

# THE PRE-RECORDED DCC MUSIC COMPACT CASSETTE



**DIGITAL**  
**dcc**  
COMPACT CASSETTE



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MUSIC COMPACT CASSETTE**

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## Introduction

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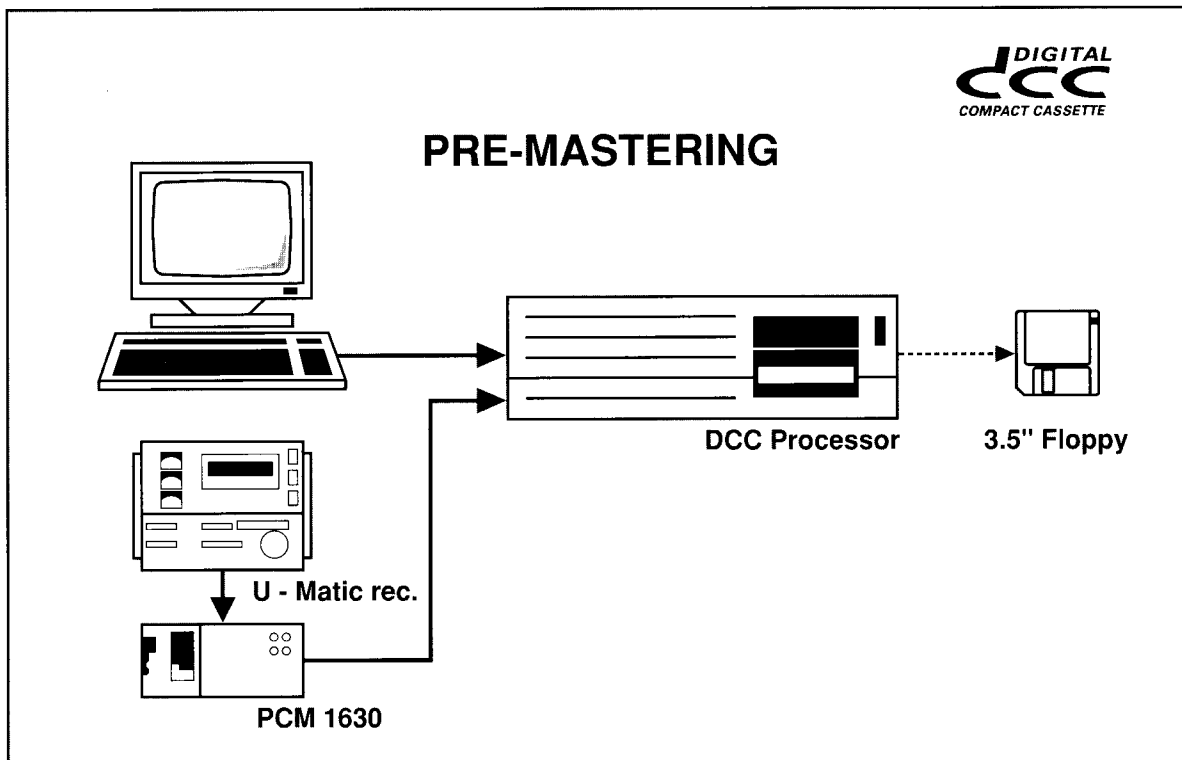
As the Digital Compact Cassette (DCC) enters the final phase before public launch, its performance and features are generally known within the industry.

All the hardware and software necessary for the production of pre-recorded DCC music compact cassettes is now commercially available. The purpose-built PolyGram pre-recorded DCC factory at Amersfoort in the Netherlands is already operating at full capacity and other pre-recorded DCC factories are coming on stream in the USA (Sonopress, Cinram), Germany (Sonopress) and Japan (JVC). Other manufacturers have already signed up and a number of deliveries are scheduled for the coming months.

Much valuable information and experience was gained during the commissioning of the Amersfoort plant. To make this available to companies interested in DCC manufacturing, and support them during and after installation, Philips has set up a special business unit 'Mastering and Duplication'. The DCC manufacturing equipment is highly modular and this support is available to all potential purchasers, whether it be for just a pre-mastering station or a complete production facility.

This document introduces the manufacturing technology for pre-recorded DCC tapes. The production process consists of five sequential stages: pre-mastering, mastering, downloading, duplicating and finishing. Each of these is described in the following pages.

