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DCC SYSTEM DESCRIPTION VOL. 1

(for DCC player and / or recorder manufacturers)

The System Description of Digital Compact Cassette (DCC)
is published by Philips Consumer Electronics B.V.
and has been prepared in close cooperation with
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.

DIGITAL
dcc
COMPACT CASSETTE

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List of Illustrations

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1. Scope

1. SCOPE

Scope

The DCC System Description applies to the Digital Compact Cassette (DCC) system for consumer audio applications and is intended to be used by manufacturers of DCC players and/or recorders.
Characteristic of the DCC system is digitally encoded audio information by means of a Precision Adaptive Subband Coding technique (PASC) on a magnetic tape of 3.78 mm width, packaged in a cassette.
The DCC System Description defines all those parameters that affect the interchangeability of DCC blank and (pre)recorded cassettes on consumer DCC players and/or recorders.
Play back of analogue coded compact cassettes by DCC players or DCC players with recording capability is also specified in this DCC System Description.

Object

The DCC System Description shall be applied for the construction of all those components, products and services which are intended to be used within the DCC system.
The DCC System Description specifies which parts are mandatory, minimum or optional requirements or are included for reference only.

The following chapters are mandatory requirements for:

DCC players or recorders	**Chapters 7 through 14, and 16 through 19**

Other chapters are for reference or information only.

(for manufacturers of DCC players)

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2. NORMATIVE REFERENCES

In this standard reference is made to the following standards, of which the most recent editions dated up to the date of publication of this document should be used.

- IEC 958 — Digital audio interface (including amendments 1 and 2)
- IEC 94 — Magnetic tape sound recording and reproducing systems (Compact Cassette)
- ISO 3901 — International Standard Recording Code (ISRC)
- UPC/EAN code — Universal Product Code/International Article Numbering Association
- ISO 3166 — Codes for the representation of names of countries
- JIS X 0208-1990 — Code of the Japanese Graphic Character Set for Information Interchange

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3. DESCRIPTION OF THE SYSTEM

3.1 Introduction

The Digital Compact Cassette system is an extension of the existing analogue Compact Cassette system.

This extension defines a magnetic tape system that includes recording and playback of digital data.

The data can be either digitally encoded audio signals or other related digital information.

The data are recorded longitudinally on 9 adjacent parallel tracks simultaneously for each tape travel direction.

The magnetic tape, wound on hubs located in a DCC cassette, is used as the information carrier.

The cassette is of a specified construction and includes a slider to protect the tape.
The cassette slider will be opened if inserted into the player.

In a DCC player and/or recorder the tape can move in both directions during recording and playback at only one specified tape speed of 4.76 cm/sec. For high speed copying a speed of 9.52 cm/sec is defined. Either direction makes use of the upper/lower half of the tape.

Re-recording is done by overwriting. No separate erase cycle is required.

The information according to the DCC format can be divided into Main data and Auxiliary data.

The Main data can be divided into main user data and system information.

Every DCC player shall be able to playback analogue Compact Cassettes according to the IEC 94 standard.

A DCC recorder may record in the analogue Compact Cassette format onto an analogue Compact Cassette, but neither a DCC cassette can be recorded in the analogue Compact Cassette format nor an analogue Compact Cassette can be recorded in the DCC format.

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3.2 Basic parameters

(More detailed specifications may be found in the relevant chapters).

Tape speed	:	4.76 cm/s (9.52 cm/s)
Tape width	:	3.78 mm
No. of tracks/direction	:	8 digital Main data tracks +1 digital Aux data track
Frame duration		
With nominal IFG length	:	170 2/3 ms
Transmission rates		
User main data	:	384 kbit/s
System info data rate	:	6 kbit/s
Auxiliary data rate	:	6.750 kbit/s max. 1.6875 kbit/s eff.
Error correction		
Main data	:	Product code of C1-RS (24,20,5) and C2-RS (32,26,7)
Auxiliary data	:	RS (24,18,7)
Modulation		
Modulation method	:	8 to 10 (ETM)
Main data		
Channel bit rate/track	:	96 kbit/s (modulated)
Auxiliary data		
Bit rate/track	:	12 kbit/s (modulated)
Cassette		
Cassette dimensions	:	100.4 mm x 63.8 mm x 9.6 mm
Total redundancy (main data)	:	50% of recorded signal (error correction, synchronization and modulation).

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3.3 Parameters for audio application

Audio format		
Sampling frequency	:	48 kHz, 44.1 kHz, 32 kHz
Quantization	:	$\geq$ 16 bit/sample
Representation	:	2's complement
Number of channels	:	2
Audio modes	:	stereo, 2-channel mono, joint stereo mode
Audio coding		
System	:	Precision Adaptive Subband Coding (PASC)
Bitrate of coded signal	:	384 kbit/s

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4. TEST CONDITIONS

Unless specified otherwise, the tests and measurements made on the system to verify conformity with the provisions of this standard shall be carried out under the following environmental conditions:

Temperature	:	20 ± 2°C
Relative humidity	:	40 to 70% RH
Atmospheric pressure	:	86 to 106 kPa
Conditioning before testing	:	4 h

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5. CASSETTE

5.1 General Cassette Specifications

5.1.1 Definitions

The specification defines two types of cassettes:

- Blank (DCC) cassettes
  These cassettes are for distribution in blank, non-recorded format, and are intended to be used by consumers for recording on DCC consumer recorders.

- Prerecorded (DCC) cassettes
  These cassettes contain program information on tape and are produced and/or published by or with the authority of the owner of the program material with the intention of commercial distribution.
  The tape is recorded in the DCC format and contains digital audio and/or other data. Prerecorded cassettes are intended to be used by consumers on DCC playback equipment.

Both cassette types are unique and only to be applied for the purposes described above.
General cassette specifications applicable for both types are included in this section.

Note: If measurements specified in the text are different from those in the figures, the measurements of the figures are to be interpreted as valid.
Drawings are in European projection.

Note: All drawings and figures referred to in Chapter 5 can be found in Volume II of this DCC System Description.
For the definition of the sides and elements see Fig. 5.1.

5.1.2 Dimensions of the cassette

To guarantee interchangeability, the dimensions of the cassettes shall be in accordance with Figures 5.1 to 5.12. To make the drawings more clear the slider is drawn only in Fig. 5.2.
Fig. 5.12 defines the dimensions for prerecorded cassettes only.

5.1.3 General tolerances for dimensions of the DCC cassette

Unless specified otherwise, the tolerances are:

dimension		tolerance
length (mm)	> 0 to 3	± 0.05
	> 3 to 6	± 0.06
	> 6 to 10	± 0.075
	> 10 to 18	± 0.09
	> 18 to 30	± 0.105
	> 30 to 50	± 0.125
	> 50 to 80	± 0.15
	> 80 to 120	± 0.175
angle (deg)		± 1°

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5.1 General Cassette Specifications

5.1.4 Test environment

5.1.4.1 Mechanical stability of the cassette

The dimensions of the finished cassette, including labels and stickers where applicable, and loaded with tape, shall be within the tolerances before and after a temperature test +95°C, RH<40%, 8 h, recovery 4 h and a humidity test +40°C, 85% RH, 8 h, recovery 4 h. Labels shall stay within the outer dimensions after these tests.

5.1.4.2 Operational environment of the cassette in a DCC player

The cassette shall retain basic operational features within the temperature range of -10°C to +80°C and a humidity range of 10 to 90% RH, non-condensing (see Fig 5.13 for the climatogram). Basic operational features are defined as record, play, wind and search.

Note: DCC cassettes manufactured in 1992/1993 shall remain operational up to 60°C.

5.1.5 Datum planes A, B and C (Fig. 5.7)

Datum plane A shall be defined by the datum areas R, S and T, indicated by hatching.
Datum plane B shall be perpendicular to datum plane A and shall run tangential to the back of datum hole U and datum hole V.
Datum plane C shall be perpendicular to both datum plane A and datum plane B and shall run through the centre of datum hole U.

5.1.6 Datum holes

The datum holes are defined in Fig. 5.1, Fig. 5.7 and Fig. 5.11.

5.1.7 Support areas (Fig. 5.7)

The cassette shall be supported in the player within the hatched support areas.
The support areas shall be coplanar with datum areas A and B within ± 0.05 mm. The datum areas can also be used as support areas.

At the front the cassette can be supported within the two support areas at the left and the right of the recess for the slider.

5.1.8 Cassette holding areas (Fig. 5.7)

The cassette shall be pushed against the supports in the player within the cross-hatched areas.
The holding force has to be determined together with the support points in such a way that the cassette is attached securely on the height supports of the player. The cassette shall not be deformed when the cassette is in the player under operational conditions. At the back the cassette shall be held within the hatched area.

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5.1 General Cassette Specifications

Stiffness of the cassette
The cassette has to withstand a minimum holding force of 2 N applied by a pin of 3 mm diameter on any position within the holding areas, while the cassette is supported on 4 pins of diameter 2 mm on the four cassette corners. All cassette dimensions shall remain within the tolerances. To provide maximum stiffness the cassette has to be provided with two supports between the lower and the upper shell, as shown in Fig. 5.6.

5.1.9 DCC Cassette recognition hole (Fig. 5.1)

The cassette shall be provided with a hole (hole 1) in the lower wall at the bottom side to distinguish it from the analogue Compact Cassette. The DCC mode is indicated by an open hole 1.

5.1.10 Cassette handling

5.1.10.1 Changer grips (Fig.5.1)

The cassette shall be provided with two changer grips for an automatic changer mechanism.

5.1.10.2 Storage grips (Fig. 5.1)

The cassette shall be provided with two storage grips for fixing the cassette in storage devices.

5.1.10.3 Grip slot (Fig. 5.1)

The cassette shall be provided with a grip slot in the top to be used for car loaders or similar mechanisms.
The positions and dimensions are shown in Fig. 5.1. The maximum width is defined by the boundary of the label area.

5.1.11 Slider

5.1.11.1 Slider dimensions (Fig. 5.2)

The maximum dimensions of the slider and the recesses for the slider opener and the maximum clearance between cassette and the slider are shown in Fig. 5.2.
The slider shall cover the reel holes. At the rear bottom side the slider shall be guided.

5.1.11.2 Slider operation (Fig. 5.2)

The recesses for the slider operation device are defined in Fig. 5.2. The surface of the entire recesses must be smooth without any interruptions e.g. parting lines.
The opening force, measured parallel to the datum plane B shall be: maximum 0.7 N at the beginning of the sliderstroke, and maximum 1.65 N at the end of the sliderstroke. The slider must closed completely under all circumstances, without any external help.
The slider guiding has to be determined in such a way that the slider runs smoothly. When an additional force of 0.5 N parallel to the datum plane C is applied, the operation force shall not increase more than 0.2 N.

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5.1 General Cassette Specifications

5.1.12 Reels

5.1.12.1 Friction torque of the full reel

The friction torque of the full reel shall not exceed 1.5 mNm. The slider has to be in the open position.

5.1.12.2 Friction torque of both reels

The friction torque of both reels without applied back tension torque, shall not exceed 2.7 mNm. If a back tension torque of 0.8 mNm is applied to the nearly empty reel, the required torque to be applied to the nearly full reel shall not exceed 4.5 mNm.
It is recommended to measure the friction torque with a friction torque measuring device, with the following characteristics:
- The accuracy of the friction torque measurement must be better than ± 0.1 mNm.
- The tapespeed during the measurement must be between 0.04 m/s and 0.10 m/s.
- The measuring device must be provided with a hold-back torque of 0.8 mNm, which can be switched on and off.
- The slider has to be in open position.

5.1.12.3 Hub lock

To prevent unwanted unrolling of the tape and to minimize rattle the hub shall be locked when the slider is closed.

5.1.13 Tape path and guiding elements

5.1.13.1 Tape path

The rated distance between datum plane A and the tape centre is the same as for Compact Cassette and is shown in Fig. 5.9. The position and dimensions of internal tape guides are shown in Fig. 5.3 indicated with the numbers 1..15. The elements are described in the table below. The recommended position of insertion elements is indicated in Fig. 5.4. However the minimum distance between head and datum plane B shall be 3.3 mm.

1 and 15	= Reel
2 and 14	= Tension post
3 and 13	= Roller
4, 12, 5, 11, 6 and 10	= Guiding pin
9 and 7	= ALP
8	= Pressure pad

Note:
- The position and use of the elements 2 and 14 are free to the manufacturers discretion
- The position and dimensions of the elements 3 and 13 are free to the manufacturers discretion
- The perpendicularity related to datum plane A in the tilt direction shall be smaller than the values mentioned in Fig. 5.3.

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5.1 General Cassette Specifications

5.1.13.2 Pressure pad (Fig. 5.10 A,B,C)

The dimensions and the position of the pressure pad are shown in Fig. 5.10A.
When the record/playback head is inserted into the cassette in accordance with the head position in the play mode defined in Fig. 5.4, the force on the head shall be 0.21 ± 0.08 N. The force measured shall be within the tolerance field of the head position. For measuring purposes a head with a radius of 6 mm shall be used.

5.1.13.3 Azimuth Locking Pins (ALP) (Fig. 5.10 A,B,C)

The cassette must be provided with Azimuth Locking Pins. The dimensions and the position of the azimuth locking pins are shown in Fig. 5.10A and Fig. 5.10B. When the record/playback head is inserted into the cassette in accordance with the head position defined in Fig. 5.4, the force F on the ALP support bosses is 0.15 N < F < 0.50 N.

5.1.13.4 Capstan diameter (Fig. 5.4)

The diameter of the capstan shall not exceed 3 mm.

5.1.13.5 Head dimensions, FATG (Fixed Azimuth Tape Guiding) (Fig. 5.10 D,E)

The head has to be provided with two bosses on each side to support the ALP. The clearance between the support bosses for the ALP and the tape edges on the upper side and the lower side must be 0.1 mm +0.1/-0.05 mm. The bosses shall protrude beyond the housing in the tape running area for 0.1 mm minimum.
Head dimensions indicated in Fig 5.10E which are marked with 1) are for reference only.
Application of FATG is required.

5.1.13.6 Shielding plate

It is recommended that the DCC cassette will be provided with a shielding plate behind the pressure pad and the ALP, to reduce the noise signals in the head, induced by an external magnetic field.

5.1.14 Tape winding (Fig. 5.6)

The magnetic coating on the tape shall face out of the cassette. Cassettes are loaded so that the full reel is on the left side. When the tape moves from the left to the right reel, then the upper side is defined as section A, and the lower side is section B.
The maximum reel diameter shall be 52 mm, as shown in Fig. 5.6.

5.1.14.1 Areas for tape (Fig. 5.6)

The areas to be kept free for tape are defined in Fig. 5.6. The area between reel and head area has to be defined at the manufacturer's discretion. When the cassette is ejected, the area around the capstan shall be free from tape.

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5.1 General Cassette Specifications

5.1.15 Cassette name and identification (Fig. 5.8)

The DCC logo shall be used to identify DCC cassettes complying with the specification.
The logo may be printed or recessed moulded. See Annex B for the logo use.
The logo shall be on the top of the cassette and may be on the bottom. The position is indicated in Fig. 5.8. On the bottom the distance between logo and cassette front shall be 2.5 mm minimum as indicated in Fig. 5.8.

5.1.16 Cassette deck interface

5.1.16.1 Reference pin(s) (Fig. 5.11)

The dimensions of the reference pin(s) shall be as defined in Fig. 5.11.

The height support planes for both the Compact Cassette and DCC shall be such that there is enough clearance from the cassette when they are not used as height support planes. Depending on the choice to support the cassette on the reference pins or on the front supporting areas, the dimension a.) of the reference pin(s) has to be defined at the player manufacturer's discretion.

5.1.16.2 Hub

The maximum hub dimensions are shown in Fig. 5.9.

5.1.17 Dimensions of the Leader and Trailer tape

The length of both the leader and the trailer tape shall be 370 mm ± 30 mm. The width of the leader and the trailer tape shall be 3.77 mm ± 0.02 mm. The thickness of the leader and the trailer tape shall be sufficient to allow the tape to withstand a peak load at tape end during winding of 10 N, but shall not have a thickness of more than 20 μm.

5.1.17.1 Surface structure of the Leader and the Trailer tape

Printings or coatings shall not exceed the specified total thickness and may not contaminate or damage the DCC head.

5.1.17.2 Attachment to the hub

The attachment of the leader and the trailer tape to the hubs shall be capable of withstanding a peak load at tape end during winding of 10 N. The manner of attachment is the manufacturer's own individual choice. The maximum allowable misalignment of the leader and the trailer tape to the hub is 0.5°.

5.1.17.3 Splicing

The splice shall be capable of withstanding a peak load force of 5 N during 3 sec. and a continuous force of 1 N during 4 hours at a temperature of 40 degrees centigrade. The thickness of the splicing tape shall not exceed 30 μm. The width of the splicing tape has to be determined so that neither it protrudes the magnetic tape nor the leader/trailer tape, but may not be less than 3 mm. The length shall be 16 mm ± 3 mm. The splicing tape may not contaminate nor damage the head.

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5.1 General Cassette Specifications

5.1.18 Cassette weight

The weight of the cassette including tape shall be 70 g max.

5.1.19 Electrostatic charge

The maximum voltage due to the static charge after or during winding in one direction with a speed of 17 rotations/sec. of the take up reel shall be 0.5 kV.
It is recommended that the slider and the head including the FATG and the ALP are grounded in Play/Wind/Search modes. For this reason, the ALP requires an electrical resistance below 1000 Ω.

5.1.20 Tape-capstan slip

The tape-capstan slip is defined as the difference between the tape speed Vb at the beginning of the tape measured at 20°C, and the tape speed Ve at the end of the cassette measured at the test temperature.
The tape-capstan slip (S) is quantified by the following equation:

$$S = (Vb-Ve)/Vb*100$$

Where: S = Slip rate
Vb = The tape velocity at the beginning of the cassette, measured under the conditions as specified in chapter 4.
Ve = The tape velocity at the end of the cassette when Ve is measured at the test temperature.

The tape-capstan slip shall not exceed 0.8% when measured in the temperature range of +5°C to +60°C.
The tape-capstan slip shall not exceed 2.5% when measured in the temperature range of -10°C to < +5°C.
The measuring deck, unless specified otherwise, must fulfill the following specifications in the temperature range of -10°C to +60°C:

Winding torque	: 2.5 mNm
Hold back torque	: 0.5 mNm
Head position	: 3.55 mm from datum plane B
Head	: Defined DCC head provided with FATG's

Capstan:

Capstan speed	: Constant DCC play back speed.
Capstan material	: SUS420J2 (According to DINX30Cr13)
Capstan diameter	: 2.2 mm
Capstan roughness	: Ra ≤ 0.035 μm

Pressure roller:

Pressure roller material	: Chloroprene rubber
Pressure roller diameter	: 13.5 mm
Pressure roller width	: 6 mm
Pressure roller hardness	: 65 Sh A (at environmental conditions acc. to Chapter 4)
Pressure force	: 3 N

The frequency of the recorded signal must be constant all over the tape.
The defined DCC head can be ordered from Philips Consumer Electronics B.V. (see Preface).

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5.2 Blank DCC Cassette

5.2.1 Label and window area

5.2.1.1 Label area (Fig. 5.8)

The cassette may be provided with three label areas.

The labels shall not extend beyond the height of the cassette. The maximum permitted depression is 0.3 mm, except for the top label area of which the depression is 0.5 mm maximum. The label dimensions are at manufacturers discretion, but they shall not exeed beyond the hatched areas of Fig. 5.8.

5.2.1.2 Window area (Fig. 5.8)

Part of the reels may be visible somewhere within the hatched area at the manufacturer's discretion.
The window through which a part of the reels can be seen shall not extend beyond the height of the cassette.

5.2.2 Recognition holes

5.2.2.1 Dimensions (Fig. 5.1)

The positions and dimensions are shown in Fig. 5.1. A closed hole has a maximum depth of 0.1 mm. An open hole has a minimum depth of 1.6 mm. If, for manufacturing reasons, cassette shells are moulded with integral break-out lugs at the position of the recognition holes, which break-out lugs are designed for removal at a later stage, then the gap between the boundary of a recognition hole and a non-removed lug shall be 0.3 mm maximum.

5.2.2.2 Erasure protection (Fig. 5.1)

Recognition of erasure protection shall be possible from the bottom and the rear side of the cassette (hole 2, and the back recognition hole). The cassette shall be provided with a device allowing the user to open and close both the erasure protection holes simultaneously. The device shall be operated at the bottom side as indicated in Fig. 5.1. At the rear side the closed hole has a maximum depth of 0.3 mm and the open hole a minimum depth of 3 mm. When the hole is closed, the maximum gap between cassette and device shall be 0.3 mm. The cassette shall be capable to withstand a force of 0.5 N. The force to open and close the erasure protection hole shall be 1 N minimum and the stroke shall be 3 mm minimum. When the erasure protection holes are closed, recording shall be impossible on both sections of the tape. When the erasure protection holes are open, recording shall be possible on both sections of the tape. The record protected state of the cassette must be indicated by a pictogram located close to the indication hole. The pictogram drawn in Fig. 5.1 is recommended.

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5.2.2.3 Playing time and thickness indication (Fig. 5.1)

The cassette shall be provided with three recognition holes (holes 3, 4, 5) for distinguishing the playing time.
The tape length shall be determined by the following formula:

L = [(1.03 * Vt * T * 60/1000)]/2 (+1,+3) m
Vt : Tape speed in mm/s
T : Playing time in min.

Example for a 90 minute cassette:
Vt = 47.6 mm/sec.
T = 90 min
L = 132.4 (+1,+3) m
L max = 135.4 m

The time code is as follows:

Total playing time [min]	hole 3	hole 4	hole 5
45	open	open	open
60	closed	open	open
75	open	closed	open
90	closed	closed	open
105	open	open	closed
120	closed	open	closed
undefined length	open	closed	closed

The tape thickness can be detected by hole 5.

An open hole indicates a total tape thickness of 12 μm and a closed hole indicates tape with lesser thickness, except for the undefined length (hole 3 open, hole 4 closed, hole 5 closed).
A closed recognition hole shall be constructed so that it can withstand a force of 0.5 N.

Cassettes with a total playing time of above 90 minutes are subject to a specific release investigation and have to be sent to Philips Consumer Electronics B.V. (see Preface).

5.2.2.4 Optional recognition holes (Fig. 5.1)

Three optional recognition holes (holes 6, 7 and 8) are defined on the cassette, on the bottom left. The holes are reserved for future use, and shall be closed.

5.2.2.5 Splicing tape

The reflectivity of the material shall be more than 70% for a light source with a wavelength of 920-960 nm. For the measuring method see section 6.9.2.2.

5.2.2.6 Reflectivity at the back of the leader and trailer tape

It is recommended to use leader tape and trailer tape with a reflectivity of more than 70% for a lightsource with a wavelength of 920-960 nm. For the measuring method see section 6.9.2.2.

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5.3 Prerecorded DCC Cassette

5.3.1 Recognition holes

5.3.1.1 Tape length and thickness indication (Fig. 5.1)

Neither tape length nor thickness of prerecorded tapes are prescribed. Prerecorded cassettes are indicated by means of closed holes 3, 4 and 5 (absence of the recognition holes 3, 4, 5).

105 and 120 minutes tapes are subject to a specific release investigation and have to be sent to Philips Consumer Electronics B.V. (see Preface).

5.3.1.2 Erasure protection

Prerecorded cassettes are protected against erasure by the absence of the erasure protection holes (see section 5.2.22). These cassettes cannot be recorded on consumer recorders.

5.3.2 Label and window area (Fig. 5.12)

5.3.2.1 Window area

There is no window defined for prerecorded cassettes.

5.3.2.2 Extended label

The cassette has to be provided with a one-piece label which covers the top and the back label area. The minimum dimensions are shown in Fig. 5.12.

The proposed dimensions of the label shown in the same figure can be adapted at the manufacturer's discretion.

To prevent damage of the label from the underneath of the cassette, the upper cassette half must not have holes above the reels.

5.3.2.3 Bottom label and printing area

The bottom label area has the same dimensions as defined in section 5.2.1.

For printing the whole bottom side, including the slider and excluding the logo areas, can be used.

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5.3.2.4 L-cover

The label shall be protected by means of a non-detachable plastic cover.

The depression on the top should be 0.15 mm ± 0.15 mm in order to prevent scratches.

The L-cover shall not extend beyond the height of the cassette.

The dimensions of the label area are shown in Fig. 5.12. The maximum gap between the cassette halves around the L-cover and the L-cover shall be 0.3 mm.

To prevent a sharp edge between the L-cover and the label area, the rib has to be shortened by 0.8 mm, as shown in Fig. 5.12 marked X.

5.3.2.5 Reflectivity of the splicing tape

It is recommended to use splicing tape with a reflectivity of more than 70% for a lightsource with a wavelength of 920-960 nm. For the measuring method see section 6.9.2.2.

5.3.2.6 Reflectivity of the rear of the leader and trailer tape

It is recommended to use leader and trailer tape with a reflectivity of more than 70% for a lightsource with a wavelength of 920-960 nm. For the measuring method see section 6.9.2.2.

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6. TAPE

6.1 Scope

This specification applies to magnetic tapes suitable for the DCC system.
The purpose of this specification is to define the characteristics of the tape for use with the DCC system.
Refer to section 6.9 for the description of the measuring methods.

6.2 Types of tape

CrO_2 tape or its equivalent

Note: For high speed duplication, bulk erased tape should only be used with residual flux < 1% of remanent flux. No overwriting should be used.

6.3 Reference and calibration cassettes (DRT1)

DRT1 reference tape should be used for comparing the characteristics of the tapes under test with the reference tape. Sub-reference tape with compensation factors can be used as reference tape for the measurements of the R.F. characteristics. Calibration cassettes "DCC Level Tape 0 dB-9.6 kHz" and "DCC Level Tape 0 dB-48 kHz" are available for indirect calibration of DCC record and playback electronics. Reference tape, sub-reference tapes and calibration cassettes can be ordered from Philips Consumer Electronics B.V. (see Preface).

6.4 Mechanical properties

6.4.1 Tape width (including tape width variation)		: 3.78 ± 0.01 mm
6.4.2 Tape width variation		: < 6 μm
6.4.3 Total tape thickness	Version 1	: 12.0 ± 0.8 μm
	Version 2	: 9.0 ± 0.8 μm

Note: 9 μm tapes are subject to a specific release investigation.

6.4.4 Yield strength F 1%	- longitudinal direction	: F ≥ 1.4 N
	- transverse direction	: F > 0.7 N
6.4.5 Residual elongation		: < 0.2 %
6.4.6 Static longitudinal curvature		: < 5 mm per m
6.4.7 Dynamic single-sided edge variation for upper and lower edge		: < 6 μm (prerecorded tape only)
6.4.8 Abrasiveness/corrosiveness at:	-10°C	: > 250 hours
	+ 5°C, 50% RH	: > 500 hours
	+20°C, 60% RH	: > 1500 hours
	+40°C, 90% RH	: > 500 hours
	+60°C, 25% RH	: > 250 hours

Use unused cassettes for each test

6.5 Optical and electrical properties

6.5.1 Transparency	: < 20 % for λ = 920 - 960 nm
6.5.2 Reflectivity (back)	: < 20 % for λ = 920 - 960 nm
6.5.3 Coating resistance	: < 10^{11} Ohm/square

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6.6 Tape characteristics

All properties, unless specified otherwise shall be measured at the calibrated recording current $I_{cal+20°C}$. For the measurement of $I_{cal+20°C}$ see section 6.9.4.2. The figures mentioned below are all related to the reference tape.

6.6.1 Signal characteristics, measured on blank cassettes only

Recording current sensitivity: < 1 dB
Temperature dependency of the recorded level: ± 1 dB

Relative signal output level U_f:
48 kHz : > - 1 dB, < + 5 dB
24 kHz : > - 3 dB, < + 2 dB
9.6 kHz : > - 3 dB, < + 2 dB
6.0 kHz : > - 3 dB, < + 2 dB
3.0 kHz : > - 3 dB, < + 2 dB
1.2 kHz : > - 3 dB, < + 2 dB

Relative frequency response
Output (9.6 kHz = 0 dB)
48 kHz : > - 1.5 dB, < + 5 dB
24 kHz : > - 1.5 dB, < + 2 dB
6.0 kHz : > - 2 dB, < + 1.5 dB
3.0 kHz : > - 2 dB, < + 1.5 dB
1.2 kHz : > - 2 dB, < + 1.5 dB

Overwrite characteristics
Remaining 9.6 kHz signal W (48 kHz overwrite): ≥ -1 dB
Remaining 1.2 kHz signal W (6 kHz overwrite): ≥ -1 dB
Remaining 1.2 kHz signal W (48 kHz overwrite): ≥ -1 dB

Temperature dependency of overwrite characteristics
$W_{60/20}$, $W_{20/60}$, $W_{-10/20}$, $W_{20/-10}$ 9.6 kHz(48 kHz overwrite): ≥ -1 dB
$W_{60/20}$, $W_{20/60}$, $W_{-10/20}$, $W_{20/-10}$ 1.2 kHz(6 kHz overwrite): ≥ -1 dB
$W_{60/20}$, $W_{20/60}$, $W_{-10/20}$, $W_{20/-10}$ 1.2 kHz(48 kHz overwrite): ≥ -1 dB

Functional overwrite characteristics
Deck A is adjusted such that it records 9.6 kHz on a DRT1 tape 2 dB above the level of the DCC Level Tape 0 dB-9.6 kHz, for the average of track 0-7.
Deck B is adjusted such that it records 9.6 kHz on a DRT1 tape 0.5 dB below the level of the DCC Level Tape 0 dB-9.6 kHz, for the average of track 0-7.

The test is done with 10 cassettes. For each of these:
The cassette is fully recorded with DCC format on side A and B on deck A.
The cassette is fully overwritten with DCC format on side A and B on deck B.
The overwrite is played back. The overall SER (average of 8 main data tracks) should be better than 5*E-4 (recommendation).

Noise
Carrier-to-noise ratio > -6 dB

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6.6.2 Symbol error rate, measured on prerecorded and blank cassettes

Symbol error rate requirements:

1 - Main data

Measurement window should be 5 min.

A - Number of uncorrectable symbols (C2 Hard flags): 0
B - Number of critical frames: $\leq$ 1
C - Overall SER (average over 8 main data tracks): $\leq$ 1E-4
If the SER is $\geq$ 1E-4 then the ERROR FRAME SYMBOL ERROR RATE (EFSER) is calculated for that track.
If the EFSER < 2.604 E-3 (< 4 errors per error frame) then the track is passed.

2 - Aux data

A - Number of frames without valid Aux symbols: 0
B - Aux symbol error rate (SER): $\leq$ 5E-3

Definition of a SYMBOL ERROR:

The bits of DCC are grouped in 8-bit symbols. A symbol is in error if the value of the 8 bit symbol during playback is different from the original 8 bit symbol during recording.

The number of symbol errors is determined by counting the Main data symbols:
- changed by the C1 error correction (but not by the C2 error correction)
- changed by the C2 error correction
- uncorrectable by the C2 error correction (C2 Hard flags)

For the Aux track the symbol errors are found by counting the symbols:
- changed by the C_{AUX} error correction
- uncorrectable by the C_{AUX} error correction (Aux flags)

Definition of the SYMBOL ERROR RATE (SER) per track:

The SER is found by adding all symbol errors in 1 track during the measuring time together and dividing the sum by the total number of symbols in 1 track.

Definition of the ERROR FRAME SYMBOL ERROR RATE (EFSER):

The EFSER is found by calculating the SER per track of the frames with errors (neglecting the error free frames).

All symbol errors in 1 track during the measuring time are added, divided by 1536 (the number of symbols in 1 frame per track) and divided by the number of frames with errors in that track.

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6.7 Storage tests

Definition of a CRITICAL FRAME:

If the number of errors in a track in one frame is less than 5, then it is very likely that these errors are corrected by C1. Therefore these errors will not contribute to the possibility of an uncorrectable C2 codeword. A frame is called not critical if, after the tracks with less then 5 errors are neglected, it fullfills at least one of the following criteria:

1 - the error rate is < 8.138E-3 (< 100 errors per frame). These errors must be located in more then 2 tracks
2 - all errors are located in 1 track
3 - all errors are located in 2 tracks AND the error rate is < 4.07E-2 (<500 errors per frame)

All other frames are called critical.

Definition of the AUX SYMBOL ERROR RATE:

The Aux track contains maximum 4x48 symbols in 1 frame (exclusive of the header). In a non-labelled frame only 2 blocks of 48 symbols are written. In a labelled frame all 4 blocks of 48 symbols are written.

If 95 or less errors are measured (the frame was labelled) the Aux symbol error rate is : the number of errors divided by 192.

If 96 or more errors in 1 frame are measured the frame is considered to be non-labelled. The Aux symbol error rate is: the number of errors minus 96 divided by 96.

If 192 errors are measured, the frame contains no valid Aux symbols.

Measuring method

The measuring conditions are:

Measuring signal	: DCC signal with non-labelled Aux track.
Measuring equipment	: AR350D[1] deck or equivalent
Measuring time	: ≥ 5 minutes (≥ 1758 frames).

Note: All other measuring methods are permitted but must be correlated with the procedure of section 6.6.2.

6.7 Storage tests, measured on prerecorded and blank cassettes

During these tests no functional problems during playback, wind or search may occur.
Signal loss, at 48 kHz, tape in cassette (24 h acclimatization):

6 hours at	+70°C/RH 10-20%	≤ 3.5 dB
24 hours at	-30°C	≤ 1.5 dB
21 days at	+40°C/RH 85%	≤ 3.5 dB
21 days at	-10°C	≤ 1.5 dB

[1] The AR350D deck is a selected DCC tape deck for testing and reference purposes. For more information please contact Philips Consumer Electronics B.V., (see Preface).

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6.8 Durability tests

6.8.1 Play test

40 cycles +20°C/RH 60%
40 cycles +40°C/RH 85%
40 cycles +60°C/RH 10-25%
40 cycles -10°C
Use unused cassettes for each test.

During these tests no basic functional problem during playback, wind or search may occur.

One cycle means one full tape run in normal play of Sector A, and fast rewind of Sector A.

6.8.2 Play, search and wind test

During these tests no basic functional problem during playback, wind or search may occur.
The number of cycles under the climatical conditions shall be as defined in section 6.8.1. The following test sequence shall be done for D90 and D60 cassettes:

	Location in playing time	
Sequence	D90 cassette	D60 cassette
Start	0 minutes	0 minutes
wind to	20	13
search forward to	25	17
search backwards to	20	13
play to	27	18
rewind to	19	13
wind to	29	19
play to	37	25
rewind to	29	19
search forward to	35	23
search backwards to	29	19
play to	end	end
rewind to	39	26
wind to	end	end

Next the player is switched over to Sector B, followed by this cycle at Sector B. Playing times on cassettes with other lengths should be adapted proportionally.

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6.9 Measuring methods for DCC tape properties

Testing environment

All properties, unless specified otherwise, shall be measured at a temperature of 20 ± 2°C at a relative humidity of RH = 55 to 65% and an atmospheric pressure between 86 kPA and 106 kPA. The samples to be measured must be stored for 24 h under the above conditions.

6.9.1 Mechanical properties

6.9.1.1 Tape width

Prepare 8 samples with a length of 100 mm on arbitrary points of one tape. Measure the width of the center part of each sample (covered with a glass) 5 times to obtain the average of the tape width of this sample. The 8 averaged values obtained must stay within the tape width tolerance field (see 6.4.1). Calculate the average of the 8 values to obtain the tape width.

6.9.1.2 Tape width variation

The difference between the maximum and minimum of the 8 values is defined as the tape width variation.

6.9.1.3 Tape thickness

The tape thickness is defined as an average value of a defined number of measurements, expressed in μm.

Method

The tape is placed between a measuring block and a measuring pin. The top of the pin has a spherical shape with a diameter of 60 mm. The measuring pin is coupled with an instrument that has a reading accuracy of 0.1 μm (force of the measuring pin: 0.2 - 0.4 N).

6.9.1.4 Yield strength (F 1%)

The measurements are made in accordance with ISO Recommendation R 527. The length of the test sample shall be 200 mm. The rate of elongation for all tensile tests shall be 100 mm/min.

The yield strength (F 1%) is defined as the force necessary to produce 1% elongation of the tape.

6.9.1.5 Residual elongation

The tape shall be subjected to a force of 2 N for a period of 3 minutes; the measurement (with negligible force < 0.25 N) is made 3 minutes after the applied force has been removed.

The residual elongation is expressed as a percentage of the original tape length.

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6.9 Measuring methods for DCC tape properties

6.9.1.6 Static longitudinal curvature

A tape sample of 1 m is allowed to unroll and assume its natural curvature on a flat surface. The maximum deviation of the edge of the tape from a straight line joining the extremities of the tape sample is defined as the static longitudinal curvature.

6.9.1.7 Dynamic single-sided edge variation

The dynamic single-sided edge variation is defined as the value, expressed in mm, for the peak to peak amplitude of a tape edge.

See Fig. 6.1 for the measurement setup.

The tape must be transported by a dual capstan system. The tape must be guided by the tape guide "G". The height and the angle of the tape guide are adjustable. The width of the tape guide is 3.800 mm, its length is 22 mm.

The tape position is limited by two fixed limiters "L" with a width of 3.795 mm.

The tape height is adjusted by tape guide "G", such that the tape runs through the limiters "L", barely touches the borders of the limiters.

The measurement unit "M" must be provided with a sensor, positioned at each edge of the tape, to measure the variation at each edge of the tape.

Tape movement direction:	From the tape guide "G" towards the measuring unit "M".
Tape tension:	1.4 N ± 0.4 N
Tape speed:	3.0 m/s

6.9.1.8 Abrasiveness/corrosion (see Fig. 6.3)

The abrasiveness of the tape is the tendency of the tape, supplied in a DCC cassette, to wear the DCC head. The corrosiveness of the tape is the tendency of the chemicals in the tape to corrode the head. Both properties are measured simultaneously.

The abrasiveness/corrosiveness of the tape is expressed in the number of hours at which both the following criteria are met:
- The largest breakdown of the coating, (within a surface area of 3.8 mm x 0.8 mm symmetrical around the head gap as defined in Fig. 6.3), may be 20 μm maximum.
- The DCC head must keep its functionality.

Method

The abrasion/corrosion is measured using a DCC deck comprising a DCC head. This DCC head can be ordered from Philips Consumer Electronics B.V. (see Preface).

The head position is 3.3 mm from datum plane B (refer to chapter 5). After each 100 passes ($\approx$ 75 hours for a D90 cassette) the cassette must be replaced with a new one.

The measurements done under the different climatic conditions may not exceed the specified values.

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6.9.2 Optical properties

6.9.2.1 Transparency (see Figure below)

The transparancy is defined by convention as the relationship between the intensity of the light beam which passes through the test piece, related to the intensity of the light beam when the test piece is removed. The transparency value is expressed as the percentage ratio of the two readings.

