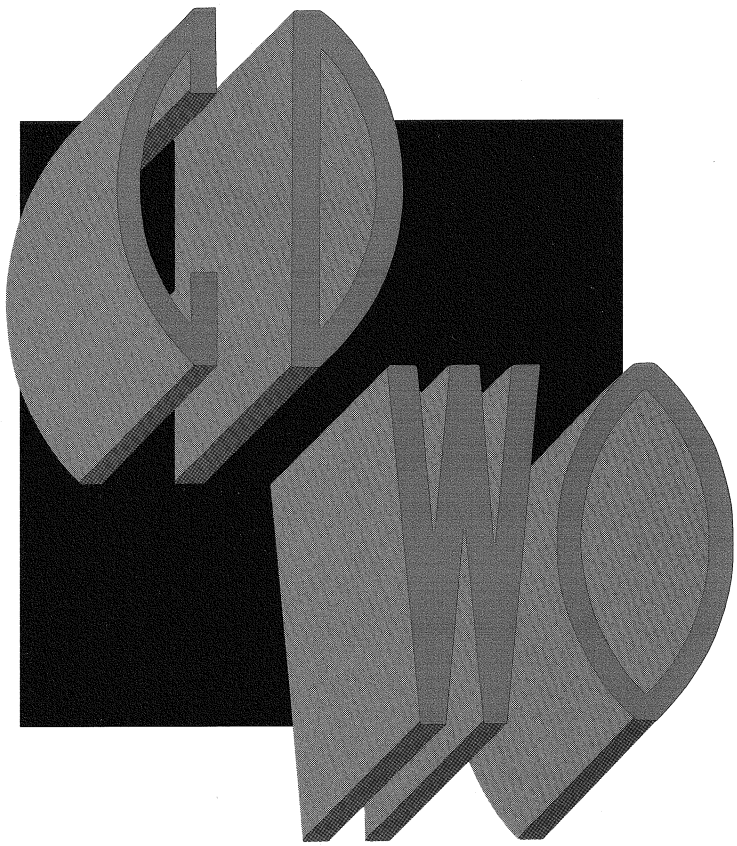
KENWOOD

CD Write Once Technology



TEST & MEASURING INSTRUMENT

CD-WO (CD WRITE ONCE)

In the analog era, a certain amount of sound recording was done using simply made disc devices, but the greater part of the recording was made on tape. Then the digital age came along, and the optical disc CD disc made its entrance. A disc having the same quality as this CD can now be produced without any large, complicated equipment. This disc is the CD WRITE ONCE (CD-WO). In 1989 the Philips Company developed a plan with a system description called the Orange Book, and in 1990 marketed a Machine for commercial use based on this interim model of the Orange Book.

At present the Orange Book system description is being finalized, but it is behind the original schedule, and the final version is due to be issued in the Spring of 1991.

The Orange Book is divided into two parts; Part 1 is the rewritable MAGNETIC OPTICAL (CD-MO) and Part 2 is the WRITE ONCE (CD-WO).

The CD-WO can be played back on A conventional CD player, but the CD-MO has the disadvantage of requiring a special pickup and more RF circuits for playback, and cannot be played back on a conventional CD player. Therefore, the ordinary installed, portable and car CD players that were marketed and spread quickly in 1982 can play only CD-WO.

Also, the price of the CD-WO disc described in this paper is expected to be around 1/5 to 1/10 of that of the CD-MO disc, and although it cannot be rewritten, it is expected to satisfy the general demand.

CD-WO

- It can be rewritten only once, but partial recording is possible.
- It is interchangeable with the ordinary CD disc.
- The CD-WO disc has a dye layer, a method suitable for mass production is planned, and the price will become lower in the future.

CD-MO

- It can be rewritten.
- It is not interchangeable with the ordinary CD disc (A special player is required).
- CD-MO discs are made of magnetic metals, and their price will not become appreciably lower.

We think that now, since the writable disc has been developed, is a good time to extend the use of CD-WO to commercially used CD players, and then to home models.

In 1990, the general purpose CD-WO System DD-7200 (CD WRITER), and DA-7000 (ENCODER) were announced, and their development was started in Japan. In 1991, considering its general purpose use, the special Digital Audio LZ-13, constructed as a single unit, was announced. Its date of appearance on the market is not decided of yet, because of an unsolved copyright problem.

The state of development of CD-WO and CD-MO and its principles at Kenwood are described below.

