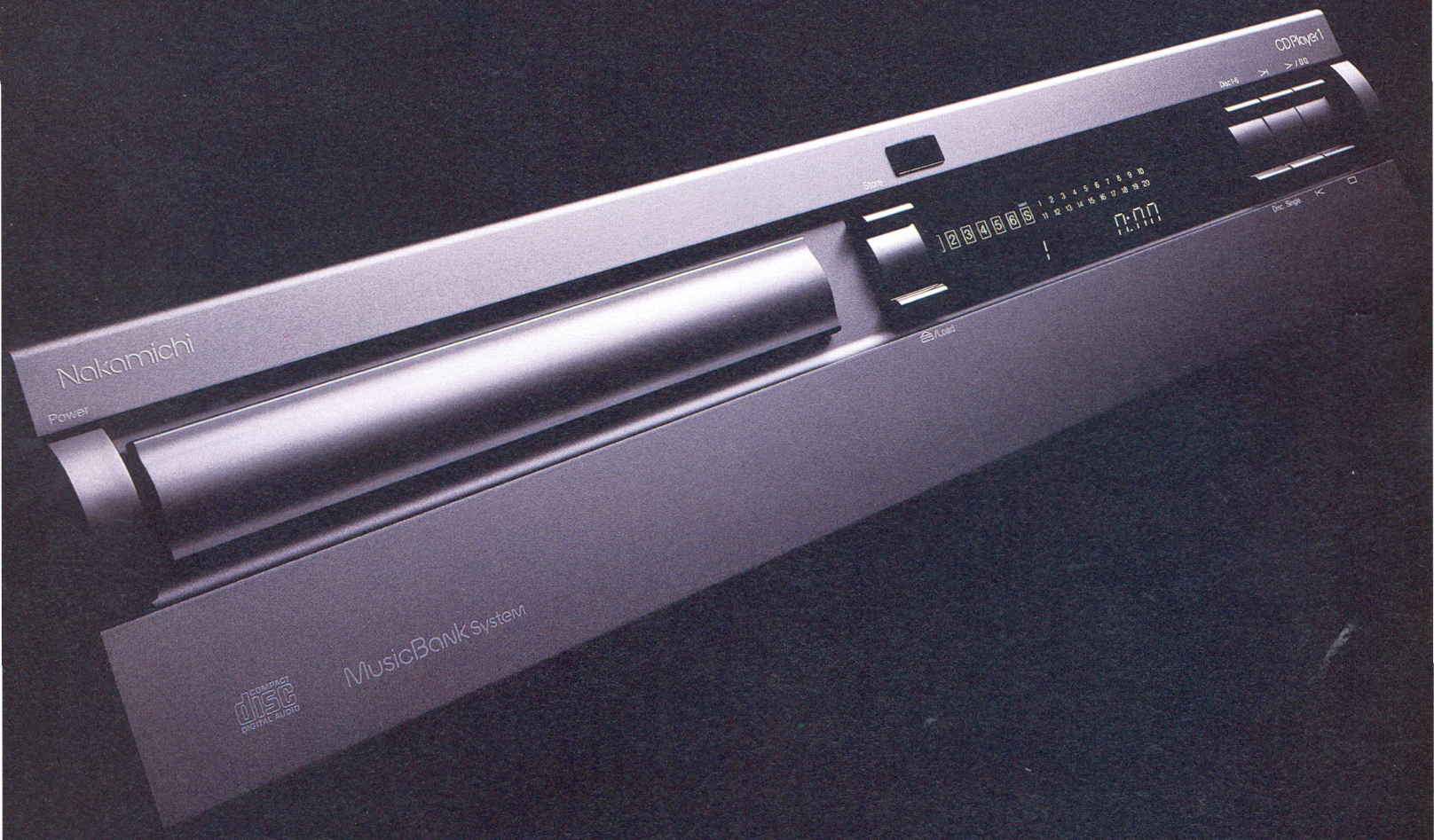
CD Player 1



Nakamichi

Extraordinary Engineering, Unprecedented

No pain, no gain. Consider CDPlayer1. One can certainly describe the elaborate *acoustic fine-tuning* process applied by Nakamichi engineers as a *painstaking* effort. But their "pain" is your gain—something you will appreciate the first time, and every time, you listen to music reproduced by this remarkable CD player.

CDPlayer1 is the result of an unparalleled study of factors that affect Compact Disc reproduction quality. Intense and single-minded in focus, this ambitious engineering effort relied as much on elaborate trial and error experimentation as on acoustic and electronics theory. The design principles that emerged from this research provide a path to astonishing sonic refinement, even where there is seemingly little room for improvement.