## Pre-mastering



The special feature of DCC whereby text is displayed simultaneously with the music involves an extra process before mastering. This process is known as pre-mastering. The pre-mastering source material is the music on the studio master tape, usually the industry standard U-matic, and the display text in the form of a simple ASCII file on floppy disk. Pre-mastering involves the addition of DCC PQ codes to the studio master and configuring the text on the floppy disk for synchronisation with the music. The DCC PQ codes are almost identical to those used for CD, so a studio master previously used for CD requires only small alterations during pre-mastering. If required, text can be created during pre-mastering instead of importing it from a floppy disk.

### Hardware and software

The hardware and software required for pre-mastering is:

- Sony Master Recorder DMR-4000
- Sony Audio Processor PCM-1630
- DCC Text Editing Station
- Text Software Package

The first two items are standard equipment within the industry. The DCC text creation tool is a PC (20 MHz 386 (SX), MS-DOS 5.0, Microsoft mouse) containing a PQ interface card and connected to the DMR-4000 by a PQ editor cable.

## Pre-mastering

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The application software is a PQ editor and DCC text editor. The PQ editor adapts the PQ data on the studio master for DCC. The DCC text editor configures the text on the floppy disk for the three possible displays:

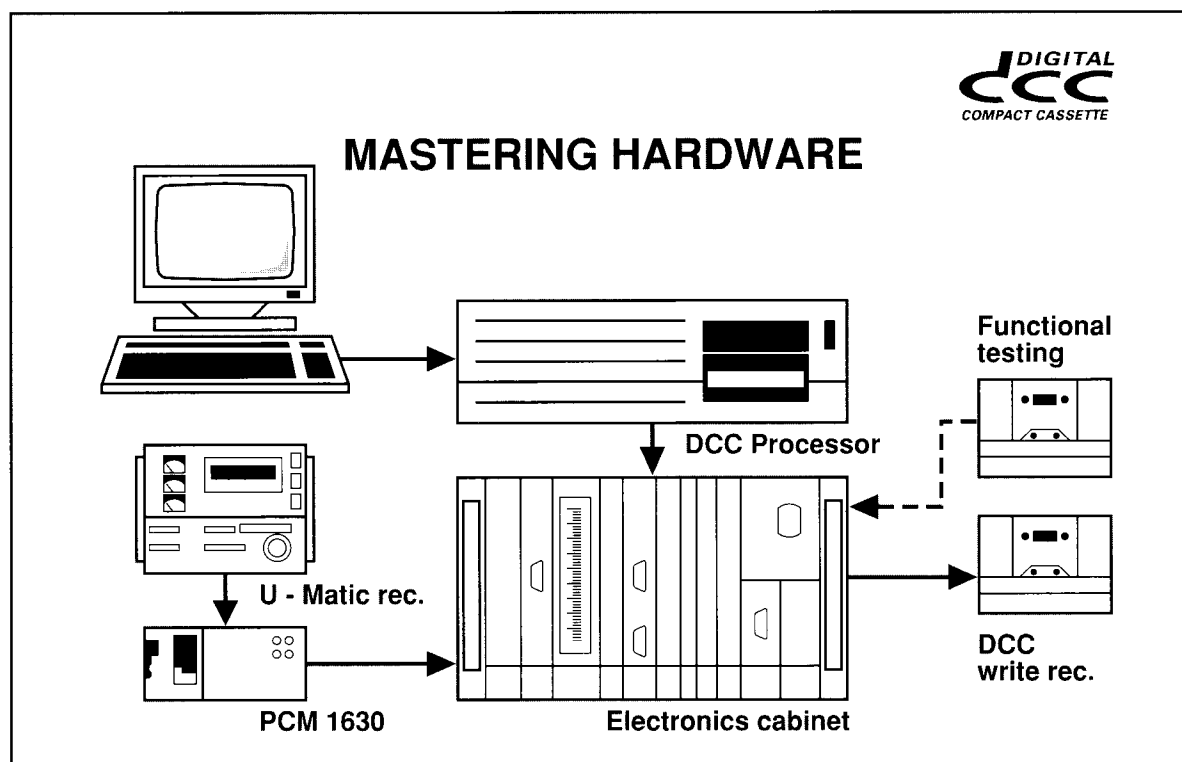
- TV screen mode with 21 lines of 40 characters in 16 colours
- two line 40 character mode for DCC players (black and white)
- single line 12 character window (black and white)

Text information is linked with the PQ cue codes to position the text on the tape. Mandatory information, such as the album title and table of contents, appears everywhere on the tape while track titles and lyrics are synchronised with the audio. A quick survey of different aspects of the text on the tape is presented on a menu basis. At the moment the system can use up to seven languages. More features are in development, such as scrolling the text, etc.

