

Accuphase

COMPACT DISC PLAYER

DP-70



COMPACT
disc
DIGITAL AUDIO

Discrete D/A Converter That ACCUPHASE Boats To The World Incorporates GIC Type 5-Pole Low-pass Filters & Four-times Oversampling Digital Filters



DP-70 COMPACT DISC PLAYER

The quality of the sounds recorded in a studio can be reproduced with utmost faith in your own listening room. This is why the digital audio system is so attractive with the growing acceptance of CD technology. In short, a new era of listening excellence is unfolding in the audio world.

In the analog disc world, components such as tape recorders, cartridges, tone arms, and headshells have their own effects that modify the original sound. However, in a digital system in which the signals are encoded and processed, such modification of the actual sounds hardly takes place. A defective digital system may cause dropout or distortion of sounds. In developing a digital system, therefore, the utmost emphasis must be placed on how to prevent such dropout or distortion of the actual sounds and to improve the system's performance up to the theoretical upper limit before pursuing perfection of sound quality. This should be the basic policy of manufacturers of digital audio systems. Without adhering to this policy, manufacturers should never attempt anything that may result in modification of the actual sounds nor attempt to compensate for the dropped out or distorted sounds by means of sound modification technique.

In developing a digital audio system, there is one problem to be solved. Since digital signals contain radio-frequency noise components in a wide range, extending up to the bandwidth equivalent to VHF band of TV broadcasting frequency, these noise components interfere with the audio signals and cause inter-modulation distortion, which degrades the sound quality. This degradation is sometimes witnessed when audio equipment is placed very close to a computer radiating strong spurious waves. Therefore, eliminating the interference of the digital signal and radio-frequency noise inside the equipment and eliminating the spurious radiation from the equipment are important points in improving the sound quality. To suppress the radio-frequency noise components, the applications of radio-frequency technology is indispensable. Consequently, it can be said that digital audio equipment is not refined by digital signal technology alone, but through a unique integration with other disciplines based on radio-frequency technology and audio technology. With this philosophy in mind, Accuphase has developed a CD player in which theoretical upper-limit performance is achieved.

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The D/A converter, which converts a digital signal to an analog signal, is the heart of the CD player. The DP-70 uses discrete D/A converters which employ super-precision, high-performance elements.

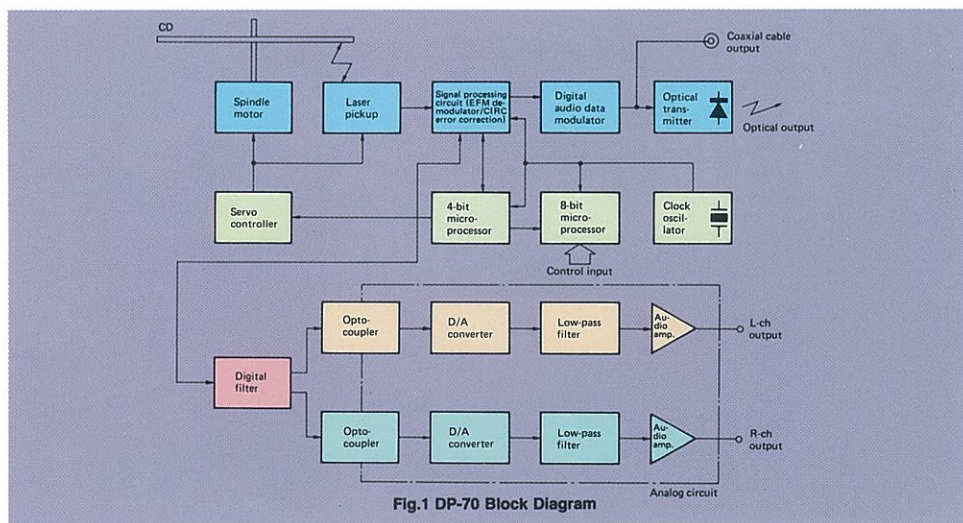
The discrete D/A converter is employed in the DP-70 to obtain the theoretical-limit-precision in 16-bit digital-to-analog conversion. With the discrete D/A converter, a total distortion, close to the theoretical-limit and extremely difficult to obtain with the LSI converter is achieved.