Do not be overly concerned with the "pain" suffered by Nakamichi engineers in the development of CDPlayer1. Their obsession with sound quality is a labor of love. And their greatest reward is the pure musical pleasure CDPlayer1 will bring to those who appreciate the finer things in life.

Acoustic Stabilizer

The acoustic fine-tuning process so critical to CDPlayer1's superb sonic characteristics primarily concerns internal details. However, there is one piece of external evidence: the **Acoustic Stabilizer**. Permanently attached to the top panel, this massive reinforcement, which some might describe as unsightly, serves a real and important sonic purpose.

Formed from a non-ferrous metallic plate 3 millimeters in thickness, the Acoustic Stabilizer is positioned over the player's drive mechanism. There it suppresses the effects of vibration generated by the mechanism itself. It also contributes to the overall fine-tuning of the chassis' acoustic characteristics. The material, thickness, shape, size, surface treatment, and placement of the Acoustic Stabilizer were all precisely determined through extensive listening tests. These parameters were optimized for the best possible three-dimensional spatial imaging, instrumental timbre, and overall musical realism. While a slight change in any one of these parameters may be inaudible to most listeners, the time-consuming process of optimization was essential: the sum total effect of the Acoustic Stabilizer is unmistakably beneficial.

High-Rigidity 2-Layer Steel Chassis

Less obvious to the naked eye is the CDPlayer1 chassis, which features a 2-layer steel construction of extraordinary rigidity. The top, bottom, side, and rear panels are reinforced in this manner. The two layers are of different thicknesses (the inner being 2 millimeters) in order to effectively neutralize all modes of vibration and resonance. The considerable heft of CDPlayer1—almost 30 pounds—is in large

Musical Quality

part attributable to this extravagant chassis construction.

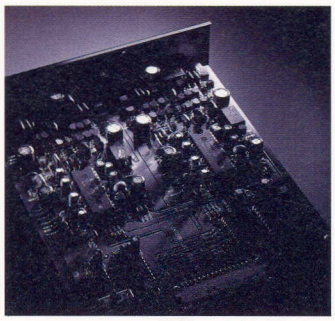
Why all the fuss over vibration? Recent Nakamichi experiments clearly demonstrate the detrimental effect of vibrations on the quality of CD reproduction. These tests show that it is always preferable to reduce vibration and resonance *before* they can affect the various mechanical, digital, and analog sections of a CD player. After-the-fact countermeasures, by comparison, are rarely effective. The acoustic fine-tuning process, which has dictated the construction details of CDPlayer1, results in substantial attenuation of vibration. The utterly natural, superbly musical sound quality of CDPlayer1 is the ultimate justification of these efforts.

Improved EL 20-Bit D/A Converter

Nakamichi digital audio technology has historically produced some of the finest sounding circuitry. Nakamichi's innovative approach to digital-to-analog conversion, for example, has resulted in highly original techniques that effectively subdue a variety of digital "ills," such as glitches and non-linearity. Given present-day integrated circuit technology, Nakamichi engineers remain convinced that the best sonic results lie in refinement of multi-bit D/A converter design. And one of the best examples of such refinement is the Nakamichi **EL (Enhanced Linearity) 20-bit D/A converter**, originally introduced with CDPlayer2.

In CDPlayer1, the EL 20-bit converter has evolved to an even higher state. The converter circuitry features the latest devices mounted on an independent high-quality composite circuit board. The D/A converter LSI chip itself is a specially selected device with an exceptionally low distortion rating. The 8-times oversampling digital filter also employs improved devices that result in the lowest levels of distortion ever achieved in this type of circuitry. These advances ensure exceptionally natural, superbly musical digital audio reproduction across the entire dynamic range.

CDPlayer1 also incorporates an advanced **3rd-order linear-phase Bessel-type analog low-pass filter**. It is a fully discrete design—not a single IC is used. The basic performance of this filter circuit has thus been highly optimized, providing an open-loop bandwidth that extends well beyond the audio spectrum. The result is a nearly ideal filter that does not color the music with phase or harmonic distortion.



The Technical Advantages of the EL Converter

It is a relatively easy matter to design a 20-bit D/A converter. Designing a converter that provides true 20-bit precision is another matter entirely. In fact, a good 16-bit design will sound better than an imprecise 20-bit converter. However, if a full 20-bit path can be maintained from the digital filter to the converter, and if the converter can provide true 20-bit precision, the resulting reduction of re-quantization noise and improvement in resolution and low-level linearity will greatly enhance reproduction quality.