### Output

The output of the pre-mastering process is the master tape, and the floppy disk containing the text configured in the DCC format. Pre-mastering is not directly integrated into any other aspect of DCC production and can, if required, be performed as an independent activity external to the studio or factory. Philips is able to supply a DCC pre-mastering processor as a stand-alone unit.

## Mastering



The DCC mastering process involves taking the two sources from pre-mastering (the studio master and the text floppy), and merging them both on a DCC Master. The DCC Master is recorded on a standard DCC tape. Its digital format makes it particularly suitable for storage, allows easy functional testing and can be played back on any DCC player.

The studio master has one video track and two audio tracks. The video track contains the music in digital form, one of the audio tracks contains an SMPT real-time signal and the other contains the DCC PQ codes. During mastering, the music and text data are encoded into PASC and recorded on the eight main data tracks on the DCC tape. This process involves 8:10 modulation, to remove the DC element, and the encoding of the music and data in frames. Each frame contains 13,056 bytes, of which 8192 bytes are PASC signal, 3968 bytes are available for error correction code (cross interleaved Reed Solomon) and 128 bytes contain system information. The remainder are accounted for by synchronisation and addressing signals, giving 1632 bytes per track per frame.

The ninth track on the DCC tape contains program track and index number, time code, table of contents, etc. Because the use of a single channel limits the use of error correction code, the bit rate on this channel is 12 Kb per second against 96 for the main data tracks.

# Mastering

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## Hardware

DCC mastering is performed at a dedicated DCC Mastering Workstation. A Mastering Workstation comprises:

- Sony Master Recorder DMR-4000
- Sony Audio Processor PCM-1630
- DCC Controller
- DCC Electronics Cabinet/Processor
- DCC Recorder

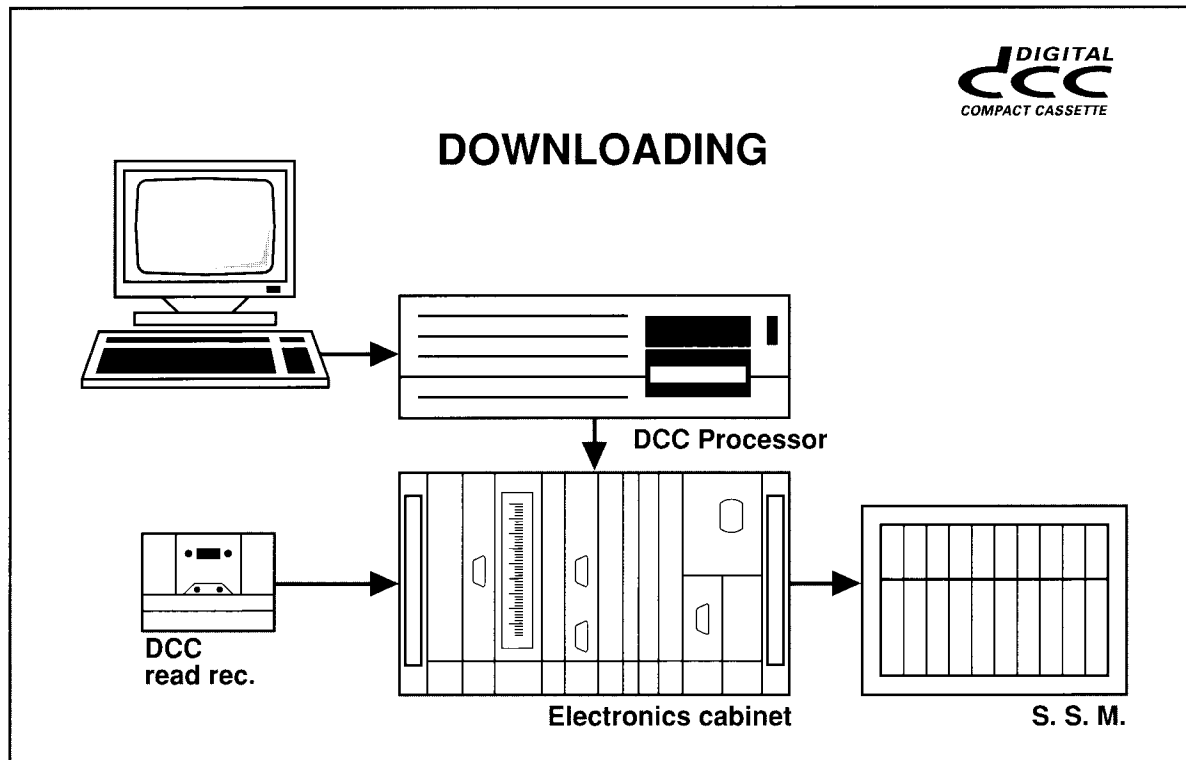
The Sony Master Recorder reads the music and timing tracks from the U-matic tape under the control of the DCC Processor. The music output is fed to the Audio Processor and the timing tracks to the DCC Processor. The Sony PCM-1630 demodulates the digital audio signal from the Master Recorder and feeds it as an AES/EBU signal to the DCC Electronics Cabinet. Under the control of the DCC Processor the Electronics Cabinet merges the music and text data, encodes the resulting signal in PASC and writes it to the DCC Recorder.