HISTORY OF CD

First of all, our company's relationship with CD will be explained. The Kenwood Company began operation in 1946 as a producer of radio coils. Then we developed and began selling AM HI-FI tuners for audio systems in 1954. In the same year, we developed and began selling a test oscillator for use as test and measuring instrument. Thus, we also have a long history in the field of test and measuring instrument.

The close relationship of the field of test and measuring instrument to that of CD in the development stage is not a widely known fact.

In 1980, the system description known as the Red Book was announced, and the development of the encoder, which generates the language used by the player and the CD, was started. In 1982, we began marketing not only CD players, but also CD encoders. Since then, we have developed and marketed several kinds of CD test and measuring equipment that responds to the needs of the Green Book and Yellow Book system descriptions, and we have obtained the largest share of the market.

We also performed developments pertaining to the Orange Book, which is related to CD-WO and CD-MO. Although it is not widely known, our company developed the ATIP ENCODER and DECODER, which will be described later, and cooperated on a large scale with a CD disc producing company by supplying them with CD-WO and CD-MO discs. We were also able to evaluate the CD-WO and CD-MO discs using our test and measuring equipment, and thus speed up the development of discs and recorders.

As a result, we developed a commercially used CD-WO system in 1990, and a CD-WO recorder in 1991.

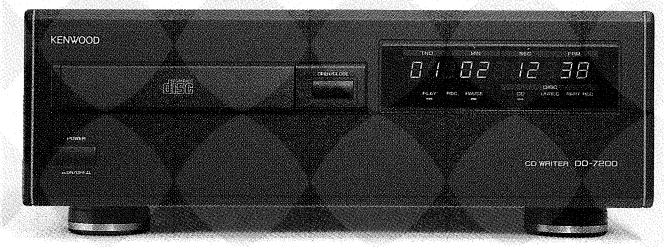
CD-WO SYSTEM DEVELOPMENT

As a result, at Kenwood, it was possible to combine the CD-WO system with test and measuring equipment that was already developed, but we judged that it was not suitable for use with new media, and we began anew the development of instruments that became attractive in the production of CD-WO. At that time, we aimed for performance, of course, and also a size that would enable easy use of CD-WO. One of the developments was the use of an LSI in the CD encoder. In the past, the CD encoder has been combined as one unit with the general purpose IC, which is also measuring equipment. However, the size of the circuit and the amount of current consumed by the general purpose IC are huge, and there was also the problem of the thorough understanding of the system description, so we miniaturized the unit by using an LSI and also improved its performance.

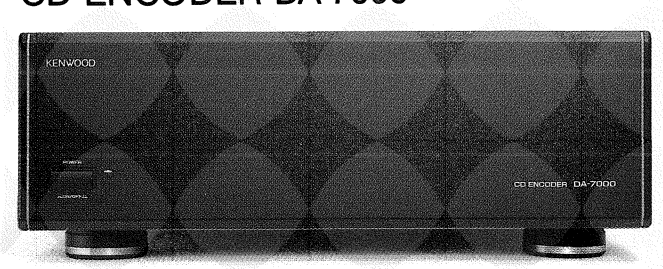
By this technical improvement, a commercial use CD-WO system suitable for use with the CD-WO was developed, using the DD-7200 and DA-7000.

Also, in the development of the single unit type LZ-13 CD-WO recorder, we undertook independent development to miniaturize the ATIP Decoder, which can be called the heart of the CD-WO and CD-MO system, by using an LSI, and also improved its performance.