Filters are employed to eliminate high-frequency noise components contained in the analog signal. These high-frequency noise components interfere with the audio signal. In the DP-70, the most advanced 5-pole Butterworth low-pass filter and four-time oversampling digital filters are employed. The band-pass ripple of the digital filter is plus or minus 0.00005dB. Additionally, the attenuation of -100dB is achieved. These can be said to be amazing

values.

The digital circuit and analog circuit are electrically isolated by employing optocouplers, so that digital signals are input to the D/A converter through super-high-speed optocouplers. In addition, the digital and analog circuits have their own independent power supply to maintain their isolation.

The DP-70 weighs 21kg and belongs among the extremely heavy class of CD players. This heavy chassis is extremely effective to kill vibration and resonance generated by the disc drive system. Emphasis is placed on the simplicity of operation. Only four keys appear on the front panel. Other controls keys are hidden in the subpanel at the lower part of the front panel. Therefore, you can operate the DP-70 as if you are operating a conventional analog player. The DP-70 can be fully remote controlled by the remote commander attached as an accessory. We believe the appearance of the DP-70 on the market will contribute toward up grading the quality of CD players in the audio industry.



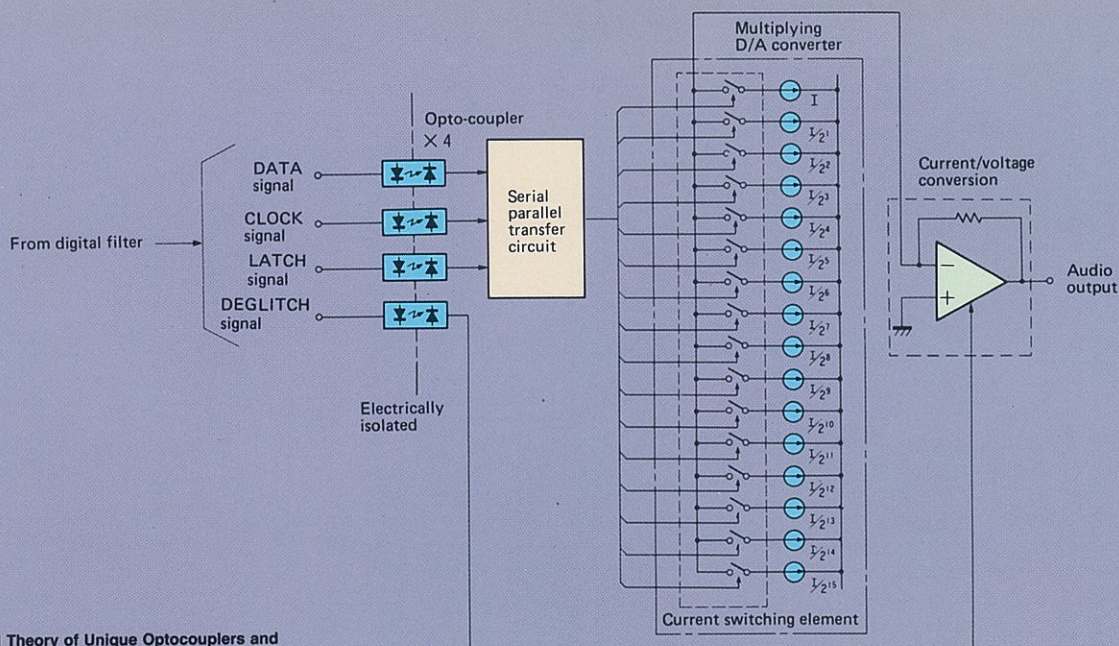


Fig. 2 Operational Theory of Unique Optocouplers and Multiplying Discrete D/A Converter

1 Only Accuphase employs the discrete D/A converter, which gives near theoretical limit of 0.001% in distortion performance.

The D/A converter which converts a digital signal to an analog signal is the heart of the digital processor. How accurately the original audio signal is reproduced is the most important point of the D/A converter.

In the DP-70, the current multiplying type D/A converters are employed, which has an excellent linearity. The discrete D/A converter was developed for the previously introduced DC-81 digital processor, which achieved for the first time in the world near theoretical limit performance. As shown in Fig. 2, precision current switch elements and super-precision resistors are used in the D/A converters.