Figure 1—Nakamichi EL 20-Bit D/A Converter—Block Diagram (see text)

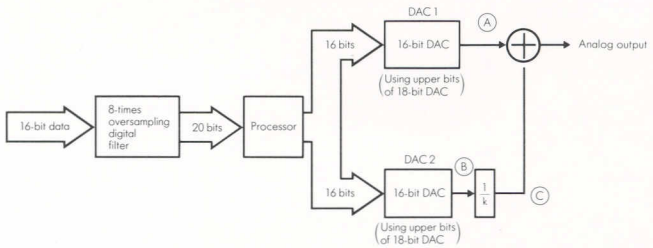
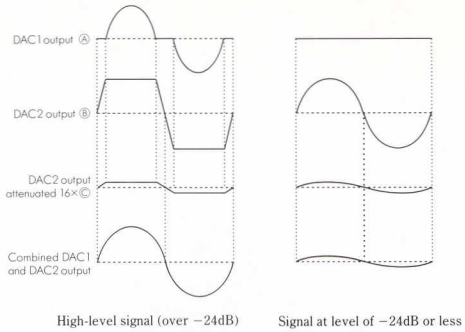


Figure 2—Nakamichi EL 20-Bit D/A Converter—Principle of Operation (see text)



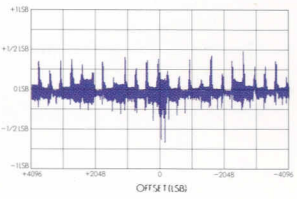


Figure 3—Competitive 20-Bit D/A Converter—Offset vs. Differential Error

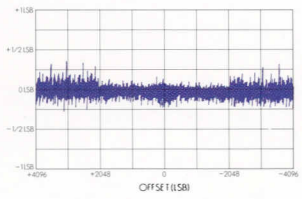


Figure 4—Nakamichi EL 20-Bit D/A Converter—Offset vs. Differential Error

Figures 3 and 4 compare the offset error of a competitive 20-bit D/A converter and that of the Nakamichi EL 20-bit D/A converter. The fluctuations of a 1kHz square wave signal at a level equivalent to 1 LSB (least significant bit) were measured with offset added in 1 LSB increments from −4096 to +4096 LSBs. A 16-bit measurement signal is used. In theory the differential error of a true 20-bit converter must be within 1/16 of an LSB. In Figure 3, the competitive 20-bit D/A converter shows an error of more than 1/2 LSB in the zero-cross region, which means it does not even achieve 16-bit precision. With the EL 20-bit converter (Figure 4), there is a significant reduction of differential error below −24dB (offsets between −2048 and +2048 LSBs). Note that because the offset scale is linear (rather than logarithmic), the actual area of improvement near the center is sonically more significant than visually implied. In actuality, the EL 20-bit D/A converter has an error of 1/16 LSB in this critical region, but it is practically impossible to measure the 1 LSB equivalent voltage (30 μV) down to a precision of 1/16 (1.9 μV). The components visible between −2048 and +2048 LSBs are primarily noise in the measurement circuitry and the analog circuits external to the D/A converter.

The Nakamichi EL 20-bit D/A converter represents a novel approach to attaining the required precision.

As shown in the block diagram (Figure 1), the 8-times oversampling digital filter provides 20-bit data to a special processor which converts the signal into two 16-bit data streams—one data stream representing signal levels above −24dB, the other representing signals below this point. The data streams are handled by independent 16-bit D/A converters, DAC1 and DAC2, whose outputs are combined to produce the desired analog signal. The low-level (below −24dB) data stream, however, is boosted via digital calculation by a factor of 16 prior to D/A conversion. Following conversion (B), it is attenuated by the same amount (C) before being summed with the high-level signal (A). The 16x amplification factor is equivalent to 4 additional bits of precision. The critical low-level signals thus benefit from 20-bit (16+4) converter precision, which significantly improves resolution and linearity.

Figure 2 illustrates this type of conversion using a sinusoidal wave. The waveform at (A) represents the output of DAC1, (B) the output of DAC2. (C) is the DAC2 signal after being attenuated by a factor of 16 (24dB) in the analog domain. The output waveform is the sum of (A) and (C). Note that for signals below −24dB, DAC1 contributes nothing to the final output. Instead, such low-level signals are handled entirely by DAC2, receiving the 16x "boost" in the digital domain and the equivalent attenuation in the analog domain.

It is important to understand the fundamental difference between this approach and that used by competitive 20-bit designs. The latter generally use two D/A converters per channel as well but split the 20-bit output from the digital filter into upper and lower bit groups, for example, 16 bits and 4 bits. Simply adding four extra bits to the lower end of a 16-bit device does nothing to improve converter precision. In fact, such designs merely compound differential non-linearity and zero-cross errors. This is not the case with the Nakamichi EL 20-bit system because the assignment of the data to the two D/A converters is based on signal level, *not* bit significance.