Calibration of the measurement setup

The IR transmitter, formed by the LED, emits light of a wavelength between 920 and 960 nm. The mask shall have a thickness of 2 mm and a circular aperture diameter such that the area is 80% of the active area of the IR receiver. The surface of the mask shall be matt black. The test piece shall be held firmly against the mask to cover the aperture and to ensure that no ambient light leaks passes. The IR transmitter is positioned perpendicular to the mask. The IR receiver must be capable of measuring light of the specified wavelength with an accuracy of nominal 1%. The distance from the emitting surface of the transmitter and the mask shall be:

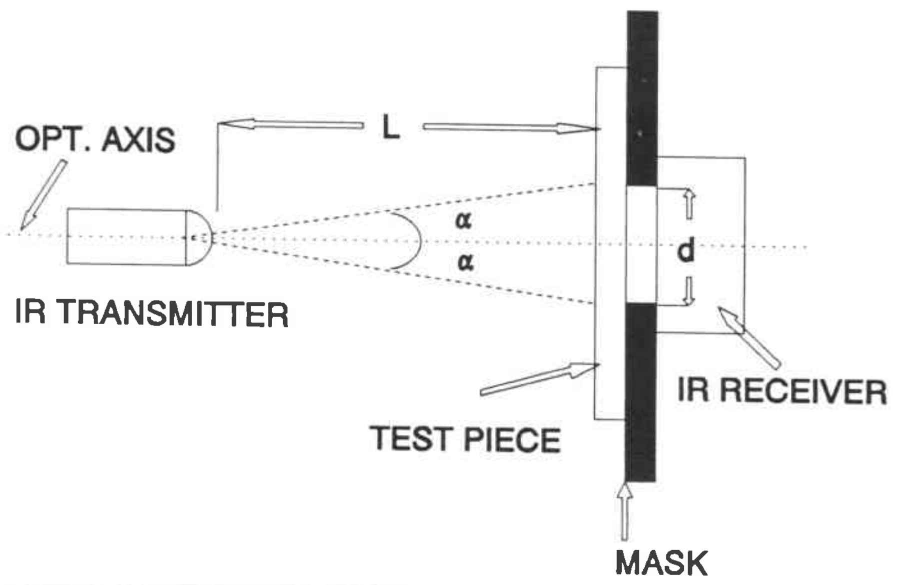
$$L = d/2\tan\alpha$$

where α is the angle where the relative intensity of the IR transmitter is equal to, or greater than, 95% of the maximum intensity of the optical axis. The measurement setup must be stable and must be shielded from external light by a matt black case.

Measurement

With no test piece mounted, the current of the LED must be varied until the output of the IR receiver equals a suitable value (U1). The power dissipation of the LED must be far within its maximum limit. With the test piece mounted on the mask, the output of the IR receiver must be measured again (U2). The light transmittance is calculated using the formula:

Light transmittance (%) = U2/U1 x 100%



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6.9 Measuring methods for DCC tape properties

6.9.2.2 Reflectivity

The reflectivity is defined as the relationship between the reading obtained from the measuring equipment with the test piece placed and the reading when the test piece is replaced by a 100% reflective mirror. The reflectivity value is expressed as the percentage ratio of the two readings. (see fig below).

Calibration of the measurement setup

The IR transmitter, formed by the LED, emits light of a wavelength between 920 and 960 nm. It is recommended to band the emitted light by means of a lens.
The LED is positioned with an angle of 28 degrees to the perpendicular line of the mir-or. The reflection factor of the mirror equals >99.5%

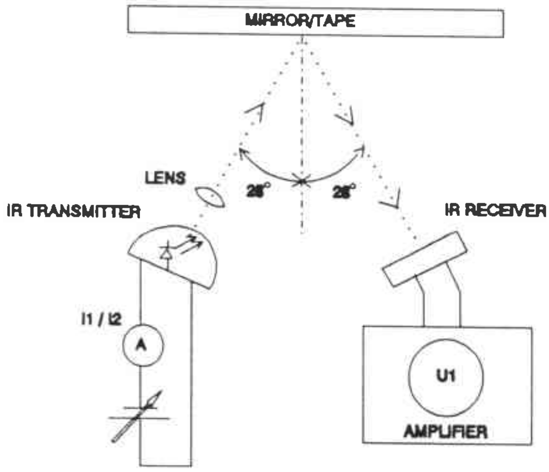
The IR receiver which is capable of measuring light of the specified wavelength, is also placed with an angle of 28 degrees to the perpendicular line of the mirror.

The distances of the transmitter and receiver to the mirror do not influence the measurement accuracy, but should be less than 1 cm. Be sure that the measurement setup is stable and is shielded from external light.
Measure the output (U1) of the IR receiver and the input current (I1) of the IR transmitter.

Measurement

Replace the mirror by the tape to be measured. Be sure that the light is banned in the centre of the tape and that the tape surface is not deformed. Vary the input current of the LED until the output of the IR receiver equals U1. Be sure that the power-dissipation of the LED is far within its maximum limit. Now measure the value of the input current (I2) and calculate the reflection factor using the formula:

Reflection factor (%) = I1/I2 x 100%



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6.9 Measuring methods for DCC tape properties

6.9.3 Magnetic and electrical properties

6.9.3.1 Coating resistance (See Fig. 6.2)

The coating surface resistance is defined as the electric square resistance of a length of tape equal to the tape width, expressed in Ohms.

Method

Place the tape with the coating side over the measuring electrodes and apply a weight of 5 N/mm² on both tape ends (the cross-section of each electrode shall be a quarter of a circle of radius 1 cm). The mm² stands for the intersection area of the tape.

Measure the electrical resistance with a MOhm meter.

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6.9 Measuring methods for DCC tape properties

6.9.4 Tape characteristics measured according to DCC System Description

Calibration tapes for adjusting the reference recorder are to be used. Cassettes and pancakes can be ordered from Philips Electronics B.V. (see Preface).

6.9.4.1 Conditions

Measurements according to the DCC System Description have to be carried out in a carefully adjusted DCC player, referred to as a reference recorder. This reference recorder should have the facility to adjust and measure the recording current. The signal output level has to be measured at a test point at the output of the linear head amplifier.

The read amplifier must have a flat frequency response and have a negligible harmonic distortion. Recordings and measurements are to be executed on bulk-erased DCC cassettes.

6.9.4.2 $I_{cal+20°C}$, $I_{cal-10°C}$ and $I_{cal+60°C}$ measurement method

$I_{cal+20°C}$ is defined as the recording current which is necessary to obtain the same output at playback, as the output of the calibration tape.

The measurements are done at a temperature of +20°C/RH = 40%-70%.

The output of the calibration tape, which is recorded with a 9.6 kHz signal, is measured during playback.

The recording current of a 9.6 kHz signal on the tape to be tested is varied such that the output during play back equals the output of the calibration tape. The thereby obtained value of the current is defined as the calibrated recorded current I_{cal}.

$I_{cal-10°C}$ is obtained by varying the 9.6 kHz recording current for recordings made on the reference tape at a temperature of -10°C such that the output equals the output level of the calibration tape, played back at +20°C.

$I_{cal+60°C}$ is obtained by varying the 9.6 kHz recording current for recordings made on the reference tape at a temperature of +60°C such that the output equals the output level of the calibration tape, played back at +20°C. The recording is done at RH = 10%-25%.

6.9.4.3 Recording current sensitivity

The recording current sensitivity is defined at play back as the difference of signal output, expressed in dB, due to a variation of the recording current.

The output of a 9.6 kHz recording on the tape to be tested is measured with the recording level of $I_{cal+20°C}$ +1 dB and with the recording level of $I_{cal+20°C}$ -1 dB. The difference is expressed in dB. The same procedure is repeated for the reference tape. The difference between the figures of both procedures may not exceed the specified value.

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6.9.4.4 Temperature dependency of the recorded level

The temperature dependency of the recorded level is defined as the ratio of the output of a 9.6 kHz recording made at -10°C (respectively at +60°C) with the recording current $I_{cal-10°C}$ (respectively $I_{cal+60°C}$) on the tape to be tested, compared to the output of a 9.6 kHz recording made at +20°C with the recording current $I_{cal+20°C}$ on the tape to be tested. The temperature dependency is expressed in dB and may not exceed the specified value.

6.9.4.5 Relative signal output level U_f

The playback output level of a 48 kHz square-wave signal with a duty cycle of 50%, which is recorded on the tape to be tested at the calibrated recording current $I_{cal+20°C}$ is measured.

The same procedure is repeated for the reference tape.

The relative signal output level shall be expressed in dB as the ratio relative to the playback output level of the tape to be tested and the playback output level of the reference tape with the following formula:

$$U_f\,(\mathrm{dB}) = 20 \log U_t / U_r$$

where U_t = playback output level of the test tape
U_r = playback output level of the reference tape

The relative signal output level at other frequencies shall be measured in the same way as described above, taking into account that the recording current has the same value as the calibrated recording current $I_{cal+20°C}$ at 48 kHz.

Repeat these measurements with the remaining specified frequencies.

6.9.4.6 Relative frequency response U_r

The relative frequency response is defined as the ratio of the output level of a square-wave signal with a duty cycle of 50%, of a certain frequency which is recorded on the tape to be tested at the calibrated recording current $I_{cal+20°C}$, and the signal output level at 9.6 kHz.

For this procedure a 9.6 kHz squarewave signal is recorded on the tape to be tested at the calibrated recording current $I_{cal+20°C}$, followed by a squarewave signal of the other frequency recorded with the recording current $I_{cal+20°C}$.

The frequency response can now be obtained by measuring both fundamental frequency outputs. The difference between the output levels is expressed in dB.

The same procedure shall be repeated for the reference tape.

Both frequency response characteristics must be normalized at 9.6 kHz = 0 dB.

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6.9 Measuring methods for DCC tape properties

6.9.4.7 Overwrite characteristics

9.6 kHz signal overwritten with a 48 kHz signal

The 9.6 kHz square-wave signal recorded at the calibrated recording current $I_{cal+20°C}$ shall be overwritten by a 48 kHz square-wave signal at the recording current $I_{cal+20°C}$.

The ratio (W_t) of the original and the residual playback fundamental frequency signal output levels of 9.6 kHz, expressed in dB, shall be measured for the tape to be tested. The same procedure shall be repeated for the reference tape resulting in W_r.

The overwrite characteristic is expressed by:

$$W\ (dB) = W_t - W_r.$$

W_t is the ratio of the original fundamental output level and the residual fundamental output level of the tape to be tested, expressed in dB.

W_r is the ratio of the original fundamental output level and the residual fundamental output level of the reference tape, expressed in dB.

1.2 kHz signal overwritten with a 6 kHz signal

The 1.2 kHz square-wave signal recorded at the calibrated recording current $I_{cal+20°C}$ +1.2 dB shall be overwritten by a 6 kHz square-wave signal at the recording current $I_{cal+20°C}$ + 1.2 dB.

The difference (W_t) of the original and the residual playback fundamental frequency output levels of 1.2 kHz, expressed in dB, shall be measured for the tape to be tested. The same procedure shall be repeated for the reference tape resulting in W_r.

The overwrite characteristic is expressed by:

$$W\ (dB) = W_t - W_r.$$

W_t is the ratio of the original fundamental output level and the residual fundamental output level of the tape to be tested, expressed in dB.

W_r is the ratio of the original fundamental output level and the residual fundamental output level of the reference tape, expressed in dB.

1.2 kHz signal overwritten with a 48 kHz signal

The 1.2 kHz square-wave signal recorded at the calibrated recording current $I_{cal+20°C}$ +1.2 dB shall be overwritten by a 48 kHz square-wave signal at the recording current $I_{cal+20°C}$ +3.2 dB.

The difference (W_t) of the original and the residual playback fundamental frequency output levels of 48 kHz, expressed in dB, shall be measured for the tape to be tested. The same procedure shall be repeated for the reference tape resulting in W_r.

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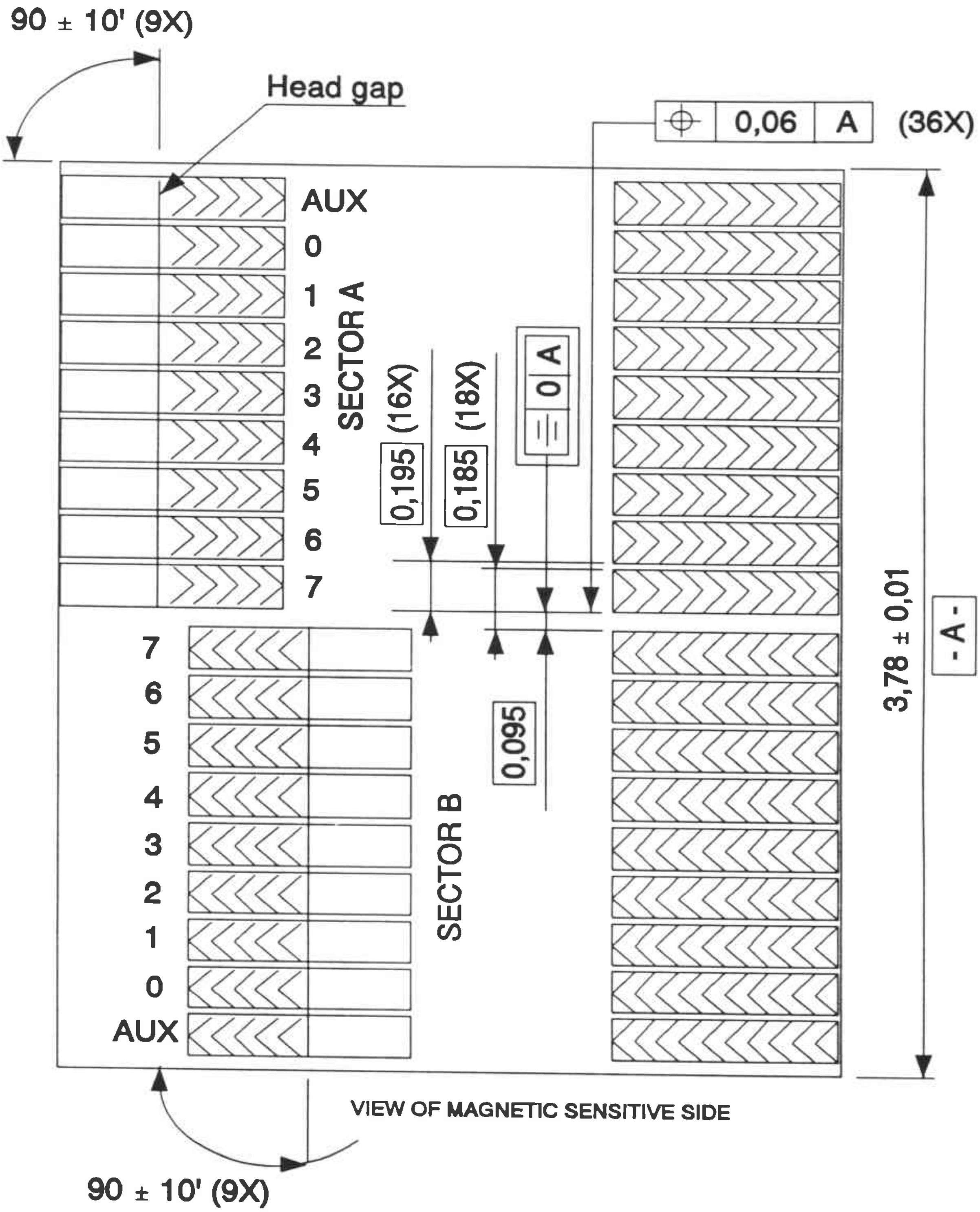

FIG.7.1 : Track configuration, dimensions and identification

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8. RECORDING PARAMETERS

8.1 Recording parameters for prerecorded tapes

See also the calculation formulae in section 8.3.

8.1.1 Recording signals

8.1.1.1 Main data channel bit length

For the Main data channels, the length of each bit recorded on tape is 0.496 μm ± 3%.

8.1.1.2 Aux data channel bit length

For the Aux data channel, the length of each bit recorded on tape is 3.967 μm ± 3 %. The Aux data channel will be recorded by using write pulses with a repetition rate equal to the Main data channel bitrate. So each Aux data channel bit is written by means of 8 write pulses with the same polarity.

8.1.1.3 Polarity

Bits will be recorded with the polarity as in Fig 8.1.

8.1.2 Recording levels

8.1.2.1 Measuring method

Levels are measured by recording square waves of 9.6 kHz (5 T_{Main}) and 48 kHz (1 T_{Main}) on the tape to be tested, after which during playback the fundamental frequency level is measured.
The **relative 9.6 kHz level** is the difference of the measured output of this tape to be tested and the measured outputs of the prerecorded DCC Level Tape 0 dB-9.6 kHz and DCC Level Tape 0 dB 48 kHz, expressed in dB.

The ratio of the 48 kHz level and the 9.6 kHz level is called resolution. The **relative 48/9.6 kHz resolution** is the difference of the measured resolution of the tape to be tested and the measured resolution of the prerecorded DCC Level Tapes, expressed in dB.

8.1.2.2 Main data

The allowed relative 9.6 kHz level and the relative 48/9.6 kHz resolution for each of the main data channels is:

relative 9.6 kHz level	: - 4 dB to + 4 dB
relative 48/9.6 kHz resolution	: - 2 + X dB to + 6 dB

In case the relative 9.6 kHz level > - 1 dB	: X = 0 (dB)
In case the relative 9.6 kHz level < - 1 dB	: X = - 1 - (relative 9.6 kHz level)

8.1.2.3 Allowed relative level for the Aux data channel

relative 9.6 kHz level	: - 4 dB to + 4 dB

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8.2 Recording parameters for consumer recorded tapes

8.2.2.3 Resolution for each Main data track

relative 48/9.6 kHz resolution: - 2 dB to + 4 dB

8.2.2.4 Temperature effect

Within the temperature operating range of a DCC recorder, the 9.6 kHz recording level of each track must fulfill the description in section 8.2.2.2. At the same time the relative average 9.6 kHz level of channel 0...7 is recommended to be within the following limits respective to the recording made at an ambient temperature of +20°C.

relative average 9.6 kHz level: - 1 dB to + 1 dB

8.2.2.5 Aux data track level

The write current for Aux data must be 1.2 dB ± 0.2 dB higher than the current used for Main data, for an Aux data record head track with an identical structure as the record head tracks for the Main data channels.

8.2.2.6 Non identical structure of the record channels

If the recording Aux track structure is not identical to the Main data track structure, the Aux data record current must be such that a recording of 1.2 kHz square wave on the DRT1 Reference Tape gives a fundamental frequency level which equals the level of a recording made with a head and current as described in section 8.2.2.5.

8.2.2.7 Aux data erase method

When old Aux data must be erased, as described in section 11.4.2, this may be done by overwrite with a high frequency signal or by overwrite with new Aux data signal. The frequency used for the high frequency signal for this Aux data erase must be 48 kHz or higher.

8.2.2.8 Aux data erase current

For Aux data erase with a high frequency signal, the write current must be increased by more than 1 dB compared to the Aux data current. More than 2 dB increase is recommended.

8.2.3 Tape speed during recording

The permitted tape speed during recording is 4.76 cm/s ± 3% when measured in the frequency range from 0 to 0.5 Hz.
During high speed copying the only permitted tape speed is 9.52 cm/s ± 3% when measured in the frequency range from 0 to 1 Hz. In this case the bitrates as described in sections 8.2.1.1, 8.2.1.2 and 8.2.2.7 must be doubled.

The tape speed variation during recording must be below 2.5% peak, when measured in the frequency range from 0.5 Hz to 500 Hz.
The tape speed variation during recording must be below 1% peak, when measured in the frequency range from 500 Hz to 2 kHz.
During high speed copying the frequencies above must be doubled.
Measurement method: T.B.F.

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8.2.4 Recording direction

The recording direction is as specified in chapter 7.

8.2.5 Erase method

Main data : by means of overwrite with new Main data.
Aux data : by means of overwrite with new Aux data, or by means of overwrite with a high frequency signal as described in sections 8.2.2.7 and 8.2.2.8

8.3 Calculation formulae

relative 9.6 kHz Level (sections 8.1.2.2, 8.1.2.3 and 8.2.2.2):

relative 9.6 kHz Level = $O_t - O_c$

O_t = 20 Log (output level of the tape to be tested)
O_c = 20 Log (output level of the DCC Level tape 0 dB-9.6 kHz)

relative average 9.6 kHz Level vs temperature (section 8.2.2.4):

relative average 9.6 kHz Level = AvgT - Avg20

AvgT is the average 9.6 kHz output, recorded at temperature T and expressed in dB:
AvgT = 20 Log ((sum of channels 0 to 7) / 8)

Avg20 is the average 9.6 kHz output, recorded at +20°C and expressed in dB:
Avg20 = 20 Log ((sum of channels 0 to 7) / 8)

relative resolution (sections 8.1.2.2 and 8.2.2.3):

relative 48/9.6 kHz resolution = Rt - Rc

Rt is the resolution expressed in dB of the tape to be tested:

$$Rt = 20 \text{ Log } \frac{\text{48 kHz output level}}{\text{9.6 kHz output level}}$$

Rc is the resolution expressed in dB of the DCC Level Tape 0 dB-48 kHz and DCC Level Tape 0 db-9.6 kHz:

$$Rc = 20 \text{ Log } \frac{\text{48 kHz output level}}{\text{9.6 kHz output level}}$$

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9. MODULATION

9.1 Parameters

The modulation scheme is 8 - 10 modulation. The characteristics are shown below:

T_{min}	T_{max}	T_{max}/T_{min}	T_w	λ_{min}	λ_{max}	DC
0.8T	4T	5	0.8T	0.992	4.96	free

T = time interval of one unmodulated data bit.
T_{min} = minimum time interval between magnetic transitions
T_{max} = maximum time interval between magnetic transitions
T_w = detection window
λ_{min} = minimum wavelength (μm) of Main data
λ_{max} = maximum wavelength (μm) of Main data
T_{ch} = time interval of 1 modulated data bit (T_{ch} =0.8 T)

9.2 Modulation method

The modulation table is shown in 9.3.
The code word is selected by the data word and the Digital Sum Value (DSV) of the previous code word: DSV old. The table shows the code words in NRZ notation (decimal, hex and binary). The left bit (MSB) is shifted out first. See also Fig. 9.1.

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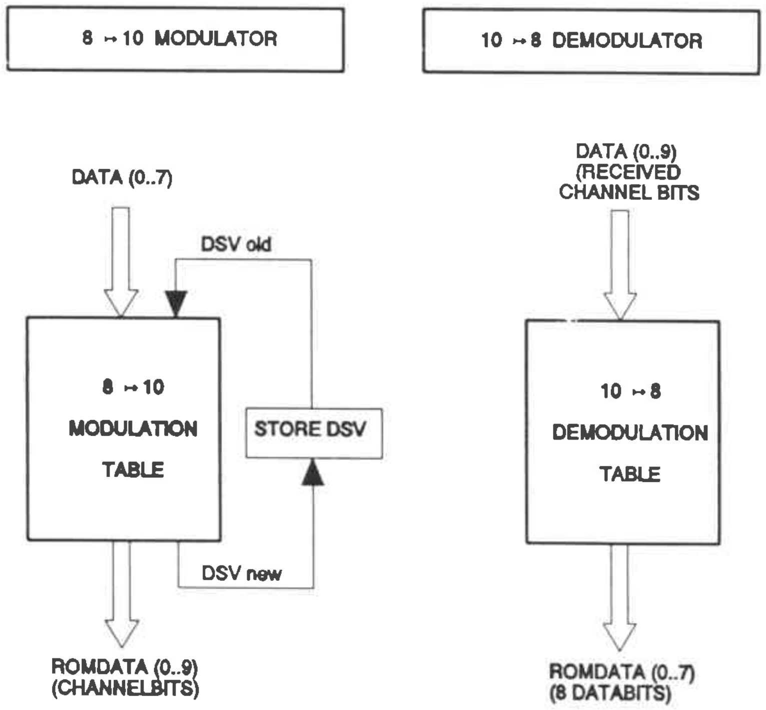
9.3 Modulation table

Input byte : 8 bit data.
S0 table : previous DSV=0
S1 table : previous DSV=1

The new DSV determines the table for the next input.



EXAMPLE:

DATAWORD	sync (old DSV=0)	AA (old DSV=1)	AA (old DSV=0)
NEW DSV	1	0	1
CODEWORD	0100111110	0101000101	0101110101

MODULATED WAVEFORM

Figure 9.1: Modulator and Demodulator

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9.3 Modulation table

9.3 Modulation table.

			MODULATOR OUTPUT									
INPUT BYTE			S0 TABLE (old DSV=0)				S1 TABLE (old DSV=1)					
DEC	HEX	BINARY	DEC	HEX	BINARY	DSV	DEC	HEX	BINARY	DSV		
0	00	00000000	171	0AB	0010101011	0	171	0AB	0010101011	1		
1	01	00000001	173	0AD	0010101101	0	173	0AD	0010101101	1		
2	02	00000010	174	0AE	0010101110	0	174	0AE	0010101110	1		
3	03	00000011	179	0B3	0010110011	0	179	0B3	0010110011	1		
4	04	00000100	181	0B5	0010110101	0	181	0B5	0010110101	1		
5	05	00000101	182	0B6	0010110110	0	182	0B6	0010110110	1		
6	06	00000110	185	0B9	0010111001	0	185	0B9	0010111001	1		
7	07	00000111	186	0BA	0010111010	0	186	0BA	0010111010	1		
8	08	00001000	203	0CB	0011001011	0	203	0CB	0011001011	1		
9	09	00001001	205	0CD	0011001101	0	205	0CD	0011001101	1		
10	0A	00001010	206	0CE	0011001110	0	206	0CE	0011001110	1		
11	0B	00001011	211	0D3	0011010011	0	211	0D3	0011010011	1		
12	0C	00001100	213	0D5	0011010101	0	213	0D5	0011010101	1		
13	0D	00001101	214	0D6	0011010110	0	214	0D6	0011010110	1		
14	0E	00001110	217	0D9	0011011001	0	217	0D9	0011011001	1		
15	0F	00001111	218	0DA	0011011010	0	218	0DA	0011011010	1		
16	10	00010000	227	0E3	0011100011	0	227	0E3	0011100011	1		
17	11	00010001	229	0E5	0011100101	0	229	0E5	0011100101	1		
18	12	00010010	230	0E6	0011100110	0	230	0E6	0011100110	1		
19	13	00010011	233	0E9	0011101001	0	233	0E9	0011101001	1		
20	14	00010100	234	0EA	0011101010	0	234	0EA	0011101010	1		
21	15	00010101	299	12B	0100101011	0	299	12B	0100101011	1		
22	16	00010110	301	12D	0100101101	0	301	12D	0100101101	1		
23	17	00010111	302	12E	0100101110	0	302	12E	0100101110	1		
24	18	00011000	307	133	0100110011	0	307	133	0100110011	1		
25	19	00011001	309	135	0100110101	0	309	135	0100110101	1		
26	1A	00011010	310	136	0100110110	0	310	136	0100110110	1		
27	1B	00011011	313	139	0100111001	0	313	139	0100111001	1		
28	1C	00011100	314	13A	0100111010	0	314	13A	0100111010	1		
29	1D	00011101	331	14B	0101001011	0	331	14B	0101001011	1		
30	1E	00011110	333	14D	0101001101	0	333	14D	0101001101	1		
31	1F	00011111	334	14E	0101001110	0	334	14E	0101001110	1		
32	20	00100000	339	153	0101010011	0	339	153	0101010011	1		
33	21	00100001	341	155	0101010101	0	341	155	0101010101	1		
34	22	00100010	342	156	0101010110	0	342	156	0101010110	1		
35	23	00100011	345	159	0101011001	0	345	159	0101011001	1		
36	24	00100100	346	15A	0101011010	0	346	15A	0101011010	1		
37	25	00100101	355	163	0101100011	0	355	163	0101100011	1		
38	26	00100110	357	165	0101100101	0	357	165	0101100101	1		
39	27	00100111	358	166	0101100110	0	358	166	0101100110	1		
40	28	00101000	361	169	0101101001	0	361	169	0101101001	1		
41	29	00101001	362	16A	0101101010	0	362	16A	0101101010	1		
42	2A	00101010	395	18B	0110001011	0	395	18B	0110001011	1		
43	2B	00101011	397	18D	0110001101	0	397	18D	0110001101	1		
44	2C	00101100	398	18E	0110001110	0	398	18E	0110001110	1		
45	2D	00101101	403	193	0110010011	0	403	193	0110010011	1		

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9.3 Modulation table

9.3 Modulation table (continued)

INPUT BYTE			MODULATOR OUTPUT							
			S0 TABLE (old DSV=0)				S1 TABLE (old DSV=1)			
DEC	HEX	BINARY	DEC	HEX	BINARY	DSV	DEC	HEX	BINARY	DSV
46	2E	00101110	405	195	0110010101	0	405	195	0110010101	1
47	2F	00101111	406	196	0110010110	0	406	196	0110010110	1
48	30	00110000	409	199	0110011001	0	409	199	0110011001	1
49	31	00110001	410	19A	0110011010	0	410	19A	0110011010	1
50	32	00110010	419	1A3	0110100011	0	419	1A3	0110100011	1
51	33	00110011	421	1A5	0110100101	0	421	1A5	0110100101	1
52	34	00110100	422	1A6	0110100110	0	422	1A6	0110100110	1
53	35	00110101	425	1A9	0110101001	0	425	1A9	0110101001	1
54	36	00110110	426	1AA	0110101010	0	426	1AA	0110101010	1
55	37	00110111	555	22B	1000101011	0	555	22B	1000101011	1
56	38	00111000	557	22D	1000101101	0	557	22D	1000101101	1
57	39	00111001	558	22E	1000101110	0	558	22E	1000101110	1
58	3A	00111010	563	233	1000110011	0	563	233	1000110011	1
59	3B	00111011	565	235	1000110101	0	565	235	1000110101	1
60	3C	00111100	566	236	1000110110	0	566	236	1000110110	1
61	3D	00111101	569	239	1000111001	0	569	239	1000111001	1
62	3E	00111110	570	23A	1000111010	0	570	23A	1000111010	1
63	3F	00111111	587	24B	1001001011	0	587	24B	1001001011	1
64	40	01000000	589	24D	1001001101	0	589	24D	1001001101	1
65	41	01000001	590	24E	1001001110	0	590	24E	1001001110	1
66	42	01000010	595	253	1001010011	0	595	253	1001010011	1
67	43	01000011	597	255	1001010101	0	597	255	1001010101	1
68	44	01000100	598	256	1001010110	0	598	256	1001010110	1
69	45	01000101	601	259	1001011001	0	601	259	1001011001	1
70	46	01000110	602	25A	1001011010	0	602	25A	1001011010	1
71	47	01000111	611	263	1001100011	0	611	263	1001100011	1
72	48	01001000	613	265	1001100101	0	613	265	1001100101	1
73	49	01001001	614	266	1001100110	0	614	266	1001100110	1
74	4A	01001010	617	269	1001101001	0	617	269	1001101001	1
75	4B	01001011	618	26A	1001101010	0	618	26A	1001101010	1
76	4C	01001100	651	28B	1010001011	0	651	28B	1010001011	1
77	4D	01001101	653	28D	1010001101	0	653	28D	1010001101	1
78	4E	01001110	654	28E	1010001110	0	654	28E	1010001110	1
79	4F	01001111	659	293	1010010011	0	659	293	1010010011	1
80	50	01010000	661	295	1010010101	0	661	295	1010010101	1
81	51	01010001	662	296	1010010110	0	662	296	1010010110	1
82	52	01010010	665	299	1010011001	0	665	299	1010011001	1
83	53	01010011	666	29A	1010011010	0	666	29A	1010011010	1
84	54	01010100	675	2A3	1010100011	0	675	2A3	1010100011	1
85	55	01010101	677	2A5	1010100101	0	677	2A5	1010100101	1
86	56	01010110	678	2A6	1010100110	0	678	2A6	1010100110	1
87	57	01010111	681	2A9	1010101001	0	681	2A9	1010101001	1
88	58	01011000	682	2AA	1010101010	0	682	2AA	1010101010	1
89	59	01011001	175	0AF	0010101111	1	43	02B	0000101011	0
90	5A	01011010	303	12F	0100101111	1	45	02D	0000101101	0
91	5B	01011011	559	22F	1000101111	1	46	02E	0000101110	0
92	5C	01011100	207	0CF	0011001111	1	51	033	0000110011	0
93	5D	01011101	625	271	1001110001	0	53	035	0000110101	0
94	5E	01011110	604	25C	1001011100	0	54	036	0000110110	0
95	5F	01011111	399	18F	0110001111	1	57	039	0000111001	0

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9.3 Modulation table

9.3 Modulation table (continued)

INPUT BYTE			MODULATOR OUTPUT S0 TABLE (old DSV = 0)				S1 TABLE (old DSV=1)			
DEC	HEX	BINARY	DEC	HEX	BINARY	DSV	DEX	HEX	BINARY	DSV
96	60	01100000	655	28F	1010001111	1	58	03A	0000111010	0
97	61	01100001	620	26C	1001101100	0	60	03C	0000111100	0
98	62	01100010	183	0B7	0010110111	1	75	04B	0001001011	0
99	63	01100011	311	137	0100110111	1	77	04D	0001001101	0
100	64	01100100	567	237	1000110111	1	78	04E	0001001110	0
101	65	01100101	215	0D7	0011010111	1	83	053	0001010011	0
102	66	01100110	343	157	0101010111	1	85	055	0001010101	0
103	67	01100111	599	257	1001010111	1	86	056	0001010110	0
104	68	01101000	407	197	0110010111	1	89	059	0001011001	0
105	69	01101001	663	297	1010010111	1	90	05A	0001011010	0
106	6A	01101010	791	317	1100010111	1	92	05C	0001011100	0
107	6B	01101011	231	0E7	0011100111	1	99	063	0001100011	0
108	6C	01101100	359	167	0101100111	1	101	065	0001100101	0
109	6D	01101101	615	267	1001100111	1	102	066	0001100110	0
110	6E	01101110	423	1A7	0110100111	1	105	069	0001101001	0
111	6F	01101111	679	2A7	1010100111	1	106	06A	0001101010	0
112	70	01110000	807	327	1100100111	1	108	06C	0001101100	0
113	71	01110001	455	1C7	0111000111	1	113	071	0001110001	0
114	72	01110010	711	2C7	1011000111	1	114	072	0001110010	0
115	73	01110011	839	347	1101000111	1	116	074	0001110100	0
116	74	01110100	433	1B1	0110110001	0	120	078	0001111000	0
117	75	01110101	187	0BB	0010111011	1	139	08B	0010001011	0
118	76	01110110	315	13B	0100111011	1	141	08D	0010001101	0
119	77	01110111	571	23B	1000111011	1	142	08E	0010001110	0
120	78	01111000	219	0DB	0011011011	1	147	093	0010010011	0
121	79	01111001	347	15B	0101011011	1	149	095	0010010101	0
122	7A	01111010	603	25B	1001011011	1	150	096	0010010110	0
123	7B	01111011	411	19B	0110011011	1	153	099	0010011001	0
124	7C	01111100	667	29B	1010011011	1	154	09A	0010011010	0
125	7D	01111101	795	31B	1100011011	1	156	09C	0010011100	0
126	7E	01111110	235	0EB	0011101011	1	163	0A3	0010100011	0
127	7F	01111111	363	16B	0101101011	1	165	0A5	0010100101	0
128	80	10000000	619	26B	1001101011	1	166	0A6	0010100110	0
129	81	10000001	427	1AB	0110101011	1	169	0A9	0010101001	0
130	82	10000010	683	2AB	1010101011	1	170	0AA	0010101010	0
131	83	10000011	811	32B	1100101011	1	172	0AC	0010101100	0
132	84	10000100	459	1CB	0111001011	1	177	0B1	0010110001	0
133	85	10000101	715	2CB	1011001011	1	178	0B2	0010110010	0
134	86	10000110	843	34B	1101001011	1	180	0B4	0010110100	0
135	87	10000111	779	30B	1100001011	0	184	0B8	0010111000	0
136	88	10001000	243	0F3	0011110011	1	195	0C3	0011000011	0
137	89	10001001	371	173	0101110011	1	197	0C5	0011000101	0
138	8A	10001010	627	273	1001110011	1	198	0C6	0011000110	0
139	8B	10001011	435	1B3	0110110011	1	201	0C9	0011001001	0
140	8C	10001100	691	2B3	1010110011	1	202	0CA	0011001010	0
141	8D	10001101	819	333	1100110011	1	204	0CC	0011001100	0
142	8E	10001110	467	1D3	0111010011	1	209	0D1	0011010001	0
143	8F	10001111	723	2D3	1011010011	1	210	0D2	0011010010	0
144	90	10010000	851	353	1101010011	1	212	0D4	0011010100	0
145	91	10010001	787	313	1100010011	0	216	0D8	0011011000	0

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9.3 Modulation table

9.3 Modulation table (continued)

INPUT BYTE			MODULATOR OUTPUT							
			S0 TABLE (old DSV=0)				S1 TABLE (old DSV=1)			
DEC	HEX	BINARY	DEC	HEX	BINARY	DSV	DEC	HEX	BINARY	DSV
146	92	10010010	483	1E3	0111100011	1	225	0E1	0011100001	0
147	93	10010011	739	2E3	1011100011	1	226	0E2	0011100010	0
148	94	10010100	867	363	1101100011	1	228	0E4	0011100100	0
149	95	10010101	803	323	1100100011	0	232	0E8	0011101000	0
150	96	10010110	189	0BD	0010111101	1	267	10B	0100001011	0
151	97	10010111	317	13D	0100111101	1	269	10D	0100001101	0
152	98	10011000	573	23D	1000111101	1	270	10E	0100001110	0
153	99	10011001	221	0DD	0011011101	1	275	113	0100010011	0
154	9A	10011010	349	15D	0101011101	1	277	115	0100010101	0
155	9B	10011011	605	25D	1001011101	1	278	116	0100010110	0
156	9C	10011100	413	19D	0110011101	1	281	119	0100011001	0
157	9D	10011101	669	29D	1010011101	1	282	11A	0100011010	0
158	9E	10011110	797	31D	1100011101	1	284	11C	0100011100	0
159	9F	10011111	237	0ED	0011101101	1	291	123	0100100011	0
160	A0	10100000	365	16D	0101101101	1	293	125	0100100101	0
161	A1	10100001	621	26D	1001101101	1	294	126	0100100110	0
162	A2	10100010	429	1AD	0110101101	1	297	129	0100101001	0
163	A3	10100011	685	2AD	1010101101	1	298	12A	0100101010	0
164	A4	10100100	813	32D	1100101101	1	300	12C	0100101100	0
165	A5	10100101	461	1CD	0111001101	1	305	131	0100110001	0
166	A6	10100110	717	2CD	1011001101	1	306	132	0100110010	0
167	A7	10100111	845	34D	1101001101	1	308	134	0100110100	0
168	A8	10101000	781	30D	1100001101	0	312	138	0100111000	0
169	A9	10101001	245	0F5	0011110101	1	323	143	0101000011	0
170	AA	10101010	373	175	0101110101	1	325	145	0101000101	0
171	AB	10101011	629	275	1001110101	1	326	146	0101000110	0
172	AC	10101100	437	1B5	0110110101	1	329	149	0101001001	0
173	AD	10101101	693	2B5	1010110101	1	330	14A	0101001010	0
174	AE	10101110	821	335	1100110101	1	332	14C	0101001100	0
175	AF	10101111	469	1D5	0111010101	1	337	151	0101010001	0
176	B0	10110000	725	2D5	1011010101	1	338	152	0101010010	0
177	B1	10110001	853	355	1101010101	1	340	154	0101010100	0
178	B2	10110010	789	315	1100010101	0	344	158	0101011000	0
179	B3	10110011	485	1E5	0111100101	1	353	161	0101100001	0
180	B4	10110100	741	2E5	1011100101	1	354	162	0101100010	0
181	B5	10110101	869	365	1101100101	1	356	164	0101100100	0
182	B6	10110110	805	325	1100100101	0	360	168	0101101000	0
183	B7	10110111	241	0F1	0011110001	0	387	183	0110000011	0
184	B8	10111000	377	179	0101111001	1	389	185	0110000101	0
185	B9	10111001	633	279	1001111001	1	390	186	0110000110	0
186	BA	10111010	441	1B9	0110111001	1	393	189	0110001001	0
187	BB	10111011	697	2B9	1010111001	1	394	18A	0110001010	0
188	BC	10111100	825	339	1100111001	1	396	18C	0110001100	0
189	BD	10111101	473	1D9	0111011001	1	401	191	0110010001	0
190	BE	10111110	729	2D9	1011011001	1	402	192	0110010010	0
191	BF	10111111	857	359	1101011001	1	404	194	0110010100	0
192	C0	11000000	793	319	1100011001	0	408	198	0110011000	0
193	C1	11000001	489	1E9	0111101001	1	417	1A1	0110100001	0
194	C2	11000010	745	2E9	1011101001	1	418	1A2	0110100010	0
195	C3	11000011	873	369	1101101001	1	420	1A4	0110100100	0