In order to assure perfect operations even if the ambient temperature changes significantly, stringent requirements were placed on selecting the current switch elements so as to have the same temperature characteristic. Employed for each bit are the exclusively developed, super precision metal film resistors, the resistance value of which virtually does not change even when the temperature significantly varies. The resistors have a maximum tolerance of 0.0015% (the tolerance of generally used resistors is at best 1%). Additionally, each unit is carefully adjusted to its exact specification.

2 Super-highspeed optocouplers and independent power transformers for the digital and analog circuits are used for electrically shielding these stages and to eliminate radio-frequency interference.

It is well-known that radio-frequency noise interferes with reproduced audio signals. Therefore, the digital circuit and analog circuit must be electrically and magnetically isolated to eliminate interference between these two circuits. In the DP-70, digital data, shift clock signal, latch clock signal, and deglitch signal are input to the D/A converter through four optocouplers, that are provided for each channel. So, the D/A converters are electrically isolated to eliminate interference, that could be caused by common mode noises.

Even though the digital and analog circuits are isolated by optical isolators, the radio-frequency noise can come through the power line or space. Therefore, in this unit, the both digital and analog circuits are shielded by metal shield.

In addition, the digital and analog circuits have their own independent power transformer to maintain their isolation. In addition, for the audio circuit, the power to the left and right channels are supplied from different windings to reduce the cross-channel interference.

3 5-pole GIC type Butterworth low-pass filters having specially selected elements and directly coupled 0dB-gain buffer amp as output stage for better sound quality

A low-pass filter is used to cut-off unnecessary high-frequency components contained in the D/A converter output and to pass only the necessary audio frequency band. In the DP-70, GIC type Butterworth filters are used for this purpose. The Butterworth filter satisfies both the phase and attenuation characteristics for this application. The quality of the last audio stage is very important for overall sound quality. Many new ideas are also incorporated in this stage. First, the output level of the D/A converter is set in a manner that no amplification is necessary in the following stage. First, the output stage consists simply of a buffer amplifier. Second, the original Accuphase circuits and push-pull DC servo direct coupling method are used. As a result, an outstanding signal-to-noise ratio and linearity are achieved.

4 Four-time oversampling digital filters so that pass-band ripple of 0.00005dB max. and attenuation of -100dB are obtained

The digital filter employed in the DP-70 is four-time oversampling digital filters. The most important characteristics required for the digital filter are band-pass ripple and attenuation outside the band-pass. In the DP-70, four-time oversampling type digital filter is independently used for each channel. Because of this, the band-pass ripple with effects on sound quality is within plus or minus 0.00005dB, and attenuated to -100dB.