A real-time representation of the mastering activity is displayed on the screen of the DCC Controller during mastering.

## Functional testing

The quality of the DCC master is crucial to the quality of the end product, which should be identical. The DCC master can be functionally tested at the Mastering Workstation for audio quality, text content and synchronisation. Depending on the result of this functional test a decision is made whether to re-master or go into production. This functional test also acts as a performance indicator for the hardware used in the creation of the DCC master.

## Downloading



The DCC Master is downloaded into the solid-state master, whose content is then duplicated onto the final product - the consumer's DCC tape. If required, dedicated error checking can be performed before downloading. This is particularly of use where a DCC master is received from an external source and its quality is not known or the master has been stored for repeat orders. Downloading is performed at a dedicated DCC Downloading station. A Downloading station comprises:

- DCC Controller
- DCC Electronics Cabinet/Processor
- DCC Playback Deck
- Solid-state master (S.S.M)

The data on the DCC Master is downloaded to the solid-state master at normal play speed but, because both A and B sectors are read simultaneously, the action takes about half the play time. This means that the B sector is loaded in reverse. So that its data can be corrected its frames are 'flipped' during loading.



## Downloading

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### **Solid-state master**

The solid-state master is essentially just a vast memory - about four giga bits. Solid state masters already exist for analogue tape production but tend to be very bulky and expensive. Due to the highly efficient PASC coding employed by DCC, the new solid-state master is a factor of four smaller but, because the audio content requires an equivalent amount of system and control data, the actual saving in memory is 50%.

The solid-state master can contain up to 115 minutes of recorded music - two programmes can be simultaneously stored if their total length is less than 115 minutes. They cannot be loaded simultaneously but while the second is being loaded the first can be written to a group of slave duplicators.

Up to five DCC solid-state masters can be rack mounted in a single cabinet.

## Duplication

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The solid-state-master can simultaneously write to up to 31 slave duplicators at 64 times normal recording speed. This is merely the initial target speed and there is no fundamental reason why faster speeds will not be eventually achieved. The 18 tracks which form the two sectors are transmitted in parallel over an RS 485 interface at a data rate of 6.5 Mb per second. Patch panels between the solid-state master(s) and the slave duplicators enable flexibility of routing.

### Slave duplicators

DCC employs high volume video chrome tape so the minimum recordable wavelength is 1 micron. Each channel on the tape is 185 microns wide with a track pitch of 195 microns. The track width required for playback is only 70 microns and this is the ultimate target track width.

During duplication, tape is streamed from a large spool, known as a "pancake", at a speed of three metres per second. The recording head is a thin-film unit that has been specially designed by Philips Professional Recording Group. To avoid crosstalk and dissipation adjacent tracks are not recorded simultaneously.

The data the slave receives from the solid-state master is a perfect transcription of the DCC Tape Master. Duplication is a critical process if the consumer's DCC tape is to achieve its potential audio quality. To help achieve this, the duplicating room can be equipped with local clean air working areas around the slaves. The entire production area does not need to be at clean-room standard but a certain amount of discipline regarding cleanliness should be observed, such as excluding paper or other dust-generating materials, and the wearing of protective clothing. Ideally, the room should be kept slightly pressurized to reduce the entry of dust.

The PolyGram factory utilises slave duplicators that have been adapted from analogue slave duplicators. These four-deck duplicators are now commercially available from Philips. Other DCC slave duplicators include an all new model specially developed by Lyrec (Denmark) and an upgraded analogue slave duplicator from Gauss (USA). These products will be integrated into the Philips pilot line delivery of mastering and duplicating systems.