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9.3 Modulation table

9.3 Modulation table (continued)

INPUT BYTE			MODULATOR OUTPUT							
			S0 TABLE (old DSV=0)				S1 TABLE (old DSV = 1)			
DEC	HEX	BINARY	DEC	HEX	BINARY	DSV	DEC	HEX	BINARY	DSV
196	C4	11000100	809	329	1100101001	0	424	1A8	0110101000	0
197	C5	11000101	190	0BE	0010111110	1	523	20B	1000001011	0
198	C6	11000110	316	13C	0100111100	0	525	20D	1000001101	0
199	C7	11000111	572	23C	1000111100	0	526	20E	1000001110	0
200	C8	11001000	222	0DE	0011011110	1	531	213	1000010011	0
201	C9	11001001	350	15E	0101011110	1	533	215	1000010101	0
202	CA	11001010	606	25E	1001011110	1	534	216	1000010110	0
203	CB	11001011	414	19E	0110011110	1	537	219	1000011001	0
204	CC	11001100	670	29E	1010011110	1	538	21A	1000011010	0
205	CD	11001101	798	31E	1100011110	1	540	21C	1000011100	0
206	CE	11001110	238	0EE	0011101110	1	547	223	1000100011	0
207	CF	11001111	366	16E	0101101110	1	549	225	1000100101	0
208	D0	11010000	622	26E	1001101110	1	550	226	1000100110	0
209	D1	11010001	430	1AE	0110101110	1	553	229	1000101001	0
210	D2	11010010	686	2AE	1010101110	1	554	22A	1000101010	0
211	D3	11010011	814	32E	1100101110	1	556	22C	1000101100	0
212	D4	11010100	462	1CE	0111001110	1	561	231	1000110001	0
213	D5	11010101	718	2CE	1011001110	1	562	232	1000110010	0
214	D6	11010110	846	34E	1101001110	1	564	234	1000110100	0
215	D7	11010111	782	30E	1100001110	0	568	238	1000111000	0
216	D8	11011000	246	0F6	0011110110	1	579	243	1001000011	0
217	D9	11011001	374	176	0101110110	1	581	245	1001000101	0
218	DA	11011010	630	276	1001110110	1	582	246	1001000110	0
219	DB	11011011	438	1B6	0110110110	1	585	249	1001001001	0
220	DC	11011100	694	2B6	1010110110	1	586	24A	1001001010	0
221	DD	11011101	822	336	1100110110	1	588	24C	1001001100	0
222	DE	11011110	470	1D6	0111010110	1	593	251	1001010001	0
223	DF	11011111	726	2D6	1011010110	1	594	252	1001010010	0
224	E0	11100000	854	356	1101010110	1	596	254	1001010100	0
225	E1	11100001	790	316	1100010110	0	600	258	1001011000	0
226	E2	11100010	486	1E6	0111100110	1	609	261	1001100001	0
227	E3	11100011	742	2E6	1011100110	1	610	262	1001100010	0
228	E4	11100100	870	366	1101100110	1	612	264	1001100100	0
229	E5	11100101	806	326	1100100110	0	616	268	1001101000	0
230	E6	11100110	242	0F2	0011110010	0	643	283	1010000011	0
231	E7	11100111	378	17A	0101111010	1	645	285	1010000101	0
232	E8	11101000	634	27A	1001111010	1	646	286	1010000110	0
233	E9	11101001	442	1BA	0110111010	1	649	289	1010001001	0
234	EA	11101010	698	2BA	1010111010	1	650	28A	1010001010	0
235	EB	11101011	826	33A	1100111010	1	652	28C	1010001100	0
236	EC	11101100	474	1DA	0111011010	1	657	291	1010010001	0
237	ED	11101101	730	2DA	1011011010	1	658	292	1010010010	0
238	EE	11101110	858	35A	1101011010	1	660	294	1010010100	0
239	EF	11101111	794	31A	1100011010	0	664	298	1010011000	0
240	F0	11110000	490	1EA	0111101010	1	673	2A1	1010100001	0
241	F1	11110001	746	2EA	1011101010	1	674	2A2	1010100010	0
242	F2	11110010	874	36A	1101101010	1	676	2A4	1010100100	0
243	F3	11110011	810	32A	1100101010	0	680	2A8	1010101000	0
244	F4	11110100	376	178	0101111000	0	122	07A	0001111010	1
245	F5	11110101	872	368	1101101000	0	91	05B	0001011011	1

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9.3 Modulation table

9.3 Modulation table (continued)

INPUT BYTE			MODULATOR OUTPUT							
			S0 TABLE (old DSV=0)				S1 TABLE (old DSV = 1)			
DEC	HEX	BINARY	DEC	HEX	BINARY	DSV	DEC	HEX	BINARY	DSV
246	F6	11110110	744	2E8	1011101000	0	93	05D	0001011101	1
247	F7	11110111	488	1E8	0111101000	0	94	05E	0001011110	1
248	F8	11111000	856	358	1101011000	0	107	06B	0001101011	1
249	F9	11111001	728	2D8	1011011000	0	109	06D	0001101101	1
250	FA	11111010	472	1D8	0111011000	0	110	06E	0001101110	1
251	FB	11111011	824	338	1100111000	0	115	073	0001110011	1
252	FC	11111100	696	2B8	1010111000	0	117	075	0001110101	1
253	FD	11111101	440	1B8	0110111000	0	118	076	0001110110	1
254	FE	11111110	632	278	1001111000	0	121	079	0001111001	1
255	FF	11111111	868	364	1101100100	0	155	09B	0010011011	1
sync word			318	13E	0100111110	1	62	03E	0000111110	1

10. MAIN DATA ORGANIZATION

10.1 Main data format

See Figure below and Fig. 10.1.
Tracks numbered 0,1,2,3,4,5,6 and 7 will be used for Main data.
The data will be carried in units called tape frames. One tape frame is divided into 32 tape blocks for each track, i.e. 32x8 = 256 tape blocks. Frames are separated by an Inter Frame Gap (IFG).

<———— 1 Main data tape frame ————>

track										
0	0	1	2	3	//	29	30	31		0
1					//					
2					//					
3					//					
4					//					
5					//					
6					//					
7	0	1	2	3	//	29	30	31		0

——> IFG <——

<———— 32 tape blocks ————>

——— play direction ———>

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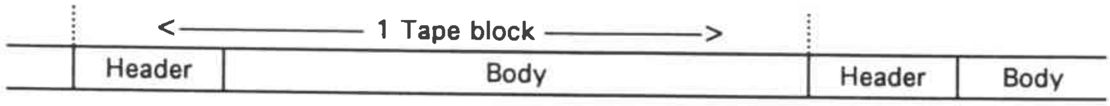
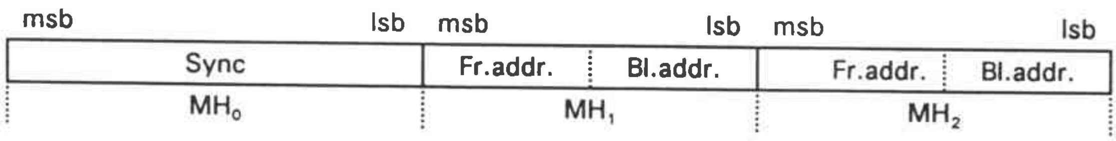
10.2 Tape block (Main data)

A tape block contains 510 channel bits. Tape blocks are encoded using 8 - 10 modulation as specified in chapter 9.

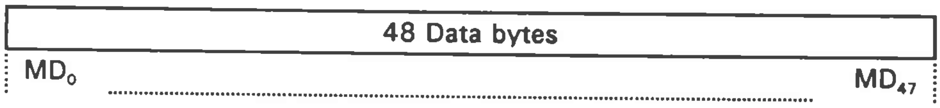
A tape block is composed of a header and a body. The diagram below shows a tape block:



Header:



Body:



The header consists of the sync pattern (MH_0) and 2 bytes, MH_1 and MH_2.
Both MH_1 and MH_2 contain a 3-bit frame address and a 5-bit block address. The frame address will count tape frames (modulo 8) in a binary sequence, incrementing with every tape frame. The block address will indicate the position of the tape block in the sequence of tape blocks for that track: the first tape block will have address 0, the next one address 1, etc. The final tape block will have address 1F hex (31 in decimal notation). MH_2 is a copy of MH_1. The word in the sync pattern (MH_0) can be found in the modulation table of chapter 9.
The body will carry 48 data bytes, numbered MD_0 to MD_{47}.

10.3 Inter-frame gap (IFG)

The nominal length of the IFG will be 64 channel bits. The length may vary from 31 to 96 channel bits due to the sampling frequency deviation of the nominal value.
The number of bits in the IFG will be an integer number and will be the same for all main data tracks. The signal recorded in the IFG consists of channel bits alternating with every bit cell, starting with a "0" or a "1".

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10.4 Main data allocation

The number of Main data bytes in a Tape frame is 12288 (8 x 32 x 48). The Main data consists of User main data bytes and Sysinfo bytes. The following notation will be used to indicate each byte:

$UMD_{t,b,i}$ or $SI_{t,b,i}$

in which:

t	- Track	(0 - 7)
b	- Tape Block	(0 - 31)
i	- Symbol no. within a block	(0 - 47)

10.4.1 User main data

The number of User main data bytes in a tape frame is 8192, numbered 0 to 8191. The location of these bytes can be found with the help of the following formulae:

u = order number of User main data byte: 0 ... 8191

Define:

d = u mod 2048
e = u div 2048

(d = 0 ... 2047 and e = 0 ... 3)

Then:

t = ((((d div 8) mod 13) + 1) * 5 -
(((d div 8) mod 13) div 6) * 6 +
(((d div 8) mod 13) div 12) * 6) mod 8

b = (d mod 8) + (e * 8)

i = (d div 104) * 2 +
(1 - 2 * (e mod 2)) *
(((d div 8) mod 13) div 6 -
((d div 8) mod 13) div 12) +
(e mod 2)

In addition 'Slots' are defined as follows:

Z = number of Slot (0...2047)
Y = number of byte (0...3)

Z = u div 4
Y = u mod 4

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10.4 Main data allocation

10.4.2 System information

There are also 128 system information bytes in a Main data tape frame, numbered SI_0 to SI_{127}. The location of these bytes can be found using of the following formulae:

z = order number of system information byte: 0 ... 127

Define:

d = (z mod 32) + 2048, and e = (z div 32).

(d = 2048 ... 2079 and e = 0 ... 3)

Then:

t = ((((d div 8) mod 13) + 1) * 5 -
(((d div 8) mod 13) div 6) * 6 +
(((d div 8) mod 13) div 12) * 6) mod 8

b = (d mod 8) + (e * 8)

i = (d div 104) * 2 +
(1 - 2 * (e mod 2)) * (((d div 8) mod 13) div 6 -
((d div 8) mod 13) div 12) + (e mod 2)

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10.4 Main data allocation

10.4.3 Error detecting and correcting code (Main data)

An error detecting and correcting code is used:

C1 : $GF(2^8)$ Reed-Solomon Code (24,20,5)
C2 : $GF(2^8)$ Reed-Solomon Code (32,26,7)

The calculation is defined on $GF(2^8)$ by the following polynomial:

$$g(X) = X^8 + X^4 + X^3 + X^2 + 1$$

A primitive element α in $GF(2^8)$ is defined as follows:

$$\alpha = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$
$$\quad\quad\ \ \alpha^7 \ \ \alpha^6 \ \ \alpha^5 \ \ \alpha^4 \ \ \alpha^3 \ \ \alpha^2 \ \ \alpha^1 \ \ \alpha^0$$

10.4.4 C1 interleaving format (Main data)

The code symbols in a C1 code word will be numbered 0 to 23. A tape frame will have 512 C1 words numbered 0 to 511. The location of code symbol s in code word w can be calculated with the following formula :

tape track : (w div 2) mod 8
tape block : (w div 16)
tape symbol : (w mod 2) + s * 2

The code symbols 20,21,22 and 23 will contain the parity bytes.
This implies that in a tape block tape symbols MD_{40} to MD_{47} will be C1 parity code symbols.

10.4.5 C2 interleaving format (Main data)

The code symbols in a C2 code word will be numbered 0 to 31. A tape frame will have 384 C2 code words numbered 0 to 383. The location of code symbol t in code word v can be calculated with the following formula :

tape track : (t * 5) mod 8
tape block : ((t * 48 + v) mod 384) div 48 + (t div 8) * 8
tape symbo : v mod 48

The position of the parity code symbols differs between odd and even C2 words:

- Even words (v mod 2 = 0) : parity in code symbols 0,7,8,16,23,24
- Odd words (v mod 2 = 1) : parity in code symbols 0,8,15,16,24,31

This means that the parity will be in the following tracks on tape :

Track 0 will be a full C2 parity track, it will carry C2 code symbols 0,8,16 and 24.
Track 3 will be half full with C2 parity as it carries C2 code symbols 7,15,23 and 31.

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10.4.6 Parity symbols (Main data)

The parity code symbols are defined so as to satisfy the following equations:

$$C1: \quad H_P * V_P = 0 \quad ; \quad C2: \quad H_Q * V_Q = 0 \quad ;$$

Parity check matrix:

$$H_P = \begin{bmatrix} 1 & \alpha^{23} & \alpha^{46} & \alpha^{69} \\ 1 & \alpha^{22} & \alpha^{44} & \alpha^{66} \\ 1 & \alpha^{21} & \alpha^{42} & \alpha^{63} \\ 1 & \alpha^{20} & \alpha^{40} & \alpha^{60} \\ 1 & \alpha^{19} & \alpha^{38} & \alpha^{57} \\ 1 & \alpha^{18} & \alpha^{36} & \alpha^{54} \\ 1 & \alpha^{17} & \alpha^{34} & \alpha^{51} \\ 1 & \alpha^{16} & \alpha^{32} & \alpha^{48} \\ 1 & \alpha^{15} & \alpha^{30} & \alpha^{45} \\ 1 & \alpha^{14} & \alpha^{28} & \alpha^{42} \\ 1 & \alpha^{13} & \alpha^{26} & \alpha^{39} \\ 1 & \alpha^{12} & \alpha^{24} & \alpha^{36} \\ 1 & \alpha^{11} & \alpha^{22} & \alpha^{33} \\ 1 & \alpha^{10} & \alpha^{20} & \alpha^{30} \\ 1 & \alpha^{9} & \alpha^{18} & \alpha^{27} \\ 1 & \alpha^{8} & \alpha^{16} & \alpha^{24} \\ 1 & \alpha^{7} & \alpha^{14} & \alpha^{21} \\ 1 & \alpha^{6} & \alpha^{12} & \alpha^{18} \\ 1 & \alpha^{5} & \alpha^{10} & \alpha^{15} \\ 1 & \alpha^{4} & \alpha^{8} & \alpha^{12} \\ 1 & \alpha^{3} & \alpha^{6} & \alpha^{9} \\ 1 & \alpha^{2} & \alpha^{4} & \alpha^{6} \\ 1 & \alpha^{1} & \alpha^{2} & \alpha^{3} \\ 1 & 1 & 1 & 1 \end{bmatrix}^T \qquad V_P = \begin{bmatrix} S_0 \\ \vdots \\ S_{23} \end{bmatrix}$$

$$\text{Generator Polynomial: } GP(X) = \prod_{i=0}^{3} (X-\alpha^i)$$

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10.4 Main data allocation

$$
H_Q = \begin{bmatrix}
1 & \alpha^{31} & \alpha^{62} & \alpha^{93} & \alpha^{124} & \alpha^{155} \\
1 & \alpha^{30} & \alpha^{60} & \alpha^{90} & \alpha^{120} & \alpha^{150} \\
1 & \alpha^{29} & \alpha^{58} & \alpha^{87} & \alpha^{116} & \alpha^{145} \\
1 & \alpha^{28} & \alpha^{56} & \alpha^{84} & \alpha^{112} & \alpha^{140} \\
1 & \alpha^{27} & \alpha^{54} & \alpha^{81} & \alpha^{108} & \alpha^{135} \\
1 & \alpha^{26} & \alpha^{52} & \alpha^{78} & \alpha^{104} & \alpha^{130} \\
1 & \alpha^{25} & \alpha^{50} & \alpha^{75} & \alpha^{100} & \alpha^{125} \\
1 & \alpha^{24} & \alpha^{48} & \alpha^{72} & \alpha^{96} & \alpha^{120} \\
1 & \alpha^{23} & \alpha^{46} & \alpha^{69} & \alpha^{92} & \alpha^{115} \\
1 & \alpha^{22} & \alpha^{44} & \alpha^{66} & \alpha^{88} & \alpha^{110} \\
1 & \alpha^{21} & \alpha^{42} & \alpha^{63} & \alpha^{84} & \alpha^{105} \\
1 & \alpha^{20} & \alpha^{40} & \alpha^{60} & \alpha^{80} & \alpha^{100} \\
1 & \alpha^{19} & \alpha^{38} & \alpha^{57} & \alpha^{76} & \alpha^{95} \\
1 & \alpha^{18} & \alpha^{36} & \alpha^{54} & \alpha^{72} & \alpha^{90} \\
1 & \alpha^{17} & \alpha^{34} & \alpha^{51} & \alpha^{68} & \alpha^{85} \\
1 & \alpha^{16} & \alpha^{32} & \alpha^{48} & \alpha^{64} & \alpha^{80} \\
1 & \alpha^{15} & \alpha^{30} & \alpha^{45} & \alpha^{60} & \alpha^{75} \\
1 & \alpha^{14} & \alpha^{28} & \alpha^{42} & \alpha^{56} & \alpha^{70} \\
1 & \alpha^{13} & \alpha^{26} & \alpha^{39} & \alpha^{52} & \alpha^{65} \\
1 & \alpha^{12} & \alpha^{24} & \alpha^{36} & \alpha^{48} & \alpha^{60} \\
1 & \alpha^{11} & \alpha^{22} & \alpha^{33} & \alpha^{44} & \alpha^{55} \\
1 & \alpha^{10} & \alpha^{20} & \alpha^{30} & \alpha^{40} & \alpha^{50} \\
1 & \alpha^{9} & \alpha^{18} & \alpha^{27} & \alpha^{36} & \alpha^{45} \\
1 & \alpha^{8} & \alpha^{16} & \alpha^{24} & \alpha^{32} & \alpha^{40} \\
1 & \alpha^{7} & \alpha^{14} & \alpha^{21} & \alpha^{28} & \alpha^{35} \\
1 & \alpha^{6} & \alpha^{12} & \alpha^{18} & \alpha^{24} & \alpha^{30} \\
1 & \alpha^{5} & \alpha^{10} & \alpha^{15} & \alpha^{20} & \alpha^{25} \\
1 & \alpha^{4} & \alpha^{8} & \alpha^{12} & \alpha^{16} & \alpha^{20} \\
1 & \alpha^{3} & \alpha^{6} & \alpha^{9} & \alpha^{12} & \alpha^{15} \\
1 & \alpha^{2} & \alpha^{4} & \alpha^{6} & \alpha^{8} & \alpha^{10} \\
1 & \alpha^{1} & \alpha^{2} & \alpha^{3} & \alpha^{4} & \alpha^{5} \\
1 & 1 & 1 & 1 & 1 & 1
\end{bmatrix}^{T}
\qquad
V_Q = \begin{bmatrix} T_0 \\ \vdots \\ T_{31} \end{bmatrix}
$$

$$
\text{Generator Polynomial: } GQ(X) = \prod_{i=0}^{5} (X - \alpha^{i})
$$

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10.4 Main data allocation

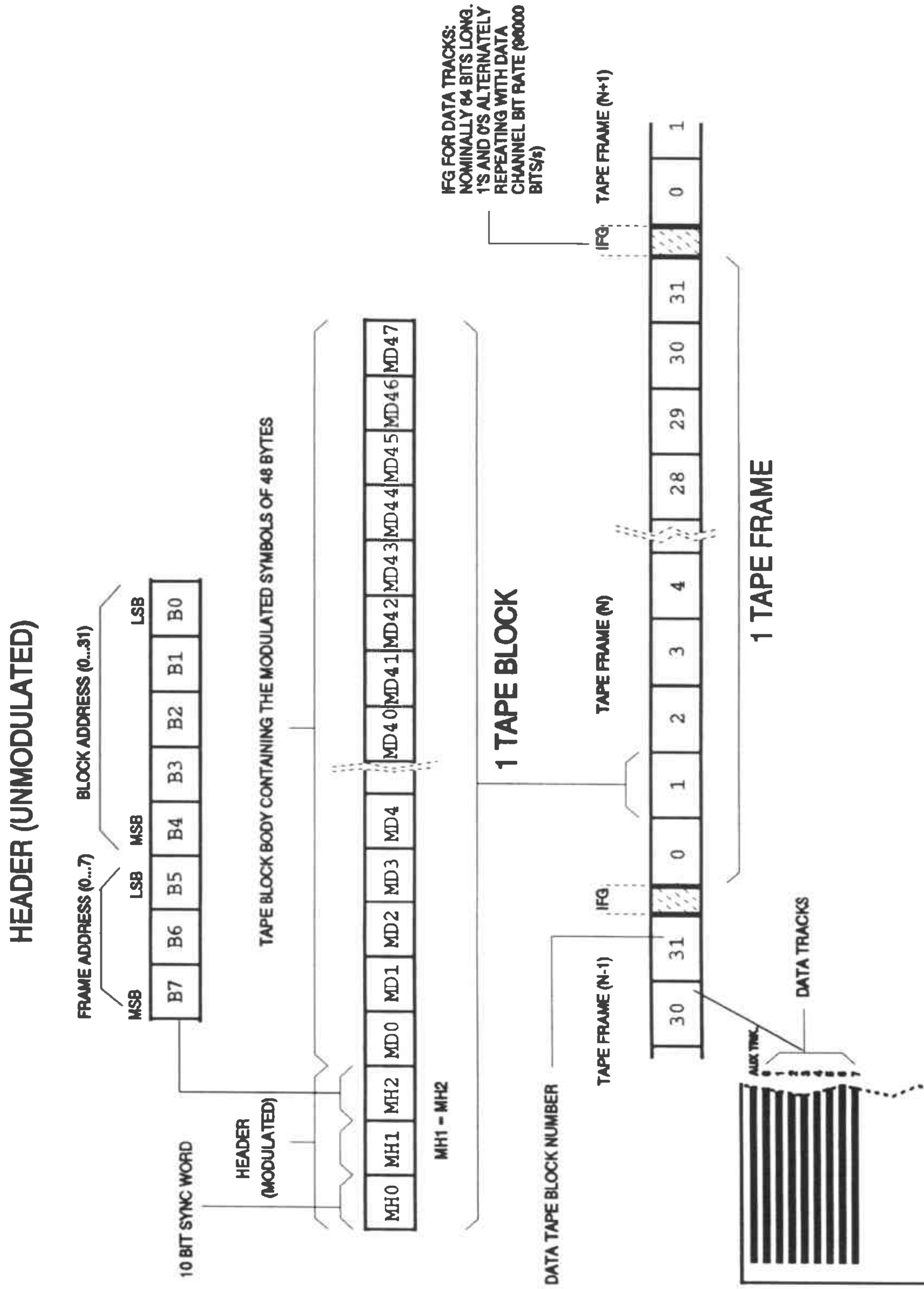

FIGURE 10.1: MAIN DATA TAPE FRAME FORMAT

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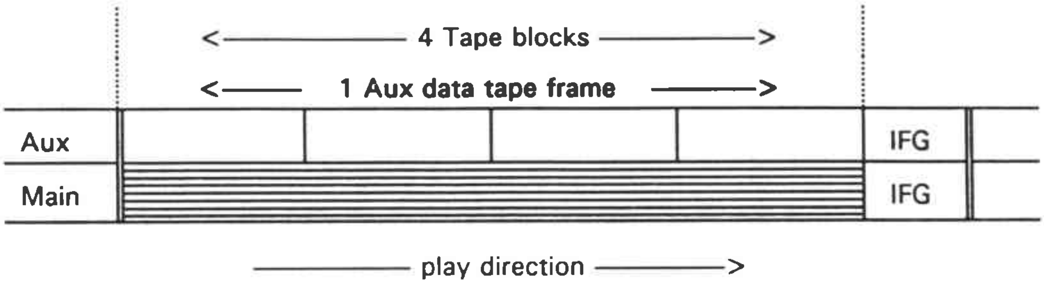
11. AUXILIARY DATA ORGANIZATION

11.1 Aux data format

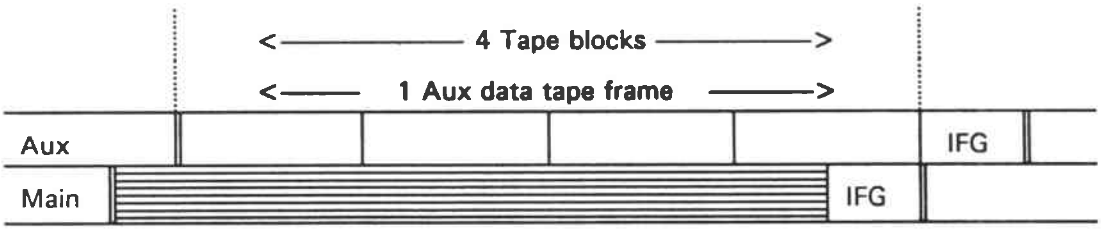
See the Figures below and Fig. 11.1.

The Auxiliary track will be used to carry Aux data. The data will be carried in units called Aux data tape frames. One tape frame is divided into 4 tape blocks. Frames are separated by inter frame gaps (I.F.G.), similar to the Main data allocation.
As the bit rate of the Aux data is 1/8th of the bit rate of the Main data tracks, the nominal length of the Aux data tape frame is the same as the length of the Main data tape frame.

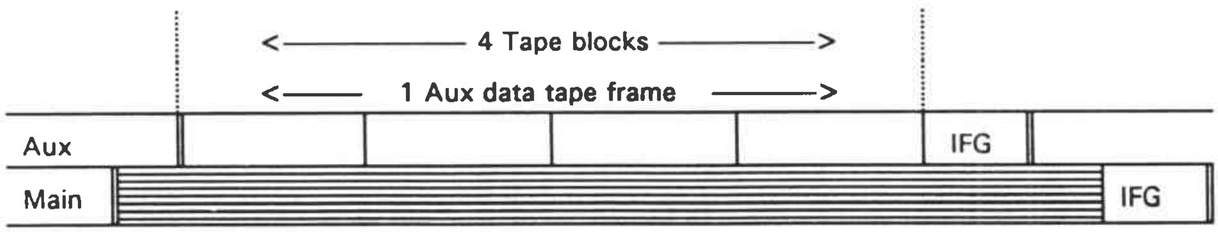
Search information will be encoded onto the Aux data track by recording or not recording the contents of some of the tape blocks on tape (see 11.8).



The Aux data tape frames do not have to be aligned to the Main data tape frames. Misalignment may occur in the case of Aux data re-recording, without changing the Main data:



Apart from misalignment, the bit rate of the Aux data can also deviate from 1/8th of the bit rate of the main channel due to variation in the recording tape speed:



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11.1 Aux data format

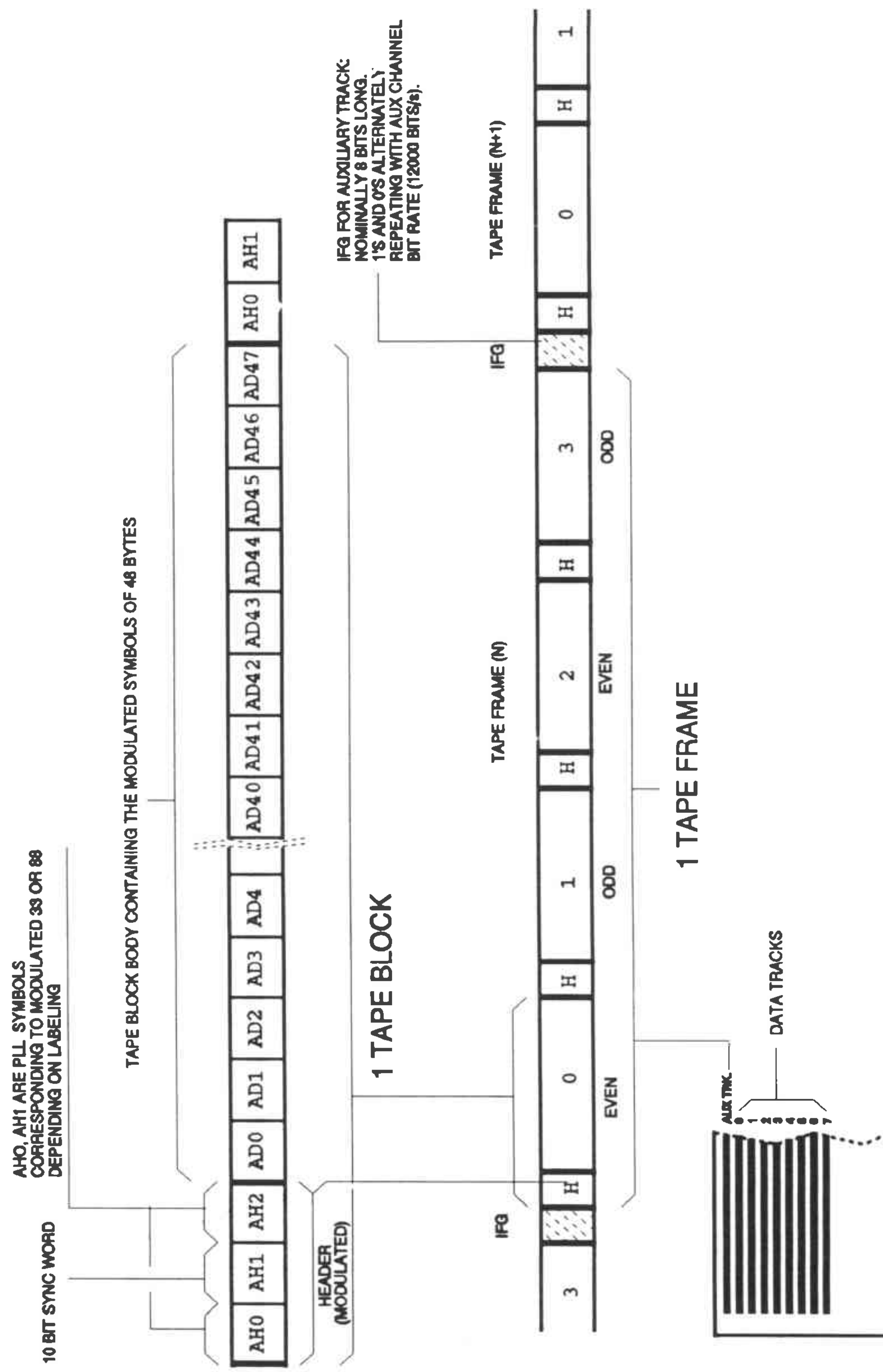

FIGURE 11.1: AUX DATA TAPE FRAME FORMAT

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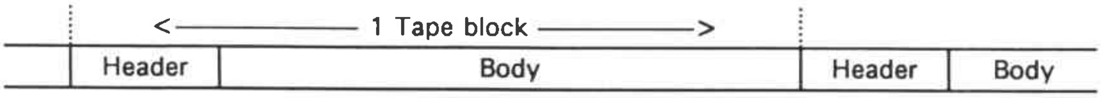
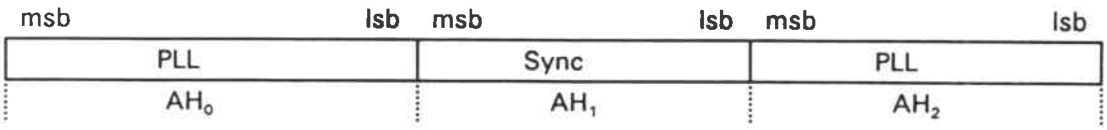
11.2 Tape block

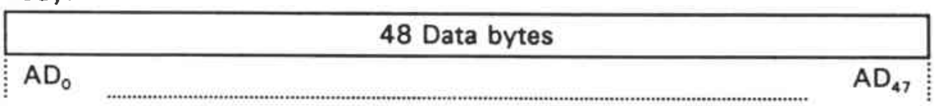
A tape block consists of 510 channel bits. Tape blocks are encoded using 8 - 10 modulation. A tape block is composed of a header and a body. The diagram below shows a tape block:



Header:



Body:



The header contains a Sync pattern and 2 ten-bit PLL sequences (AH_0 and AH_2) to enable easy clock recovery for both reading directions. These PLL symbols indicate the validation of the following or the previous Tape block body. The first header of a Tape frame will start with the modulated symbol 88 (Dec) as the variable length of the IFG prevents correct reading in the reverse direction. According to the table below and figure 11.2, AH_0 and AH_2 are recorded modulated 88 (Dec) or modulated 33 (Dec):

	AH_0	AH_2
Modulated 88 (Dec) 1010101010	- Recorded in Tape block number 0 - Previous Tape block body is not recorded	- Following Tape block body is not recorded
Modulated 33 (Dec) 0101010101	- Previous Tape block body is recorded	- Following Tape block body is recorded

The sequences of the modulated channel bits have alternating polarity, (0101..) or (1010..), with every bit cell (see modulation table 9.3). See also the examples in Fig. 11.2.

The Sync pattern word (AH_1) can be found in the modulation table of chapter 9 and will be generated according to the DSV rules of the modulation table.

The Body will carry 48 data bytes, numbered AD_0 to AD_{47}, the format of which will be explained in the following chapters.

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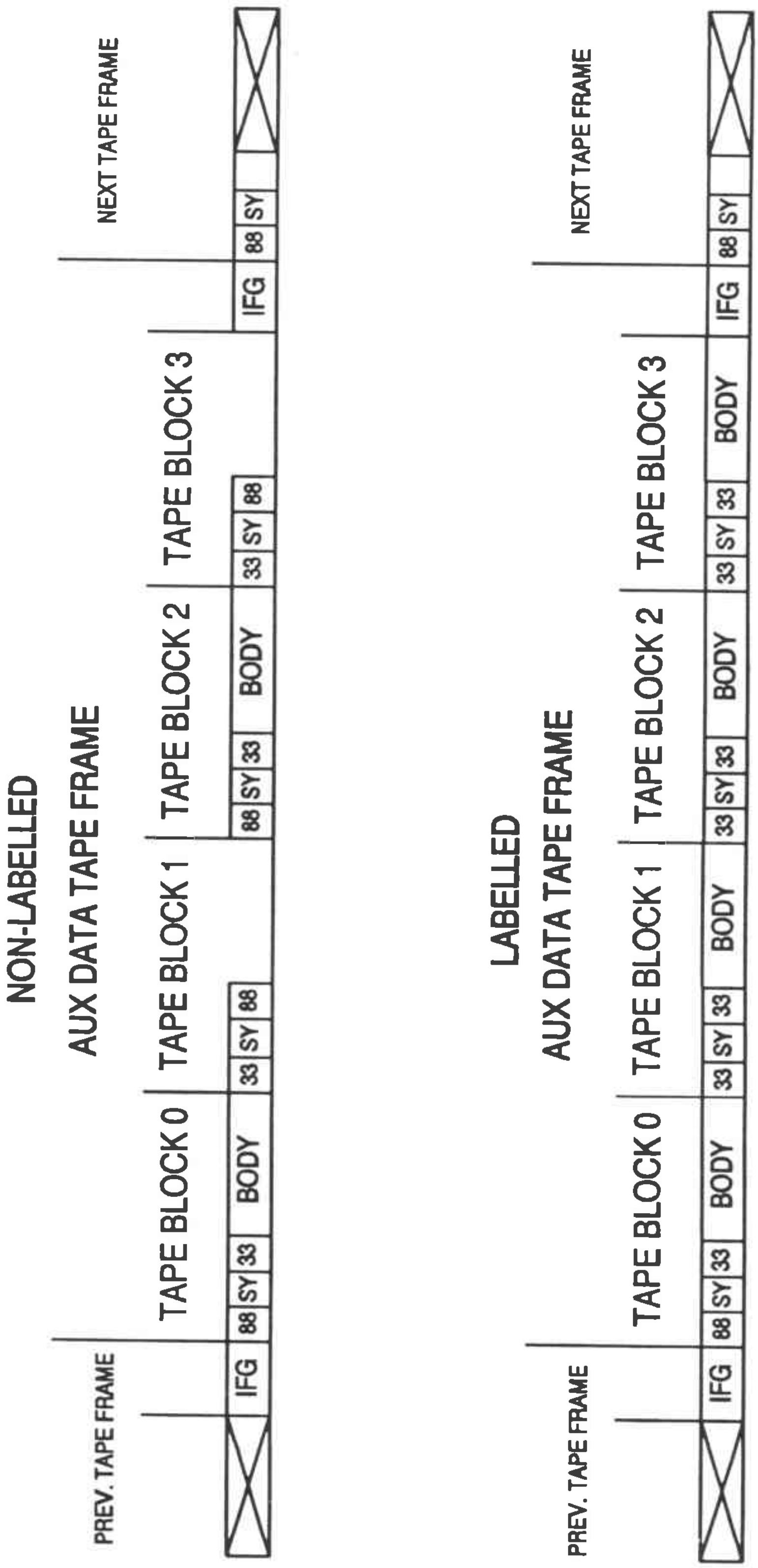

Fig 11.2: Examples of header in Aux data

11.3 Inter Frame Gap

See also section 10.3. During recording of Main and Aux data the number of bits in the inter frame gap should be approximately 1/8th of the number of bits in the inter frame gap of the Main data tracks.
However, it should be an integer number (i.e. the IFG length is an integer number of bits).

11.4 Aux data allocation

11.4.1 Aux code data

The number of data bytes in every Tape frame of the tape block bodies is 192.
In one Tape block body the bytes will be indicated with the following notation:

$$AD_i$$

in which i is the symbol number (0 - 47).

As most of the information is repeated in the four tape blocks of a frame. The number of data bytes in a Tape frame is 48. The number of user Aux data bytes in a Tape frame is 36. The remaining 12 bytes in a Tape frame are used for parity code.