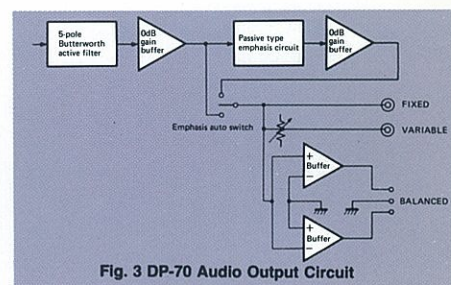


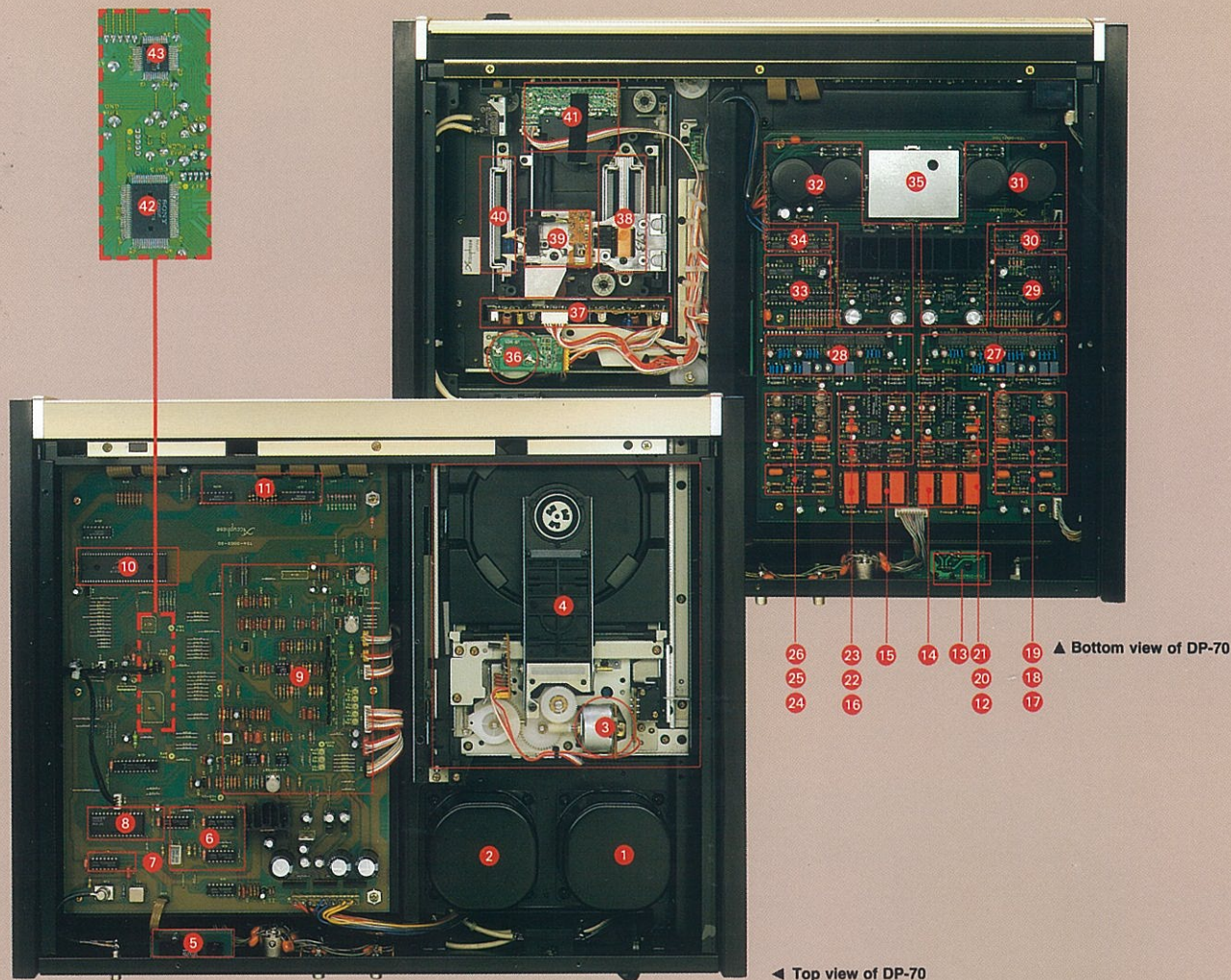
Fig. 3 DP-70 Audio Output Circuit

With this four-time oversampling, the frequency of high-frequency noise components is raised to over $(44.1 \times 4) \pm 20 = 176.4 \pm 20\text{kHz}$. Therefore, the low-pass filter to eliminate these noise components can be a 5-pole low-pass filter with a shallow attenuation slope. This makes designing the circuit easier and is advantageous for superior sound quality.

5 The deglitching circuit and I/V conversion circuit employ a high-speed C-MOS analog switch.

The output of each discrete D/A converter is obtained as current signal and must be converted to a voltage signal. This conversion is performed by the I/V conversion circuit. In the DP-70, a high-performance amplifier is used as the I/V converter for each channel. Also provided in each channel is the deglitching circuit, which eliminates pulse-like glitch waves. Some CD players have no deglitching circuits. However, glitch waves contained in the D/A converter output signal cause inter-modulation with the audio signal and deteriorates the sound quality. Therefore, for the best possible performance, glitch waves must be eliminated by a deglitch circuit.

In the DP-70, the deglitch circuit featuring a high-speed C-MOS analog switches are employed to remove harmful glitch waves. The high-speed C-MOS has a small charge injection so that the switching noise is minimized and its effect on the audio circuit is virtually eliminated.



