Matsushita Electric and N. V. Philips have developed a new Digital Compact Cassette (DCC) standard as a system to replace existing analog cassettes. The companies reached an agreement to jointly offer DCC technology to other companies. Licenses for the related patents will be collectively granted by Philips.

The specifications of DCC are different from those of DAT, a commercially-available digital audio tape system that feature a rotary head similar to those used in video cassette recorders. DCC features a stationary head, an idea suggested but still under development when DAT was being standardized. With the realization of a multi-channel thin-film head, DCC is expected to overtake DAT as the standard for digital recording on compact cassettes.

The development of DCC involved the implementation of a multi-channel thin-film head, development of a high-performance digital coding algorithm, and use of precision semiconductor technology. Features of DCC are listed below.

(1) In addition to digital recording and playback, DCC allows the same tape deck to perform analog playback using existing analog cassettes, thus providing backward compatibility.

(2) A new digital coding algorithm provides tone quality close to that of CD or DAT using only one fourth of the information.
(3) Existing analog cassette mechanisms with the exception of the magnetic head can be used, keeping new equipment costs down.

(4) Since existing analog cassette equipment can be modified to make duplicating equipment for DCC tapes, new equipment cost can be kept to a minimum.

A DCC tape has the same length and width (100.4 x 63.8mm) as existing analog cassette, however, the analog cassette is 8.7mm thick while the DCC tape is 9.6mm thick (see Fig. 1). The DCC is stronger, and because it has no convexities to support the tape running mechanism or holes for the reel hubs on the front face, a larger label can be used. A shutter similar to that used on 3.5-inch floppy disks is used to protect the exposed tape when the DCC is not in use. The shutter also covers the reel hub holes on the back side. When the cassette is loaded into a tape deck, the shutter opens automatically.

There are eight digital tracks and one control signal track for each tape direction.

An integrated thin-film magnetic head provides digital recording and playback as well as analog playback (see Fig. 2 and 3).
Precision Adaptive Sub-band Coding (PASC) is used to compress audio information to one fourth its original size. By taking advantage of the characteristics of the human ear (See Fig. 4), signals below the audibility limit and signals masked by larger signals are cut to compress the original 1,536-K bits/s. signal to one fourth its original size (384K bits/s.). Address information is also recorded on the tape to allow the user to select music in a CD-like manner. Response to music selections will be slower than with CDs, however, because of tape travel time.

In addition to audio information, DCC will support text mode. Text mode will allow characters and pictures to be displayed on a CRT as either on line of 12 characters, two lines of 40 characters, or 21 lines of 40 characters. Text mode can be used to display tape titles, song titles, composers, players as well as other information.

In addition to pre-recorded DCC tapes, blank DCC tapes will be available in two formats. The standard format will contain a start and reverse marker. The special format will contain the start and reverse markers as well as TOC information (various markers, text information, recording/reproduction channel number settings, etc.). Initially, gamma-iron-based 90-minute tapes will be available (120-minute tapes will be available in the future). The tape playback speed will be 4.76cm/s., the same as that for existing audio cassettes. Other deck specifications include a sampling frequency of 32, 44.1 or 48kHz; 16 bits per input sample, and 24 input channels.

Matsushita Electric recently demonstrated a DCC system using a trial DCC deck which delivered virtually CD-quality response. Music tapes will be the key to the popularity of the new medium. Matsushita and Philips say they have already obtained support from major recording companies. It is probable that DCC will be the standard for the next generation of audio tape systems.

![Figure 4: Precision Adaptive Sub-Band Coding (PASC) Method](image)

- **Sound Level (dB)**
  - Audible Sound
  - Audible Limit
  - Inaudible Sound
  - Audibility Limit

- **Signals below the Audibility Limit are Cut**
- **Masking Effect of Large Signals**
  - Changes in the audibility limit caused by signal A (signal B becomes inaudible)
  - Signal B is audible but signal C is not
Transmission Rate

- Main: 96 kbit/sec x 8
  Aux: 12 kbit/sec x 1

- System Info: 6 kbit/sec
  Aux: 6.75 kbit/sec

- Main: 384 kbit/sec
  Main: 576 kbit/sec
  Aux: 9 kbit/sec

- System: 48 kHz, 1.728 Mbit/sec
  44.1 kHz, 1.5876 Mbit/sec
  32 kHz, 1.152 Mbit/sec
The specification of the DCC system

Number of channels: 2 (stereo or 2 channel mono)

Frequency characteristics:
\[ f_s = 48 \text{ kHz} \quad 5 \sim 22 \text{ kHz} \]
\[ f_s = 44.1 \text{ kHz} \quad 5 \sim 20 \text{ kHz} \]
\[ f_s = 32 \text{ kHz} \quad 5 \sim 14.5 \text{ kHz} \]

Dynamic range: more than 105 dB

THD: more than 92 dB

Sampling frequency: 48 - 44.1 - 32 kHz

Audio coding: Precision Adaptive Subband Coding (PASC)

Bitrate of coded signal: 384 kbit/sec

Error correction: product code of RS (24,20,5) and RS (32,26,7)

Modulation: 8 - 10

Recording time: ¥90 45min x 2

Types of tape: CrO2

Tape width: 3.78 mm

Tape speed: 4.76 cm/sec

Number of tracks:
- 8 digital main data tracks
- 1 digital aux. data track

Track width: 185 \mu m

Track pitch: 195 \mu m

Minimum wavelength (\lambda_{\text{min}}): 0.992 \mu m
Mechanism & Tape

Head

Digital Recording Tracks

Head Rotates

Digital Playback Tracks

Tape Direction

Sector A

Sector B

Analogue Playback Tracks

Track Configuration & Dimensions

Digital Recording

Digital Playback

185 μm

70 μm

3.78 mm

Right: 600 μm

Left

Analogue Playback
Main data format

1 tape frame = 32 tape blocks × 8 tracks = 256 tapeblocks
1 tape block = 3 (Header) + 48 (Modulated Symbols) = 51 byte

= 408 unmodulate bits
Aux data format

1 auxiliary data tape frame = 4 tape blocks
1 tape block = 3 (Header) + 48 (Modulated symbols) = 51 byte