11.4.1.1 Error detecting and correcting code

For the Aux data bytes an error detecting and correcting code is used:

AC : $GF(2^8)$ Reed-Solomon Code (24,18,7)

The calculation is defined on $GF(2^8)$ by the following polynomial:

$$g(X) = X^8 + X^4 + X^3 + X^2 + 1$$

A primitive element α in $GF(2^8)$ is defined as follows:

$$\alpha = \begin{array}{ccccccccc} (& 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0\ ) \\ & \alpha^7 & \alpha^6 & \alpha^5 & \alpha^4 & \alpha^3 & \alpha^2 & \alpha^1 & \alpha^0 \end{array}$$

11.4.1.2 Error correction code interleaving format

The code symbols in a code word will be numbered 0 to 23. A tape block body will have 2 code words numbered 0 to 1. The location of code symbol s in code word w may be calculated with the following formula:

Tape symbol number in block : (w mod 2) + s * 2

The code symbols 18, 19, 20, 21, 22 and 23 of a code word will be the parity symbols.
This implies that in Tape block symbols AD_{36} to AD_{47} will be parity symbols.

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11.4.1.3 Parity symbols

The parity symbols are defined so as to satisfy the following equation:

$$H_Q * V_Q = 0 \quad ;$$

Parity check matrix :

$$H_Q = \begin{bmatrix} 1 & \alpha^{23} & \alpha^{46} & \alpha^{69} & \alpha^{92} & \alpha^{115} \\ 1 & \alpha^{22} & \alpha^{44} & \alpha^{66} & \alpha^{88} & \alpha^{110} \\ 1 & \alpha^{21} & \alpha^{42} & \alpha^{63} & \alpha^{84} & \alpha^{105} \\ 1 & \alpha^{20} & \alpha^{40} & \alpha^{60} & \alpha^{80} & \alpha^{100} \\ 1 & \alpha^{19} & \alpha^{38} & \alpha^{57} & \alpha^{76} & \alpha^{95} \\ 1 & \alpha^{18} & \alpha^{36} & \alpha^{54} & \alpha^{72} & \alpha^{90} \\ 1 & \alpha^{17} & \alpha^{34} & \alpha^{51} & \alpha^{68} & \alpha^{85} \\ 1 & \alpha^{16} & \alpha^{32} & \alpha^{48} & \alpha^{64} & \alpha^{80} \\ 1 & \alpha^{15} & \alpha^{30} & \alpha^{45} & \alpha^{60} & \alpha^{75} \\ 1 & \alpha^{14} & \alpha^{28} & \alpha^{42} & \alpha^{56} & \alpha^{70} \\ 1 & \alpha^{13} & \alpha^{26} & \alpha^{39} & \alpha^{52} & \alpha^{65} \\ 1 & \alpha^{12} & \alpha^{24} & \alpha^{36} & \alpha^{48} & \alpha^{60} \\ 1 & \alpha^{11} & \alpha^{22} & \alpha^{33} & \alpha^{44} & \alpha^{55} \\ 1 & \alpha^{10} & \alpha^{20} & \alpha^{30} & \alpha^{40} & \alpha^{50} \\ 1 & \alpha^{9} & \alpha^{18} & \alpha^{27} & \alpha^{36} & \alpha^{45} \\ 1 & \alpha^{8} & \alpha^{16} & \alpha^{24} & \alpha^{32} & \alpha^{40} \\ 1 & \alpha^{7} & \alpha^{14} & \alpha^{21} & \alpha^{28} & \alpha^{35} \\ 1 & \alpha^{6} & \alpha^{12} & \alpha^{18} & \alpha^{24} & \alpha^{30} \\ 1 & \alpha^{5} & \alpha^{10} & \alpha^{15} & \alpha^{20} & \alpha^{25} \\ 1 & \alpha^{4} & \alpha^{8} & \alpha^{12} & \alpha^{16} & \alpha^{20} \\ 1 & \alpha^{3} & \alpha^{6} & \alpha^{9} & \alpha^{12} & \alpha^{15} \\ 1 & \alpha^{2} & \alpha^{4} & \alpha^{6} & \alpha^{8} & \alpha^{10} \\ 1 & \alpha^{1} & \alpha^{2} & \alpha^{3} & \alpha^{4} & \alpha^{5} \\ 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}^T \qquad V_Q = \begin{bmatrix} S_0 \\ \\ \vdots \\ \\ S_{23} \end{bmatrix}$$

$$\text{Generator Polynomial: } GQ(X) = \prod_{i=0}^{5} (X-\alpha^i)$$

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11.4.2 Search information (see Figure 11.2)

Search information will be encoded on the Aux track using envelope encoding. This can be used to implement a high speed search function.

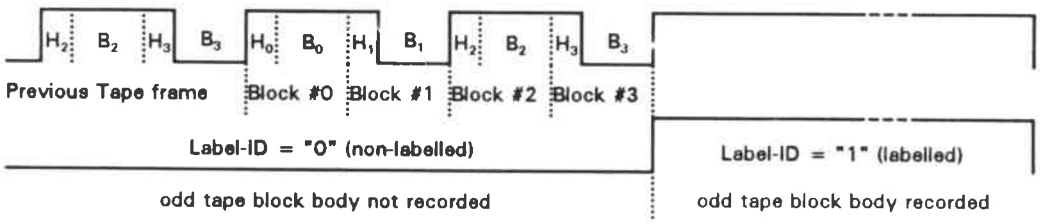
A labelled location on tape can be searched for during search forward or search reverse actions. Two levels of labelling exist, in the Search information and in the tape block body. The rules on how to use the labelling of tape positions are explained in chapters 14, 15 and 16.

The Search information is indicated by the mere existence of a label, without numbering information. For this 2 states are defined:

- labelled,
- non-labelled.

The labelled state is coded by recording all 4 tape blocks of a tape frame, both header and body. The non-labelled state is coded by not recording the body of the odd tape blocks of a tape frame, such that the headers remain recorded (the information on the tape will be erased by overwriting instead, at the position of the body of the odd tape blocks). If a tape block body is not recorded, any previously recorded signals in the track will have to be erased.

This results in the following envelopes of the recorded signal:



Numbers indicate Tape block numbers in a frame: "H" indicates Header, "B" indicates Body.
For the description of the Label ID see chapters 14 and 15.

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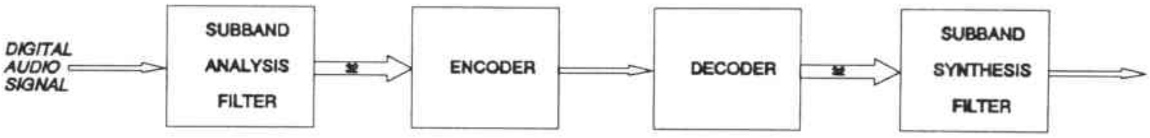
12. AUDIO CODING (for consumer recorded cassettes)

Introduction

A Precision Adaptive Subband Coding encoder as described in this chapter must be used to create a digital signal of 384 kbits/sec. The data thus created are inserted in the User main data area.

The setup of the Precision Adaptive Subband Coding (PASC) system is shown below:



The digital audio input signal is split into 32 subbands. These subband samples are sent to the encoder that determines the accuracy with which the samples need to be transferred. It quantizes the samples according to that accuracy, and adds synchronization and allocation information to form the PASC encoded signal.
In the decoding chain the decoder de-quantizes the samples to form the subband signals that are sent to the subband synthesis filter, in which all are joined. In this way the audio signal is reconstructed.

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12.1 PASC frame format

The basic unit of this format is called a Slot. A Slot contains 32 bits, numbered 0 to 31. Slots are grouped together to form a PASC Frame, the length of which depends on the sampling frequency Fs:

Sampling frequency	PASC Frame length	Frame period
48 kHz 44.1 Khz 32 kHz	96 Slots 104 Slots + padding 144 Slots	8 msec. 8.7 msec. 12 msec.

In the case of 44.1 kHz sampling frequency an extra 'dummy' Slot may have to be added to the PASC frame. Dummy Slots will be distributed such that every odd PASC frame in a sequence of 49 frames, numbered 0 to 48, will have a dummy slot:

Frame Number:	47	48	0	1	2	3	4
Padding :	P			P		P	
Frame length:	105	104	104	105	104	105	104

A frame contains the following fields of information:

SYNC & CODING INFO	ALLOCATION INFORMATION	SCALE FACTORS	CODED SAMPLES

The slot numbering in a frame starts with 1.

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12.1.1 Synchronization and coding info field

The first Slot (1) will contain the synchronization pattern and subband coding information:

SYNCHRONIZATION PATTERN	BITRATE	Fs	P	F	Mo	Sw	Tr	Emp
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 0 0							
0 15	16 19	20		23	24			31

The numbers 0..31 are the bit numbers of a Slot.

The synchronization pattern consists of 16 bits, numbered 0 to 15, all of which are '1'.

The bitrate indication must be '1 1 0 0'. For all other bitrate indications the audio output must be muted during decoding.

The sampling frequency is indicated using 2 bits :

Bits 20 21	Sampling frequency
0 0	44.1 kHz
0 1	48 kHz
1 0	32 kHz
1 1	Reserved

The padding bit (bit 22) indicates whether the current frame contains a 'dummy' slot. In this case it will be '1', otherwise it will be '0'. Padding mode is valid for 44.1 kHz sampling frequency only.

Bit 23 is reserved for future applications, '0' for the time being. This bit cannot be used for a validity check, i.e. if a decoder detects a '1' in this location it will not be effected by it and continue with the decoding, as the future applications will be backwards compatible.

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Bits 24 and 25 provide an indication of the coding mode:

Bits 24 25	Mode assignment
0 0	Stereo
0 1	Joint Stereo Mode (Reserved for future use)
1 0	2-channel mono (Double Play Mono)
1 1	Reserved for future use

The 2-channel mono mode is the only allowed mode on 4-Sector prerecorded tapes (see Chapter 15.1).

The coding mode may change with every PASC frame. A decoder must continue to operate without interrupting the output signal, especially when Stereo and Joint Stereo Coding frames are mixed.

Bits 26 and 27 are used in Joint Stereo Mode only, for other modes they must be '0 0'. However, this must not be used for a validity check: i.e. in other modes a decoder must disregard these bits.
In Joint Stereo Mode (bits 24 and 25 equal to '0 1') they indicate which subbands signals of the Left and Right channel are jointly coded:

Bits 26 27	Subbands that are jointly coded
0 0	4 ... 31
0 1	8 ... 31
1 0	12 ... 31
1 1	16 ... 31

If applicable bits 26 and 27 may change with every PASC frame.
In Joint Stereo Coding mode a PASC coded sample for the subbands specified is used for both Left and Right channel, but the scale factor index is transferred separately.

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12.1 PASC frame format

Bit 28 : TR0 — transparent bit 0, state is equal to CP1 (see chapter 13)

'1' = copyright protected
'0' = not copyright protected

Bit 29 : TR1 — transparent bit 1
reserved for future use, '0' for the time being

Note: Transparent means that the bitsetting will be copied from the source signal.

Bits 30 and 31 : Emphasis

Bits 30 31	Assignment
0 0	No emphasis
0 1	50/15 μs emphasis
1 0	Reserved for future use, not used for consumer applications
1 1	CCITT J.17, not used for consumer applications

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12.1.2 Allocation information field

For every subband the encoder has to provide information on the number of bits allocated to the samples of that subband. The allocation information may differ between channels L and R (channels I and II in 2 channel mono mode). Also the total number of bits allocated to the L channel may differ from the total number of bits allocated to the R channel. In the case of 'digital silence' bits do not have to be allocated at all (no samples will be transferred and the decoder will make all subband signals '0').
The number of bits allocated to the samples will be encoded as a 4 bit binary number, according to the following table:

number of allocated bits:	allocation info: msb..lsb	
0	0000	no samples or scale factors transferred
2	0001	
3	0010	
4	0011	
5	0100	
6	0101	
7	0110	
8	0111	
9	1000	
10	1001	
11	1010	
12	1011	
13	1100	
14	1101	
15	1110	

The combination '1111' is not used.

Normally the slots of the allocation info field carry 8 allocation info units:

ALLOC UNIT	ALLOC UNIT	ALLOC UNIT	ALLOC UNIT	ALLOC UNIT	ALLOC UNIT	ALLOC UNIT	ALLOC UNIT
0 . . 3 msb lsb	4 . . 7 msb lsb	8 . . 11 msb lsb	12 . . 15 msb lsb	16 . . 19 msb lsb	20 . . 23 msb lsb	24 . . 27 msb lsb	28 . . 31 msb lsb

In Joint Stereo Coding mode the allocation information field may end in the middle of a slot, in which case this last slot carries only 4 allocation info units (see tables on next pages).

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12.1 PASC frame format

The subbands are numbered 0 to 31. Subband 0 contains the lowest frequency components of the audio signal, and subband 31 the highest frequency components.
The channels are indicated as L and R in the case of a stereo signal, I and II in the case of 2-channel mono.

In stereo mode the allocation units must be sent in the following order:

Slot 2:

0 . . 3 L-0	4 . . 7 R-0	8 . . 11 L-1	12 . . 15 R-1	16 . . 19 L-2	20 . . 23 R-2	24 . . 27 L-3	28 . .31 R-3

Slot 3:

0 . . 3 L-4	4 . . 7 R-4	8 . . 11 L-5	12 . . 15 R-5	16 . . 19 L-6	20 . . 23 R-6	24 . . 27 L-7	28 . .31 R-7

Slot 4:

0 . . 3 L-8	4 . . 7 R-8	8 . . 11 L-9	12 . . 15 R-9	16 . . 19 L-10	20 . . 23 R-10	24 . . 27 L-11	28 . .31 R-11

Slot 5:

0 . . 3 L-12	4 . . 7 R-12	8 . . 11 L-13	12 . . 15 R-13	16 . . 19 L-14	20 . . 23 R-14	24 . . 27 L-15	28 . .31 R-15

Slot 6:

0 . . 3 L-16	4 . . 7 R-16	8 . . 11 L-17	12 . . 15 R-17	16 . . 19 L-18	20 . . 23 R-18	24 . . 27 L-19	28 . .31 R-19

Slot 7:

0 . . 3 L-20	4 . . 7 R-20	8 . . 11 L-21	12 . . 15 R-21	16 . . 19 L-22	20 . . 23 R-22	24 . . 27 L-23	28 . .31 R-23

Slot 8:

0 . . 3 L-24	4 . . 7 R-24	8 . . 11 L-25	12 . . 15 R-25	16 . . 19 L-26	20 . . 23 R-26	24 . . 27 L-27	28 . .31 R-27

Slot 9:

0 . . 3 L-28	4 . . 7 R-28	8 . . 11 L-29	12 . . 15 R-29	16 . . 19 L-30	20 . . 23 R-30	24 . . 27 L-31	28 . .31 R-31

The same table applies to the 2-channel mono mode if one substitutes channel I for L and channel II for R.

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12.1 PASC frame format

In Joint Stereo Coding mode the allocation units must be sent in the following order (M indicates the joint subband samples allocation information):

Bit 26 = 0, bit 27 = 0, subbands 4 ... 31 jointly coded.

Slot 2:

0 . . 3 L-0	4 . . 7 R-0	8 . . 11 L-1	12 . . 15 R-1	16 . . 19 L-2	20 . . 23 R-2	24 . . 27 L-3	28 . .31 R-3

Slot 3:

0 . . 3 M-4	4 . . 7 M-5	8 . . 11 M-6	12 . . 15 M-7	16 . . 19 M-8	20 . . 23 M-9	24 . . 27 M-10	28 . .31 M-11

Slot 4:

0 . . 3 M-12	4 . . 7 M-13	8 . . 11 M-14	12 . . 15 M-15	16 . . 19 M-16	20 . . 23 M-17	24 . . 27 M-18	28 . .31 M-19

Slot 5:

0 . . 3 M-20	4 . . 7 M-21	8 . . 11 M-22	12 . . 15 M-23	16 . . 19 M-24	20 . . 23 M-25	24 . . 27 M-26	28 . .31 M-27

Slot 6:

0 . . 3 M-28	4 . . 7 M-29	8 . . 11 M-30	12 . . 15 M-31

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12.1 PASC frame format

Bit 26 = 0, bit 27 = 1, subbands 8 ... 31 jointly coded.

Slot 2:

0 . . 3 L-0	4 . . 7 R-0	8 . . 11 L-1	12 . . 15 R-1	16 . . 19 L-2	20 . . 23 R-2	24 . . 27 L-3	28 . .31 R-3

Slot 3:

0 . . 3 L-4	4 . . 7 R-4	8 . . 11 L-5	12 . . 15 R-5	16 . . 19 L-6	20 . . 23 R-6	24 . . 27 L-7	28 . .31 R-7

Slot 4:

0 . . 3 M-8	4 . . 7 M-9	8 . . 11 M-10	12 . . 15 M-11	16 . . 19 M-12	20 . . 23 M-13	24 . . 27 M-14	28 . .31 M-15

Slot 5:

0 . . 3 M-16	4 . . 7 M-17	8 . . 11 M-18	12 . . 15 M-19	16 . . 19 M-20	20 . . 23 M-21	24 . . 27 M-22	28 . .31 M-23

Slot 6:

0 . . 3 M-24	4 . . 7 M-25	8 . . 11 M-26	12 . . 15 M-27	16 . . 19 M-28	20 . . 23 M-29	24 . . 27 M-30	28 . .31 M-31

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12.1 PASC frame format

Bit 26 = 1, bit 27 = 0, subbands 12 ... 31 jointly coded.

Slot 2:

0 . . 3 L-0	4 . . 7 R-0	8 . . 11 L-1	12 . . 15 R-1	16 . . 19 L-2	20 . . 23 R-2	24 . . 27 L-3	28 . .31 R-3

Slot 3:

0 . . 3 L-4	4 . . 7 R-4	8 . . 11 L-5	12 . . 15 R-5	16 . . 19 L-6	20 . . 23 R-6	24 . . 27 L-7	28 . .31 R-7

Slot 4:

0 . . 3 L-8	4 . . 7 R-8	8 . . 11 L-9	12 . . 15 R-9	16 . . 19 L-10	20 . . 23 R-10	24 . . 27 L-11	28 . .31 R-11

Slot 5:

0 . . 3 M-12	4 . . 7 M-13	8 . . 11 M-14	12 . . 15 M-15	16 . . 19 M-16	20 . . 23 M-17	24 . . 27 M-18	28 . .31 M-19

Slot 6:

0 . . 3 M-20	4 . . 7 M-21	8 . . 11 M-22	12 . . 15 M-23	16 . . 19 M-24	20 . . 23 M-25	24 . . 27 M-26	28 . .31 M-27

Slot 7:

0 . . 3 M-28	4 . . 7 M-29	8 . . 11 M-30	12 . . 15 M-31

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12.1 PASC frame format

Bit 26 = 1, bit 27 = 1, subbands 16 ... 31 jointly coded.

Slot 2:

0 . . 3	4 . . 7	8 . . 11	12 . . 15	16 . . 19	20 . . 23	24 . . 27	28 . .31
L-0	R-0	L-1	R-1	L-2	R-2	L-3	R-3

Slot 3:

0 . . 3	4 . . 7	8 . . 11	12 . . 15	16 . . 19	20 . . 23	24 . . 27	28 . .31
L-4	R-4	L-5	R-5	L-6	R-6	L-7	R-7

Slot 4:

0 . . 3	4 . . 7	8 . . 11	12 . . 15	16 . . 19	20 . . 23	24 . . 27	28 . .31
L-8	R-8	L-9	R-9	L-10	R-10	L-11	R-11

Slot 5:

0 . . 3	4 . . 7	8 . . 11	12 . . 15	16 . . 19	20 . . 23	24 . . 27	28 . .31
L-12	R-12	L-13	R-13	L-14	R-14	L-15	R-15

Slot 6:

0 . . 3	4 . . 7	8 . . 11	12 . . 15	16 . . 19	20 . . 23	24 . . 27	28 . .31
M-16	M-17	M-18	M-19	M-20	M-21	M-22	M-23

Slot 7:

0 . . 3	4 . . 7	8 . . 11	12 . . 15	16 . . 19	20 . . 23	24 . . 27	28 . .31
M-24	M-25	M-26	M-27	M-28	M-29	M-30	M-31

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12.1.3 Scale factor index field

For every subband for which samples are transferred (the corresponding allocation information is not equal to '0000') a scale factor index must be transferred. Scale factor indices are binary numbers of 6 bits, in the range 0 to 62 (000000 to 111110 in binary notation).

In Joint Stereo Coding mode two scale factor indices must be transferred for any joint subband that has been allocated bits (e.g. if allocation unit M-20 of the tables on the previous pages contains a non-zero entry this means that 2 scale factor indices - the first for the left channel, the second for the right channel - are to be included in the scale factor index field).
Scale factor indices must be sent in the same order as the allocation information units.

Example : assume in stereo mode subbands L-1, R-2 and R-8 have allocation information '0000' and other subbands have allocation information not equal to '0000', then the scale factor index field will start as follows:

Slot 10:

0 . . 5 L-0	6 . . 11 R-0	12 . . 17 R-1	18 . . 23 L-2	24 . . 29 L-3	30 .. 31 R-3

Slot 11:

0 . . 3 R-3	4 . . 9 L-4	10 . . 15 R-4	16 . . 21 L-5	22 . . 27 R-5	28 .. 31 L-6

Slot 12:

0 . . 1 L-6	2 . . 7 R-6	8 . . 13 L-7	14 . . 19 R-7	20 . . 25 L-8	26 .. 31 L-9

continued in the following slots ....

Note: The two most significant bits of R-3 are carried in Slot 10, the remaining 4 bits are carried in slot 11. This is similar for L-6 in Slot 11 and 12.

The Scale factor index field does not necessarily have to contain an integer number of slots, but may end - and in the case of Joint Stereo Coding may begin - somewhere in a slot. The remaining bits must be used for the samples field.

12.1.4 Samples field

The samples will be represented by means of a special notation (see 12.2.1.4). The number of bits for each sample of a subband is as coded in the allocation information field unit for that subband.
Twelve sample sequences must be transferred, each sequence contains one sample of every subband with allocation information not equal to '0000'. The order of the samples in a sample sequence is the same as the order of the scale factor indices.
The samples are located in the slots with the msb first. Samples and slots do not necessarily have to be aligned.

In the case of Joint Stereo Coding samples are shared between the left and right channel for those subbands that are jointly coded (e.g. if allocation information unit M-20 contains a non-zero entry the same samples that are used to reconstruct the left channel must be used to reconstruct the right channel signal). However, as a separate scale factor index is transferred for the left and right channel a subband signal may be positioned in the stereo signal by providing different scalefactors for the multiplication.

If not all the bits in the field are used, the remaining bits will be '0', as indicated below.
However, in future applications this need not be the case.

SYNC & CODING INFO	ALLOCATION INFORMATION	SCALE FACTORS	CODED SAMPLES	0000000

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12.2 PASC sample representation

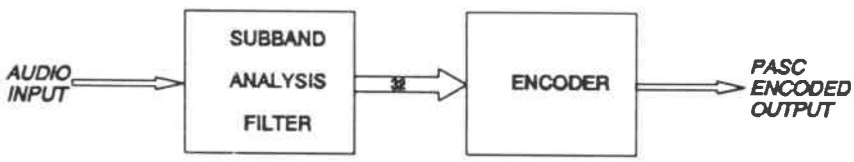
In this clause the following representation and ranges are assumed for the samples:

Audio samples	:	2's complement, -1 <= sample < 1, linear coded
Subband samples	:	2's complement, -2 <= sample < 2, linear coded
PASC samples	:	special notation

These samples may be found in the system at the following places:

Audio samples	:	At the input of the analysis filter and the output of the synthesis filter.
Subband samples	:	At the interface between the output of the analysis filter and the input of the coder, and at the interface between the output of the decoder and the input of the synthesis filter.
PASC samples	:	Coded samples in the PASC bitstream. The notation is explained in 12.2.1.4.

12.2.1 Audio encoding



This clause contains a description of the encoding according to the PASC system. Two major blocks are the subband analysis and the transformation of subband data into PASC bitstream.

12.2.1.1 Subband analysis

A subband analysis filter bank is used to split the broadband audio signal with sampling frequency Fs into 32 equally spaced subbands with sampling frequencies Fs/32.
A separate analysis filter bank is used for each channel.
The analysis includes the following steps:

- input of 32 audio samples;

- build an input sample vector X of 512 elements. The 32 audio samples are shifted in at positions 0 to 31 and the 32 oldest elements are shifted out. The element X_0 is the last one to be shifted in;

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- window vector X by vector C :

$$Z_i = C_i \cdot X_i \,, \quad i = 0 \ldots 511$$

The coefficients are to be found in Table 12.1 ;

- calculate the 64 values Yi :

$$Y_i = \sum_{j=0}^{7} Z_{i+64j} \,, \quad i = 0 \ldots 63$$

- calculate the 32 subband samples by matrixing :

$$S_i = \sum_{k=0}^{63} M_{ik} \cdot Y_k \,, \quad i = 0 \ldots 31$$

The coefficients of the matrix can be calculated as indicated in 12.2.1.2.

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12.2 PASC sample representation

Table 12.1 : Coefficients C_i of the analysis window

For reasons of accuracy the values C_i are presented here in integer notation.
In an implementation these values must be divided by 2 to the power 21 (e.g. -1 represents a value of -0.00000047683...).

C[0] =	0	C[1] =	-1	C[2] =	-1
C[3] =	-1	C[4] =	-1	C[5] =	-1
C[6] =	-1	C[7] =	-2	C[8] =	-2
C[9] =	-2	C[10] =	-2	C[11] =	-3
C[12] =	-3	C[13] =	-4	C[14] =	-4
C[15] =	-5	C[16] =	-5	C[17] =	-6
C[18] =	-7	C[19] =	-7	C[20] =	-8
C[21] =	-9	C[22] =	-10	C[23] =	-11
C[24] =	-13	C[25] =	-14	C[26] =	-16
C[27] =	-17	C[28] =	-19	C[29] =	-21
C[30] =	-24	C[31] =	-26	C[32] =	-29
C[33] =	-31	C[34] =	-35	C[35] =	-38
C[36] =	-41	C[37] =	-45	C[38] =	-49
C[39] =	-53	C[40] =	-58	C[41] =	-63
C[42] =	-68	C[43] =	-73	C[44] =	-79
C[45] =	-85	C[46] =	-91	C[47] =	-97
C[48] =	-104	C[49] =	-111	C[50] =	-117
C[51] =	-125	C[52] =	-132	C[53] =	-139
C[54] =	-147	C[55] =	-154	C[56] =	-161
C[57] =	-169	C[58] =	-176	C[59] =	-183
C[60] =	-190	C[61] =	-196	C[62] =	-202
C[63] =	-208	C[64] =	213	C[65] =	218
C[66] =	222	C[67] =	225	C[68] =	227
C[69] =	228	C[70] =	228	C[71] =	227
C[72] =	224	C[73] =	221	C[74] =	215
C[75] =	208	C[76] =	200	C[77] =	189
C[78] =	177	C[79] =	163	C[80] =	146
C[81] =	127	C[82] =	106	C[83] =	83
C[84] =	57	C[85] =	29	C[86] =	-2
C[87] =	-36	C[88] =	-72	C[89] =	-111
C[90] =	-153	C[91] =	-197	C[92] =	-244
C[93] =	-294	C[94] =	-347	C[95] =	-401
C[96] =	-459	C[97] =	-519	C[98] =	-581
C[99] =	-645	C[100] =	-711	C[101] =	-779
C[102] =	-848	C[103] =	-919	C[104] =	-991
C[105] =	-1064	C[106] =	-1137	C[107] =	-1210
C[108] =	-1283	C[109] =	-1356	C[110] =	-1428
C[111] =	-1498	C[112] =	-1567	C[113] =	-1634
C[114] =	-1698	C[115] =	-1759	C[116] =	-1817
C[117] =	-1870	C[118] =	-1919	C[119] =	-1962
C[120] =	-2001	C[121] =	-2032	C[122] =	-2057
C[123] =	-2075	C[124] =	-2085	C[125] =	-2087
C[126] =	-2080	C[127] =	-2063	C[128] =	2037
C[129] =	2000	C[130] =	1952	C[131] =	1893
C[132] =	1822	C[133] =	1739	C[134] =	1644
C[135] =	1535	C[136] =	1414	C[137] =	1280
C[138] =	1131	C[139] =	970	C[140] =	794
C[141] =	605	C[142] =	402	C[143] =	185
C[144] =	-45	C[145] =	-288	C[146] =	-545
C[147] =	-814	C[148] =	-1095	C[149] =	-1388
C[150] =	-1692	C[151] =	-2006	C[152] =	-2330
C[153] =	-2663	C[154] =	-3004	C[155] =	-3351
C[156] =	-3705	C[157] =	-4063	C[158] =	-4425
C[159] =	-4788	C[160] =	-5153	C[161] =	-5517

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Table 12.1 (continued)

C[162] =	-5879	C[163] =	-6237	C[164] =	-6589
C[165] =	-6935	C[166] =	-7271	C[167] =	-7597
C[168] =	-7910	C[169] =	-8209	C[170] =	-8491
C[171] =	-8755	C[172] =	-8998	C[173] =	-9219
C[174] =	-9416	C[175] =	-9585	C[176] =	-9727
C[177] =	-9838	C[178] =	-9916	C[179] =	-9959
C[180] =	-9966	C[181] =	-9935	C[182] =	-9863
C[183] =	-9750	C[184] =	-9592	C[185] =	-9389
C[186] =	-9139	C[187] =	-8840	C[188] =	-8492
C[189] =	-8092	C[190] =	-7640	C[191] =	-7134
C[192] =	6574	C[193] =	5959	C[194] =	5288
C[195] =	4561	C[196] =	3776	C[197] =	2935
C[198] =	2037	C[199] =	1082	C[200] =	70
C[201] =	-998	C[202] =	-2122	C[203] =	-3300
C[204] =	-4533	C[205] =	-5818	C[206] =	-7154
C[207] =	-8540	C[208] =	-9975	C[209] =	-11455
C[210] =	-12980	C[211] =	-14548	C[212] =	-16155
C[213] =	-17799	C[214] =	-19478	C[215] =	-21189
C[216] =	-22929	C[217] =	-24694	C[218] =	-26482
C[219] =	-28289	C[220] =	-30112	C[221] =	-31947
C[222] =	-33791	C[223] =	-35640	C[224] =	-37489
C[225] =	-39336	C[226] =	-41176	C[227] =	-43006
C[228] =	-44821	C[229] =	-46617	C[230] =	-48390
C[231] =	-50137	C[232] =	-51853	C[233] =	-53534
C[234] =	-55178	C[235] =	-56778	C[236] =	-58333
C[237] =	-59838	C[238] =	-61289	C[239] =	-62684
C[240] =	-64019	C[241] =	-65290	C[242] =	-66494
C[243] =	-67629	C[244] =	-68692	C[245] =	-69679
C[246] =	-70590	C[247] =	-71420	C[248] =	-72169
C[249] =	-72835	C[250] =	-73415	C[251] =	-73908
C[252] =	-74313	C[253] =	-74630	C[254] =	-74856
C[255] =	-74992	C[256] =	75038	C[257] =	74992
C[258] =	74856	C[259] =	74630	C[260] =	74313
C[261] =	73908	C[262] =	73415	C[263] =	72835
C[264] =	72169	C[265] =	71420	C[266] =	70590
C[267] =	69679	C[268] =	68692	C[269] =	67629
C[270] =	66494	C[271] =	65290	C[272] =	64019
C[273] =	62684	C[274] =	61289	C[275] =	59838
C[276] =	58333	C[277] =	56778	C[278] =	55178
C[279] =	53534	C[280] =	51853	C[281] =	50137
C[282] =	48390	C[283] =	46617	C[284] =	44821
C[285] =	43006	C[286] =	41176	C[287] =	39336
C[288] =	37489	C[289] =	35640	C[290] =	33791
C[291] =	31947	C[292] =	30112	C[293] =	28289
C[294] =	26482	C[295] =	24694	C[296] =	22929
C[297] =	21189	C[298] =	19478	C[299] =	17799
C[300] =	16155	C[301] =	14548	C[302] =	12980
C[303] =	11455	C[304] =	9975	C[305] =	8540
C[306] =	7154	C[307] =	5818	C[308] =	4533
C[309] =	3300	C[310] =	2122	C[311] =	998
C[312] =	-70	C[313] =	-1082	C[314] =	-2037
C[315] =	-2935	C[316] =	-3776	C[317] =	-4561
C[318] =	-5288	C[319] =	-5959	C[320] =	6574
C[321] =	7134	C[322] =	7640	C[323] =	8092
C[324] =	8492	C[325] =	8840	C[326] =	9139
C[327] =	9389	C[328] =	9592	C[329] =	9750
C[330] =	9863	C[331] =	9935	C[332] =	9966
C[333] =	9959	C[334] =	9916	C[335] =	9838
C[336] =	9727	C[337] =	9585	C[338] =	9416

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12.2 PASC sample representation

Table 12.1 (continued)

C[339] =	9219	C[340] =	8998	C[341] =	8755
C[342] =	8491	C[343] =	8209	C[344] =	7910
C[345] =	7597	C[346] =	7271	C[347] =	6935
C[348] =	6589	C[349] =	6237	C[350] =	5879
C[351] =	5517	C[352] =	5153	C[353] =	4788
C[354] =	4425	C[355] =	4063	C[356] =	3705
C[357] =	3351	C[358] =	3004	C[359] =	2663
C[360] =	2330	C[361] =	2006	C[362] =	1692
C[363] =	1388	C[364] =	1095	C[365] =	814
C[366] =	545	C[367] =	288	C[368] =	45
C[369] =	-185	C[370] =	-402	C[371] =	-605
C[372] =	-794	C[373] =	-970	C[374] =	-1131
C[375] =	-1280	C[376] =	-1414	C[377] =	-1535
C[378] =	-1644	C[379] =	-1739	C[380] =	-1822
C[381] =	-1893	C[382] =	-1952	C[383] =	-2000
C[384] =	2037	C[385] =	2063	C[386] =	2080
C[387] =	2087	C[388] =	2085	C[389] =	2075
C[390] =	2057	C[391] =	2032	C[392] =	2001
C[393] =	1962	C[394] =	1919	C[395] =	1870
C[396] =	1817	C[397] =	1759	C[398] =	1698
C[399] =	1634	C[400] =	1567	C[401] =	1498
C[402] =	1428	C[403] =	1356	C[404] =	1283
C[405] =	1210	C[406] =	1137	C[407] =	1064
C[408] =	991	C[409] =	919	C[410] =	848
C[411] =	779	C[412] =	711	C[413] =	645
C[414] =	581	C[415] =	519	C[416] =	459
C[417] =	401	C[418] =	347	C[419] =	294
C[420] =	244	C[421] =	197	C[422] =	153
C[423] =	111	C[424] =	72	C[425] =	36
C[426] =	2	C[427] =	-29	C[428] =	-57
C[429] =	-83	C[430] =	-106	C[431] =	-127
C[432] =	-146	C[433] =	-163	C[434] =	-177
C[435] =	-189	C[436] =	-200	C[437] =	-208
C[438] =	-215	C[439] =	-221	C[440] =	-224
C[441] =	-227	C[442] =	-228	C[443] =	-228
C[444] =	-227	C[445] =	-225	C[446] =	-222
C[447] =	-218	C[448] =	213	C[449] =	208
C[450] =	202	C[451] =	196	C[452] =	190
C[453] =	183	C[454] =	176	C[455] =	169
C[456] =	161	C[457] =	154	C[458] =	147
C[459] =	139	C[460] =	132	C[461] =	125
C[462] =	117	C[463] =	111	C[464] =	104
C[465] =	97	C[466] =	91	C[467] =	85
C[468] =	79	C[469] =	73	C[470] =	68
C[471] =	63	C[472] =	58	C[473] =	53
C[474] =	49	C[475] =	45	C[476] =	41
C[477] =	38	C[478] =	35	C[479] =	31
C[480] =	29	C[481] =	26	C[482] =	24
C[483] =	21	C[484] =	19	C[485] =	17
C[486] =	16	C[487] =	14	C[488] =	13
C[489] =	11	C[490] =	10	C[491] =	9
C[492] =	8	C[493] =	7	C[494] =	7
C[495] =	6	C[496] =	5	C[497] =	5
C[498] =	4	C[499] =	4	C[500] =	3
C[501] =	3	C[502] =	2	C[503] =	2
C[504] =	2	C[505] =	2	C[506] =	1
C[507] =	1	C[508] =	1	C[509] =	1
C[510] =	1	C[511] =	1		

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12.2.1.2 Calculation of coefficients $M_{i,k}$ of the analysis matrix

The coefficients of $M_{i,k}$ of the analysis matrix can be calculated as follows:

$M_{i,k}$ = cos { (k - 16) * (i + 0.5) * (Pi / 32) }

in which Pi = 3.141592653.... , i = 0 ... 31, k = 0 ... 63 .

Example : $M_{0,0}$ = 0.7071067811... , $M_{14,28}$ = -0.1950903220.... .

Note: In an implementation in 2's complement notation the value 1.0000... cannot be represented (values are >= -1 and < 1). In this case one should substitute

$1 - 2^{-(\text{number of bits} - 1)}$.

For implementations in a different notation similar considerations apply.

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12.2.1.3 The encoding process

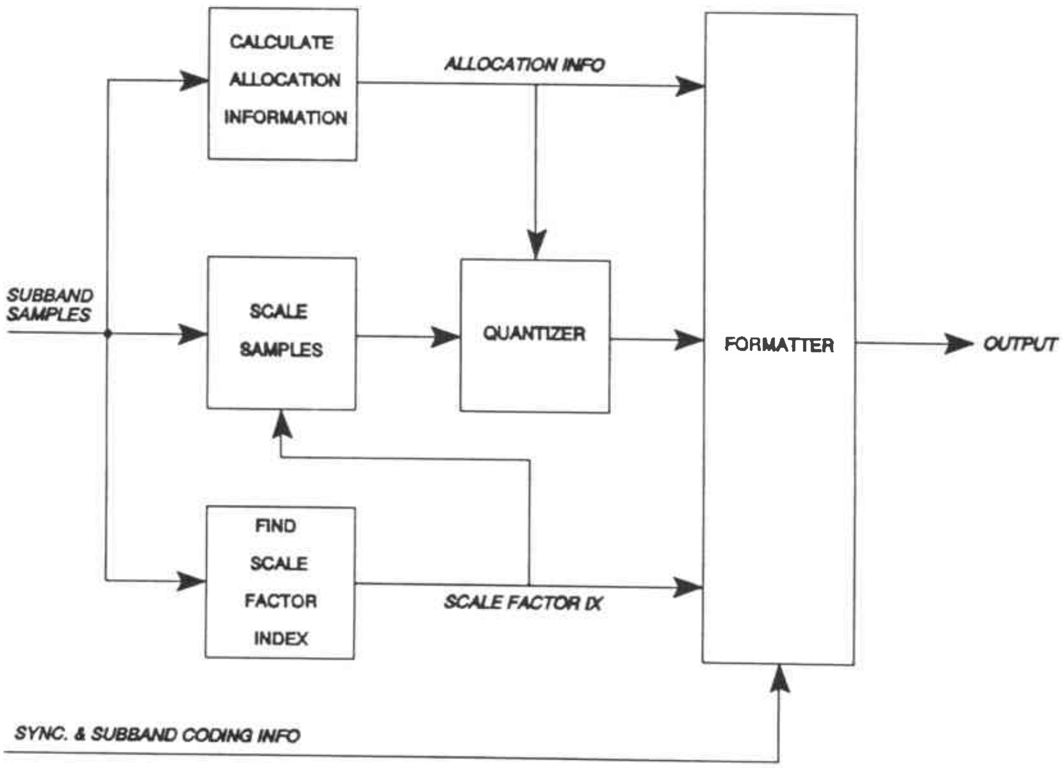
This clause contains a simple description of the encoding process. Only 1 channel is explained. For stereo or 2-channel mono mode the other channel should be treated similarly.
As Joint Stereo Coding mode is reserved for future use this mode is not included in this description.
The calculation of the allocation information is explained in section 12.3.