- 1 Power transformer for digital circuits
- 2 Power transformer for analog circuits
- 3 Chucking motor
- 4 CD mechanical deck
The deck is mounted on a base which is stiff and made of special resin mixed with ceramic to prevent resonance. Also, it is raised from the chassis.
- 5 Transmitter for optical fiber transmission (digital output)
- 6 Master clock generator
- 7 Optical fiber transmission driver
- 8 IC for modulating digital audio signals
- 9 Servo control ICs
- 10 8-bit microprocessor
- 11 Display driver
- 12 De-emphasis selector relay for right channel
- 13 Transmitter for optical fiber transmission
- 14 Muting relay for right channel
- 15 Muting relay for left channel
- 16 De-emphasis selector relay for right channel
- 17 De-emphasis circuit for right channel
- 18 Unbalanced output circuit for right channel
- 19 5-pole GIC type Butterworth low-pass filter
- 20 Balanced output circuit for right channel

- 21 I/V converter and deglitching circuit for right channel
- 22 Balanced output circuit for left channel
- 23 I/V converter and deglitching circuit for left channel
- 24 De-emphasis circuit for left channel
- 25 Imbalanced output circuit for left channel
- 26 5-pole Butterworth low-pass filter for left channel
- 27 Discrete 16-bit D/A converter for right channel
- 28 Discrete 16-bit D/A converter for left channel
- 29 Serial/parallel converter for right channel
- 30 Optoisolator for right channel
- 31 Analog power supply for right channel
- 32 Analog power supply for left channel
- 33 Serial/parallel converter for left channel
- 34 Optoisolator for left channel
- 35 Four-times oversampling digital filter in shielded case
- 36 Disc turntable driver motor
- 37 RF amplifier assy.
- 38 Linear motor
- 39 Bottom of laser pickup
- 40 Linear motor position sensor
- 41 Bottom of spindle motor and driver circuit board
- 42 IC for processing digital signals
- 43 4-bit microprocessor for mechanical control

6 De-emphasis circuit consisting of passive elements and buffer amplifier

On some CD discs, the recording level is emphasized towards the higher frequency when recorded. This is called pre emphasis. When playing a pre-emphasized disc, measures to offset the pre emphasis must be taken. This is called de-emphasis. These procedures are to improve the signal-to-noise ratio through the recording and reproducing processes. However, pre-emphasis and de-emphasis are not necessary for all digital recordings.

A disc whose contents are pre-emphasized contains a special signal which indicates that the contents are pre-emphasized. This signal is detected by the player, and the response characteristics are automatically changed. Fig.

3 shows the de-emphasis circuit which is important for the sound quality. The de-emphasis circuit consists of a passive filter and buffer amplifiers so that excellent sound quality is maintained.

7 Fixed level audio output and variable level audio output and additional XLR-type balanced output are provided

Two pairs of RCA type phono jacks, one for fixed level output and the other for controlled output level, are provided. The output level for the controlled output can be adjusted by the volume control on the subpanel. The XLR-type balanced output connectors are also provided for commercial use. These outputs are low impedance (50 ohms: 25/25) (Fig. 3).

8 In addition to a standard 75-ohm coaxial cable connector, a wide-band optical fiber output connector is provided

Digital output pins are provided for a connection with other independent digital processors or amplifiers having built-in converters. The digital signals are output from a standard 75-ohm coaxial cable connector, which outputs the digital signal in accordance with the standard format, and an Accuphase dedicated optical fiber connector. The optical fiber output can transmit digital signals without being affected by spurious radiation which lowers the quality of the sound. The optical fiber cable is sold separately. When you order, specify the part number LF-10.

9 One master clock control system is employed for all operation timing to avoid beat which deteriorates the sound quality.

The reference signal which controls operations inside the player is generated by the crystal clock oscillator. Generally, two clock oscillators are used, one for digital signal processing and the other for microprocessor. However, if the frequencies of the two oscillators differ even slightly, beat is generated and the sound quality may be affected. This unit uses only one clock oscillator as shown in Fig. 1, so that no beat can be generated.

10 Selection time of less than 1 second is achieved by employing a linear motor laser pickup and 8-bit microprocessor

The direct key selection is an attractive feature of the CD player. This unit employs the most advanced linear motor mechanism which can operate swiftly and smoothly for the tracking of the laser pickup. Thanks to the linear motor mechanism and an 8-bit microprocessor specially developed for this CD player, selection time of less than 1 second is achieved. Additionally, the disc compartment can be opened or closed swiftly so that minimum effort is required to enjoy the

player.

