0.001% weighted peak)
Output		
Digital Output	Optical, coaxial (CD only)	Optical, coaxial (CD only)
Analog Output	Unbalanced, balanced (w/ON/OFF switch for balanced)	Unbalanced
Output Level		
Digital (optical)	-18 dBm (fixed)	-18 dBm (fixed)
Digital (coaxial)	0.5 V p-p (fixed)	0.5 V p-p (fixed)
Digital (unbalanced)	2 V ms (fixed)	2 V ms (fixed)
Analog (balanced)	2 V ms (fixed)	–
General		
Dimensions (whd)	430 x 149 x 436 mm (17 x 5 7/8 x 17 1/4)	430 x 149 x 436 mm (17 x 5 7/8 x 17 1/4)
Weight	Approx 26.5 kg (58 lbs.)	Approx 25 kg (55 lbs.)

SONY

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