CD WRITER DD-7200

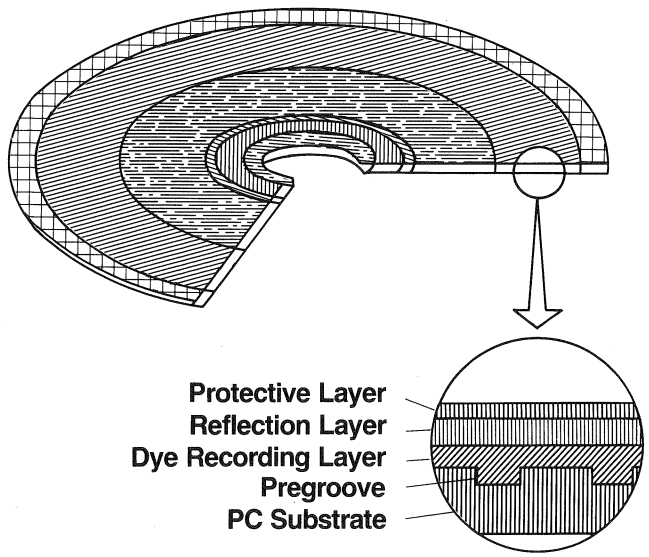


CD ENCODER DA-7000



CONFIGURATION OF CD-WO

The CD-WO disc, using laser power, changes the optical quality of the dye layer, and creates the same functions as those of the PIT of the ordinary CD disc. For writing this PIT onto the disc, a device called a "pregroove" is used. Various kinds of information is recorded in this pregroove, including, in addition to indicating the pitch of the PIT (1.6μm), the most suitable value of laser power and the absolute time in pregroove (ATIP). By making the recording in compliance with this information, the perfect compatibility of the CD disc is attained.

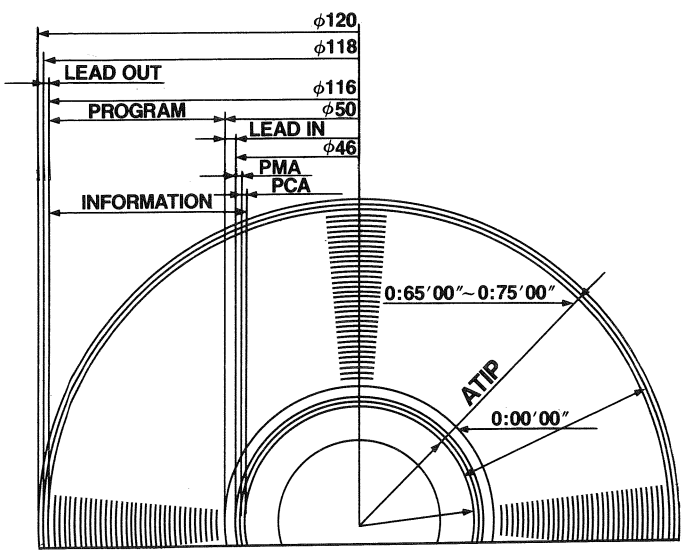


LAYOUT OF THE CD-WO DISC

The lead-in is the part called the TOC of an ordinary CD, and the lead-out from this point is exactly the same as that of the CD. PMA and PCA are parts needed for the writing operation, and are different from those of the ordinary CD. ATIP is the absolute time which shows the position in the area of the PMA and PCA, and control is performed using this time value.

PMA (Program Memory Area): When recording, the contents of the program are temporarily recorded in the area where the absolute time, track number, etc., are recorded, and are finally recorded in the lead-in area.

PCA (Power Calibration Area): When recording on a disc on which a preliminary write operation has been performed, the required power is read, the laser power which is recorded in this area is increased or decreased within a certain range, and a trial write operation is performed to determine the most suitable laser power.



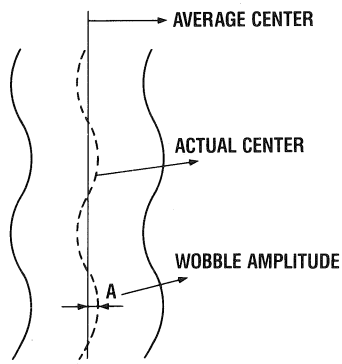
ATIP (Absolute Time In Pregroove)

In addition to the information needed for recording and the information concerning the absolute time described above, the signal that controls the revolution of the disc is recorded on the pregroove. Unlike the analog disc, the CD disc uses CAV (Constant Angular Velocity) instead of CLV (Constant Linear Velocity). For this reason, it is necessary to change the speed of revolution by the recoring position from the center. By recording this control information on the disc in advance, the compatibility of the disc can be perfectly maintained.

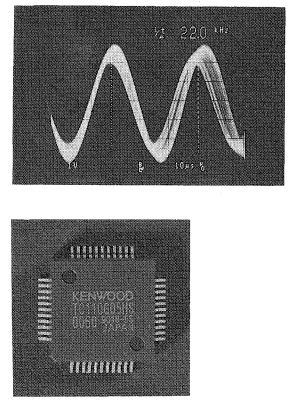
The pregroove has a winding pattern. This winding pattern is called "WOBBLE", and is an FM signal having a center frequency of 22.5kHz that is necessary for the CLV. The CLV servo activates to keep the center frequency of the signal read out from the wobble constant at 22.05kHz. Also, encoded information from the FM signal, information used for recording, and the absolute time in pregroove (ATIP) information are read out, and various kinds of control are provided.