11 The moving mechanism is mounted on a ceramic composite, special resin mountings floated from the chassis, to virtually eliminate the effect of vibration and resonance on the sound quality.

The disc rotates at 200 to 500rpm. Therefore, if measures to eliminate vibration and resonance are not taken, components inside the unit will vibrate and cause deterioration of the sound quality. In this CD player, the mechanism itself is attached to a very hard ceramic, special resin mountings floated from the chassis so that vibration is almost totally dampened. Together with the mechanism, the disc compartment is also floated from the chassis to minimize the external shock to the mechanism.

12 Heavy chassis kills resonance

The DP-70 CD player weighs 21kg and can be classed to belong among heavy CD players. The rotating section is supported by a thick metal frame, and the entire unit is designed to resist vibration. The sturdy frame construction employed in the entire unit and the legs lathed

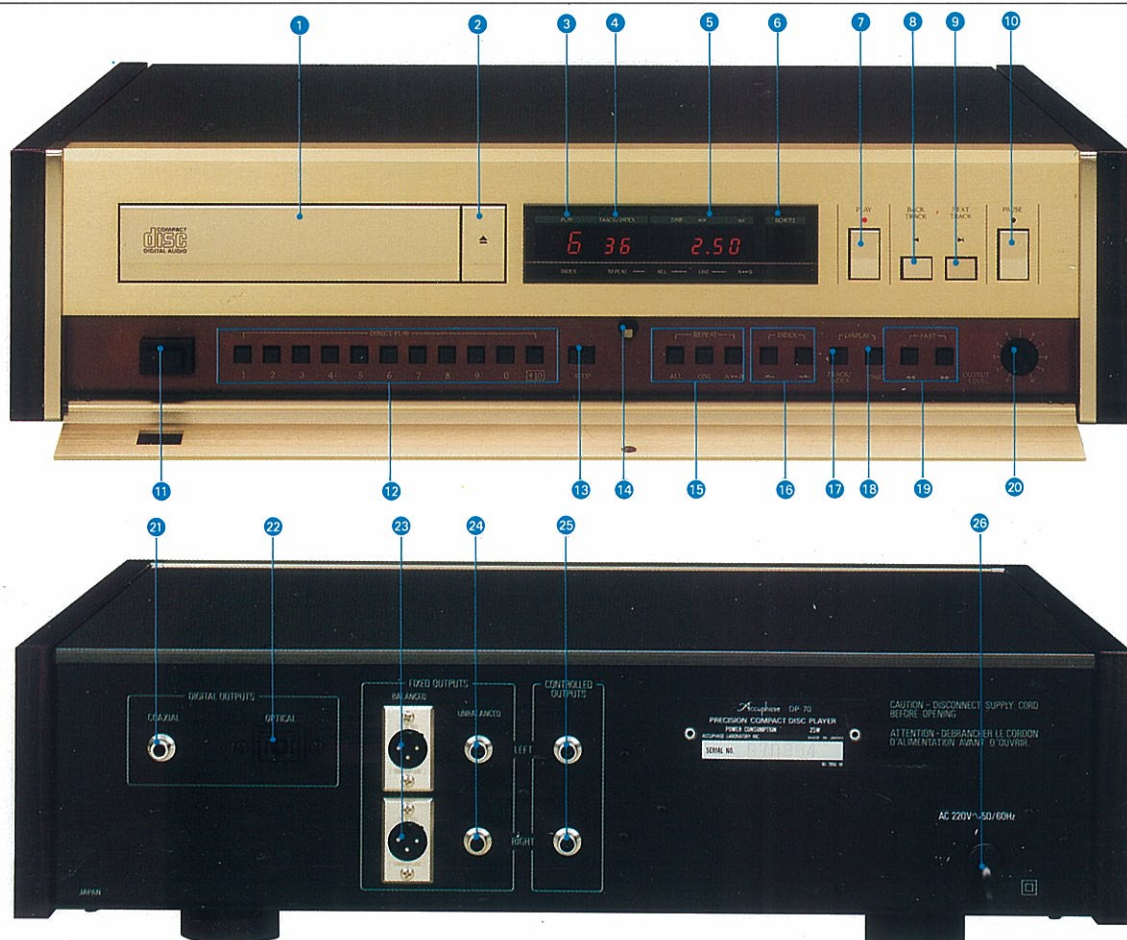
out from a pure brass bar are also effective against resonance. Therefore, the sound quality is not affected by the sound pressure from the speakers or location. These guarantee stable operation.