### Pancake tester

To check the validity of the data written by a slave duplicator, and as a quality check on the final product, the recorded pancake can be checked by a 'pancake tester'. The pancake tester transport is a Lyrec TR 55 tape deck upgraded with finer tolerances in the headstack area to handle the narrow track width. Critical components, such as the heads, guides and capstan motors, are mounted on a precision machined reference plate. The electronics is based on the quality control modules developed by Philips. The ability to read and write makes the pancake tester also suitable for quality testing blank pancakes received from the tape manufacturer.

## Finishing

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### **Cassette loader**

Once the pancake of recorded tape has been satisfactorily tested it can be loaded into cassettes. Cue marks written during duplication are used as reference for splicing. A cassette loader for DCC (that can also wind in analogue tape) is available from Tapematic (Italy).

### **Cassette tester**

The final quality check of individual cassettes can be performed either on the error checking part of the downloader or on a dedicated cassette tester. The cassette tester simultaneously runs four cassettes from a batch, each playing a different quadrant. So a batch test can be performed in one quarter tape play time.

### **Printing and packing**

Final finishing involves positioning the cassette inlay card and ultrasonically welding the plastic window. The rear side of the cassette can be tampon printed with track information.

The printed spine and reverse cover is inserted in the case together with a booklet, where required. Standard factory automation tools to perform these functions are available from GeMa(Italy).

Finishing by cellophaning or shrink wrapping are standard.

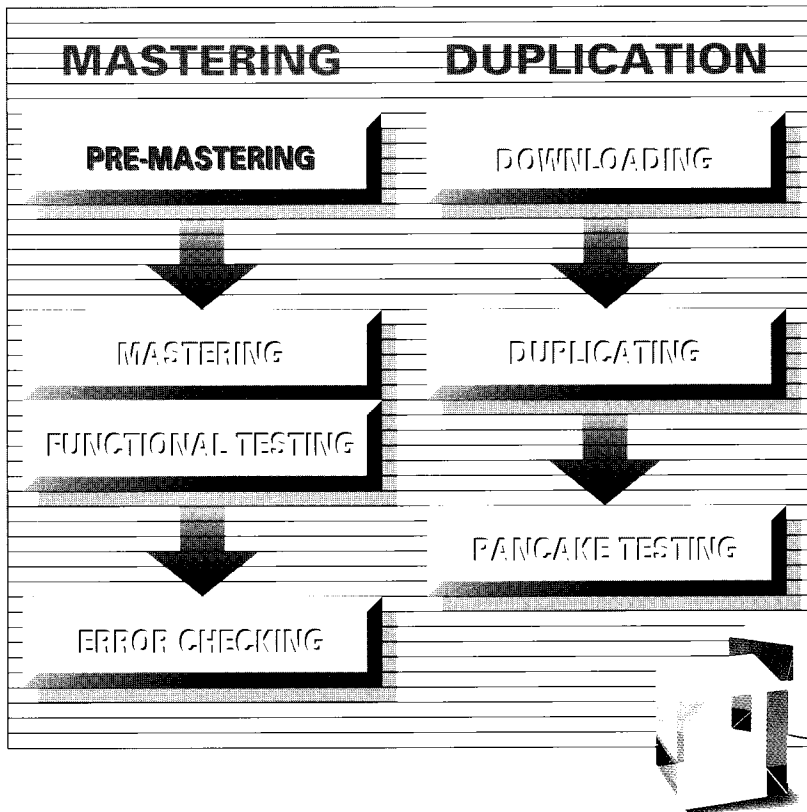
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# PRE-MASTERING STATION



- Generating and editing of DCC display text and graphics
- Text in seven languages
- Adding of DCC PQ codes
- Interfaces with standard professional audio equipment
- Easy-to-use menu based software
- Compact and inobtrusive hardware

*All manufacturing equipment for DCC pre-recorded tapes is available, either as individual modules or incorporated in a turn-key production system. Make a sound investment in the future. Manufacturing modules for pre-recorded DCCs from Philips, originator of the Digital Compact Cassette format.*

Pre-mastering involves the addition of DCC PQ codes to the studio master and configuring the text in preparation for inclusion on the DCC Master. The source material for Pre-Mastering is the PQ data on the studio master and the text, which is supplied on a diskette in ASCII format or generated at the Pre-Mastering Station. The output of the Pre-Mastering process is the studio master, with PQ codes adapted for DCC and a diskette containing the text configured in the DCC format.