This is a big feature of the disc system that can write this ATIP signal. For example, there is the case of partial recording on the CD-WO. The final position for every time recording performed is controlled by ATIP.

For the LZ-13, the ATIP decoder has already been independently designed to use an LSI, and to improve its performance.



GROOVE WOBBLE



ATIP LSI

COMPARISON OF CD-WO & CD-MO

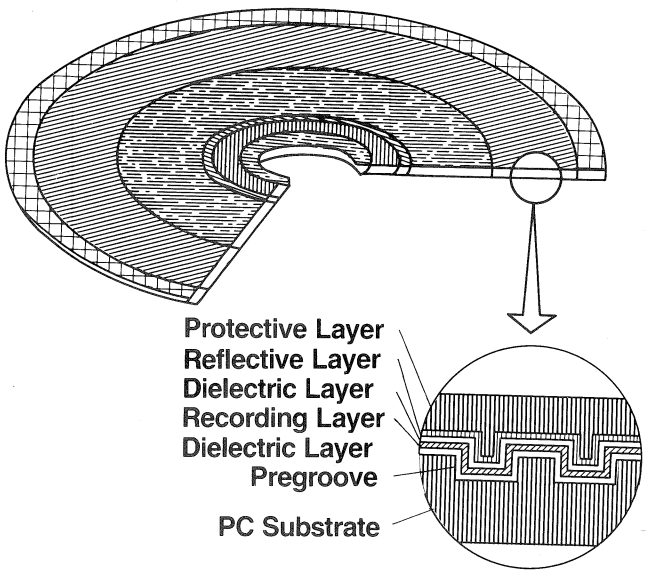
Although the CD-WO forms the same PIT as a CD disc by changing the dye layer's optical characteristics according to the strength or weakness of the laser power, the CD-MO make a recording by raising the temperature of the magnetic metal on the disc with a laser to the temperature at which the metal becomes a nonmagnetic metal (the Curie point), grasping the disc pickup and the disc, and changing the magnetic poles of the magnetic head on the opposite side. When the linear deflection laser is radiating, by the deflection of the reflected wave (Kerr rotation angle), this changing of magnetic poles is detected as the phase difference of the laser. For this reason, reading is not possible unless a pickup that can perform this kind of detection is used.

	CD-WO	CD-MO
RECORDING LAYER	DYE LAYER ORGANIC COLORING MATTER FILM TYPE	MAGNETO OPTICAL TYPE Tb-Fe-Co VERTICAL MAGNETIZED FILM TYPE
LASER POWER for RECORDING	from 4mW to 8mW	from 2.5mW to 5.0mW
LASER POWER for PLAYBACK	maximum 0.7mW	maximum 0.7mW
METHODE of RECORDING	HEAT and MELT	HEAT and CHANGE of MAGNETIAL POLARITY
METHODE of PLAYBACK	DETECTED with REFLECTION RATIO	DETECTED with KERR ROTATION ANGLE
CONFORMABILITY of RED BOOK	YES	NO

CD-MO DISC STRUCTURE

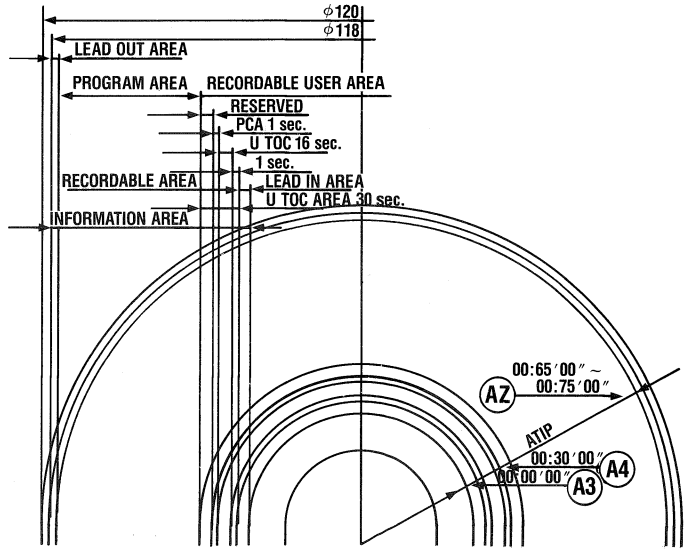
The structure of the CD-MO disc, except for the recording layer, is basically the same as that of the CD-WO disc. In other words, the recording of the CD-MO also is controlled by signal of ATIP, etc., that is written in advance on the wobble of the pregroove.