One PASC frame carries information on 384 subband samples, 12 samples of each subband. For every subband the sample with the highest amplitude is used to find the scale factor and scale factor index for that subband. The samples are then divided by the scale factor so that they represent the fraction of the highest amplitude.

The calculation of the allocation information provides an allocation information table. This information changes with every frame ('adaptive allocation').

Next the samples are quantized. The quantizer reduces the number of bits of the samples to the number in the allocation information table for the corresponding subband. Its output is in a special representation.

Finally the synchronization pattern and coding information are added and all the information is formatted into the correct sequence.



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12.2.1.4 Scaling and quantization

In order to find the scale factor to scale the 12 samples of one subband, the following algorithm is used :

- The maximum of the absolute value of the 12 subband samples is determined.

- The next larger value in the Table 12.3 is the scale factor.
  The corresponding scale factor index must be included in the scale factor index field (provided the allocation information for that subband is not '0000').

- Next all 12 samples of the subband are normalized by dividing their value by the scale factor.

After normalization the subband samples have a value V, $-1 < V < 1$. In the quantizer these samples have to be represented using N bits, N being the number of bits allocated to the current subband.

For each normalized sample X a quantized sample Y is calculated as follows :

- calculate $a * X + b$
- take N most significant bits
- invert the MSB.

Constants a and b, which are different for every N, can be found in Table 12.4.

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Table 12.3 : Scale factors and indices

The scale factors are calculated according to the formula

$$2^{1 - \text{index}/3} \quad (0 <= \text{index} <= 62) :$$

index	scale factor	index	scale factor
0	2.00000000000000000	32	0.00123039165028796
1	1.58740105196819947	33	0.00097656250000000
2	1.25992104989487316	34	0.00077509816990635
3	1.00000000000000000	35	0.00061519582514398
4	0.79370052598409974	36	0.00048828125000000
5	0.62996052494743658	37	0.00038754908495317
6	0.50000000000000000	38	0.00030759791257199
7	0.39685026299204987	39	0.00024414062500000
8	0.31498026247371829	40	0.00019377454247659
9	0.25000000000000000	41	0.00015379895628600
10	0.19842513149602493	42	0.00012207031250000
11	0.15749013123685915	43	0.00009688727123829
12	0.12500000000000000	44	0.00007689947814300
13	0.09921256574801247	45	0.00006103515625000
14	0.07874506561842957	46	0.00004844363561915
15	0.06250000000000000	47	0.00003844973907150
16	0.04960628287400623	48	0.00003051757812500
17	0.03937253280921479	49	0.00002422181780957
18	0.03125000000000000	50	0.00001922486953575
19	0.02480314143700312	51	0.00001525878906250
20	0.01968626640460739	52	0.00001211090890479
21	0.01562500000000000	53	0.00000961243476787
22	0.01240157071850156	54	0.00000762939453125
23	0.00984313320230370	55	0.00000605545445239
24	0.00781250000000000	56	0.00000480621738394
25	0.00620078535925078	57	0.00000381469726563
26	0.00492156660115185	58	0.00000302772722620
27	0.00390625000000000	59	0.00000240310869197
28	0.00310039267962539	60	0.00000190734863281
29	0.00246078330057592	61	0.00000151386361310
30	0.00195312500000000	62	0.00000120155434598
31	0.00155019633981269		

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Table 12.4 : Quantization constants

The quantization constants may be calculated as follows:

If N = number of allocated bits, then

$a = 1 - 2^{-N}$ and $b = -2^{-N}$:

Alloc. Bits (N)	# steps	a	b
2	3	0.750000000000000	-0.250000000000000
3	7	0.875000000000000	-0.125000000000000
4	15	0.937500000000000	-0.062500000000000
5	31	0.968750000000000	-0.031250000000000
6	63	0.984375000000000	-0.015625000000000
7	127	0.992187500000000	-0.007812500000000
8	255	0.996093750000000	-0.003906250000000
9	511	0.998046875000000	-0.001953125000000
10	1023	0.999023437500000	-0.000976562500000
11	2047	0.999511718750000	-0.000488281250000
12	4095	0.999755859375000	-0.000244140625000
13	8191	0.999877929687500	-0.000122070312500
14	16383	0.999938964843750	-0.000061035156250
15	32767	0.999969482421875	-0.000030517578125

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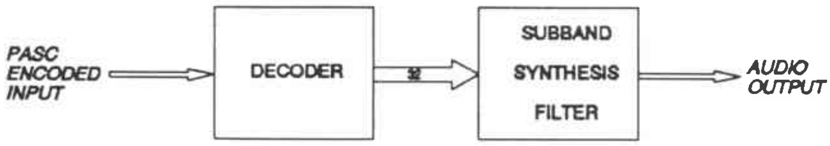
12.2 PASC sample representation

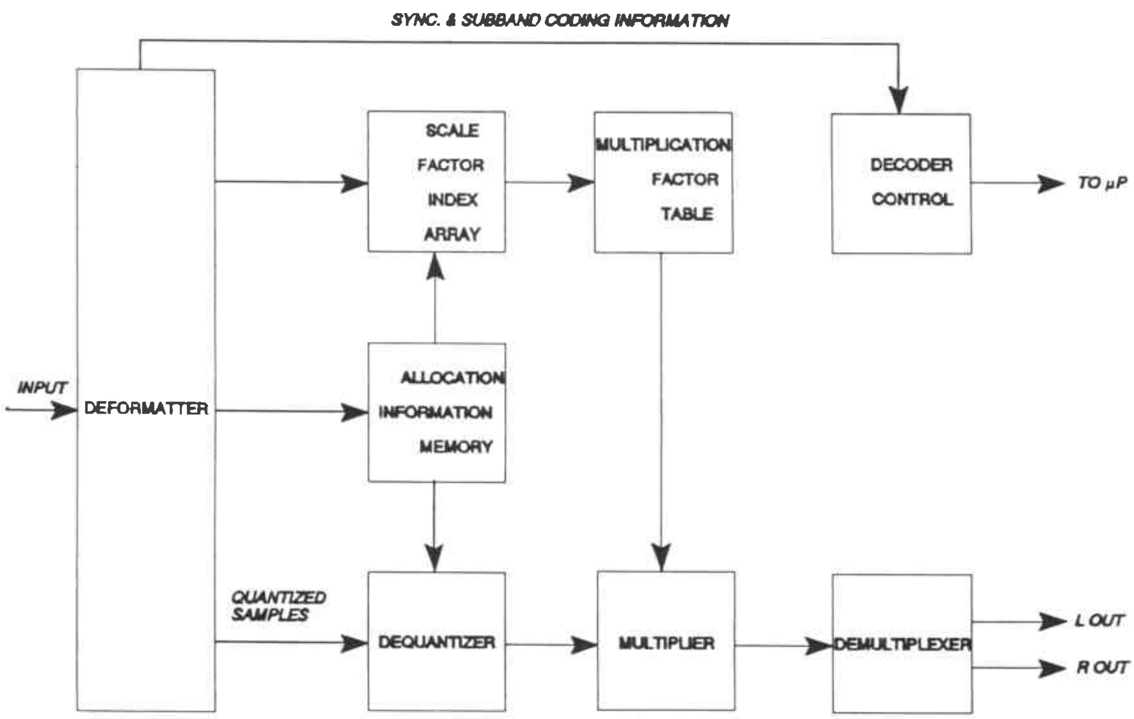
12.2.2 Audio decoding



This section contains a description of the decoding according to the PASC system. Two major blocks are the transformation of the PASC bitstream into subband data and the subband synthesis.

12.2.2.1 The decoding process

The decoding process will be repeated with every frame. After the reception of the Sync and Subband coding information, the allocation information is used to fill the scale factor index array correctly.
The scale factor index array is an array with two columns of 32 rows, 6 bits wide. Each column corresponds with one of the output channels, each row with one of the 32 subbands. The received scale factor indices are stored in this array.
The decoder contains a table of scale factors with which the subband samples have to be multiplied before they are sent to the synthesis filter.
For the subbands that have not been transferred the decoder will set the value of the audio output samples to 0 automatically.



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In the case of 2-channel mono coding the decoder will send just 1 of the 2 channels on both L and R output. The channel can be selected by the user.

In the case of Joint Stereo Coding the decoder will use the same PASC sample to generate both the left and right channel information for a subband, but the amplitude may differ, as separate scalefactors for left and right channel are transferred in the PASC signal.

12.2.2.2 De-quantization and de-scaling

Each of the 12 subband samples Y are de-quantized, using the following procedure :

- invert the MSB
- calculate $Z = c * (Y + d)$
- each Z is de-normalized by multiplying its value by the scale factor for the subband.

Constants c and d, which are different for every N, can be found in Table 12.5.

Table 12.5 : De-quantization constants

The de-quantization constants may be calculated as follows:

If N = number of allocated bits, then

$c = 1 + 1/(2^N - 1)$ and $d = 2^{1-N}$:

Alloc. bits (N)	# steps	c	d
2	3	1.333333333333333	0.500000000000000
3	7	1.142857142857143	0.250000000000000
4	15	1.066666666666667	0.125000000000000
5	31	1.032258064516129	0.062500000000000
6	63	1.015873015873016	0.031250000000000
7	127	1.007874015748032	0.015625000000000
8	255	1.003921568627451	0.007812500000000
9	511	1.001956947162427	0.003906250000000
10	1023	1.000977517106549	0.001953125000000
11	2047	1.000488519785051	0.000976562500000
12	4095	1.000244200244200	0.000488281250000
13	8191	1.000122085215480	0.000244140625000
14	16383	1.000061038881768	0.000122070312500
15	32767	1.000030518509476	0.000061035156250

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12.2 PASC sample representation

12.2.2.3 Subband synthesis

A subband synthesis is used to merge the 32 equal bandwidth subbands at sampling frequency Fs/32 into a broadband signal at sampling frequency Fs.
A separate subband synthesis is used for each channel.

It includes the following steps :

- Input of 32 subband samples S_i, i = 0 ... 31 ;

- Calculate 64 values V_i by matrixing.

$$V_i = \sum_{k=0}^{31} N_{ik} \cdot S_k \quad , i = 0 \ldots 63$$

  The coefficients of the matrix can be calculated as indicated in 12.2.2.4.

- Build a vector V of 1024 samples. The 64 input values V_i are shifted in at position 0 to 63 and the 64 oldest elements are shifted out;

- Build a vector U of 512 samples, by dropping 512 values from vector V according to the following algorithm :

  Repeat 8 times:
  - take 32 values from V;
  - drop 64 next values from V;
  - take 32 next values from V.

- Window vector U by vector D.

$$W_i = U_i \cdot D_i \quad , \; i = 0 \ldots 511$$

  The coefficients are to be found in Table 12.7 ;

- Calculate the 32 samples S_j :

$$S_j = \sum_{i=0}^{15} W_{j+32i} \quad , \quad j = 0 \ldots 31$$

- Output of 32 reconstructed samples S_j, S_0 is the first sample to appear on the output.

12.2.2.4 Calculation of the Coefficients $N_{i,k}$ of the synthesis matrix

The coefficients of $N_{i,k}$ of the synthesis matrix can be calculated as follows:

$N_{i,k}$ = cos { (i + 16) * (k + 0.5) * (Pi / 32) }

in which Pi = 3.141592653...., i = 0 ... 63, k = 0 ... 31 .

Example : $N_{0,0}$ = 0.7071067811... , $N_{14,28}$ = -0.6343932841.... .

Note: in an implementation in 2's complement notation the value 1.0000... cannot be represented (values are >= -1 and < 1). In this case one should substitute

$1 - 2^{-(\text{number of bits} - 1)}$.

For implementations in a different notation similar considerations apply.

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12.2.2.5 Calculation of the coefficients D_i of the synthesis window

To calculate the values D_i one can use the same values as presented in Table 12.1 and divide these by 2 to the power 16.

Examples : D_1 = -0.00001525878... , D_{50} = -0.001785278...

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12.3 PASC allocation table

This section describes the algorithm that calculates a table containing for each channel and each subband the number of bits that have to be allocated to the normalized samples of the PASC frame. This table is calculated for every single PASC frame.

All deviations of this algorithm must be submitted and approved by Philips Consumer Electronics B.V. (see Preface). The reference level MinNoise and the relative minimum hearing threshold constants $qpwr_i$ need to be implemented as close as possible to the values defined here. In addition the PASC signals generated by the coder must satisfy the minimum conditions as defined in section 12.4.
It is assumed that the subband samples have a value between 2 and -2 (with 2's complement notation -2 <= subband sample < 2), and the original broadband audio samples had a resolution of at minimum 16 bits.

The following description applies to both stereo and 2-channel mono mode. For 2-channel mono mode substitute L with I and R with II.

As Joint Stereo Coding is reserved for future use no description of the allocation information calculation is presented here. However, a PASC decoder must be able to decode this mode, as specified in section 12.4.

Definitions of constants used in allocation table calculation algorithm

MinNoise:

The MinNoise constant represents the reference value for the minimum hearing threshold. It is fixed at the following value: MinNoise = 0.0000000000002425319204

Endbitn:

The value endbitn should be chosen such that it represents a value lower than the minimum value of the bitneed for each band (e.g. the maximum negative number in the representation used). In the algorithm it acts as a flag that a subband is no longer available for the allocation of bits.

Bitpool:

In the allocation calculation algorithm shown above a separate bitcount B_c is used for each channel. The total number of bits allocated is the same for the left and right channel. However, a PASC decoder must be able to decode PASC frames with a different number of bits allocated to the channels, including the case in which all bits are allocated to one channel. The total number of bits allocated to the L and R channel does not exceed the total bitpool available. The decoder must also allow for the case that no bits or just a few bits are allocated (e.g. when encoding 'digital silence').
The total bitpool changes with the sampling frequency:

sampling frequency	# bits in bitpool (both channels combined)
48 kHz	2784
44.1 kHz	3040 (+ 32 optionally in a padding frame)
32 kHz	4320

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12.3 PASC allocation table

The following calculations have to be performed:

- Construct for every subband for both left and right channels for every PASC frame the average power of the subband samples as received from the subband analysis :

$$pwr_{i,c} = 1/12 \sum_{k=0}^{11} x^2_{i,k,c}$$

i = subband index, 0 ... 31
c = channel index, L or R
k = sample index in PASC frame

If this average power is smaller than the system constant MinNoise the value of MinNoise is used instead of the calculated value (see above for exact value).

- Also determine for every subband of the left and right channel the peak value as the maximum absolute value of the 12 samples for that subband :

$$peak_{i,c} = \mathrm{Max}\,\{\ |x_{i,0,c}|\ , \dots ,\ |x_{i,11,c}|\ \}$$

- Next calculate the masked power :

$$mpwr_{i,c} = MinNoise\ .\ qpwr_i\ +\ \sum_{j=0}^{31} m_{i,j}\ .\ pwr_{j,c}$$

$qpwr_i$ = minimal relative value of the hearing threshold within subband i
$m_{i,j}$ = masking coefficient, representing the masking of subband i caused by subband j

$qpwr_i$ and $m_{i,j}$ can be found in Tables 12.8 and 12.9 respectively.

- Using the previous calculated values the bitneed is calculated:

$$bitn_{i,c} = 0.5 \log_2 \frac{peak^2_{i,c}}{3\ mpwr_{i,c}}$$

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12.3 PASC allocation table

- The following algorithm is used to determine the number of bits $abit_{i,c}$ (the allocation table) allocated to the subbands:

```
 { comments between brackets }

0. { initialization }
  for c = L ... R
  do
   for i = 0 ... 31
   do
    abit_i,c := 0 ;

1. for c = L ... R          { switch-off-state counters }
  do
   for i = 0 ... 31
   do
    begin
     if pwr_i,c >= mpwr_i,c
     then
      switch-off-state_i,c := 5 ;

     if pwr_i,c < mpwr_i,c and switch-off-state_i,c > 0
     then
      switch-off-state_i,c := switch-off-state_i,c - 1 ;
    end ;

  if mode = stereo                    { make switch-off-state counters equal for stereo }
  then
   for i = 0 ... 31
   do
    if switch-off-state_i,L < switch-off-state_i,R
    then
     switch-off-state_i,L := switch-off-state_i,R
    else
     switch-off-state_i,R := switch-off-state_i,L ;

2. for c = L ... R           { initial allocation of bits }
  do
   begin
    B_c := Bitpool / 2 ;                 { B_c = bitcount for this channel }
    { Bitpool is a function of sampling frequency and padding }
    for i = 0 ... 31
    do
     if switch-off-state_i,c > 0
     then
      begin
       abit_i,c := 2 ; { abit_i,c = allocated bits to subband i of channel c }
       bitn_i,c := bitn_i,c - 2 ;
       B_c := B_c - 30 ;
      end ;
   end ;
```

12.3 PASC allocation table

```
3. for c = L ... R
  do
   begin
    end_c := false ;

    repeat
     begin
      j := 0 ;                            { determine maximum bitneed }
      mbitn := bitn_j,c ;                 { j = corresponding index }

      for i = 1 to 31
      do
       if mbitn < bitn_i,c
       then
        begin
         j := i ;
         mbitn := bitn_i,c ;
        end ;

      if mbitn = endbitn        { see if you have to stop }
      then
       end_c := true ;

      if abit_j,c = 0          { first time bits allocated ? }
      then
       begin
        d := 2 ;
        D := 30 ;
       end
      else
       begin
        d := 1 ;
        D := 12 ;
       end ;

      if (B_c < D) or (abit_j,c = 15)
      then                     { all bits in pool allocated ? }
       bitn_j,c := endbitn ;

      if not (bitnj,c = endbitn)
      then
       begin
        abit_j,c := abit_j,c + d ;
        bitn_j,c := bitn_j,c - d ;
        B_c := B_c - D ;
       end ;
     end ;
    until
     end_c ;
   end ;
```

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12.3 PASC allocation table

Emphasis

Recordings from analogue sources must be made without emphasis applied.
If a recording is made from a digital source (through an IEC 958 digital interface) and it is indicated that (50/15 microsec.) emphasis has been applied the allocation algorithm can be adjusted to the changed nature of the signal by restoring the proper values for $peak_{i,c}$ and $pwr_{i,c}$. This can be done by compensating for the average increase in signal level due to the emphasis applied.

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Table 12.8: Hearing threshold constants $qpwr_i$

	sampling frequency		
i	48 kHz	44.1 kHz	32 kHz
0	8.8123402679	9.5385198176	13.4239006858
1	4.6842138782	5.1418317986	6.8692077715
2	2.2770707585	2.7815711615	4.6842138782
3	1.1051413228	1.3279514629	2.9844605449
4	1.1051413228	1.0176061983	1.7220848257
5	1.1764645428	1.0176061983	1.1051413228
6	2.3786282737	1.6523424364	1.0328398715
7	4.0381583960	3.1333705698	1.0328398715
8	5.1076560649	4.4748623598	1.4495910550
9	6.1106205071	5.3493342981	2.3786282737
10	7.7447810770	6.3514209732	3.5332101688
11	10.7284805042	7.9811654688	4.4560931110
12	16.5524974588	10.8303351989	5.1076560649
13	29.0107118950	16.1021638759	5.7350679218
14	59.0184736654	26.6336492212	6.5563806747
15	142.6622489172	49.8292446165	7.7447810770
16	420.2042805355	107.3527851751	9.5184002748
17	1549.3751984655	271.4840520861	12.2378837569
18	7360.0896200076	822.5412676450	16.5524974588
19	46440.1768588627	3051.2960507790	23.6926095065
20	401984.0907597922	14180.8882980310	36.1152073138
21	1000000.0000000000	84594.2264455936	59.0184736654
22	1000000.0000000000	664457.7225871481	104.1249641310
23	1000000.0000000000	1000000.0000000000	199.7991274190
24	1000000.0000000000	1000000.0000000000	420.2042805355
25	1000000.0000000000	1000000.0000000000	976.4830306161
26	1000000.0000000000	1000000.0000000000	2528.5280410517
27	1000000.0000000000	1000000.0000000000	7360.0896200076
28	1000000.0000000000	1000000.0000000000	24303.8834180098
29	1000000.0000000000	1000000.0000000000	91909.7936371756
30	1000000.0000000000	1000000.0000000000	401984.0907597922
31	1000000.0000000000	1000000.0000000000	1000000.0000000000

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Table 12.9: Masking coefficients $m_{i,j}$

i	j = 0	j = 1	j = 2	j = 3
0	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
1	0.0000000000000000	0.0000000042792348	0.0000000000000545	0.0000000000000000
2	0.0000000000000000	0.0000169350878084	0.0000127251525752	0.0000000042792348
3	0.0000000000000000	0.0000009536743164	0.0000976562500000	0.0000336281613319 8
4	0.0000000000000000	0.0000001024000000	0.0000104857600000	0.0006046617600000
5	0.0000000000000000	0.0000000165381717	0.0000169350878084	0.0000976562500000
6	0.0000000000000000	0.0000000035401332	0.0000036250963708	0.0000209041323829 4
7	0.0000000000000000	0.0000000009313226	0.0000009536743164	0.0000054993666708 5
8	0.0000000000000000	0.0000000002867972	0.0000002936803319	0.0000169350878084
9	0.0000000000000000	0.0000000001000000	0.0000001024000000	0.0000005904900000
10	0.0000000000000000	0.0000000000385543	0.0000000394796328	0.0000002276594569 8
11	0.0000000000000000	0.0000000000161506	0.0000000165381717	0.0000000953674316 4
12	0.0000000000000000	0.0000000000072538	0.0000000074279066	0.0000000428330523 6
13	0.0000000000000000	0.0000000000034572	0.0000000035401332	0.0000000204141917 8
14	0.0000000000000000	0.0000000000017342	0.0000000017757727	0.0000000102400000
15	0.0000000000000000	0.0000000000009095	0.0000000009313226	0.0000000053704752 6
16	0.0000000000000000	0.0000000000004960	0.0000000005079380	0.0000000029290267 2
17	0.0000000000000000	0.0000000000002801	0.0000000002867972	0.0000000016538171 7
18	0.0000000000000000	0.0000000000001631	0.0000000001670183	0.0000000009631114 3
19	0.0000000000000000	0.0000000000000977	0.0000000001000000	0.0000000005766503 9
20	0.0000000000000000	0.0000000000000600	0.0000000000613913	0.0000000003540133 2
21	0.0000000000000000	0.0000000000000377	0.0000000000385543	0.0000000002223236 9
22	0.0000000000000000	0.0000000000000241	0.0000000000247185	0.0000000001425391 6
23	0.0000000000000000	0.0000000000000158	0.0000000000161506	0.0000000000931322 6
24	0.0000000000000000	0.0000000000000105	0.0000000000107374	0.0000000000619173 6
25	0.0000000000000000	0.0000000000000071	0.0000000000072538	0.0000000000418291 5
26	0.0000000000000000	0.0000000000000049	0.0000000000049735	0.0000000000286797 2
27	0.0000000000000000	0.0000000000000034	0.0000000000034572	0.0000000000199357 3
28	0.0000000000000000	0.0000000000000024	0.0000000000024340	0.0000000000140356 5
29	0.0000000000000000	0.0000000000000017	0.0000000000017342	0.0000000000100000 0
30	0.0000000000000000	0.0000000000000012	0.0000000000012493	0.0000000000072043 6
31	0.0000000000000000	0.0000000000000009	0.0000000000009095	0.0000000000052446 0

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Table 12.9 (continued)

i	j = 4	j = 5	j = 6	j = 7
0	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
1	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
2	0.0000000000086550	0.0000000000000545	0.0000000000000007	0.0000000000000000
3	0.0000006801500913	0.0000000042792348	0.0000000000589176	0.0000000000014390
4	0.00020225610450206	0.0000127251525752	0.0000001752032857	0.0000000042792348
5	0.00173415299158326	0.00062916037103202	0.00000866244735282	0.00000021157506461
6	0.00037120986837328	0.00345716130336078	0.00137682660123784	0.00003362816133198
7	0.0000976562500000	0.00090949470177293	0.00563135147094727	0.00244243983241972
8	0.00003007286598217	0.00028007538972582	0.00173415299158326	0.00810131102224121
9	0.00001048576000000	0.0000976562500000	0.00060466176000000	0.00282475249000000
10	0.00000404271440257	0.00003765071185835	0.00023312328394265	0.00108906436681886
11	0.00000169350878084	0.00001577202957909	0.0000976562500000	0.00045621329741699
12	0.00000076061763475	0.00000708380373891	0.00004386104561932	0.0002049023206415[illegible]
13	0.00000036250963708	0.00000337613408531	0.00002090413238294	0.0000976562500000
14	0.00000018183912073	0.00000169350878084	0.00001048576000000	0.00004898552981016
15	0.00000009536743164	0.00000088817841970	0.00000549936667085	0.00002569097423475
16	0.00000005201285578	0.00000048440746759	0.00000299932336038	0.00001401171149065
17	0.00000002936803319	0.00000027351112278	0.00000169350878084	0.00000791143654516
18	0.00000001710266952	0.00000015928102208	0.00000098622610583	0.00000460727770868
19	0.00000001024000000	0.00000009536743164	0.00000059049000000	0.00000275854735352
20	0.00000000628647172	0.00000005854733024	0.00000036250963708	0.00000169350878084
21	0.00000000394796328	0.00000003676827330	0.00000022765945698	0.00000106353942072
22	0.00000000253117139	0.00000002357337056	0.00000014596009712	0.00000068187071690
23	0.00000000165381717	0.00000001540237264	0.00000009536743164	0.00000044552079826
24	0.00000000109951163	0.00000001024000000	0.00000006340338097	0.00000029619676670
25	0.00000000074279066	0.00000000691777709	0.00000004283305236	0.00000020009992250
26	0.00000000050928663	0.00000000474310132	0.00000002936803319	0.00000013719641353
27	0.00000000035401332	0.00000000329700594	0.00000002041419178	0.00000009536743164
28	0.00000000024924126	0.00000000232124010	0.00000001437250687	0.00000006714295040
29	0.00000000017757727	0.00000000165381717	0.00000001024000000	0.00000004783743146
30	0.00000000012793312	0.00000000119146998	0.00000000737726808	0.00000003446382384
31	0.00000000009313226	0.00000000086736174	0.00000000537047526	0.00000002508884203

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Table 12.9 (continued)

i	j = 8	j = 9	j = 10	j = 11
0	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
1	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
2	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
3	0.0000000000000545	0.0000000000000029	0.0000000000000002	0.0000000000000000
4	0.0000000001619295	0.0000000000086550	0.0000000000006117	0.0000000000000545
5	0.0000000800616172	0.0000000042792348	0.0000000003024471	0.0000000000269232
6	0.0000127251525752	0.0000006801500913	0.0000000480715486	0.0000000042792348
7	0.0009242378498324	0.0000493998365986	0.0000034914744235	0.0000003108041952
8	0.0037840762239 6469	0.0002022561045 0206	0.0001429502736210	0.0000127251525752
9	0.0107374182400000	0.0053449268072658 1	0.0003777679548727 0	0.0000336281613319 8
10	0.0041397395482302 5	0.0134430632749311 9	0.0070677853690937 3	0.0006291603710320 2
11	0.0017341529915832 6	0.0056313514709472 7	0.0161505582889845 7	0.0089018035802733 9
12	0.0007788724579811 1	0.0025292489089603 3	0.0072538150286405 7	0.0188145280374965 5
13	0.0003712098683732 8	0.0012054376104299 2	0.0034571613033607 8	0.0089669860639415 0
14	0.0001862032596277 7	0.0006046617600000 0	0.0017341529915832 6	0.0044979462465789 4
15	0.0000976562500000 0	0.0003171211938934 0	0.0009094947017729 3	0.0023589950252244 3
16	0.0000532611643200 3	0.0001729560987373 7	0.0004960332468155 2	0.0012865824938866 8
17	0.0000300728659821 7	0.0000976562500000 0	0.0002800753897258 2	0.0007264434303609 3
18	0.0000175131335864 1	0.0000568707669169 9	0.0001631037666128 0	0.0004230491648658 7
19	0.0000104857600000 0	0.0000340506289160 2	0.0000976562500000 0	0.0002532951621191 4
20	0.0000064373470374 5	0.0000209041323829 4	0.0000599524661660 9	0.0001555012570827 0
21	0.0000040427144025 7	0.0000131279914794 2	0.0000376507118583 5	0.0000976562500000 0
22	0.0000025919195040 6	0.0000084167947018 7	0.0000241391314572 1	0.0000626106902105 1
23	0.0000016935087808 4	0.0000054993666708 5	0.0000157720295790 9	0.0000409085828012 3
24	0.0000011258999068 4	0.0000036561584400 6	0.0000104857600000 0	0.0000271973609384 2
25	0.0000007606176347 5	0.0000024699696376 6	0.0000070838037389 1	0.0000183735625366 2
26	0.0000005215095050 8	0.0000016935087808 4	0.0000048569357496 2	0.0000125976404797 6
27	0.0000003625096370 8	0.0000011771851664 4	0.0000033761340853 1	0.0000087568223280 7
28	0.0000002552230480 0	0.0000008287911699 7	0.0000023769498616 8	0.0000061651957817 6
29	0.0000001818391207 3	0.0000005904900000 0	0.0000016935087808 4	0.0000043925256314 2
30	0.0000001310035098 9	0.0000004254104520 8	0.0000012200652611 5	0.0000031645350719 3
31	0.0000000953674316 4	0.0000003096886659 1	0.0000008881784197 0	0.0000023037060793 2

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Table 12.9 (continued)

i	j = 12	j = 13	j = 14	j = 15
0	0.00000000000000000	0.00000000000000000	0.00000000000000000	0.00000000000000000
1	0.00000000000000000	0.00000000000000000	0.00000000000000000	0.00000000000000000
2	0.00000000000000000	0.00000000000000000	0.00000000000000000	0.00000000000000000
3	0.00000000000000000	0.00000000000000000	0.00000000000000000	0.00000000000000000
4	0.00000000000000059	0.00000000000000007	0.00000000000000001	0.00000000000000000
5	0.00000000000029090	0.00000000000003707	0.00000000000000545	0.00000000000000091
6	0.00000000004623593	0.00000000000589176	0.00000000000086550	0.00000000000014390
7	0.00000000335815176	0.00000000042792348	0.00000000006286205	0.00000000001045177
8	0.00000013749168812	0.00000001752032857	0.00000000257373979	0.00000000042792348
9	0.00000363342808071	0.00000046300147073	0.00000006801500913	0.00000001130853235
10	0.00006797900535831	0.00000866244735282	0.00000127251525752	0.00000021157506461
11	0.00096181479499329	0.00012256239968315	0.00001800444115189	0.00000299351286943
12	0.01080471823850057	0.00137682660123784	0.00020225610450206	0.00003362816133198
13	0.02140583156013078	0.01274282744673323	0.00187192391358582	0.00031123589333553
14	0.01073741824000000	0.02390677160551000	0.01469002010276541	0.00244243983241972
15	0.00563135147094727	0.01253815679310719	0.02630755761638284	0.01662652477895474
16	0.00307130712102898	0.00683823953129503	0.01434799256642480	0.02860377655391562
17	0.00173415299158326	0.00386107708316231	0.00810131102224121	0.01615055828898457
18	0.00100989553236712	0.00224852392801322	0.00471785237368721	0.00940538507296811
19	0.00060466176000000	0.00134627433446289	0.00282475249000000	0.00563135147094727
20	0.00037120986837328	0.00082649565682853	0.00173415299158326	0.00345716130336078
21	0.00023312328394265	0.00051904703538338	0.00108906436681886	0.00217112977004284
22	0.00014946313944873	0.00033277842572362	0.00069823561410766	0.00139198395841504
23	0.00009765625000000	0.00021743082111707	0.00045621329741699	0.00090949470177293
24	0.00006492506210855	0.00014455510594906	0.00030330548909611	0.00060466176000000
25	0.00004386104561932	0.00009765625000000	0.00020490232064152	0.00040848781931514
26	0.00003007286598217	0.00006695698374499	0.00014048912744966	0.00028007538972582
27	0.00002090413238294	0.00004654287532813	0.00009765625000000	0.00019468490390983
28	0.00001471744703277	0.00003276827231317	0.00006875438121350	0.00013706690662329
29	0.00001048576000000	0.00002334645664601	0.00004898552981016	0.00009765625000000
30	0.00000755432251516	0.00001681963568593	0.00003529095561617	0.00007035511094293
31	0.00000549936667085	0.00001224429374327	0.00002569097423475	0.00005121684326648

Table 12.9 (continued)

i	j = 16	j = 17	j = 18	j = 19
0	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
1	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
2	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
3	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
4	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
5	0.0000000000000017	0.0000000000000003	0.0000000000000001	0.0000000000000000
6	0.0000000000002668	0.0000000000000545	0.0000000000000121	0.0000000000000029
7	0.0000000000193752	0.0000000000039550	0.0000000000008798	0.0000000000002114
8	0.0000000007932711	0.0000000001619295	0.0000000000360206	0.0000000000086550
9	0.0000000209634013	0.0000000042792348	0.0000000009519007	0.0000000002287220
10	0.0000003922111950	0.0000000800616172	0.0000000178094248	0.0000000042792348
11	0.0000055492799300	0.0000011327680875	0.0000002519802723	0.0000000605456252
12	0.0000623388269573	0.0000127251525752	0.0000028306653817	0.0000006801500913
13	0.0005769593022349	0.0001177740344015	0.0000261984192393	0.0000062949359367
14	0.0045277180802040	0.0009242378498324	0.0002055934552107	0.0000493998365986
15	0.0308217282789946	0.0062916037103202	0.0013995450909694	0.0003362816133198
16	0.1853768522812874	0.0378407622396469	0.0084175443129336	0.0020225610450206
17	0.3079461476574387	0.2041288422689799	0.0454077421713956	0.0109105372117961
18	0.1793344879248388	0.3288161986316662	0.2224464787370027	0.0534492680726581
19	0.1073741824000000	0.1968744043407227	0.3486784401000000	0.2402792275073543
20	0.0659184336634629	0.1208638061077120	0.2140583156013078	0.3675725423828691
21	0.0413973954823025	0.0759036054540019	0.1344306327493119	0.2308390090569343
22	0.0265412557216196	0.0486643417798789	0.0861879777471490	0.1479986143699440
23	0.0173415299158326	0.0317963154291396	0.0563135147094727	0.0966993583693765
24	0.0115292150460685	0.0211392282015721	0.0374390624262449	0.0642888893233994
25	0.0077887245798111	0.0142809051296139	0.0252924890896033	0.0434312700804961
26	0.0053402573320669	0.0097915528461043	0.0173415299158326	0.0297781948907956
27	0.0037120986837328	0.0068062657230895	0.0120543761042992	0.0206993017722760
28	0.0026134840115559	0.0047919164228167	0.0084868215804510	0.0145732370934210
29	0.0018620325962777	0.0034141033725364	0.0060466176000000	0.0103830145435164
30	0.0013414759412784	0.0024596441246253	0.0043562030292735	0.0074803009549433
31	0.0009765625000000	0.0017905622766259	0.0031712119389340	0.0054454807399305

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Table 12.9 (continued)

i	j = 20	j = 21	j = 22	j = 23
0	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
1	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
2	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
3	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
4	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
5	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
6	0.0000000000000007	0.0000000000000002	0.0000000000000001	0.0000000000000000
7	0.0000000000000545	0.0000000000000149	0.0000000000000043	0.0000000000000013
8	0.0000000000022295	0.0000000000006117	0.0000000000001778	0.0000000000000545
9	0.0000000000589176	0.0000000000161656	0.0000000000046979	0.0000000000014390
10	0.0000000011023096	0.0000000003024471	0.0000000000878954	0.0000000000269232
11	0.0000000155962524	0.0000000042792348	0.0000000012436060	0.0000000003809291
12	0.0000001752032857	0.0000000480715486	0.0000000139702700	0.0000000042792348
13	0.0000016215442350	0.0000004449125611	0.0000001292978647	0.0000000396052423
14	0.0000127251525752	0.0000034914744235	0.0000010146717066	0.0000003108041952
15	0.0000866244735282	0.0000237676626652	0.0000069072179584	0.0000021157506461
16	0.0005210016806266	0.0001429502736210	0.0000415433654974	0.0000127251525752
17	0.0028105002011582	0.0007711333527448	0.0002241022273611	0.0000686447764033
18	0.0137682660123784	0.0037776795487270	0.0010978469522979	0.0003362816133198
19	0.0618947357159857	0.0169824200867362	0.0049353307749856	0.0015117416792982
20	0.2575950337367022	0.0706778536909373	0.0205399810303393	0.0062916037103202
21	0.3855432894295317	0.2743758397267078	0.0797374884615748	0.0244243983241972
22	0.2471847061218657	0.4026378396234679	0.2906141026884780	0.0890180358027339
23	0.1615055828898457	0.2630755761638284	0.4189038878845929	0.3063101032579833
24	0.1073741824000000	0.1749012287659809	0.2785009760094021	0.4343884542236321
25	0.0725381502864057	0.1181570032379008	0.1881452803749655	0.2934572750251116
26	0.0497350220760971	0.0810131102224121	0.1289998385127840	0.2012059032955585
27	0.0345716130336078	0.0563135147094727	0.0896698606394150	0.1398614565440123
28	0.0243399665835864	0.0396472407839464	0.0631316048052633	0.0984687400991002
29	0.0173415299158326	0.0282475249000000	0.0449794624657894	0.0701561605000068
30	0.0124934682741615	0.0203505433415962	0.0324048391366050	0.0505430472223555
31	0.0090949470177293	0.0148147103280047	0.0235899502522443	0.0367941332634283

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Table 12.9 (continued)

i	j = 24	j = 25	j = 26	j = 27
0	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
1	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
2	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
3	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
4	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
5	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
6	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
7	0.0000000000000004	0.0000000000000001	0.0000000000000001	0.0000000000000000
8	0.0000000000000175	0.0000000000000059	0.0000000000000021	0.0000000000000007
9	0.0000000000004626	0.0000000000001555	0.0000000000000545	0.0000000000000198
10	0.0000000000086550	0.0000000000029090	0.0000000000010188	0.0000000000003707
11	0.0000000001224572	0.0000000000411583	0.0000000000144146	0.0000000000052447
12	0.0000000013756451	0.0000000004623593	0.0000000001619295	0.0000000000589176
13	0.0000000127318922	0.0000000042792348	0.0000000014986926	0.0000000005452955
14	0.0000000999141851	0.0000000335815176	0.0000000117610677	0.0000000042792348
15	0.0000006801500913	0.0000002286008959	0.0000000800616172	0.0000000291302177
16	0.0000040907531808	0.0000013749168812	0.0000004815294731	0.0000001752032857
17	0.0000220672275448	0.0000074168746758	0.0000025975706629	0.0000009451195419
18	0.0001081044074886	0.0000363342808071	0.0000127251525752	0.0000046300147073
19	0.0004859794054840	0.0001633394289421	0.0000572054574541	0.0000208140615826
20	0.0020225610450206	0.0006797900535831	0.0002380790801083	0.0000866244735282
21	0.0078517082246545	0.0026389874203786	0.0009242378498324	0.0003362816133198
22	0.0286166166542767	0.0096181479499329	0.0033685103278516	0.0012256239968315
23	0.0984694699587655	0.0330959435930852	0.0115910077889870	0.0042173589839350
24	0.3214698728883640	0.1080471823850057	0.0378407622396469	0.0137682660123784
25	0.4491371071418633	0.3361036025373580	0.1177116906777382	0.0428291021135896
26	0.3079461476574387	0.4631934880846845	0.3502244242224523	0.1274282744673323
27	0.2140583156013078	0.3219732365906962	0.4765990433600399	0.3638474807981797
28	0.1507066576155911	0.2266836034468044	0.3355471084868285	0.4893928979531777
29	0.1073741824000000	0.1615055828898457	0.2390677160551000	0.3486784401000000
30	0.0773562625552248	0.1163544903896892	0.1722330694239238	0.2512006178472362
31	0.0563135147094727	0.0847032947254300	0.1253815679310719	0.1828680603340951

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Table 12.9 (continued)

i	j = 28	j = 29	j = 30	j = 31
0	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
1	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
2	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
3	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
4	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
5	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
6	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
7	0.0000000000000000	0.0000000000000000	0.0000000000000000	0.0000000000000000
8	0.0000000000000003	0.0000000000000001	0.0000000000000000	0.0000000000000000
9	0.0000000000000075	0.0000000000000029	0.0000000000000012	0.0000000000000005
10	0.0000000000001397	0.0000000000000545	0.0000000000000219	0.0000000000000091
11	0.0000000000019772	0.0000000000007705	0.0000000000003096	0.0000000000001281
12	0.0000000000222113	0.0000000000086550	0.0000000000034784	0.0000000000014390
13	0.0000000002055705	0.0000000000801040	0.0000000000321936	0.0000000000133185
14	0.0000000016132254	0.0000000006286205	0.0000000002526413	0.0000000001045177
15	0.0000000109817780	0.0000000042792348	0.0000000017198157	0.0000000007114880
16	0.0000000660497497	0.0000000257373979	0.0000000103438075	0.0000000042792348
17	0.0000003562998772	0.0000001388382507	0.0000000557988086	0.0000000230839762
18	0.0000017454656250	0.0000006801500913	0.0000002733509284	0.0000001130853235
19	0.0000078466768046	0.0000030575898307	0.0000012288390896	0.0000005083709308
20	0.0000326564925566	0.0000127251525752	0.0000051142127530	0.0000021157506461
21	0.0001267745425168	0.0000493998365986	0.0000198536931354	0.0000082134760728
22	0.0004620470324321	0.0001800444115189	0.0000723594801757	0.0000299351286943
23	0.0015898988664271	0.0006195308825458	0.0002489881926110	0.0001030064556998
24	0.0051904878406445	0.0020225610450206	0.0008128631408587	0.0003362816133198
25	0.0161461097240892	0.0062916037103202	0.0025285826430801	0.0010460750498900
26	0.0480390855742005	0.0187192391358582	0.0075232238630915	0.0031123589333553
27	0.1371665773478078	0.0534492680726581	0.0214811513497214	0.0088867558002704
28	0.3769892182485437	0.1469002010276541	0.0590388898738498	0.0244243983241972
29	0.5016118252560145	0.3896668496519306	0.1566063086582128	0.0647880553127505
30	0.3613793855096196	0.5132902804635093	0.4018979515401455	0.1662652477895474
31	0.2630755761638284	0.3736630856289844	0.5244604750487269	0.4137001623232687

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12.4 PASC additional requirements

In addition to the requirements to the PASC codec presented above an implementation of the PASC coder has to satisfy the following requirements:

1) The Total Harmonic Distortion plus Noise vs. frequency of a PASC coder:

   To the Coder Under Test a PCM signal representation of a sinewave with a reference level amplitude and a frequency within the test frequency range (which depends on the sampling frequency) is supplied on the digital input of the analysis filter. The resolution of the sinewave is at least 18 bits. The PASC signal generated by the coder is supplied to a PASC reference decoder. The total harmonic distortion plus noise is measured (no weighting filter applied) at the digital output of the PASC reference decoder.