The Pre-Mastering station consists of a DCC Processor and the DCC Pre-Mastering program. The software is no more difficult to use than a word processor. No special programming or other skills, apart from initial training, are necessary. Once trained, a user is able to exercise his or her creative abilities to enhance the end product. Recording company logos can be incorporated or created and house styles for text easily established.

A DCC Pre-Mastering station takes up no more space than a normal office computer and can, if required, be installed as a

stand-alone unit in a supplied cabinet. The hardware requires no special environmental conditions and its compactness allows it to fit in easily alongside existing mastering equipment.

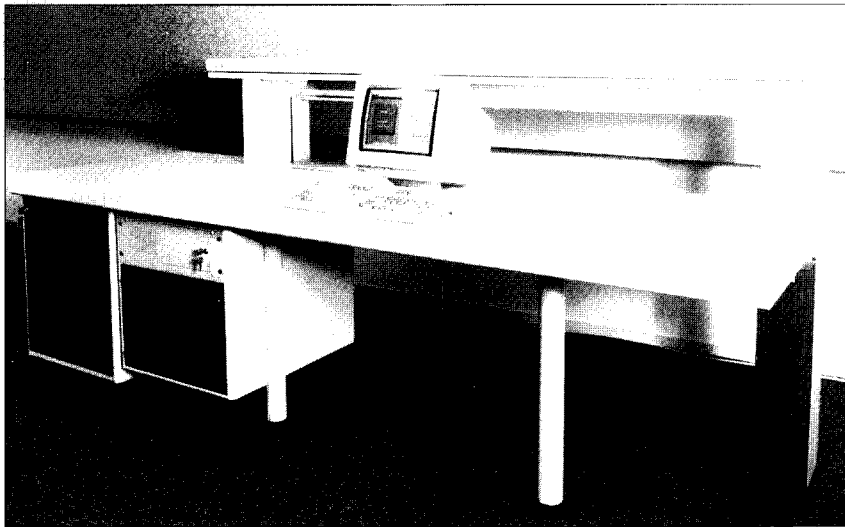
## Text Mode

Text Mode is feature of DCC whereby text from the tape can be visually displayed while the tape is playing. This text can be:

- the album title
  - the track list
  - the credits
  - a menu of the above items
- All of which are mandatory, and:
- the lyrics
  - a language menu

which are not obligatory. The required item is chosen from the menu by the user. The album title and track list are available at any time while the tape is playing. The credits can be similarly available or tailored to a specific track. The lyrics are always displayed in synchronisation with the music.





Upon completion a status report is presented detailing any errors. The procedure can be repeated until an error free status report is presented, thus ensuring that the text is correctly configured.

Extra characters not included in the basic alpha/numeric set on the keyboard area also available.

The text can be displayed on a variety of mediums including:

- the DCC player itself
- the remote control unit
- a monitor
- a TV set

The attributes that can be assigned include simple graphics, 16 colours, different fonts and visual effects such as scrolling. TV screen mode allows 21 lines of 40 characters, whereas DCC players can display 2 lines of 40 characters. A single line 12 character display is also possible.

#### DCC Processor

The DCC Processor consists of a personal computer. A 3½" diskette drive is included and this is protected against wrongful use by a lockable door. Inside, the DCC Processor contains a PQ interface card, which is connected by a PQ Editor cable to the unit on which the studio master is played.

The DCC Processor can be protected from unauthorised use by means of a hardware key that plugs into the printer port. A printer can be connected to the DCC processor although it is not supplied.

#### Software User Interface

The user interface is menu based. Items are selected either by the arrow cursor keys or the mouse. If an inappropriate menu item is selected, an error message is given plus (where appropriate) the selectable range.

The program works in much the same way as a word processor. The text is loaded from the diskette (or locally generated) and then manipulated as required and attributes assigned to it. A Help window is also available.

#### Technical Data

DCC Processor:	20 MHz 386 (SX)
RAM	4 Mb
Hard disk	40 Mb
Diskette	3½", 1.4 Mb (High density)
Operating system	MS-DOS 5.0, plus QEMM v6.1
Installed cards	HD Controller VGA Card I/O Card Processor Card PQ Interface LT Interface

Dimensions: (mm)	( d x w x h )
DCC Processor:	440 x 490 x 180
Station	850 x 2080 x 1210
Ancillary equipment cabinet	850 x 540 x 780

*Values are to the nearest 10 mm above the maximum dimension.*

Power:	
Voltage	220 V a.c.
Current	2 A
Weight:	185 kg
Operating ranges:	
Temperature	0-55°C
Humidity	Up to 80° non-condensing
Storage temperature:	-25° to +80° C

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