The signal that is recorded on the CD-MO is the same as that of the CD-WO, and during the control operation, the pickup and disc are grasped, and the up and down direction focus servo is added for the magnetic head on the opposite side.



LAYOUT OF THE CD-MO DISC

Because the reading of the CD-MO disc cannot be accomplished by an ordinary CD player, to avoid mistaken operation, a PIT that is the same as that of an ordinary disc is formed in its lead-in area so that the CD player can recognize that it is a CD-MO disc. Also, because the rewriting of the PMA area where the progress of the recording that is being performed is recorded is possible with the CD-MO disc, it is provided as U-TOC. This is the big difference between the CD-MO and the CD-WO disc.



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CD Write-Once

Easy to Make Just the Quantity You Need.

The Kenwood CD-R (CD Recordable) System Lets You Make CD-ROMs from Your Database in Realtime.

The Kenwood CD-R (CD Recordable) system conforms to Orange Book standards and allows CD-ROM discs to be produced in a short time by recording data base data onto CD-R blank discs.
No longer is there any need to go through complex computations using a large computer. At last, it is possible to produce CD-ROMs in realtime using a simple hardware configuration.
With Kenwood CD-R you can make precisely the quantity of high quality data discs that you need. It's ideal for game software simulation, engineering design support, publishing and book archiving, order taking and inventory, and much more.

CD-ROM Production in Realtime Using Simple Hardware Configuration

The Kenwood CD-R (CD Recordable) system basic configuration comprises the DA-7000A CD encoder, the DD-7200A CD writer, the S-~~7001~~ 701 system software, and a personal computer (IBM PS2/AT or IBM 100% compatible) to control the system. For CD-ROM production, you simply connect the optional CD-ROM/I formatter unit between the database and the CD encoder. There's no need for a large computer performing extensive CD-ROM formatting calculations; while leaving the data close to its original state, you can put it in CD-ROM disc format, quickly and easily. It's a convenient way for a software house to produce demo samples of game software and for publishers to archive books. Manufacturers can create CD-ROM discs of frequently used IC or other design data to distribute to engineers for quick access from a workstation or personal computer; it's also handy for parts lists and product lists in automated order taking and inventory systems.

Music CD and CD Graphics Formats

The Kenwood CD-R (CD Recordable) system can be used with the SD-IF or AES/EBU Digital I/O interface for music or data source applications. CD-DA (conventional digital audio CD format) discs can be produced by direct connection to the kind of U-matic VCR and PCM audio processor used for conventional CD mastering. Or, if you use a digital I/O interface, a pro spec DAT deck or CD player can be used as the sound source for digital-to-digital recording. Using an existing CD-G (CD graphics) editor and the optional CD graphics unit, still images can also be recorded. This is handy for producing sample discs for recording studios, and for TV commercial and broadcast program applications. Of course, the system can also be used for "direct-to-disc" recording of live musical events.

Up to 13 CD Writers Can Be Chained for Simultaneous Production

Up to 13 CD writers can be connected in series to the DA-7000A to enable simultaneous operation. This is convenient when a larger number of sample discs needs to be produced.

DA-7000 CD Encoder

The DA-7000A converts data into a CD format EFM signal, using as its input music or CD-ROM data recorded on a U-matic VCR or DAT deck. It is designed for use with the DD-7200A CD writer to configure a CD-R (CD Recordable) system.

* Complies with Red Book, Yellow Book, and Orange Book standards, working with the DD-7200A CD writer to configure a CD-R (CD Recordable) system.
* Control functions for the encoder include subcode generation, for complete control via GP-IB. GP-IB can also be used for control of VCR and DAT operation, thereby simplifying system configuration.
* High reliability thanks to dedicated LSI CD encoder section circuitry.

Three kinds of data input interface can be used: SDIF, digital audio interface, and parallel. This simplifies connection to U-matic VCRs, DAT decks, and other data sources.