   For an input level of 0 dBFS THD+N must be below -90 dBFS in the frequency range from 20 Hz to 10 kHz and must be below -70 dBFS in the frequency range from 10kHz to 20 kHz.
   For an input level of -60 dBFS THD+N must be below -105 dBFS over the whole frequency range.

   The test frequency range is defined as follows:

For 44.1 kHz sampling frequency:	20 Hz to 20 kHz
For 48 kHz sampling frequency:	20 Hz to 20 kHz
For 32 kHz sampling frequency:	20 Hz to 15 kHz

2) The Total Harmonic Distorsion plus Noise vs. input level of a PASC coder:

   Use the same test circuit as in test 1). The input signal is a PCM representation of a sinewave with a fixed frequency. The amplitude level is decreased, starting from 0 dBFS. Resolution is at least 18 bits.

   For frequencies in the range 50 Hz to 10 kHz the THD+N (without weighting filter applied) should be below the following maximum levels:

   For an input of 0 dBFS to -15 dBFS the maximum level is 90 dBFS below the input level (i.e. -90 dBFS for 0 dBFS input, -100 dBFS for -10 dBFS input, etc.)
   For an input level lower than - 15 dBFS the maximum level is -105 dBFS.

Note: As a PASC reference decoder one may use the Philips PASC decoder IC's SAA 2021 + 2 SAA 2001 (PASC codec + 2 subband filters).

An implementation of a PASC decoder must be able to decode the PASC signals that are recorded on the PASC decoder test tape.

Note: Signals on this tape are coded using Stereo, Joint Stereo and 2-channel mono coding as well as mixed modes.

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13. MAIN DATA CONTENTS

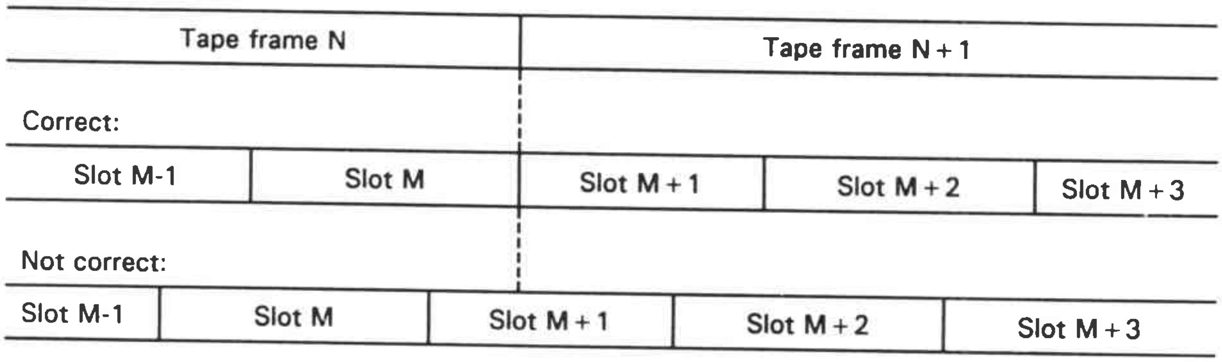
13.1 User Main Data

The Main Data can be divided into User Main Data and Sysinfo Data.

The User Main Data bytes will be used as a transparent channel to transfer data at a nominal rate of 384 kbits/sec. The data will be transferred as units of 32 successive bits (4 bytes) called 'Slots'. Each Tape frame contains 2048 slots, numbered 0 to 2047.

The audio information, coded in Precision Adaptive Subband Coding, is recorded in the User Main Data area. The slots defined for the PASC signal (chapter 12) will coincide with the slots in the User Main Data (chapter 10). This means that a subband slot may not be split into two parts recorded in different tape frames:

Example:



The PASC Slot is converted into a Tape frame slot as shown below:

PASC Slot:	0 … 7	8 … 15	16 … 23	24 … 31
Byte:	0	1	2	3
	msb	msb	msb	msb

This definition allows the use of the name 'Slots' for both slots in the subband signal and slots defined for the User Main Data, as both coincide.

The bits 0...31 of a PASC slot are mapped onto the bits of a User Main Data slot as follows:

P = number of bit in a PASC slot (0...31)
Y = number of byte in a User Main Data slot (0...3)
X = number of bit in a User Main Data byte (0...7) , 7 = msb, 0 = lsb
Y = P div 8
X = 7 - (P mod 8)

13.2 Sysinfo Data

Each tape frame contains 128 bytes of Sysinfo, numbered SI_0 to SI_{127}.

FORMAT-ID

SI_0 will indicate the application:

7	6	5	4	3	2	1	0
FORMAT-ID							

Bits 7-4 of byte SI_0 indicate the application of the Main Data and are referred to as FORMAT-ID. The contents are the same as the FORMAT-ID in the Auxiliary Data:

The following combinations have been defined:

bit	7654	application
	0000	audio information is contained in the User Main Data and Sysinfo
		Other codes are reserved for future use

Contents of bits 3...0 depend on the application.

In this standard the FORMAT-ID for audio applications is specified as "0 0 0 0".

COPYRIGHT AND TAPE TYPE INFORMATION

SI_0 also contains copyright information as shown below:

7	6	5	4	3	2	1	0
0	0	0	0	CP1	CP2	TT1	TT2

Bits 3 and 2 are called CP1 and CP2 (Copyright Protection bits 1 and 2) and are used to implement the copyright protection system. The following combinations are defined:

CP1	CP2	result on digital output
0	0	not copyright protected, consumer recorded cassette
0	1	not copyright protected, prerecorded cassette
1	0	copyright protected, consumer recorded cassettes
1	1	copyright protected, prerecorded cassette

For more information about the copyright protection system refer to chapters 18 and 19.

Bits 1-0 of byte SI_0 are called TT1 and TT2 (Tape Type bits 1 and 2) and are used to identify the format recorded on tape. The following combinations are defined:

TT1	TT2	Tape Type
1	0	Prerecorded 4-sector format as defined in section 15.1.2
1	1	Prerecorded 2-sector format as defined in section 15.1.1
0	0	Consumer-recorded tape format as defined in section 16.1
0	1	Consumer-recorded tape format as defined in section 16.1

See chapter 15 for the definition of the TT bits.

SYSINFO MODE-ID

SI_1 will contain the Sysinfo Mode ID:

7	6	5	4	3	2	1	0
SYSINFO MODE ID							

Bits 7-4 are called the Sysinfo Mode ID and indicate the use of the Sysinfo bytes SI_5 - SI_{127}

bit	7654	Sysinfo Mode ID
	0000	Sysinfo not used, all bytes from SI_5 to SI_{127} are "00h"
	0001	ITTS Text mode

Other codes are reserved for future use

The contents of bits 3...0 are mode dependent. When Sysinfo Mode ID = "0000", bits 3...0 are to be set to "0000".

To protect the information in SI_0 and SI_1 bytes SI_2...SI_4 contain redundant information : SI_2 is equal to SI_0, SI_3 is equal to SI_1, and SI_4 contains the bitwise EXOR of SI_0 and SI_1.

bit:	7	6	5	4	3	2	1	0	
	0	0	0	0	CP1	CP2	TT1	TT2	SI_0
	Sysinfo mode ID								SI_1
	0	0	0	0	CP1	CP2	TT1	TT2	SI_2
	Sysinfo mode ID								SI_3
	SI_0 EXOR SI_1								SI_4

13.2 Sysinfo Data

13.2.1 ITTS TEXT MODE (Sysinfo Mode ID = "0 0 0 1")

General

In this mode text information is recorded in the Sysinfo channel. The format in which this text is recorded is called ITTS: Interactive Text Transmission System.
This mode may only be used on prerecorded 2-Sector and 4-Sector tape; use of the Sysinfo channel on user and super-user tape is only for a mandatory setmaker's signature (see section 13.2.6.6). The text, which is related to the recorded music, can be made available to the customer on a display linked to the DCC player.

Three kinds of displays are supported by dedicated codes:
- 21 lines of 40 characters.
- 2 lines of 40 characters.
- 1 line of minimum 12 characters.

Every line can be labelled for one or more of the mentioned display types, by means of dedicated codes attached to each 40-character wide text line.

13.2.1.1 Recorded text contents (see also Table 13.1)

The total assortment of recorded text is subdivided into different topics. The topic to which a text line belongs is indicated by its Topic Code. For regular topics this Topic Code is fixed. Each Topic can be transmitted in a maximum of 7 pre-selectable languages. The following Topic contents must be recorded continuously on prerecorded tape:
* Album/Work Title and optional Label Information
* Tracklist
* Performer's Name and Credits for the current track
* Main Menu

The following Topic contents may optionally be recorded continuously on prerecorded tape:
* Major Topics
* Additional Information
* Sung Text (may be synchronised)
* Language Selection Menu

One text line of each of the Topics 'Album/or Work Title' and 'Performer's Name and Credits for the current track' must be labelled for presentation on the 1-line display. In the 'Tracklist'-topic, one text line of each Track+Index must be labelled for presentation on the 1-line display. Labelling of a text line from any of the otner Topics is optional.

In this document a description is given of the minimal functionality for DCC plus many (optional) extensions. Manufacturers of prerecorded DCC cassettes, who want to implement the ITTS Text Mode with an extended functionality are allowed to implement optional extensions.

An application note named 'Code of Practice for the preparation of DCC Text Mode' describes the information contents and the effects of coding. More information on extended applications of ITTS Text Mode can be found in 'The ITTS reference document'. Guidelines for implementation of ITTS in a decoder can be found in 'ITTS as implemented in DCC'. These documents can be ordered from Philips Consumer Electronics B.V. (see Preface).

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13.2 Sysinfo Data

Refer also to the chapters 15 and 17 for application details. Chapter 18 specifies the ITTS output format in the digital audio interface signal.

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13.2 Sysinfo Data

Table 13.1

Mandatory contents:	21-Line display	2-Line display	1-Line display	Remarks
Album/Worktitle Topic 1	At least one line of text	At least one line of text	Album title: One line of text	1, 3 and 5
Credits Topic 3	At least one line of text	At least one line of text	Main artist: One line of text	1 and 2
Tracklist Topic 2	At least one line of text per Track/Index	At least one line of text per Track/Index	One line of text per Track/Index	1 and 3
Main menu Topic 255	One entry per Topic One entry per language if the number of languages ≥1	One entry per Topic One entry per language if the number of languages ≥1	Not applicable	1, 3 and 4
Indication code of current Track/Index IC 06	Not display type related	Not display type related	Not display type related	2
Optional contents:				
Sung text (may be synchronised) Topic 9	Optional	Optional	Optional	1
Language selection menu Topic 254	Optional	Optional	Not applicable	4
Other Topics	Optional	Optional	Optional	

Remarks:
1 - Usually the same line of text for all display types.
2 - Usually the contents changes each Track/Index.
3 - Usually the same line of text all over the tape.
4 - Language selection is needed, may be provided in the Main menu or in the Language selection menu.
5 - Album title and current Track title must be available within 5 seconds.

Table 13.1 Mandatory and optional recorded contents in different Topics

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13.2 Sysinfo Data

Packet mapping

In two consecutive tape frames 5 ITTS Packets (of 48 bytes each), plus an 8-byte Sysinfo header for each tape frame are mapped as shown in the diagram below:

DCC TAPE FRAME (N):

8 bytes Sysinfo header	SI_0	SI_7	
8 bytes ITTS packet header	SI_8	SI_{15}	Packet 1
40 bytes Character codes	SI_{16}	SI_{55}	Packet 1
8 bytes ITTS packet header	SI_{56}	SI_{63}	Packet 2
40 bytes Character codes	SI_{64}	SI_{103}	Packet 2
8 bytes ITTS packet header	SI_{104}	SI_{111}	Packet 3
16 bytes Character codes	SI_{112}	SI_{127}	Packet 3

DCC TAPE FRAME (N+1):

8 bytes Sysinfo header	SI_0	SI_7	
24 bytes Character codes	SI_8	SI_{31}	Packet 3
8 bytes ITTS packet header	SI_{32}	SI_{39}	Packet 4
40 bytes Character codes	SI_{40}	SI_{79}	Packet 4
8 bytes ITTS packet header	SI_{80}	SI_{87}	Packet 5
40 bytes Character codes	SI_{88}	SI_{127}	Packet 5

Note: DCC Tape frame (N) and (N+1) are recorded in succession. No information may be recorded between these frames.

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13.2 Sysinfo Data

Sysinfo Header

In ITTS Text Mode, the Sysinfo Header, consisting of the bytes $SI_0...SI_7$, contains the following data:

	7	6	5	4	3	2	1	0
SI_0:	0	0	0	0	CP1	CP2	TT1	TT2

See section 13.2

	7	6	5	4	3	2	1	0
SI_1:	0	0	0	1	RCC	CC	CC	CC

SI_1 bit 7-4: "0001" Indicating that text is recorded in the Sysinfo channel

SI_1 bit 3: RCC, Reset Continuity Count
When set, this bit indicates that the continuity count (CC) sequence is restarted
RCC = "1": CC is restarted
RCC = "0": No discontinuity in CC sequence

SI_1 bit 2-0: CC, Continuity Count (0...7)
These bits indicate where any split ITTS Packet can be found:
An even CC (i.e. SI_1 bit 0 = "0") indicates that the first half of a split packet can be expected at the end (bytes $SI_{104}...SI_{127}$) of this DCC frame
An odd CC (i.e. SI_1 bit 0 = "1") indicates that the second half of a split packet can be found at the beginning (bytes $SI_8...SI_{31}$) of this DCC frame. The first half of this split packet can be found in the previous frame, which should have the preceding CC

SI_2 : equals SI_0

SI_3 : equals SI_1

SI_4 : contains bitwise EXOR of SI_0 and SI_1

$SI_5...SI_7$: These bytes are reserved for future use and must contain "00h"

In the following sections the 3 types of ITTS Text Mode Packet formats are described:

* TEXT Packet, section 13.2.2
* TRACKLIST Packet, section 13.2.3
* INSTRUCTION Packet, section 13.2.5

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13.2.2 TEXT Packet format

Coding format.

byte	msb bit 7	6	5	4	3	2	1	lsb 0	
0	1	LANGUAGE NUMBER			APPLICATION CODE				
1	PACKET INDEX MSByte								
2	PACKET INDEX LSByte								
3	SC			MMCC					ITTS
4	TOPIC CODE								header
5	21-LINE CODE					2-LINE CODE			
6	ICP	SCROLAT			TCI		CDS	CDE	
7	CHARSET						0	0	
8	CHARACTER CODE								
|	1 TEXT LINE = 40 CHARACTERS								
47	CHARACTER CODE								

Note: The bits indicating a fixed "0" or "1" are reserved for future extensions. Until an application of these bits is defined, the indicated setting must be recorded.
In chapter 17 information is given on how a decoder must react if any of these bits is recorded differently.

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13.2.2.1 TEXT Packet header coding

13.2.2.1.1 Byte 0 : LANGUAGE NUMBER, APPLICATION CODE

bit 7 = "1" This bit is reserved for future applications and must be set to "1".

bit		
	654	**Language Filter**
	000	Language selection-independent text.
	001	Main language if various languages are recorded.
	010 | | | 111	Additional languages.

If text is recorded in one language only, it is recommended that the text is indicated as Language = "000".
If a text is recorded in more languages, then consecutive Language codes must be provided. The preferred language (as decided by the programme provider) is "001".
Text lines that are to be displayed independently of users language selection must be recorded as Language = "000".
The decoder must display the text coded with Language = "000" plus the text coded with Language = "001" or "010" or ... "111", as selected by the user.

bit		
	3210	**Application Code**
	0000	Text Packet for 2-line and 21-line displays, based on a 40-character per line font.
	1000	As "0000", but also for 1-line displays.

Per Topic, except the Topic "Tracklist" (see clause 13.2.3.1), only one Text Packet labelled with Application Code = "1000" is allowed (per language). If this text Packet is language selection-dependent, then one Text packet in each language must be labelled with AC = "1000".
This Application Code indicates that the text line contains characters which shall be shown on a 1-line display (if applicable).
Of the Topics "Album title" and "Performers name and credits" one Text packet must be labelled with Application code = "1000".

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13.2.2.1.2 Byte 1 and byte 2: PACKET INDEX

The main purposes of the Packet Index are:

- The decoder's cache memory management
- To specify packets, the contents of which shall not be loaded into a cache memory but displayed or executed immediately after passing the input filter stages of the decoder
- Reference for Instruction Packets

Bytes 1 and 2 together contain the Packet Index; Byte 1 = MSByte, Byte 2 = LSByte.

Byte 1	Byte 2	Packet Index
0000 0000	0000 0000	This Text Packet is intended to be displayed immediately.
0000 0000 0000 0000	0000 0001 0000 0010	Not used for Text Packets.
0000 0000 | | | | | | | | 1111 1111	0000 0011 | | | | | | | | 1111 1111	Addresses of the decoder's cache memory, at which the Text Packet may be stored.

Packet Index = "00 00h":

The text is displayed immediately when the Language number, MMCC, SC and Topic Code of the Text Packet correspond to the filtering set in the decoder. The location on the display(s) is dictated by the 21-Line Code and the 2-Line Code.

Packet Index = "00 03h"..."FF FFh":

A Packet Index in this range indicates that the packet may be stored in a cache memory in the decoder at the corresponding memory address. Memory address "00 03h" is reserved for the start of the Main Menu sequence.

All packets belonging to one Category (see 13.2.2.1.6 CDS & CDE) shall have Packet Indices that form a continuous series; no Packet Index numbers are skipped.
The text in each language must be provided by packets with lowest possible Packet Index numbers to fill a decoder's cache memory efficiently. Therefore:

- it is recommended to give packets belonging to the same language consecutive Packet Indices; not to leave ranges of Packet Index numbers unused,
- packets belonging to different languages (different Language Number) shall cover the same range of Packet Index numbers.

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13.2.2.1.3 Byte 3: SECTOR CODE AND MAIN MESSAGE CHANNEL CODE

bits 765	=	**Sector code (SC)**
000	=	This Packet is recorded on 2-Sector tape and also on 4-Sector tape, for those Packets which belong to the Channels I and II (see section 12.1.2).
010	=	This Packet is recorded on 4-Sector tape for those Packets which belong to Channel I only.
100	=	This Packet is recorded on 4-Sector tape for those Packets which belong to Channel II only.

bits 43210	=	**Main message channel code (MMCC)**
00001	=	End user information is recorded.
00010	=	Disc-jockey information is recorded.

All other codes are reserved.

13.2.2.1.4 Byte 4 : TOPIC CODE

bit 7-0	=	**Topic code:**
7654 3210		**Topic code**
0000 0000		Topic-independent packet contents.
0000 0001		Album/Work Title and optional Label Info.
0000 0010		reserved; for reference to Tracklist related packets.
0000 0011		Performer's Name and Credits of current track.
0000 0100 0000 0101 0000 0110 0000 0111 0000 1000		Major Topics (optional).
0000 1001		Sung Text (optional).**
0000 1010 |||| |||| 1001 1111		Additional Information (optional).
1111 1000 1111 1001 1111 1010 1111 1011		User character recording: free memorandum User character recording: album title User character recording: track title User character recording: artist/credits } see section 14.2.6
1111 1100		Reserved for future use
1111 1101		Setmaker's Signature, for consumer recorded tape only.
1111 1110		Language Menu (see note).
1111 1111		Main Menu (see note).

Note: Language selection provisions are required only when more than one language is recorded. In that case the language selection may be provided as part of the Main Menu or separately in a Language Menu. See also sections 13.2.6.3 and 13.2.6.4.

** The sung text may be synchronised with the music. If the sung text is provided as not synchronised text then it must also be recorded with Topic code = "0000 1001".

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13.2.2.1.5 Byte 5: 21-LINE CODE, 2-LINE CODE

bit 7-3 = **21-Line code.** These bits control the positioning on the 21-line display:

76543	**21-Line Code**
00000	Not shown on the 21-line display.
00001 … 10101	Line number 1...21
11100	Scroll in automatically from the bottom of the display or the scroll window. The whole displayed text (within the scroll window) scrolls up.
11101	Scroll in automatically from the top of the display or the scroll window. The whole displayed text (within the scroll window) scrolls down.

All other codes are reserved for future applications.

The 21-Line Codes 1...21 indicate either the absolute or the relative position on the display, depending on the scroll attributes coded in SCROLAT (see clause 13.2.2.1.6).

Text lines of which the Packet Index = "00 00h" are displayed immediately at the absolute position on the display indicated in the 21-Line Code, provided that this 21-Line Code lies in the range of 1...21.

In numbering text lines, it must be taken into account that double-height fonts and double-size fonts occupy the next display line as well.

Examples of the results of 21-Line Codes and Scroll Attributes are given in Appendix 2.

bit 2-0 = **2-Line code.** These bits control the positioning on the 2-line display:

210	**2-Line code**
000	Not shown on the 2-line display
001	TOP line: fixed on the upper line of the display. Contents of the upper display-line can be overwritten only by a new TOP line; coded "001"
010	BOTTOM line: fixed on the lower line of the display. Contents of the lower display-line can be overwritten only by a new BOTTOM line; coded "010"
011	Reserved
100	Reserved
101	ENTRY line: line which is displayed when its Topic is activated.
110	Reserved
111	FILL line: lines which fill the free line(s) of the display.

Text lines with Packet Index = "00 00h" are displayed immediately. If those lines are coded with "001", then the text line is displayed on the upper display line; the lower display line is cleared. If those lines are coded with "010", then the text line is displayed on the lower display line; the upper display line is not cleared.

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2-Line decoding functional requirements for text packets

A decoder searches through the list of Text Packets ("downwards", i.e. starting at the packet with CDS = "1", towards the packet with CDE = "1") of the selected Language and Topic.

If it finds an ENTRY line, and

a) a TOP line is found (but no BOTTOM line is found) *preceding* the ENTRY line, then:
the ENTRY line is shown in the lower line of the display and the (last found) TOP line is shown in the upper line of the display
b) a BOTTOM line is found (but no TOP line is found) *preceding* the ENTRY line, then:
the ENTRY line is shown in the upper line of the display and the (last found) BOTTOM line is shown in the lower line of the display
c) no TOP line or BOTTOM line is found *preceding* the ENTRY line, then:
the ENTRY line is shown in the upper line of the display and the lower line of the display will show the next FILL line in the list, unless a TOP line or BOTTOM line is encountered before the next FILL line; in that case the lower line remains blank because that TOP or BOTTOM line is regarded as the start of a new section
d) both a TOP line and a BOTTOM line are found *preceding* the ENTRY line (not recommended coding), then:
the (last found) TOP line is shown in the upper line of the display and the (last found) BOTTOM line is shown in the lower line of the display; in that case the ENTRY line is *not* displayed.

If no ENTRY line is found, but at least one FILL line is found in the list, then the first FILL line of the list is regarded as entry point and the same routine is used to fill the display.

If no ENTRY line and no FILL line is found in the list, and

a) a TOP line is found (but no BOTTOM line is found) in the list, then:
the (last found) TOP line is shown in the upper line of the display, the lower display line remains blank
b) a BOTTOM line is found (but no TOP line is found) in the list, then:
the (last found) BOTTOM line is shown in the lower line of the display, the upper display line remains blank
c) no TOP line or BOTTOM line is found in the list, then:
both display lines remain blank
d) both a TOP line and a BOTTOM line are found in the list, then:
the (last found) TOP line is shown in the upper line of the display and the (last found) BOTTOM line is shown in the lower line of the display.

When the decoder receives a scroll-up or scroll-down command, then the previous resp. next ENTRY or FILL line in the list is taken as entry point, and the above described routine is used to fill the display.

Note: If no ENTRY or FILL lines are found in the list, then scrolling is not possible.
In Appendix 1 examples are given of results on the display of 2-line Coding in text packets.

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13.2.2.1.6 Byte 6: ICP, SCROLAT, TCI, CDS, CDE

bit 7 = ICP (Interactive Command Present):

"1" = Interactive Command is linked.
"0" = No Interactive Command exists for this line.
See section 13.2.5.2.2 for the description of Interactive Commands.

bit **6-4** = **SCROLAT** Scroll Attributes, control the positioning on the 21-line display.

654
000 = This line is part of a group that forms a text Section or a Paragraph.

001 = Section marking (FLS):

This code marks the first line of a text Section; a group of related text lines. A text Section is kept together on the display: it scrolls in and out of the display as a whole. Several text Sections may be displayed simultaneously.

010 = Paragraph marking (FLP):

This code marks the first line of the first section of a Paragraph. This first section is the same as any text Section, except that it will always be positioned directly under the Header text (if available) when it scrolls in. The display shall not show several Paragraphs simultaneously. Display lines under the first section of a Paragraph are filled with succeeding text Sections.

110 = Static Header text (HET):

This code marks a text line to be displayed in a Header in a static way, not scrolling.

111 = Static Footer text (FOT):

This code marks a text line to be displayed in a Footer in a static way, not scrolling.

All other codes are reserved.

The 21-Line Codes of Header and Footer text lines indicate their absolute position on the display; 21-Line Code = "00001" is the top line (line 1), 21-Line Code = "10101" is the bottom line (line 21) of the display. Only one definition of Header and Footer is allowed in any Category, and this definition must precede the text in the associated Paragraphs and/or Sections. A Category consists of all Packets that belong to one specific topic in one specific language. The window in which text Sections and Paragraphs are displayed (scroll window) lies between the Header with the highest line number and the Footer with the lowest line number.

The 21-Line Codes of the text lines that form a text Section indicate their relative position on the display; relative with respect to the lowest line of the preceding text section or the Header. If this 21-Line Code equals 1, then the text line will be positioned on the display directly under the preceding text Section or Header. If it equals 2, then it will be positioned one line lower, etc.

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The 21-Line Codes of the text lines that form the first section of a Paragraph indicate in the same way their relative position on the display with respect to the lowest line of the Header. Any text Section, including the first section of a Paragraph, must fit in the scroll window; the highest 21-Line Code allowed in any text Section or first section of a Paragraph equals 21 minus the number of display lines occupied by the Header and Footer text. Examples of the results of 21-Line Codes and Scroll Attributes are given in Appendix 2.

bit 3-2 = **TCI (Topic Continuity Index):**

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00 = Packets of topics that remain the same throughout the entire tape (e.g. the Album Title) must be given the TCI = "00". The player does not clear the text until this tape is removed from the player.

01,10,11 = Cyclically changing TCI:

Packets that relate to only a part of the tape (e.g. a biography of the artist performing on the current track) must be recorded with TCI set to "01", "10" or "11". When the contents of this topic changes (e.g. at the start of the next track), the new packets must have a different TCI. The player will clear any old text and display the newly gathered text.

bit 1-0 = **CDS & CDE (Category Data Start & Category Data End):**

The bits CDS and CDE are set on the first resp. on the last packet belonging to a specific Category; a number of packets which are to be handled together, e.g. the Album Title in Spanish or the Artist Name in English. All text lines in a Category belong to the same Language and Topic; Credits in Spanish and Credits in English are two different Categories.
If the Category consists of one packet only, then both CDS and CDE must be "1".

Note: - All packets belonging to a Category may be stored in a cache memory at the memory location indicated in their Packet Index. When this Category is retrieved for display, the packets must form a continuous group, all with the same TCI setting. This means that any Topic in any language must be recorded as a series of Packets of which the Packet Indices form a continous ascending series between the CDS packet and the CDE packet.

- When synchronised Packets are read from the tape, their TCI determines whether the text is added to the text on the display or that the displayed text is cleared first. If the TCI of the synchronised text packet is equal to "00" or to the TCI of the displayed text, then the display is not cleared first.

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13.2.2.1.7 Byte 7: - bits 1...0 = "00",
- bits 7...2 = CHARSET

bits 765432	Character set control COLUMN X	COLUMN Y
000000	Alphanumeric character set *	Reserved
000100	Graphics font set *	Alphanumeric character set *
001000	Reserved for DRCS *	Alphanumeric character set *
001100	Reserved	Reserved
010000	Katakana character set *	Reserved
010100	Reserved	Reserved
011000	Reserved	Reserved
011100	Reserved	Reserved
100000	Reserved	Reserved
100100	Reserved	Reserved
101000	Reserved	Reserved
101100	Reserved	Reserved
110000	Reserved	Reserved
110100	Korean hanja font set **	Reserved
111000	Chinese hanzi font set **	Reserved
111100	Japanese font table ***	Katakana character set *

Note: * This character set is based on 40 characters per line (1 byte per character).
** This character set is based on 20 characters per line (2 bytes per character).
*** The Japanese font table is according to JIS X 0208-1990

The character sets as indicated in the columns X and Y can be selected by the serial attributes GS0 and GS3 respectively. At the beginning of a text line the character set in column X is active.

When a decoder should display text in which a character set is used that is not provided by that decoder, then it must display a blank line instead.

When a decoder cannot provide part of the characters from a character set, then it should provide an alternative character for those it cannot provide, e.g.:

- an unaccented letter instead of the accented letter
- a blank instead of a punctuation mark
- a marking indicating that the correct character cannot be displayed

In general the rule applies that the alternative character must be the one that is best understood by the reader.

The bits 1 and 0 of this byte are reserved for line-default settings of Text Attributes (see section 13.2.2.2.2). In future applications, these bits may be used to make for instance Double Height or Double Width active from the beginning of the text line onwards.

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13.2.2.2 TEXT PACKET character codes

Bytes 8...47 of the ITTS Text Packet contain the codes for the characters and the codes for the attributes which make up a line of text.

13.2.2.2.1 Character repertoire

The character repertoire that is presently defined, consists of 4 tables of character fonts: one for Latin-based alphanumeric characters, one for Graphic fonts, one for Katakana characters and one for Japanese fonts. A fifth character table is reserved for a character set of which the definition is carried on the tape (Dynamically Redefinable Character Set DRCS).

The character repertoire of the alphanumeric character set is shown in Table 13.6.
The character repertoire of the graphics font set is shown in Table 13.7.
The character repertoire of the Katakana + alphanumeric character set is shown in Table 13.8.
The character repertoire of the Japanese fonts set is shown in Table 13.9. This table contains the Hiragana fonts and the codes to access the Japanese font set as specified in JIS X 0208-1990.

13.2.2.2.2 Text Attributes and 1-Line Display Controls

Text Attributes are inserted in the text line to change the presentation of the characters that follow.
Each Text Attribute requires a character position in the text line, which is displayed as a "space".
A Text Attribute remains active for the rest of the line, unless modified by another Text Attribute.

1-Line Display Controls are inserted in the text line to guide the presentation of text on a 1-Line display. Each 1-Line Display Control requires a character position in the text line, which is displayed on the 2-line and 21-line display as a "space".

Font-presentation Text Attributes are coded as character "00h" to "0Fh". See Table 13.2.
1-Line Display Controls are coded as character "10h" to "1Fh". See Table 13.3.
Foreground colour related Text Attributes are coded as character "80h" to "8Fh". See Table 13.4.
Background colour related Text Attributes are coded as character "90h" to "9Fh". See Table 13.5.

All codes not defined in the tables are reserved for future use.

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Font-presentation Text Attributes

Table 13.2

		Font presentation
00	GS0	Switch to character set column X
01	GS1	Graphics font set
02	GS2	Reserved for DRCS
03	GS3	Switch to character set column Y
04	-	reserved
05	-	reserved
06	-	reserved
07	-	reserved
08	SMRK	Start marking
09	EMRK	End marking
0A	-	reserved
0B	-	reserved
0C	NLS	Normal Size
0D	DBH	Double Height
0E	DBW	Double Width
0F	DBS	Double Size

Character Set Selection: GS0...GS3 (see also section 13.2.2.1.7)

These serial attributes can be used to switch the character set at any position in the text line. At the beginning of a text line the character set in column X as defined by byte 7 bits 7...4 is active.

The serial attributes GS0...GS3 enable the selection within a line of four character sets:

GS0 = Switch to character set column X.
GS1 = Graphics font set.
GS2 = Reserved for DRCS.
GS3 = Switch to character set column Y.

Marking: SMRK, EMRK

To switch Marking ON at any position in the text line, the serial attribute SMRK must be inserted. The characters which follow will be marked. To switch marking OFF at any position in the text line, the serial attribute EMRK must be inserted. The "space" introduced by the EMRK attribute plus the character which follows will be shown steady, not marked. At the beginning of a text line marking will be OFF.

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Font size: NLS, DBH, DBW, DBS

The displayed size of all characters can be set to Double Height, Double Width and Double Size by means of the attributes DBH, DBW and DBS resepectively. The characters which follow the attribute will be shown in the changed size. To switch to Normal Size (at any position in the text line), the attribute NLS must be inserted; the characters which follow will be shown in normal size.

When (part of) a text line is displayed in Double Height or Double Size, two lines on the display are occupied by this text line: the display line specified by the 21-Line Code plus the one *below* that line. A text line with the numerically next 21-Line Code can therefore not be displayed, not even if only a part of the preceding text line is in Double Height or Double Size: where the text is not in Double Height or Double Size, still the background colour extends over two lines.

A "space" must be inserted after each character that is to be displayed in Double Width or Double Size. This "space" may be replaced by a Text Attribute or 1-Line Display Control; the Text Attribute becomes effective at the next character position.

At the beginning of a text line Normal Size is active.

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1-Line Display Controls.

1-Line controls are relevant only in Packets marked with Application code "1000" or "1001" as only these lines are to be displayed on a 1-line display.
These controls are inserted in the text line to guide the presentation of text on a 1-Line display. Each 1-Line Display Control requires a character position in the text line, which is displayed on the 2-line and 21-line display as a "space".

Table 13.3

		1-Line Display Control
10	-	reserved
11	S	Start Loading
12	-	reserved
13	-	reserved
14	-	reserved
15	P	Loading Pause
16	-	reserved
17	E	End of 1-line display text
18	T	Terminator for automatically scrolled text
19	NS	No automatic scrolling
1A	H1	Scroll speed, speed T.B.F.
1B	H2	Scroll speed, speed T.B.F.
1C	H3	Scroll speed, speed T.B.F.
1D	-	reserved
1E	-	reserved
1F	-	reserved

Start Loading, Loading Pause S, P

The text presented on a 1-line display depends on the positioning of the Start and Pause controls within a 40-character text line. The main functions of the "S" and "P" controls are:
S = starting-point from which characters are loaded into a 1-line display
P = point at which the loading halts; inserts a "space" in the 1-line display

Additional properties are:
- If no "S"-control is included in the text line, then loading starts at the first character of the text line. Spaces, including attributes and commands, before that first character are skipped.
- If no "P"-control is included in the text line, then loading halts at the end of the text line or sooner if the maximum number of characters on the display has been loaded.
- A "P"-control inserts a "space" on the 1-Line display, a "S"-control does not insert a "space" on the 1-Line display.

In Appendix 3 examples are given that show the effect of static 1-Line Display Controls. In Appendix 5 examples are given that show the effect of dynamic 1-Line Display Controls.

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End of 1-line text E

The E attribute marks the point beyond which no text shall be displayed on a 1-line display:
- Text beyond this E control will not be shown during scrolling.
- The E control may be used as the last P control attribute.

Terminator for automatically scrolled text T

In the automatic scroll mode, any characters after this T control are not shown, but can be displayed after a manual scroll command by the user.

No automatic scrolling NS

The NS control prevents the automatic scrolling. If the NS attribute is included anywhere in the text line, this text shall not be scrolled automatically. The line can still be displayed in full by giving a manual scroll command.

Horizontal scroll

Definition:

Horizontal scrolling means that the 40-character line moves through the display area of the 1-line display. A player may optionally skip any leading and/or trailing spaces, or it may continue to scroll until the last character is moved out of the display area. A DCC player can implement a Soft Scroll (character-column wise), Character Scroll (character by character) or Word Scroll (word by word) mode.