13 Operation is as simple as an analog player

The external appearance is designed to be much simpler than the general CD players. As can be seen in the photograph on the cover, only the PLAY, TRACK SEARCH, and PAUSE keys are on the front panel. With these keys, you can operate this CD player as though you are operating an analog player. Other control keys are hidden behind the subpanel. All functions can be controlled from the supplied remote commander.

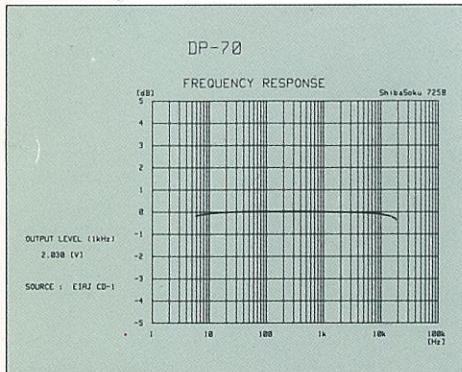
14 Simple, beautiful appearance of the CD player harmonizes with other Accuphase products

A hairline finish golden panel and natural persimmon sideboard offer good coordination with other Accuphase products, and blend right into the room to add comfort to listening.

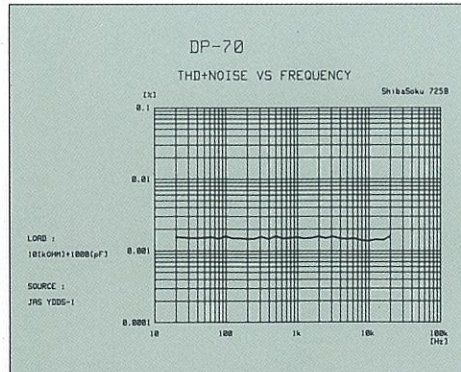


- | | |
|---------------------------------------|---|
| 1 Disc compartment | 15 REPEAT key |
| 2 Disc compartment OPEN/CLOSE key | 16 INDEX (index search) key |
| 3 PLAY track display | 17 TRACK/INDEX select key |
| 4 TRACK/INDEX indicator | 18 Time display select key |
| 5 TIME display | 19 FAST REVERSE - FAST FORWARD keys |
| 6 REMOTE sensor | 20 OUTPUT LEVEL selector |
| 7 PLAY key | 21 Digital output jack (used to connect external D/A converter) |
| 8 BACK TRACK search key | 22 Digital output optical fiber connector |
| 9 NEXT TRACK search key | 23 Imbalanced output connector (audio output/output level fixed): |
| 10 PAUSE key | cannon connector XLR-3-32 or equivalent ① Ground ② Cold ③ Hot |
| 11 Power switch | 24 Imbalanced output jack (audio output/output level fixed) |
| 12 DIRECT PLAY (direct selection) key | 25 Imbalanced output jack (audio output/output level variable) |
| 13 STOP (reset) key | 26 AC power cable |
| 14 Subpanel open/close magnet catch | |