Specifications

Coding format: Complies with CD RED/YELLOW/ORANGE BOOK
Clock: 8.6436 MHz Internal/External switchable
EFM output: symmetry adjusted EFM/EFM, 50 ohm TTL output BNC connector
Digital audio interface data input format: Balanced (cannon connector)
External sync clock: 44.1 kHz 50 ohm TTL level output BNC connector
SDIF data input: Word sync 75 ohms TTL level output (BNC connector)
DEC CH1 75 ohms TTL level output (BNC connector)
DEC CH2 75 ohms TTL level output (BNC connector)
Parallel data input data format: 8-bit units, normal logic, twos complement
Input level: TTL, pullup 330 ohms, pulldown 390 ohms
Connector: 50-pin miniature delta ribbon receptacle
RS-422 communications port connector: 9-pin D-sub
GP-IB control: IEEE 488-1978
Interface: SH1, AH1, T6, L3, SR1, DCO, DTO, CO
Power supply: AC 85 to 250V, 50 to 440Hz, about 10W
Dimensions: 428(w) x 133(h) x 415(d) mm
Weight: about 10 kg
Rack mounting: Possible
Supplied accessories: Manual, AC power cord

DD-7200A CD Writer

The DD-7200A CD writer works with the DA-7000A CD encoder as a CD production system conforming to Orange Book standards. It allows both uninterrupted recording and incremental recording. It also has a playback function for play of both conventional CDs and partially recorded discs.

* EFM Signal Input

Accepts signal input from CD encoder only.

* EFM Signal Output

Up to 13 CD writers can be connected in series to one CD encoder. The EFM output of the first CD writer goes to the EFM input of the second CD writer, and so on.

* Clock Mode

Signal recording mode uses external mode, with the FS signal from the CD encoder connected to the FS signal input. The internal mode is possible for playback.

* FS Signal Input

With one encoder connected to up to 13 CD writers in series, the FS signal output from the first CD writer goes to the FS signal input of the second CD writer and so on.

* Recording/Playback Audio Monitor Output

18-bit D/A converter, low-pass filter, and balanced output circuitry are included to provide monitoring capability for the audio signal during recording and playback.

* Digital Data Output

A digital data output is provided conforming to EIAJ/EBU standards for digital audio interfaces.

* Encoder Start/Stop Signal Output

Control signal output for starting and stopping CD encoder subcode generation during recording.

* GP-IB Interface

The four modes of uninterrupted recording, incremental recording, CD play, and partial disc playback are all controlled through the GP-IB bus from a personal computer (IBM PS2/AT or IBM 100% compatible), using the S-~~7001~~ 701 system software.

* Q Code Indication

Displays Q-code based TNO and TNO elapsed time during recording and playback.

* Mode/Status indication

Indicates rec, play, and pause modes, as well as four conditions of recording, play, rec standby, and play standby.

* Disc Type Indication

After a disc has been loaded, the disc type according to the Orange Book Part II standard is indicated.

Specifications

Coding format: Complies with CD RED/YELLOW/ORANGE BOOK

Recording format: Optical modulation by laser

Recording wavelength: 780 to 790nm

Recording power: Approx. 4 mW to 8 mW, automatic setting based on ATIP code

Playback power: about 0.5mW

Rotation system:

While recording:	CLV according to WOBBLE signal
During reproduction:	CLV according to EFM signal
CLV range:	1.2m/s - 1.4m/s
Recording position control:	Time control by ATIP within WOBBLE signal

Recorded disc CI error rate: 3 x 10-2 or less (using our discs)

Recorded disc EFM signal ST jitter: 30ns or less (using our discs)

Sync error: Between ATIP and Sub-coder: +/- 10 EFM frame

Connection at the time of increment: 26 EFM +/- EFM frame

Input/Output signal: EFM signal: 50 ohms according to TTL level,(BNC connector)

Sync signal: 50 ohms according to 44.1 kHz TTL level, (BNC connector)

EFM start: Output at CMOS level (BNC connector)

Control signal: GP-IB, IEEE 24-pin multi-connector

Digital output: EIAJ/EBU standard, XLR3-32 connector

Audio output (L, R): 600 ohm balanced output, XLR3-32 connector

Control: All GP-IB controllable (IEEE 488 1978)

Disc loading: Front loading controlled by open/close key

Power supply: AC 100/120/220/240V, 50/60Hz, about 30W

Dimensions: 426(w) x 133(h) x 480(d) mm

Weight: about 14 kg

Rack mounting: Possible

Operating environment: 15 to 35 degrees C, 25 to 80% RF

Supplied accessories: Manual, AC power cord

CD-R: System Diagram