In a DCC player two ways of activating the scrolling can be implemented: automatically or on a user command. Automatic scrolling shall not be activated if a NS control is included in a text line.

Automatically scrolling:

Automatically scrolling means that the full text is scrolled without any user interaction. Depending on the design of the hardware, various scrolling methods may be implemented, e.g.:
- the text is scrolled again and again.
- the text is scrolled once, until the last character is moved out of the display area. This method is to be used at least for text lines of which the Packet Index equals "00 00h".
- the text is scrolled once, after which the beginning of the text is shown again on the display.
- the text is scrolled once, after which the text marked by the S and P controls is shown on the display.
- the text as marked by the S and P controls is shown first for a (player dependent) period of time, after which one of the above mentioned scrolling methods starts.

Manually scrolling:

Manually scrolling means that the text as marked by the S and P controls is displayed until a user's scroll command. Depending on the design of the hardware various reactions on a user's scroll command may be implemented, e.g.:
- the text is scrolled once, after which the beginning of the text is shown again on the display.
- the text is scrolled once, after which the text marked by the S and P controls is shown on the display.

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Scrolling speed:

The speed with which the characters move through the display is determined by the presence of one of the scrolling speed controls H1...H3. The H1...H3 controls may be anywhere within a text line. The speed defined by the control attribute is valid for the whole line. If no H1...H3 control is included in the text line, then the default speed is assumed.

It is recommended to use as the default speed for a full 40 character line 2 seconds, for H1 1.3-1.6 seconds, for H2 3-4 seconds and H3 5-8 seconds.

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Foreground and Background Colour Attributes FG00...FG15, BG00...BG15

Every text line starts with white text on a black background, unless Full Screen colours or Row colours are defined (see sections 13.2.5.2.1 and 13.2.5.2.2).

To change the foreground colour within the text line, a colour attribute FG00...FG15 must be inserted; the colour change becomes effective at the character position following that attribute and remains in effect until the end of the text line or until a new colour change is invoked within the text line.

Colour attribute FG08 ("Transparent") resets the foreground colour to the colour that is in effect at the beginning of the text line: White, unless Full Sceen colours or Row colours are defined.

Table 13.4

		Foreground colour
80	FG00	Black
81	FG01	High-intensity Red
82	FG02	High-intensity Green
83	FG03	High-intensity Yellow
84	FG04	High-intensity Blue
85	FG05	High-intensity Magenta
86	FG06	High-intensity Cyan
87	FG07	White
88	FG08	Transparent (White)
89	FG09	Half-intensity Red
8A	FG10	Half-intensity Green
8B	FG11	Half-intensity Yellow
8C	FG12	Half-intensity Blue
8D	FG13	Half-intensity Magenta
8E	FG14	Half-intensity Cyan
8F	FG15	Grey

The attributes "89h"..."8Fh" are reserved for half-intensity foreground colours. Decoders may translate these attributes to the corresponding high-intensity colour attributes.

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To change the background colour within the text line, a colour attribute BG00...BG15 must be inserted; the colour change takes immediate effect at the character position of the BG00...BG15 attribute and remains in effect until the end of the text line or until a new colour change is invoked within the text line.

Colour attribute BG08 ("Transparent") resets the background colour to the colour that is in effect at the beginning of the text line: Black, unless Full Sceen colours or Row colours are defined.

Table 13.5

		Background colour
90	BG00	Black
91	BG01	High-intensity Red
92	BG02	High-intensity Green
93	BG03	High-intensity Yellow
94	BG04	High-intensity Blue
95	BG05	High-intensity Magenta
96	BG06	High-intensity Cyan
97	BG07	White
98	BG08	Transparent (Black)
99	BG09	Half-intensity Red
9A	BG10	Half-intensity Green
9B	BG11	Half-intensity Yellow
9C	BG12	Half-intensity Blue
9D	BG13	Half-intensity Magenta
9E	BG14	Half-intensity Cyan
9F	BG15	Grey

The attributes "99h"..."9Fh" are reserved for half-intensity background colours. Decoders may translate these attributes to the corresponding high-intensity colour attributes.

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2-Line decoding functional requirements for tracklist packets

A decoder searches through the list of Text Packets ("downwards", i.e. starting at the packet with CDS = "1", towards the packet with CDE = "1") of the selected Language and Topic. If it finds an ENTRY line **within that part of the list that relates to the current Track+Index**, and:

a) a TOP line is found (but no BOTTOM line is found) *preceding* the ENTRY line, then:
the ENTRY line is shown in the lower line of the display and the (last found) TOP line is shown in the upper line of the display.
b) a BOTTOM line is found (but no TOP line is found) *preceding* the ENTRY line, then:
the ENTRY line is shown in the upper line of the display and the (last found) BOTTOM line is shown in the lower line of the display.
c) no TOP line or BOTTOM line is found *preceding* the ENTRY line, then:
the ENTRY line is shown in the upper line of the display and the lower line of the display will show the next FILL line in the list, unless
   - a TOP line or BOTTOM line is encountered before the next FILL line; in that case the lower line remains blank because that TOP- or BOTTOM line is regarded as the start of a new section, or
   - **that next FILL line is not related to the current Track+Index**; in that case the lower line remains blank.
d) both a TOP line and a BOTTOM line are found *preceding* the ENTRY line (not recommended coding), then:
the (last found) TOP line is shown in the upper line of the display and the (last found) BOTTOM line is shown in the lower line of the display; in that case the ENTRY line is not displayed.

If no ENTRY line is found, but at least one FILL line is found **in that part of the list that relates to the current Track+Index**, then the first FILL line **in that part of the list** is regarded as entry point and the same routine is used to fill the display.

If no ENTRY line and no FILL line is found **in that part of the list that relates to the current Track+Index (not-recommended coding), and in the part of the list that begins at the CDS-packet and ends after the last line that relates to the current Track+Index**:

a) a TOP line is found (but no BOTTOM line is found), then:
the (last found) TOP line is shown in the upper line of the display, the lower display line remains blank.
b) a BOTTOM line is found (but no TOP line is found), then:
the (last found) BOTTOM line is shown in the lower line of the display, the upper display line remains blank.
c) no TOP line or BOTTOM line is found, then:
both display lines remain blank.
d) both a TOP line and a BOTTOM line are found, then:
the (last found) TOP line is shown in the upper line of the display and the (last found) BOTTOM line is shown in the lower line of the display.

When the decoder receives a scroll-up or scroll-down command, then the same routine as used for scrolling Text packets (see 13.2.2.1.5) is used to fill the display.

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Note: If no ENTRY or FILL lines are found in the tracklist, then scrolling is not possible; the display changes only when the current Track + Index changes.
If no ENTRY or FILL lines are found in part of the tracklist, then that part of the tracklist is skipped during scrolling.

Byte 6 : SCROLAT, TCI, CDS, CDE

The Scrolat, TCI, CDS and CDE are recorded in the same format as described in section 13.2.2.1.6

Byte 7 : This byte must be recorded in the same way as byte 7 of the Text Packet header.

13.2.3.2 TRACKLIST Packet character codes

Bytes 8...47:

Bytes 8...47 of the Tracklist Packet contain the codes for the characters and the codes for the attributes which make up a line of text.

13.2.3.2.1 Character repertoire

The character repertoire for a Tracklist Packet is the same as described in section 13.2.2.2.1.

13.2.3.2.2 Text Attributes and 1-Line Display Controls

The Text Attributes and 1-Line Display Controls for a Tracklist Packet are recorded in the same format as described in section 13.2.2.2.2.

Per Track + Index one Tracklist Packet shall be labelled with Application Code = "1001", indicating that the text is also meant for a 1-line display. This packet may contain 1-Line Display Controls.

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13.2 Sysinfo Data

Byte 7 : MODE, HORIZONTAL POSITION

bit 7-6 = MODE. The following codes are defined:

bit 76	MODE
00	Single font definition, 12h x 10v pixels
01	Double Width font definition, 24h x 10v pixels
10	Double Height font definition, 12h x 20v pixels
11	Double Size font definition, 24(16)h x 20v pixels

bit 5-0 = HORIZONTAL POSITION.
These bits define, in terms of character positions, the horizontal position of the Graphics part on the screen. Horizontal Position = 1 means that the Graphics part starts at the left border of the text area, Horizontal Position = 2 means that the Graphics part starts one character position (i.e. 12 pixels) further to the right, etc.

Note: If a pixel pattern defined in a Graphics packet is to be displayed at the same position on the screen as a character font defined in a Text or Tracklist packet, then the Graphics packet has priority. The character font is not shown, only the pixel pattern.
Any in-text attribute at the same position as a pixel pattern shall have its normal effects.

Note: If only Graphics packets are defined for a particular display line, then any pixels on that line that are not defined shall show the background colour.

13.2.4.2 GRAPHICS Packet pixel coding

Bytes 8...47:

13.2.4.2.1 Single font mode

In Single font mode the Graphics area consists of one character area of 12 pixels horizontally by 10 pixels vertically. Two bytes are assigned to each scan line (i.e. horizontal line of pixels):

Byte	08-09 =	scan line 1	= top line
	10-11 =	scan line 2	
	|| ||	|	
	24-25 =	scan line 9	
	26-27 =	scan line 10	= bottom line

Bytes 28-47 are reserved for future use; they shall be recorded containing all zeros.

Of each group of two bytes the most significant 12 bits (e.g. byte 10 bits 7-0 and byte 11 bits 7-4) specify the pixel setting on the corresponding scan line:
bit = 1: foreground colour
bit = 0: background colour
The remaining 4 bits in the odd-numbered bytes are reserved for future use; these shall be recorded as zeros.

Bit 7 of the even-numbered bytes corresponds to the leftmost pixel in the Graphics area.

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13.2.4.2.2 Double width font mode

In Double width font mode the Graphics area consists of two character areas: 24 pixels horizontally by 10 pixels vertically. Two bytes are assigned to each scan line (i.e. horizontal line of pixels) for each of the character areas:

Byte 08-09 = scan line 1 = top line in left character area
10-11 = scan line 2
|| || |
24-25 = scan line 9
26-27 = scan line 10 = bottom line in left character area
28-29 = scan line 1 = top line in right character area
30-31 = scan line 2
|| || |
44-45 = scan line 9
46-47 = scan line 10 = bottom line in right character area

Of each group of two bytes the most significant 12 bits (e.g. byte 10 bits 7-0 and byte 11 bits 7-4) specify the pixel setting on the corresponding scan line:
bit = 1: foreground colour
bit = 0: background colour
The remaining 4 bits in the odd-numbered bytes are reserved for future use; these shall be recorded as zeros.

Bit 7 of the even-numbered bytes corresponds to the leftmost pixel in the related character area.

13.2.4.2.3 Double height font mode

In Double height font mode the Graphics area consists of two character areas: 12 pixels horizontally by 20 pixels vertically. Two bytes are assigned to each scan line (i.e. horizontal line of pixels):

Byte 08-09 = scan line 1 = top line
10-11 = scan line 2
|| || |
24-25 = scan line 9
26-27 = scan line 10
28-29 = scan line 11
30-31 = scan line 12
|| || |
44-45 = scan line 19
46-47 = scan line 20 = bottom line

Of each group of two bytes the most significant 12 bits (e.g. byte 10 bits 7-0 and byte 11 bits 7-4) specify the pixel setting on the corresponding scan line:
bit = 1: foreground colour
bit = 0: background colour
The remaining 4 bits in the odd-numbered bytes are reserved for future use; these shall be recorded as zeros.

Bit 7 of the even-numbered bytes corresponds to the leftmost pixel in the Graphics area.

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A different definition may be recorded in Bytes 16-47 of this CLUT Definition Instruction Packet. In this way each CLUT entry can be chosen from a palette of 4096 colours.

Table 13.11

Colour Attributes	Colour code	Default colour components			
		Blue	Green	Red	Resulting colour
FG00, BG00	00	0000	0000	0000	Black
FG01, BG01	01	0000	0000	1111	High-intensity Red
FG02, BG02	02	0000	1111	0000	High-intensity Green
FG03, BG03	03	0000	1111	1111	High-intensity Yellow
FG04, BG04	04	1111	0000	0000	High-intensity Blue
FG05, BG05	05	1111	0000	1111	High-intensity Magenta
FG06, BG06	06	1111	1111	0000	High-intensity Cyan
FG07, BG07	07	1111	1111	1111	White
FG09, BG09	09	0000	0000	0111	Half-intensity Red
FG10, BG10	10	0000	0111	0000	Half-intensity Green
FG11, BG11	11	0000	0111	0111	Half-intensity Yellow
FG12, BG12	12	0111	0000	0000	Half-intensity Blue
FG13, BG13	13	0111	0000	0111	Half-intensity Magenta
FG14, BG14	14	0111	0111	0000	Half-intensity Cyan
FG15, BG15	15	0111	0111	0111	Grey

Note: Attributes FG08 and BG08 ("Transparent") cannot be redefined; their result is determined by the setting of the Full Screen colours or the Row colours.

In bytes 11-15 of this CLUT Definition Instruction Packet the foreground and background colours can be designated to any of the available 15 colour codes without the need to insert serial attributes in the text line.

Full Screen Background Colour code: this colour paints the entire screen, that is, the background of the text area plus the screen area outside the text area. Inside the text area the background can be changed locally by any of the background colour attributes; it can be changed back by means of the background colour code "Transparent"; BG08.

Full Screen Foreground Colour code: this colour defines the text (-foreground) colour that is valid at the beginning of each textline. The foreground colour can be changed locally by any of the foreground colour attributes; it can be changed back by means of the foreground colour code to "Transparent"; FG08.

Row Foreground Colour code and Row Background Colour code replace the Full Screen Colour codes in the area indicated in bytes 14 and 15. This line numbering is in direct relation to the position on the display; row = "00001" is the top line on the display, row = "10101" is the bottom text line on the 21-line display. Row numbers higher than "10101" are not allowed. If both Highest row and Lowest row are set to "00000", then the Row Colour definition is inactive. If the Lowest row lies above the Highest row (i.e. Byte 15, bit 4-0 < Byte 14, bit 4-0), then the Row Colours are valid for the text lines *outside* the area indicated in bytes 14 and 15.

The Row Background colour can be set to relate only to the width of the text area on the screen (Byte 14, bits 7-5 = "000"), or it can be set to relate to the full screen width (Byte 14, bits 7-5 = "111").

Cursor Foreground code and Background Colour code define the preferred colours for highlighting a menu Hotspot on which the cursor is positioned.

The redefinition of the colour codes can be made valid for one Category (i.e. one topic in one language), by recording the CLUT Definition Instruction Packet as part of that Category, i.e. between the Category's packet with CDS = "1" and the packet with CDE = "1".

The redefinition can also be made valid for all Categories (i.e. all topics in all languages) by recording the CLUT Definition Instruction Packet with the following setting:

- Packet Index	= "00 02h"	= CLUT Definition Instruction Packet
- Language Number	= "000"	= Language-independent
- Topic Code	= "00h"	= Topic-independent

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13.2.5.2.2 DATA TYPE = "00010": Packet containing 5 Interactive Commands

Interactive Commands are used to invoke a specified reaction of the decoder. The command can be activated by the user, i.e. by triggering a Hotspot, or automatically by the player, e.g. when a certain tape position is reached.
An Instruction Packet contains 5 Interactive Commands; the first byte (Byte 0) of these commands is located in bytes 8, 16, 24, 32, and 40 of the Instruction Packet. If an Instruction Packet contains less than 5 useful commands, then the unused space is filled with the "No Command" command, i.e. IC 00. The commands in an Instruction Packet are executed in the order of Command 1 to Command 5.

Each Interactive Command consists of 8 bytes:

Bytes 0-1 carry the Command Index. Byte 0 = MSByte Byte 1 = LSByte.
(see also section 13.2.5.1, Packet Index)

If the Command Index = "00 00h", then the command shall be executed immediately when the Instruction Packet is activated.
If the Command Index is not equal to "00 00h", but equal to the Packet Index of the Instruction Packet, then the command is not executed until it is activated by an IC 05.
In all other cases, the command is appended to the text line of which the Packet Index equals this Command Index. This command is activated when the text line to which it is appended is triggered by a user.

Byte 2 is the command number, which specifies the command.

Bytes 3-7 contain command specific information.

The list on the following pages describes the format of the Interactive Commands and the intended reaction of the DCC player.

Prerecorded tapes shall contain at least the following Interactive Commands:

IC 06 to inform the decoder which Track + Index is currently playing
IC 16 to link the Hotspots in the Main Menu to the corresponding Topic and/or Language selection

DCC players that provide a menu-controlled user interface must react correctly on at least the following Interactive Commands:

IC 00 no reaction
IC 05 to execute commands that are appended indirectly to the text line
IC 16 to activate a Topic and/or Language selection as indicated by a Hotspot
IC 27 to link commands to the Hotspots in a Horizontal Menu-line

All other Interactive Commands can be recorded optionally, but it is not mandatory that a DCC player invokes the specified reaction.

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IC 00 No Command

All bytes of this command are "00h"; the command is used to fill unused space in an Instruction Packet.

IC 05 Activate Instruction Packet

Byte 0-1	Command Index
Byte 2	"05h"
Byte 3-4	Packet Index of the appointed Instruction Packet
Byte 5	"00h"
Byte 6	"00h"
Byte 7	"00h"

This command can be linked to a whole line of text or one Hotspot within a horizontal menu. When the text line is triggered, the command is activated.
This command instructs the decoder to execute commands from the Instruction Packet that is indicated by byte 3-4. Only those commands are executed of which the Command Index is equal to the Packet Index of that Instruction Packet.

IC 06 Current Track + Index

Byte 0-1	"00 00h"
Byte 2	"06h"
Byte 3	"00h"
Byte 4	Current Track number 01-99 (BCD) or Lead-in/Lead-out indication
Byte 5	Current Index number 00-99 (BCD)
Byte 6	"00h"
Byte 7	"00h"

This command informs the decoder which Track + Index is currently playing. When the tape is positioned in the Lead-in or Lead-out area, the following indication may optionally be given:

Byte 4 "ABh" = Lead-in area of sector A
"AEh" = Lead-out area of sector A
"BBh" = Lead-in area of sector B
"BEh" = Lead-out area of sector B

Note: This command must be contained in an Instruction Packet with Packet Index = "00 00h", Language Number ="000" and Topic Code = "00h" (Execute Immediately, Language-independent and Topic-independent).

It must be recorded after the beginning of each Track + Index and at regular intervals during each Track + Index. Index 0 of a Track may be regarded as part of Index 1 of that Track.

On 4-Sector tapes, the Track/Index that is currently playing on Channel I must be indicated by an IC 06 that is contained in an Instruction packet with SC = "010".

On 4-Sector tapes, the Track/Index that is currently playing on Channel II must be indicated by an IC 06 that is contained in an Instruction packet with SC = "100".

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IC 16 Select Topic and Language

Byte 0-1	Command Index	
Byte 2	"10h"	
Byte 3	bit 7-3:	"00000" Horizontal cursor Entry function not used. "xxxxx" binary sequence number of the command which relates to the cursor Entry function.
	bit 2-0:	Language Number, coding conforms to section 13.2.2.1.1, with the addition of: "000" = do not change language selection.
Byte 4	"00h"	
Byte 5	Topic code, conforms to section 13.2.2.1.4, with the addition of: "0000 0010" = select Tracklist. "0000 0000" = do not change topic selection.	
Byte 6+7	"00 00h" = (default) set cursor to text line with least significant Packet index and active ICP. "00 01h"..."FF FF" packet index for cursor position, if packet contains text, or, packet index with re-routing instruction, if packet contains a command.	

This command can be linked to a whole line of text or one Hotspot within a horizontal menu. When the text line is triggered, the command is activated. This command instructs the set to change the Topic and/or Language selection and to display the information from the resulting Topic plus Language.

IC 19 Set Default Colours

Byte 0-1	Command Index	
Byte 2	"13h"	
Byte 3	bit 7-4:	Full Screen Foreground Colour code
	bit 3-0:	Full Screen Background Colour code
Byte 4	bit 7-4:	Row Foreground Colour code
	bit 3-0:	Row Background Colour code
Byte 5	bit 7-4:	Cursor Foreground Colour code
	bit 3-0:	Cursor Background Colour code
Byte 6	bit 7-5:	"000": Row Background colour code relates to the text area width only. "111": Row Background colour code relates to the full width of the screen.
	bit 4-0:	Highest row filled with Row colours
Byte 7	bit 7-5:	"000"
	bit 4-0:	Lowest row filled with Row colours

Using this IC 19, the foreground and background colours can be designated to any of the available 15 colour codes without the need to insert serial attributes in the text line.

- Full Screen Background Colour code: this colour paints the entire screen, that is, the background of the text area plus the screen area outside the text area. Inside the text area the background can be changed locally by any of the background colour attributes; it can be changed back by means of the background colour code "Transparent"; BG08.

- Full Screen Foreground Colour code: this colour defines the text (-foreground) colour that is valid at the beginning of each textline. The foreground colour can be changed locally by any of the foreground colour attributes; it can be changed back by means of the foreground colour code "Transparent"; FG08.

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- Row Foreground Colour code and Row Background Colour code replace the Full screen colour codes in the area indicated in bytes 6 and 7. This line numbering is in direct relation to the position on the display; row = "00001" is the top line on the display, row = "10101" is the bottom text line on the 21-line display. Row numbers higher than "10101" are not allowed.
  If both Highest row and Lowest row are set to "00000" then the Row Colour definition is inactive.
  If the Lowest row lies above the Highest row (i.e. Byte 7, bit 4-0 < Byte 6, bit 4-0), then the Row Colours are valid for the text lines *outside* the area indicated in bytes 6 and 7.
  The Row Background colour can be set to relate only to the width of the text area on the screen (Byte 6, bits 7-5 = "000"), or it can be set to relate to the full screen width (Byte 6, bits 7-5 = "111").

- Cursor Foreground code and Background Colour code define the preferred colours for highlighting a menu Hotspot on which the cursor is positioned.

The colour setting can be made valid for one Category (i.e. one topic in one language), by including the IC 19 in an Instruction Packet that is part of that Category.
The colour setting can also be made valid for all Categories (i.e. all topics in all languages) by including the IC 19 in an Instruction Packet with the following setting:

- Packet Index = "00 01h" = Reserved for ICs that are valid for all Categories
- Language Number = "000" = Language selection-independent
- Topic Code = "00h" = Topic-independent

IC 27 Link to Horizontal Menu

Byte 0-1	Command Index
Byte 2	"1Bh"
Byte 3-4	Packet Index of the first Instruction Packet that contains relevant commands
Byte 5-6	Packet Index of the last Instruction Packet that contains relevant commands
Byte 7	"00h"

This command is appended to a Text Packet or Tracklist Packet, the Packet Index of which equals the Command Index in byte 0-1 of this IC 27. It informs the decoder that the text line will fuction as a Horizontal Menu-line and that commands that are to be linked to its Hotspots can be found in Instruction Packets starting from a first Instruction Packet (with the Packet Index as indicated in byte 3-4) until and including a last Instruction Packet (with the Packet Index as indicated in byte 5-6).
All Instruction Packets in the indicated Packet Index range must be of the Data Type = "00011", i.e. Packet containing 5 Interactive Commands that are activated only via a Horizontal Menu (see section 13.2.5.2.3).

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13.2.5.2.3 DATA TYPE = "00011": Packet containing 5 Interactive Commands that are activated only via a Horizontal Menu

Packets of this Data Type can be activated only by an IC 27 Link to Horizontal Menu.
The packet contains the commands that are to be executed when a Hotspot in a Horizontal Menu-line is triggered by a user.
The commands in an Instruction Packet of this Data Type are identical to the Interactive Commands defined in section 13.2.5.2.2, with the exception that the Command Index (in bytes 0 and 1) is replaced by a definition of the location of the Hotspot:

Byte 0	bit 7-6 =	"00"
	bit 5-0 =	Start position of the Hotspot within the 'Horizontal Menu-line
Byte 1	bit 7-6 =	"00"
	bit 5-0 =	End position of the Hotspot within the Horizontal Menu-line

Both Start and End position must lie in the range of "00001" to "10100" (i.e decimal 1...40 = left to right). Positions outside this range are not allowed, nor is it allowed to set the Start position to a higher numerical value than the End position.

The Interactive Commands must be arranged in a logical sequence in the Instruction Packets indicated in an IC 27. The cursor will land on the 'Hotspots' following the sequence in which the Interactive Commands (with their respective 'Hotspots' definition) are included in the Instruction Packets.

Note: An Instruction Packet of Data Type = "00011" may contain no other commands than those that relate to the associated Horizontal Menu-line, with the exception of IC 00; the "No Command" command.

Example:

A Text Packet with Packet Index = "X" contains a line of text, that tells the user that a Tracklist is available in 6 languages.
An IC 27 is linked (via its Command Index = "X") to the Text Packet; the presence of the IC 27 causes the text line to be a Horizontal Menu-line. The IC 27 tells the decoder that the commands associated with this Horizontal Menu-line can be found in Instruction Packets, the Packet Index of which lie between "Y" and "Y+1" inclusive.
At cache memory addresses "Y" and "Y+1" two Instruction Packets of Data Type = "00011" are stored. In these Instruction Packets 6 commands of the type IC 16 are contained (plus 4 IC 00 commands). Each of the IC 16 commands indicates in its bytes 0-1 which part of the Horizontal Menu-line will function as its Hotspot.
When the user moves the cursor, the Hotspots on the display will be highlighted in the same sequence as the IC 16 commands are arranged in the Instruction Packets at "Y" and "Y+1".
If, for instance, the user triggers on the display the word "Français", then the decoder will activate the IC 16 of which the Hotspot covers that word. This IC 16 will set the Language selection to the number that corresponds on this tape to French, and it will set the Topic selection to Topic Code = "02h". As a result, the Tracklist in French will be displayed.

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13.2.6 Topics

13.2.6.1 Sung Text (may be synchronized)

Sung Text packets are recorded with Topic Code = "09h".
If Sung Text is recorded with Application Code = "0000", then the text is shown on the 2-line and 21-line displays only.
If it is recorded with Application Code = "1000", then the text is shown on the 1-line displays as well.
All the rules as described in section 13.2.2.2.2 also apply.
Sung text may consist of text lines that are displayed synchronized with the music.
Further settings of such synchronized lines must be:

- Packet Index	= "00 00h"	
- SCROLAT	= "000"	
- CDS	= "1" and CDE = "1"	
- TCI	= "01" or "10" or "11"	TCI is constant per song, or as long as the previous text relates to the same part of that song.
- 2-line code	= "010" or "001".	

The presentation of (non-scrolling) headers and footers on the 21-line video display is described in the application note "Code of practice for the preparation of DCC Text Mode".

13.2.6.2 Synchronized text

Any other topic (Topic Code not equal to "09h") may also contain text lines that are synchronized to the music. Apart from the different Topic Code and possibly different Application Code, the same settings as described in section 13.2.6.1 must be applied.

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13.2.6.3 Main Menu

This topic must be recorded to ensure that players which are menu-controlled function correctly. All available topics (i.e. at least the topics Album/Work Title, Tracklist and Performer's Name) must be presented in Hotspots on this Main Menu. A Hotspot is defined as a word or character string that can be triggered by a user. The Hotspot may consist of a single character or a full text line or any number of characters in between.
A Main Menu (Topic Code = "FFh") may be recorded for the 2-line and 21-line displays for all available languages separately, or as one Main Menu for all languages (Language = "000").
Along with the Main Menu, Instruction Packets must be recorded which indicate the relation between the Hotspots and the selection criterion for the corresponding Text Packets or Tracklist Packets.

13.2.6.4 Language Pre-selection Menu

If topics are recorded in more than one language, a Language Pre-selection Menu must be provided, either as part of the Main Menu or as a separate menu with Topic Code ="FEh".

13.2.6.5 Other Topics

As an option, text on other topics may be recorded on tape. These non-standardized topics can be divided into the categories Major Topics with the Topic Codes (in byte 4) "04h" to "08h", Sung Text with the Topic Code "09h", and Additional Information with the Topic Codes "0Ah" to "9Fh".

The category Major Topics may be seen as a category of information which can be obtained on a player more easily than the category Additional Information.

Topic Codes of the Additional Information category must be used in consecutive order.

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13.2.6.6 Setmaker's Signature

While making a consumer-recorded User tape or Super-user tape a unique setmaker's signature must be recorded in alphanumeric characters. For this the Topic code "FDh" is defined. This Topic is recorded for 40-character displays only. A consumer player is not allowed to select and display this signature, except in special modes such as service mode.
In the case a consumer copies a prerecorded tape, the Text Mode contained on that tape is not duplicated; instead the recording set will write its signature in Sysinfo.
In case a consumer copies a consumer-recorded tape, the setmaker's signature of the source-tape will not be duplicated; instead the recording set will write its own signature in Sysinfo.

The coding of the Setmaker's Signature Packets is as follows:

	msb bit 7	6	5	4	3	2	1	lsb 0
byte 0	1	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1
4	1	1	1	1	1	1	0	1
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1
7	0	0	0	0	0	0	0	0
8	CHARACTER CODE							
|	SETMAKER'S SIGNATURE = 40 CHARACTERS							
47	CHARACTER CODE							

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13.2 Sysinfo Data

The character coding for the 40 characters of the Setmakers signature is divided into four elements separated by dashes (bytes no 12, 17 and 20). They are coded in the following order:

1 - Byte 8...11: Four alphanumerical characters representing the name of the setmaker.

2 - Byte 13...16: Four alphanumerical characters representing an administration number.

3 - Byte 18...19: Two characters representing the name of the country in which the company is based. These characters are coded according to ISO 3166 (ISO ALPHA-2 country code).

4 - Byte 21...47: Twentyseven alphanumerical characters which may optionally be used by the setmaker for own purpose f.i. as product identifier. It is recommended to incorporate at least a reference to:

- The type number of the product or product line
- The version number of the product(e.g. ROM code)
- The date of production of the product (e.g. production week code)
- The location of the manufacturing plant, quality or design department of the product, if the company has more than one location
- The bytes which are not assigned shall be zero or "space" code "20h".

Example: MRTZ-0002-JP-DCC900/02/226/00..00

When setmakers apply for licences the first three elements shall be issued and registered at Philips Consumer Electronics B.V. (see Preface).

13.2.7 Application requirements for text recording

Textual information must be recorded continuously during the audio tracks of both sectors and also during the Lead-ins, Lead-outs and Pauses. No empty packets shall occur. Text must be repeated continuously during the interval that it relates to. The textual information that relates to the entire tape must be equal in all Lead-in and Lead-out areas.
Time-related text lines such as in Sung Text are recorded only once.

Those lines that represent the Album title and Current track title on the 1-line display, must be recorded such that they can be read within 5 seconds during playback.

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APPENDIX 1

Examples of 2-line coding for text packets:

The following examples show the results of various codings on the presentation on a 2-line display.

Legend:

- The letters A...F stand for the contents of different text lines.
- The binary code behind the letter stands for the 2-LINE CODE of the text line.
- The result on the display is shown as two letters one above the other; the upper letter indicates the textline that is shown on the upper line of the display, the lower letter represents the textline on the lower display line.
- A frame depicts the 2-line display. Initially, that is before the user gives a scroll command, the two textlines represented in the frame are displayed. A scroll command from the user can be regarded as moving another column into the frame; the column on the right-hand side for scroll-down, the column on the left-hand side for scroll-up.

EXAMPLE 1: All lines are FILL lines, or A is ENTRY line and the rest are FILL lines.

A	111 or 101
B	111
C	111
D	111
E	111
F	111

$\boxed{A}$	B	C	D	E	F
$\boxed{B}$	C	D	E	F	-

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EXAMPLE 2: ENTRY line plus FILL lines

A	111
B	111
C	111
D	**101**
E	111
F	111

A	B	C	D	E	F
B	C	D	E	F	-

EXAMPLE 3: TOP line plus FILL lines, same results if B = ENTRY line

A	**001**
B	111 or **101**
C	111
D	111
E	111
F	111

A	A	A	A	A
B	C	D	E	F

EXAMPLE 4: BOTTOM line plus FILL lines, same results if B = ENTRY line

A	**010**
B	111 or **101**
C	111
D	111
E	111
F	111

B	C	D	E	F
A	A	A	A	A

EXAMPLE 5: TOP line, ENTRY line, plus FILL lines

A	**001**
B	111
C	111
D	**101**
E	111
F	111

A	A	A	A	A
B	C	D	E	F

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EXAMPLE 6a: TOP line within the list, which acts as header for the lines below it.

The same results if A = ENTRY line.

A	111 or **101**
B	111
C	111
D	**001**
E	111
F	111

A	B	C	D	D
B	C	-	E	F

EXAMPLE 6b: Same as 6a with different ENTRY line.

A	111
B	111
C	111
D	**001**
E	**101**
F	111

A	B	C	D	D
B	C	-	E	F

EXAMPLE 7: Scrolling in pairs of lines, with ENTRY line

A	**001**
B	111
C	**001**
D	**101**
E	**001**
F	111

A	C	E
B	D	F

EXAMPLE 8: Multiple TOP lines, plus ENTRY line

A	**001**
B	111
C	111
D	**001**
E	**101**
F	111

A	A	D	D
B	C	E	F

APPENDIX 2

Examples of 21-line coding:

The following examples show the results of various codings schemes:

- The letters A..Z stand for the contents of text lines.
- The number behind the letter stands for the the 21-Line Code. Next to this code the setting of the scroll attributes (SCROLAT) is shown.
- The result is shown as letters in a column; each letter represents a text line on the display.
- The solid frame depicts the 21-line display. Initially, that is before any scroll command from the user, the textlines listed in the leftmost column are displayed. A scroll command from the user can be regarded as moving another column into the solid frame; the column on the right-hand side for scroll-down, the column on the left-hand side for scroll-up.

EXAMPLE 1: A page-oriented text.

The text is divided into Paragraphs (coded with FLP) only. Therefore, after each scroll command a new Paragraph appears, as if the user turns a page.
Note that the line numbering needs not to be continuous; the line numbers that are not included in a Paragraph result in blank lines on the display.

Text	21-Line Code	SCROLAT
A	1	FLP
B	2	
C	5	
D	6	
E	7	
F	10	
G	11	
H	12	
I	21	
J	1	FLP
K	2	
L	5	
M	6	
N	11	
O	12	
P	15	
Q	16	
R	21	
S	1	FLP
T	2	
U	5	
V	7	
W	9	
X	15	
Y	16	
Z	21	

Display line	Presentation on the 21-line display		
1	A	J	S
2	B	K	T
3	-	-	-
4	-	-	-
5	C	L	U
6	D	M	-
7	E	-	V
8	-	-	-
9	-	-	W
10	F	-	-
11	G	N	-
12	H	O	-
13	-	-	-
14	-	-	-
15	-	P	X
16	-	Q	Y
17	-	-	-
18	-	-	-
19	-	-	-
20	-	-	-
21	I	R	Z

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Appendix 2

EXAMPLE 2: A section-oriented text.

In this example, only text-Sections (coded with FLS) are used.
When the user gives a scroll-up command, then the upper text-Section on the display is erased, all lower text-Sections scroll up, and the text-Section next in the list scrolls in from the bottom of the display (if there is enough space).
When the user gives a scroll-up command, then the text-Section preceding in the list scrolls in from the top of the display, all other text-Sections scroll down, and those sections that cannot be displayed in full are removed from the display.
Note that the line numbering needs not to be continuous; the line numbers that are not included in a text-Section result in blank lines on the display.

Text	21-Line Code	SCROLAT
A	1	**FLS**
B	2	
C	3	
D	4	
E	1	**FLS**
F	2	
G	3	
H	4	
I	2	**FLS**
J	3	
K	5	
L	6	
M	2	**FLS**
N	4	
O	5	
P	6	
Q	2	**FLS**
R	3	
S	4	
T	5	
U	2	**FLS**
V	3	
W	5	
X	7	
Y	8	
Z	10	

Presentation on the 21-line display

Display line						
1	**A**	**E**	-	-	-	-
2	B	F	**I**	**M**	**Q**	**U**
3	C	G	J	-	R	V
4	D	H	-	N	S	-
5	**E**	-	K	O	T	W
6	F	**I**	L	P	-	-
7	G	J	-	-	**U**	X
8	H	-	**M**	**Q**	V	Y
9	-	K	-	R	-	-
10	**I**	L	N	S	W	Z
11	J	-	O	T	-	-
12	-	**M**	P	-	X	-
13	K	-	-	**U**	Y	-
14	L	N	**Q**	V	-	-
15	-	O	R	-	Z	-
16	**M**	P	S	W	-	-
17	-	-	T	-	-	-
18	N	**Q**	-	X	-	-
19	O	R	-	Y	-	-
20	P	S	-	-	-	-
21	-	T	-	Z	-	-

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EXAMPLE 3: Paragraphs and Sections are used, plus a Header and Footer.

In this example, two lines of text are coded as Header (HET) and two lines are coded as Footer (FOT). On the display the Footer consists of three lines: the two text lines coded with "FOT" plus an empty line in between; the "FOT"-line highest on the display (here: 21-Line Code = 19) denotes the start of the Footer, all lines below (on the display) automatically become part of the Footer as well.
A similar rule is valid for the Header: the "HET"-line lowest on the display (here: 21-Line Code = 2) denotes the end of the Header, all lines above (on the display) automatically become part of the Header as well.
The 'Scroll Window' now consists of the display lines between the lowest Header line and the highest Footer Line.
The scrolling part of the text is partitioned into two Paragraphs. These Paragraphs both happen to be too long to be shown in full on the display, therefore each Paragraph is cut in three: one FLP segment plus two FLS segments. Initially, the FLP segment is shown together with the first FLS segment. After a scroll-down command the FLP segment disappears from the display, the first FLS segment scrolls up, and the second FLS segment scrolls in from the bottom of the display. After two more scroll-down commands the second Paragraph scrolls in.

Text	21-Line Code	SCROLAT
A	1	**HET**
B	2	**HET**
C	19	**FOT**
D	21	**FOT**
E	3	**FLP**
F	4	
G	5	
H	6	
I	4	**FLS**
J	5	
K	6	
L	4	**FLS**
M	5	
N	6	
O	7	
P	3	**FLP**
Q	4	
R	5	
S	4	**FLS**
T	5	
U	6	
V	7	
W	4	**FLS**
X	5	
Y	6	
Z	7	

Display line	Presentation on the 21-line display					
1	A	A	A	A	A	A
2	B	B	B	B	B	B
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	E	-	-	P	-	-
6	F	I	L	Q	S	W
7	G	J	M	R	T	X
8	H	K	N	-	U	Y
9	-	-	O	-	V	Z
10	-	-	-	-	-	-
11	-	-	-	S	-	-
12	I	L	-	T	-	-
13	J	M	-	U	W	-
14	K	N	-	V	X	-
15	-	O	-	-	Y	-
16	-	-	-	-	Z	-
17	-	-	-	-	-	-
18	-	-	-	-	-	-
19	C	C	C	C	C	C
20	-	-	-	-	-	-
21	D	D	D	D	D	D

APPENDIX 3

Examples of static presentation on a 1-line display

The text statically presented on a 1-line display depends on the positioning of the Start and Pause controls within a 40-character text line.
The main functions of the "S" and "P" controls are:

S = starting-point from which characters are loaded into a 1-line display
P = point at which the loading halts; inserts a "space" in the 1-line display

Additional rules are:
- If no "S"-control is included in the text line, then loading starts at the first character of the text line. Spaces, including attributes and commands, before that first character are skipped.
- If no "P"-control is included in the text line, then loading halts at the end of the text line or sooner if the maximum number of characters on the display has been loaded.
- A "P" control inserts a "space" on the 1-Line display. A "S"-control does not insert a "space" on the 1-Line display.