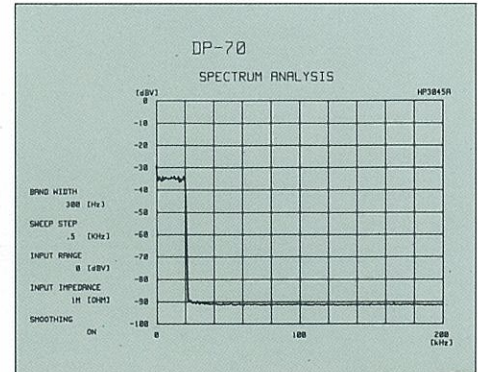
Accuphase DP-70



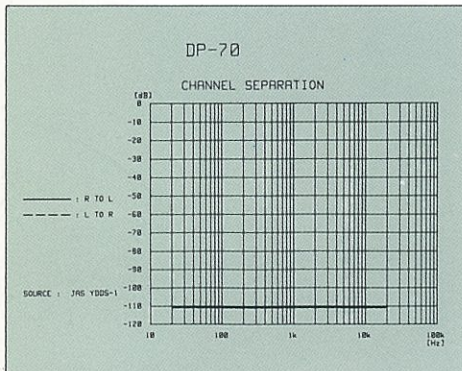
● Frequency Response



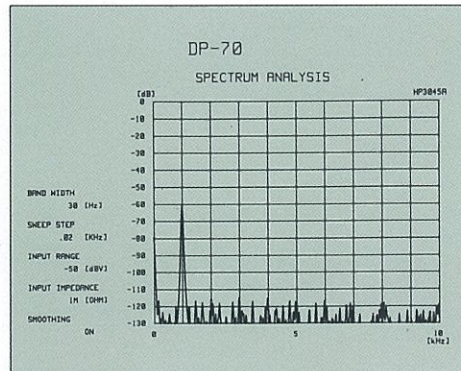
● THD + Noise vs. Frequency Characteristic



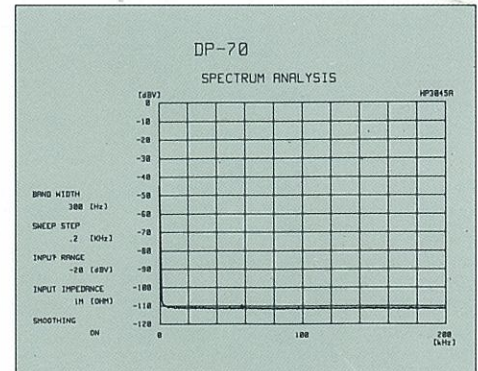
● Spectrum Analysis of -20dB White Noise



● Channel Separation Characteristic



● Spectrum Analysis of reproducing signal at 1kHz: -60dB



● Spectrum Analysis of Non-signal Reproduced Noise vs. Frequency Characteristic



GUARANTY SPECIFICATIONS

● PERFORMANCE GUARANTY:

All Accuphase product specifications are guaranteed as stated.
This system complies with the EIAJ CP-307.

● Product type: Digital CD playback unit

Format: Compact disc Standard format
Quantization: 16 bit
Sampling frequency: 44.1 kHz
Error correction principle: CIRC
Number of channels: 2
Revolution speed: 200 to 500 rpm (constant linear velocity)
Scan velocity: 1.2 to 1.4 m/s, constant

● Data extraction principle

Non-contact optical pickup (semiconductor laser)

● Laser type: GaAlAs (double heterodyne diode)

● Frequency response: 4.0 to 20,000 Hz ± 0.3 dB

● Total harmonic distortion + noise:

0.002% (20 to 20,000 Hz)

● Signal-to-noise ratio: 115 dB

● Dynamic range: 98 dB

● Channel separation: 110 dB

● Rated output level and impedance

FIXED BALANCED: 2.5V/50 ohms (25/25 ohms), balanced
XLR type connector

UNBALANCED: 2.5V/50 ohms RCA type phono jack
VARIABLE UNBALANCED: 0 to 2.5V/1.25k ohms max. RCA type phono jack

● Digital signal output format and level

Format: Digital audio interface
OPTICAL: output -20 dBm wavelength 660 nm
COAXIAL: 0.5 Vp-p, 75 ohms

● Semiconductor complement:

51 transistors, 77 ICs, 94 diodes

● Power requirements: 100/117/220/240V, 50/60 Hz

● Power consumption: 25W

● Dimensions:

475 mm (18-23/32 inches) width, 135 mm (5-5/16 inches) height (incl. Legs), 373 mm (14-11/16 inches) depth

● Weight:

21 kg (46.4 lb) net, 26 kg (57.5 lb) in shipping carton

● Supplied Remote Commander RC-1

Remote control system: Infrared control
Power supply: 3V DC with two batteries IEC designation R6 (size AA)
Dimensions: 64 mm (2-9/16 inches) width, 149 mm (5-15/16 inches) height, 18 mm (6/8 inch) depth
Weight: 115g (4.1 oz)

Accuphase
ACCUPHASE LABORATORY INC.