The Relentless Pursuit of Sonic Purity

All non-essential features, such as a headphone output and a variable line output, have been purged from CDPlayer1. While such features may add a measure of convenience in certain less critical playback situations, they involve circuitry that can degrade sound quality. Because the driving force behind CDPlayer1 is musical accuracy, the inclusion of such features conflicts with its basic design philosophy.

The circuits and other design features that have been included in CDPlayer1, therefore, represent a distillation of engineering advances that contribute to the enhancement of sonic quality. The **Multi-Regulated Power Supply**, for example, employs a transformer with separate windings for the digital and analog circuitry to minimize the possibility of mutual interference. Moreover, independent local regulators are used for the left and right channel D/A converters and analog filters to improve circuit stability. The **Isolated Ground** topology prevents noise leakage via the ground line from affecting the audio signal. All electronic devices are of the highest quality and are hand-picked for the best possible sonic characteristics. The advanced internal layout eliminates floating audio wiring. These and numerous other design details result in a CD player of incomparable sonic transparency and musical definition.

The MusicBank™ System

CDPlayer1 incorporates Nakamichi's unique **MusicBank™ system**. This novel transport mechanism provides the multi-disc convenience of CD changers without compromising the operational simplicity and performance advantages of single-disc players.

The MusicBank system features an exceptionally fast, smooth, and quiet "1+6" stocker mechanism. When playing a single disc, operation is no different from a well-designed conventional CD player. But at the same time, the internal stocker mechanism accepts up to six discs. A total of seven discs, therefore, can be quickly accessed for programmed or random playback, providing numerous versatile long-playing options. Since CDs are loaded and unloaded from the mechanism via the conventional single-disc tray, there is no need for a cartridge. Furthermore, 3-inch CDs can be played without an adaptor in the single-disc mode.

Integral to the MusicBank system mechanism is a large-diameter **Disc Stabilizer**, which is magnetically clamped atop the CD prior to playback. It dampens disc vibrations and resonances that can affect tracking and cause excessive focus servo errors. By minimizing focus servo activity, the Disc Stabilizer significantly reduces servo-generated digital noise, which can adversely affect the low-level analog stages.

Other Advanced Features

• Gold-plated analog and digital output terminals • Versatile playback capabilities: **Delete Play** enables you to specify up to 50 tracks for exclusion. **3-Way Random Play** lets you play tracks in a random order using all discs, a single disc, or a "delete" sequence. **Disc Scan** plays the first 10 seconds of each loaded disc. **Time Data Memory** stores track timing information for all loaded discs for instant recall. **4-Way Repeat Play** provides continuous playback of all tracks, a "delete" sequence, programmed tracks, or random tracks for either a single disc or all loaded discs. **Memory Play** enables you to program up to 50 tracks for playback in any desired sequence. • Synchro Record capability with compatible Nakamichi cassette decks • Compatible with Nakamichi System Remote • Full-function wireless remote control supplied

Specifications

CDPlayer 1	
System	Compact Disc digital audio
Signal Detection	Optical (semiconductor laser)
Error Correction	CIRC system
Number of Channels	2 channels, stereo
D/A Converter Type	EL 20-bit dual D/A converters
Digital Filter	$8f_s$ oversampling
Sampling Frequency	44.1kHz
Quantization	16-bit linear
Disc Rotational Velocity	Approx. 200 to 500 rpm (constant linear velocity)
Wow & Flutter	Below limits of measurement
Frequency Response	5–20,000Hz ±0.5dB
Signal-to-Noise Ratio	Better than 105dB (IHF A-wtd)
Dynamic Range	Better than 100dB
Total Harmonic Distortion	0.0025% (1kHz)
Total Harmonic Distortion + Noise	0.003% (1kHz)
Channel Separation	Better than 100dB

Output Level/Impedance	2.0V/600 ohms
Digital Output	75 ohms coaxial
Power Requirement	100–127V or 220–240V AC, 50/60Hz
Power Consumption	35W max.
Dimensions (W×H×D)	430×100×375 mm 16-15/16×3-15/16×14-3/4 inches
Approximate Weight	12.2kg/26 lb. 13 oz.
Remote Control Unit	
Principle	Infrared pulse system
Power Requirement	3V DC (1.5V×2)
Dimensions (W×H×D)	60×18×180 mm 2-3/8×11/16×7-1/16 inches
Approximate Weight	130g/5 oz. (including batteries)

- Dimensions do not include protruding parts. Height is the panel height.
- Specifications and features are subject to change without notice.
- All non-metric weights and measures are approximate.
- MusicBank is a trademark of Nakamichi Corporation.
- The full color photograph below reflects the actual appearance of this product. All other photographs of this product in this brochure (including front cover) are monotone renditions not representative of actual color.

CD Player 1

MusicBank System

Nakamichi

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