The following examples show the effect of the controls:

Legend: A...Z = character
_ = space
s = Start control
p = Pause control
♦ = other serial attribute

EXAMPLE 1: Start control, Pause control

```
         1         2         3         4
1234567890123456789012345678901234567890
♦_♦___ABC_♦DEFGH_IJKL♦sMNOPQRpSTUVW_XYZ_
                      ↑      ↑
```

```
result :  | MNOPQR |
```

The characters between the Start control and the Pause control are displayed.

EXAMPLE 2: Start control only

```
         1         2         3         4
1234567890123456789012345678901234567890
♦_♦___ABC_♦DEFGHsIJKL♦_MNOPQR_STUVW_XYZ_
                ↑
```

```
result :  | IJKL  MNOPQR |
```

The 12 characters following the Start control are displayed.
Text Attributes after the Start control are regarded as spaces.

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EXAMPLE 3: Pause control only

```
         1         2         3         4
1234567890123456789012345678901234567890
♦_♦___ABC_♦DEFGHpIJKL♦_MNOPQR_STUVW_XYZ_
                ↑
```

```
result :  | ABC  DEFGH   |
```

The characters before the Pause control are displayed, ignoring any leading spaces and Text Attributes.
If the Pause control is inserted more than 12 positions from the first character, then the result is that the first 12 characters are displayed.

EXAMPLE 4: no controls

```
         1         2         3         4
1234567890123456789012345678901234567890
♦_♦___ABC_♦DEFGH_IJKL♦_MNOPQR_STUVW_XYZ_
```

```
result :  | ABC  DEFGH I |
```

The first 12 characters from the text line are displayed, ignoring any leading spaces and Text Attributes.
Attributes after the first character are regarded as spaces.
The result would have been the same if the Pause control had been inserted more than 12 positions from the first character.

EXAMPLE 5: Pause control, Start control, Pause control

```
         1         2         3         4
1234567890123456789012345678901234567890
♦_♦___ABCp♦DEFGH_IJKL♦sMNOPQRpSTUVW_XYZ_
         ↑            ↑      ↑
```

```
result :  | ABC MNOPQR   |
```

The text before the first Pause control (ignoring leading spaces and Text Attributes) plus the text between the Start control and the second Pause control is displayed.
A Pause control inserts a space on the display, a Start control does not insert a space.

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EXAMPLE 6: Start control, Pause control, Start control

```
         1         2         3         4
1234567890123456789012345678901234567890
♦_♦___ABC_♦DEFGH_IJKL♦sMNOPQRpSTUVWsXYZ_
                      ↑      ↑     ↑

result :  | MNOPQR XYZ  |
```

The text between the Start control and the Pause control plus the text after the second Start control is displayed. The Pause control inserts a space on the display, a Start control does not insert a space.
When the end of the 40-character text line is reached before 12 characters are loaded into the display, the rest of the display is filled with spaces.

EXAMPLE 7: repeated Start controls, repeated Pause controls

```
         1         2         3         4
1234567890123456789012345678901234567890
♦_♦__sABsssssCDpEFGpHIpJKpLMsNOpPQ_RS_TU
     ↑  ↑↑↑↑↑  ↑   ↑  ↑  ↑  ↑  ↑

result :  | ABCD    NO  |
```

Start and Pause controls are show on the 40-character displays as spaces.
When for some reason in the 40-character line several spaces are inserted that are not desired on the 12-character display, these spaces can be removed by replacing them by repeated Start attributes; see between 'B' and 'C' in the above example.
If extra spaces are desired in the 12-character display, repeated Pause controls may be added; see between 'D' and 'N' in the above example.

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APPENDIX 4

Examples of 2-line coding for tracklist packets:

The following examples show the results of various codings in Tracklist packets on the presentation a 2-line display.

Legend:

- The letters A...L stand for the contents of different text lines.
- The figures that follow indicate the Track number and Index number.
- The binary code behind the letter stands for the 2-Line Code of the text line.
- The result on the display is shown as a column of two letters; the upper letter indicates the textline that is shown on the upper line of the display, the lower letter represents the text line on the lower display line.
- What is displayed initially, that is before the user gives a scroll command, is depicted for two situations; during playback of Track + Index 1.1 and 2.1 respectively.
- After a scroll command from the user the initially displayed lines are replaced by the lines that are shown in the last figure in each example. Scrolling can be regarded as moving another column into the display; the column on the right-hand side for scroll-down, the column on the left-hand side for scroll-up.

EXAMPLE 1: All lines are FILL lines, or A, D and/or G are ENTRY lines.

A	1.1	111 or **101**
B	1.1	111
C	1.1	111
D	2.1	111 or **101**
E	2.1	111
F	2.1	111
G	3.1	111 or **101**
H	3.1	111
I	3.1	111

Initial display during playback of Track + Index 1.1: $\boxed{\begin{matrix}A\\B\end{matrix}}$

Initial display during playback of Track + Index 2.1: $\boxed{\begin{matrix}D\\E\end{matrix}}$

Displayed during scrolling:

A	B	C	D	E	F	G	H	I
B	C	D	E	F	G	H	I	-

EXAMPLE 2: ENTRY lines plus FILL lines

A	1.1	111
B	1.1	**101**
C	1.1	111
D	2.1	111
E	2.1	111
F	2.1	**101**
G	3.1	**101**
H	3.1	111
I	3.1	111

Initial display during playback of Track + Index 1.1: $\boxed{\begin{matrix}B\\C\end{matrix}}$

Initial display during playback of Track + Index 2.1: $\boxed{\begin{matrix}F\\-\end{matrix}}$

Displayed during scrolling:

A	B	C	D	E	F	G	H	I
B	C	D	E	F	G	H	I	-

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Appendix 4

EXAMPLE 3: TOP line plus FILL lines, or B, D and/or G are ENTRY lines.

A	1.1	**001**
B	1.1	111 or **101**
C	1.1	111
D	2.1	111 or **101**
E	2.1	111
F	2.1	111
G	3.1	111 or **101**
H	3.1	111
I	3.1	111

Initial display during playback of Track + Index 1.1: $\boxed{\begin{matrix}A\\B\end{matrix}}$

Initial display during playback of Track + Index 2.1: $\boxed{\begin{matrix}A\\D\end{matrix}}$

Displayed during scrolling:

A	A	A	A	A	A	A	A
B	C	D	E	F	G	H	I

EXAMPLE 4: BOTTOM line plus FILL lines, or B, C, D, or G are ENTRY lines.

A	1.1	**010**
B	1.1	111 or **101**
C	1.1	111
D	2.1	111 or **101**
E	2.1	111
F	2.1	111
G	3.1	111 or **101**
H	3.1	111
I	3.1	111

Initial display during playback of Track + Index 1.1: $\boxed{\begin{matrix}B\\A\end{matrix}}$

Initial display during playback of Track + Index 2.1: $\boxed{\begin{matrix}D\\A\end{matrix}}$

Displayed during scrolling:

B	C	D	E	F	G	H	I
A	A	A	A	A	A	A	A

EXAMPLE 5: Multiple TOP lines plus FILL lines, or B, D, and/or H are ENTRY lines.

A	1.1	**001**
B	1.1	111 or **101**
C	1.1	111
D	2.1	111 or **101**
E	2.1	111
F	2.1	111
G	3.1	**001**
H	3.1	111 or **101**
I	3.1	111
J	3.2	111 or **101**
K	3.2	111

Initial display during playback of Track + Index 1.1: $\boxed{\begin{matrix}A\\B\end{matrix}}$

Initial display during playback of Track + Index 2.1: $\boxed{\begin{matrix}A\\D\end{matrix}}$

Displayed during scrolling:

A	A	A	A	A	G	G	G	G
B	C	D	E	F	H	I	J	K

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EXAMPLE 6: Results of not-recommended coding.

A	1.1	001
B	1.1	111 or 101
C	2.1	001
D	3.1	001
E	4.1	001
F	5.1	001
G	6.1	001
H	6.1	111 or 101
I	7.1	010
J	7.1	111 or 101
K	8.1	111 or 101
L	8.1	111

Initial display during playback of Track + Index 1.1:

A
B

Initial display during playback of Track + Index 2.1:

C
-

Displayed during scrolling:

A	G	G	G	G
B	H	I	I	I

During scrolling, the text lines C,D,E and F are skipped because non of these lines is an ENTRY or FILL line, and the text lines J,K and L are not displayed because these lines are preceded by both a TOP and a BOTTOM line.

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APPENDIX 5

Examples of dynamic presentation on a 1-line display

The text dynamically presented on a 1-line display depends on the positioning of the "E" , "T", "NS" and "H" controls within a 40-character text line. The main functions of the controls are defined in section 13.2.2.2.2. The speed controls (H1,H2,H3) are not shown here. They may be placed at any position in the text; the modification of the speed is valid for the whole line. The examples show the use of scroll the controls. The parts of the text that may be scrolled, respectively automatically and under manual control, are indicated by the lines under the text. Leading and trailing spaces are skipped in these examples.

Legend:

"a...z" = displayable character
"⊔" = space
"□" = other attribute or control
"**E**" = End of 1-line display text control
"**T**" = Terminator for scrolled text control
"**N**" = NS, No automatic scrolling control

EXAMPLE 1: No scroll controls

```
                        1         2         3         4
              1234567890123456789012345678901234567890
text line:    □⊔⊔⊔abc⊔□defgh⊔ijkl□⊔mnopqr⊔stuvw⊔xyz⊔⊔⊔
autom. scroll:
manual scroll:
```

EXAMPLE 2: E-control

```
                        1         2         3         4
              1234567890123456789012345678901234567890
text line:    □⊔⊔⊔abc⊔□defgh⊔ijkl□⊔mnopqrEstuvw⊔xyz⊔⊔⊔
autom. scroll:
manual scroll:
```

EXAMPLE 3: T-control

```
                        1         2         3         4
              1234567890123456789012345678901234567890
text line:    □⊔⊔⊔abc⊔□defgh⊔ijkl□⊔mnopqrTstuvw⊔xyz⊔⊔⊔
autom. scroll:
manual scroll:
```

EXAMPLE 4: T-control and E-control

```
                        1         2         3         4
              1234567890123456789012345678901234567890
text line:    □⊔⊔⊔abc⊔□defghTijkl□⊔mnopqrEstuvw⊔xyz⊔⊔⊔
autom. scroll:
manual scroll:
```

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EXAMPLE 5: NS-control and E-control

```
                           1         2         3         4
                  1234567890123456789012345678901234567890
text line:        □␣␣␣abc␣□defgh␣ijkl□␣mnopqr^Estuvw␣xyz␣^N␣
autom. scroll: no automatic scrolling
manual scroll:
```

14. AUXILIARY DATA CONTENTS

14.1 General

The Aux data will be used to provide additional information about the recording in the Main data. Most of this information is used to provide several kinds of features.

All blocks of one Aux data tape frame will contain the same information, except for the block address defined by BA0 and BA1 in byte AD_0, i.e. information will be repeated twice in the non-labelled case (in Aux data tape blocks 0 and 2) and 4 times in the labelled case (in Aux data tape blocks 0,1,2 and 3).

Each block contains 36 User Aux data bytes. The information is provided in BCD, unless stated otherwise.

Bits 7-4 of byte AD_0 indicate the application and are referred to as FORMAT-ID. The contents are the same as the FORMAT-ID in the main data system Info:

The following combinations have been defined:

bit	7 6 5 4	application
	0 0 0 0	audio use
	others	reserved for future use

14.2 Audio application

This chapter defines the position and general meaning of several fields within the Aux data. Detailed application information can be found in chapters 15, 16 and 17.

The following applies if the FORMAT-ID is '0 0 0 0':

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14.2 Audio applications

AD	msb 7	6	5	4	3	2	1	lsb 0	see section
0	0	0	0	0	CONTROL INFO				-14.2.1
1	MARKER INFO								-14.2.1
2	TRACK NUMBER								-14.2.2
3	INDEX NO. / CHAPTER NO.								-14.2.2
4	SCT	A-time FRAME			SOB	A-time HOUR units			
5	A-time MIN.tens				A-time MIN.units				14.2.3
6	A-time SEC tens				A-time SEC units				
7	PAU	T-time FRAME			ML	T-time HOUR units			
8	T-time MIN.tens				T-time MIN.units				14.2.4
9	T-time SEC.tens				T-time SEC.units				
10	first TOC entry, byte 1								
11	first TOC entry, byte 2								
12	first TOC entry, byte 3								14.2.5
13	first TOC entry, byte 4								
14	first TOC entry, byte 5								
15	second TOC entry, byte 1								
16	second TOC entry, byte 2								
17	second TOC entry, byte 3								
18	second TOC entry, byte 4								
19	second TOC entry, byte 5								
20	ADDITIONAL INFO SPECIFIER								
21	ADDITIONAL INFORMATION								
22	ADDITIONAL INFORMATION								
23	ADDITIONAL INFORMATION								
24	ADDITIONAL INFORMATION								
25	ADDITIONAL INFORMATION								
26	ADDITIONAL INFORMATION								
27	ADDITIONAL INFORMATION								
28	ADDITIONAL INFORMATION								14.2.6
29	ADDITIONAL INFORMATION								
30	ADDITIONAL INFORMATION								
31	ADDITIONAL INFORMATION								
32	ADDITIONAL INFORMATION								
33	ADDITIONAL INFORMATION								
34	ADDITIONAL INFORMATION								
35	ADDITIONAL INFORMATION								

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14.2 Audio applications

14.2.1 Control and marker info

The control and marker info bytes contain information that may affect the behaviour of the recorder during playback. The following allocations are made:

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
0	0	0	0	0	RDA	RDB	BA1	BA0
1	L	SH	F	M	TOC	SCM	SU	RES

AD_0 CONTROL INFO:

$AD_0$1 and $AD_0$0 BA1-BA0 = block address of Aux data block 0...3.

BA1	BA0	Block address
0	0	0
0	1	1
1	0	2
1	1	3

$AD_0$3 RDA = indication of the recording direction of Sector A:

"0" = The Sector A recorded in the normal direction
"1" = The Sector A recorded in the reverse direction

$AD_0$2 RDB = indication of the recording direction of Sector B:
"0" = The Sector B recorded in the normal direction
"1" = The Sector B recorded in the reverse direction

The regular play back direction for a Sector is defined as 'normal' direction. RDA and RDB must be recorded on prerecorded and on consumer recorded tapes. For prerecorded tapes all bit combinations are valid, the combination "00" must be recorded on consumer recorded tape.

$AD_0$7...$AD_0$4 = Format-ID : these bits are recorded "0000".

AD_1 MARKER INFO Refer to chapters 15, 16 and 17 for more details.

($AD_1$7) L = LABEL-ID (L-ID):
If 1 this indicates the labelled state of the search information in this block.
If 0 this indicates the non-labelled state of the search information in this block.

($AD_1$6) SH = SHORTENING ID (SH-ID):
Used to indicate start of optional shortening play, refer to chapter 16 ('SKIP marker').

($AD_1$5-4) F/M = FADE and MUTE ID (F-ID/M-ID):
These bits are used for the mute and fade functions (see section 16.4.8 and 16.4.9)

($AD_1$3) TOC = TABLE OF CONTENTS ID (TOC-ID):
If bit is "0" this indicates that the track is not included in the table of contents.

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($AD_1$2)	SCM	=	SECTOR MARKER ID (SCM-ID): This bit is "1" during the frames of a Sector marker, otherwise it is "0" (see also section 15.3 and 16.3)
($AD_1$1)	SU	=	SUPER USER ID (SU-ID): This bit indicates the Super-user format. '1' = Super User Format '0' = User Format
($AD_1$0)			is reserved for future applications. This bit must be recorded '0'.

14.2.2 Track and Index/Chapter number

An 8-bit field is reserved for track numbering:

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
2	TRACK NUMBER tens				TRACK NUMBER units			

The following combinations are defined, others are not allowed:

AD_2 TRACK NUMBER (BCD):

'00' : specific track number not indicated;
'01' ... '99' : valid track number.

The following track number values are used as Sector markers:

Prerecorded tapes:

'AB' : BEGIN Sector A or LEAD-IN A;
'AE' : END Sector A or LEAD-OUT A;
'BB' : BEGIN Sector B or LEAD-IN B;
'BE' : END Sector B or LEAD-OUT B;

Consumer-recorded tapes:

'AB' : BEGIN Sector A or LEAD-IN A;
'BB' : BEGIN Sector B or LEAD-IN B;
'CC' : use-again marker;
'EE' : stop marker;
'AF' : reverse marker;
'BF' : home marker;
'FF' : next Sector marker.

For an explanation of the 'Sector markers' refer to chapters 15, 16 and 17.

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AD_3 INDEX/CHAPTER NUMBER (BCD) : An 8-bit field is used for Index/Chapter number:

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
3	INDEX/CHAPTER No.tens				INDEX/CHAPTER No.units			

Index numbering divides a music track into separate parts. Chapter numbering combines various music tracks, for example because these have been performed by the same artist or are part of the same concert. Valid Index numbers are the combinations '00' ... '99'. "01" indicates Index 1, "02" Index 2 etc. Thus the range of Index numbers is limited to 99 Indexes.

Valid Chapter numbers are the combinations 'A0' ... 'A9', 'B0' ... 'B9', ..., 'F0' ... 'F9'. Thus, the range of Chapter numbers is limited to 60 Chapters (0-59). 'A1' indicates Chapter 1, 'A2' Chapter 2 etc. Index number "00" or Chapter number "A0" are recorded during Sector markers.

On prerecorded tapes either Index or Chapter numbers can be recorded, whereas on consumer-recorded tapes only Chapter numbers are allowed.

14.2.3 A-time

AD_4...AD_6 SOB, SCT, A-time:

Three bytes are reserved for the A-time to indicate the time elapsed since the beginning of the current program.

$AD_4$3 = SOB (Start On Sector B) bit. This bit is only applicable on Sector B. On Sector A this bit is always "0".

If $AD_4$3 = '0', then the A-time time is incremented from the beginning of the tape in Sector A and continues incrementing on Sector B.

If $AD_4$3 = '1', then the A-time for Sector B is counted from the beginning of the tape in Sector B.

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
4	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5	ABS.MINUTES tens				ABS.MINUTES units			
6	ABS.SECONDS tens				ABS.SECONDS units			

Valid combinations:

SCT	: 0 - Sector A, 1 - Sector B
ABS-HOUR	: 0 ... 7 (3 bit BCD)
ABS-MINUTES	: 00 ... 59
ABS-SECONDS	: 00 ... 59
ABS-FRAME	: 0 ... 5 (3 bit BCD)
SOB	: 0,1

14.2 Audio applications

In AD_4 the bits 4-6 contain the Abs. frame counter. Its contents change in a sequence of 375 frames (64 sec) as follows:

36 frames have a frame count from 0...5, followed by 5 frames with a frame count from 0...4.
9 of these 41 frame sequences form a sequence of 369 frames. This is followed by 6 frame counts from 0...5 to complete the 375 frame sequence.
In this way a subdivision of a second in Frame units can be specified. Transition of the frame count to 0 increments the seconds count.

Note: The Abs.frame count here is NOT equal to the frame address in the Header of the Tape blocks !

If the A-time is not recorded, the fields contain the following information:

SCT	: 0 on Sector A, 1 on Sector B
ABS-HOUR	: 7
ABS-MINUTES	: AA
ABS-SECONDS	: AA
ABS-FRAME	: 0
SOB	: 0

14.2.4 Track time, Pause and Marker length

AD_7...AD_9 PAU-ID, ML-ID, T-time:

Three bytes are reserved for the track time, the pause and the marker length indication. The track time indicates the time elapsed from the beginning of a music track.

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
7	PAU	TR.FRAME			ML	TR.HOUR units		
8	TR.MINUTES tens				TR.MINUTES units			
9	TR.SECONDS tens				TR.SECONDS units			

Valid combinations:

PAU	: 0 - music track, 1 - pause
TR-HOUR	: 0 ... 7
TR-MINUTES	: 00 ... 59
TR-SECONDS	: 00 ... 59
TR-FRAME	: 0 ... 5 (3 bit BCD)
ML	: 0 - marker length = 16 frames, 1 - marker length = 32 frames

The PAU-ID indicates a pause condition, during which the T-time decrements to zero and the Index = 00. The track frame count sequence is the same as for the absolute frame count.

The ML-ID, indicating the length of a Start marker, is only valid during Start markers, otherwise coded "0". As such it can only be "1" during a Start marker with a length of 32 frames at the beginning of Sector B on consumer recorded tapes. This ML-ID can be used to help erase these Start markers correctly.

If the T-time is not recorded, the fields contain the following information:

PAU	: 0
TR-HOUR	: 7
TR-MINUTES	: AA
TR-SECONDS	: AA
TR-FRAME	: 0
ML	: 0

14.2.5 Table of contents

AD_{10}...AD_{19} TOC items

Bytes AD_{10}...AD_{19} are reserved for TOC information. Each TOC entry contains 5 bytes, thus two TOC entries can be stored in this field. The TOC entries are identified by the contents of the first byte: TOC item. The following TOC items are allowed:

TOC ITEM :	00	: No TOC information recorded
	01 ... 99	: Track, Index or Chapter begin location
	AE	: Playing time Sector A
	BE	: Total playing time or playing time Sector B
	EE	: Stop marker position
	FF	: Next Sector marker position
	CC	: Use again marker position
	DA	: Date TOC was made with a renumber action.
	0A	: TOC partitioning
	DE	: End of Sector D (4-Sector tape only)
	AF	: Reverse marker position
	BF	: Home marker position

Each of these possible entries is explained below:

- TOC ITEM = 00 : no information, all bytes are 00

AD	msb 7	6	5	4	3	2	1	lsb 0
5N+10	TOC ITEM = (00)							
5N+11	0	0	0	0	0	0	0	0
5N+12	0	0	0	0	0	0	0	0
5N+13	0	0	0	0	0	0	0	0
5N+14	0	0	0	0	0	0	0	0

(N=0,1)

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- TOC ITEM = 01 ... 99 : Track, Index or Chapter location.

AD	msb 7	6	5	4	3	2	1	lsb 0
5N+10	TOC ITEM = (01...99)							
5N+11	INDEX / CHAPTER NUMBER (00...99)/(A1...F9)							
5N+12	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			
(N=0,1)								

This entry contains the A-time recorded in the first frame that carries a new track and/or Index/Chapter number.

Note: A tape can carry either Index or Chapter numbers.

- TOC ITEM = AE : playing time Sector A

AD	msb 7	6	5	4	3	2	1	lsb 0
5N+10	TOC ITEM = AE							
5N+11	0	0	0	0	0	0	0	0
5N+12	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			
(N=0,1)								

This entry contains the A-time recorded in the last frame before the Sector marker, which marks the end of the music area on Sector A.

- TOC ITEM = BE : total playing time or playing time Sector-B

AD	msb 7	6	5	4	3	2	1	lsb 0
5N+10	TOC ITEM = BE							
5N+11	0	0	0	0	0	0	0	0
5N+12	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			
(N=0,1)								

This entry contains the A-time recorded during the last frame before the Sector markers, which marks the end of the music area on Sector B. This gives the total playing time of the music program, or, if the SOB bit = "1", the total playing time of the program of Sector B.

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- TOC ITEM = EE : location of 'stop marker'. Only to be used on consumer-recorded tapes.

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
5N+10	TOC ITEM = EE							
5N+11	0	0	0	0	0	0	0	0
5N+12	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			
(N=0,1)								

This entry contains the A-time recorded during the first frame of the 'EE' marker.

- TOC ITEM = FF : location of 'Next Sector' marker. Only to be used on consumer-recorded tapes.

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
5N+10	TOC ITEM = FF							
5N+11	0	0	0	0	0	0	0	0
5N+12	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			
(N=0,1)								

This entry contains the A-time recorded during the first frame of the 'FF' marker.

- TOC ITEM = AF : location of 'Reverse' marker. Only to be used on consumer-recorded tapes.

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
5N+10	TOC ITEM = AF							
5N+11	0	0	0	0	0	0	0	0
5N+12	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			
(N=0,1)								

This entry contains the A-time recorded during the first frame of the 'AF' marker.

Note: SOB is "0" because the reverse marker is only valid in Sector A.

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- TOC ITEM = BF : location of 'Home' marker. Only to be used on consumer-recorded tapes.

AD	msb 7	6	5	4	3	2	1	lsb 0
5N+10	TOC ITEM = BF							
5N+11	0	0	0	0	0	0	0	0
5N+12	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			
(N=0,1)								

This entry contains the A-time recorded during the first frame of the 'BF' marker.

- TOC ITEM = CC : location of 'Use Again' marker. Only to be used on consumer-recorded tapes.

AD	msb 7	6	5	4	3	2	1	lsb 0
5N+10	TOC ITEM = CC							
5N+11	0	0	0	0	0	0	0	0
5N+12	SCT	ABS.FRAME			SOB	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			
(N=0,1)								

This entry contains the A-time recorded during the first frame of the 'CC' marker.

- TOC ITEM = DA : date of last renumber action. Only to be used on consumer-recorded tapes.

AD	msb 7	6	5	4	3	2	1	lsb 0
5N+10	TOC ITEM = DA							
5N+11	YEAR tens				YEAR units			
5N+12	MONTH tens				MONTH units			
5N+13	DAY tens				DAY units			
5N+14	HOUR tens				HOUR units			
(N=0,1)								

This entry contains the date when the TOC was written. Recording of this entry is optional.

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- TOC ITEM = 0A : TOC Partitioning

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
5N+10	TOC ITEM = 0A							
5N+11	FIRST TRACK NUMBER (01...99)							
5N+12	LAST TRACK NUMBER (01...99)							
5N+13	TOTAL # TOC ITEMS thous.				TOTAL # TOC ITEMS hundreds			
5N+14	TOTAL # TOC ITEMS tens				TOTAL # TOC ITEMS units			

(N=0,1)

The TOC partitioning entry is always the first entry of a TOC sequence. From this information the number of tracks in the music program can be calculated. The total number of TOC entries that follow after this is also indicated.

(4-SECTOR TAPE ONLY)

- TOC ITEM = DE :

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
5N+10	TOC ITEM = DE							
5N+11	0	0	0	0	0	0	0	0
5N+12	SCT	ABS.FRAME			0	ABS.HOUR units		
5N+13	ABS.MINUTES tens				ABS.MINUTES units			
5N+14	ABS.SECONDS tens				ABS.SECONDS units			

(N=0,1)

This entry contains the A-time recorded during the final frame of the music program of Sector D.
SCT="1" by Sector D.

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14.2.6. Additional information field

AD_{20} to AD_{35} Additional information:

Byte AD_{20} specifies the information stored in bytes AD_{21} to AD_{35}, and is called the Additional Information Specifier (AIS).

- AIS:	00	:	no additional information, bytes AD_{21} to AD_{35} contain '00'
	01	:	ISRC and Identification no.(Catalogue number)
	02	:	date and/or remaining (track) time
	03	:	consumer character recording
	04...FE	:	reserved for future applications
	FF	:	duplicator identification code of the prerecorded cassette manufacturer.

- **AIS = 01**: International Standard Recording Code and Identification number.

<table>
<tr><th></th><th>msb</th><th></th><th></th><th></th><th></th><th></th><th></th><th>lsb</th></tr>
<tr><th>AD</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>20</td><td colspan="8">AIS = 01</td></tr>
<tr><td>21</td><td>IV</td><td>CV</td><td colspan="6">I_1</td></tr>
<tr><td>22</td><td>0</td><td>CD</td><td colspan="6">I_2</td></tr>
<tr><td>23</td><td>0</td><td>0</td><td colspan="6">I_3</td></tr>
<tr><td>24</td><td>0</td><td>0</td><td colspan="6">I_4</td></tr>
<tr><td>25</td><td>0</td><td>0</td><td colspan="6">I_5</td></tr>
<tr><td>26</td><td colspan="4">I_6</td><td colspan="4">I_7</td></tr>
<tr><td>27</td><td colspan="4">I_8</td><td colspan="4">I_9</td></tr>
<tr><td>28</td><td colspan="4">I_{10}</td><td colspan="4">I_{11}</td></tr>
<tr><td>29</td><td colspan="4">I_{12}</td><td colspan="4">N_1</td></tr>
<tr><td>30</td><td colspan="4">N_2</td><td colspan="4">N_3</td></tr>
<tr><td>31</td><td colspan="4">N_4</td><td colspan="4">N_5</td></tr>
<tr><td>32</td><td colspan="4">N_6</td><td colspan="4">N_7</td></tr>
<tr><td>33</td><td colspan="4">N_8</td><td colspan="4">N_9</td></tr>
<tr><td>34</td><td colspan="4">N_{10}</td><td colspan="4">N_{11}</td></tr>
<tr><td>35</td><td colspan="4">N_{12}</td><td colspan="4">N_{13}</td></tr>
</table>

IV	=	ISRC VALID FLAG	: "0" = not valid ; "1" = valid
CV	=	ID NO. VALID FLAG:	: "0" = not valid ; "1" = valid
CD	=	Channel Discriminator:	

"0" = The ISRC and/or Identification no. is recorded on a 2-Sector tape or on Channel I for a 4-Sector tape, if IV and/or CV is "1".

"1" = The ISRC and/or Identification no. is recorded on Channel II for a 4-Sector tape, if IV and/or CV is "1".

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If either the ISRC or the Identification number is not valid as indicated by the flag, the fields will contain all "0" bits. This information will be recorded at least once every 50 frames, and in the first frame of a new track. AIS="01" and AIS="FF" are only valid for prerecorded tape format.

N_1 - N_{13} = Identification number is expressed in 13-digits, coded in 4-bit BCD. The numbering is according to the UPC/EAN standard.

$I_1 ... I_{12}$ = ISRC as defined in ISO 3901. $I_1 ... I_5$ = letter codes, $I_6 ... I_{12}$ = digit code.

$I_1 ... I_2$ represent the Alpha-2 country code according to ISO 3166
$I_3 ... I_5$ represent the first owner code
$I_6 ... I_7$ represent the year of recording
$I_8 ... I_9$ represent the recording
$I_{10} ... I_{12}$ represent the recording item

The characters $I_1 ... I_5$ are coded in 6-bit format as given below; the characters $I_6 ... I_{12}$ are 4-bit BCD numbers.

Character	Binary	Octal	Character	Binary	Octal
0	000 000	00	I	011 001	31
1	000 001	01	J	011 010	32
2	000 010	02	K	011 011	33
3	000 011	03	L	011 100	34
4	000 100	04	M	011 101	35
5	000 101	05	N	011 110	36
6	000 110	06	O	011 111	37
7	000 111	07	P	100 000	40
8	001 000	10	Q	100 001	41
9	001 001	11	R	100 010	42
A	010 001	21	S	100 011	43
B	010 010	22	T	100 100	44
C	010 011	23	U	100 101	45
D	010 100	24	V	100 110	46
E	010 101	25	W	100 111	47
F	010 110	26	X	101 000	50
G	010 111	27	Y	101 001	51
H	011 000	30	Z	101 010	52

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- **AIS = 02** : Date and time and/or remaining (track) time

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
20	AIS = 02							
21	YEAR tens				YEAR units			
22	MONTH tens				MONTH units			
23	DAY tens				DAY units			
24	HOUR tens				HOUR units			
25	MINUTES tens				MINUTES units			
26	SECONDS tens				SECONDS units			
27	RES	REM.FRAMES			RES	REM TIME HOURS		
28	REM.TIME MIN.tens				REM TIME MIN.units			
29	REM.TIME SEC.tens				REM TIME SEC.units			
30	RES	REM.TR.TIME			RES	REM.TR.TIME HOURS		
31	REM.TR.TIME MIN.tens				REM.TR.TIME MIN.units			
32	REM.TR.TIME SEC.tens				REM.TR.TIME SEC.units			
33	RESERVED							
34	RESERVED							
35	RESERVED							

DATE OF RECORDING : indicates the moment the recording was made.
- YEAR : 00 ... 99
- MONTH : 01 ... 12
- DAY : 01 ... 31
- HOURS : 00 ... 23
- MIN : 00 ... 59
- SEC : 00 ... 59

If the information is not available, all fields will be 'AA'.

REMAINING TIME : time remaining for playback
- HOURS : 0 ... 7
- MIN : 00 ... 59
- SEC : 00 ... 59
- FRAMES : 0 ... 5

REMAINING TRACK TIME:
- HOURS : 0 ... 7
- MIN : 00 ... 59
- SEC : 00 ... 59
- FRAMES : 0 ... 5

The bits 7 and 3 of bytes AD_{27} and AD_{30} and the bytes $AD_{33}...AD_{36}$ are reserved for future applications and will be recorded "0" for the time being.

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If recorded, this information will be recorded at least once every second. If no remaining and/or remaining track time is available, the fields will contain: HOURS:7, MIN:AA, SEC:AA, FRAMES:0

- AIS = 03 : Consumer character recording

Consumer character recording can be used to provide the means for a customer to generate a text label, e.g. the title of an own recorded music track. This mode can be used on User and Super user tapes. This text is allowed to be recorded during the Start markers only. The bytes AD_{20} to AD_{35} of four consecutive Aux data tape frames are used to record a Text packet of 48 bytes according to the ITTS format. Four ITTS Text packets can be recorded in a Start marker of 16 or 32 frames. See also chapter 13 for the coding of these ITTS packets and chapter 17 for application rules.

AD	msb 7	6	5	4	3	2	1	lsb 0	
20	AIS = 03								
21	CCF	IPC		QBC		RES			
22	RESERVED								
23	RESERVED								
24									<-------
25									
26									
27									
28									
29									1/4 ITTS PACKET =
30									QUARTER BLOCK
31									
32									
33									
34									
35									<-------

The coding of the Aux data tape block if AIS = 03 is defined:

- AD_{21} bit 7 : CCF = Continuity Count Flag. When set, this bit indicates that a discontinuity occurred in the counting sequence of the quarter blocks. The CFF bit must be set for the first quarter block of the first ITTS packet recorded during a start marker, at all other times it must be reset.
- AD_{21} bits 6-5 : IPC = ITTS Packet Count (0...3). With these bits a counting sequence can be realized to verify the recorded packets.
- AD_{21} bits 4-3 : QBC = Quarter Block Count (0...3). With these bits a counting sequence can be realised to verify the recorded blocks.
- AD_{21} bits 2-0 : RES = Reserved. These bits are reserved for future use, and are "000" for the time being.
- AD_{22}...AD_{23} : RESERVED: These bytes are reserved for future use, and are "0" for the time being.

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14.2 Audio applications

$AD_{24}...AD_{35}$: These bytes contain the ITTS data.

The contents of the data bytes $AD_{24}...AD_{36}$ depends on the value of QBC. If QBC = "00" then the bytes $AD_{24}...AD_{31}$ contain the ITTS header and the bytes $AD_{32}...AD_{36}$ contain the first 4 character codes of the ITTS packet. With QBC = "01", "10" and "11" the bytes $AD_{24}...AD_{36}$ contain the remaining 3x12 bytes of the ITTS packet.

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ITTS Text Packet coding format with QBC="00", "01", "10" and "11"

For the first ITTS Text Packet: (User cahracter recording: free memorandum)

byte	bit 7 (msb)	6	5	4	3	2	1	0 (lsb)	
0	1	0	0	0	1	0	0	0	<—
1	0	0	0	0	0	0	0	0	|
2	0	0	0	0	0	0	0	0	|
3	0	0	0	0	0	0	0	1	ITTS
4	1	1	1	1	1	0	0	0	header
5	0	0	0	0	1	1	1	1	|
6	0	1	1	0	0	0	1	1	|
7	CHARSET				0	0	0	0	<—
8	CHARACTER CODE								
|	1 TEXT LINE = 40 CHARACTERS								
47	CHARACTER CODE								

For the second ITTS Text Packet: (User character recording: album title)

byte	bit 7 (msb)	6	5	4	3	2	1	0 (lsb)	
0	1	0	0	0	1	0	0	0	<—
1	0	0	0	0	0	0	0	0	|
2	0	0	0	0	0	0	0	0	|
3	0	0	0	0	0	0	0	1	ITTS
4	1	1	1	1	1	0	0	1	header
5	0	0	0	0	1	1	1	1	|
6	0	1	1	0	0	0	1	1	|
7	CHARSET				0	0	0	0	<—
8	CHARACTER CODE								
|	1 TEXT LINE = 40 CHARACTERS								
47	CHARACTER CODE								

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For the third ITTS Text Packet: (User character recording: track title)

byte	bit 7 (msb)	6	5	4	3	2	1	0 (lsb)	
0	1	0	0	0	1	0	0	0	ITTS header
1	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	1	
4	1	1	1	1	1	0	1	0	
5	0	0	0	0	1	1	1	1	
6	0	1	1	0	0	0	1	1	
7	CHARSET				0	0	0	0	
8	CHARACTER CODE								
…	1 TEXT LINE = 40 CHARACTERS								
47	CHARACTER CODE								

For the fourth ITTS Text Packet: (User character recording: artist/credits)

byte	bit 7 (msb)	6	5	4	3	2	1	0 (lsb)	
0	1	0	0	0	1	0	0	0	ITTS header
1	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	1	
4	1	1	1	1	1	0	1	1	
5	0	0	0	0	1	1	1	1	
6	0	1	1	0	0	0	1	1	
7	CHARSET				0	0	0	0	
8	CHARACTER CODE								
…	1 TEXT LINE = 40 CHARACTERS								
47	CHARACTER CODE								

- **AIS = 04 to FE** : Reserved for future use, not to be used at present.

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14.2 Audio applications

- **AIS = FF** : Duplicator identification code of the prerecorded cassette manufacturer.

AD	7 (msb)	6	5	4	3	2	1	0 (lsb)
20	AIS = FF							
21								
22								
23								
24	DU							
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								

This information will be recorded at least once every 375 frames. The Duplicator identification code field with bytes $AD_{20}...AD_{36}$ is divided into various elements of characters without separators in the following order:

1) AD_{21} - One single ASCII character representing the name of the mastering equipment manufacturer.
2) $AD_{22}...AD_{23}$ - A double byte binary code, representing a unique administration or serial number of the mastering equipment. (MSbyte = AD_{22})
3) $AD_{24}...AD_{26}$ - A unique combination of 3 ASCII characters representing the name of the duplicating company. AD_{24} bit 7 carries a special duplicator code:
   DU="0" : The bytes $AD_{24}...AD_{35}$ carry valid duplicator information.
   DU="1" : The bytes $AD_{24}...AD_{36}$ carry no valid duplicator information.
4) AD_{27} - One single ASCII character representing the name of the downloading equipment manufacturer.
5) $AD_{28}...AD_{29}$ - A double byte binary code representing a unique administration or serial number of the downloading equipment. (MSbyte = AD_{28})
6) $AD_{30}...AD_{32}$ - Representing a BCD coded date of downloading (year/year - month/month - day/day).
7) AD_{33} - Reserved. To be recorded binary "0".
8) $AD_{34}...AD_{35}$ - Representing optional information of the duplicating company. It is recommended to incorporate at least a reference to the location of the duplication plant, if the company has more than one location.

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14.2 Audio applications

The elements 1), 3) and 4) shall be issued by a registration office at a central location (see Preface), the elements 2) and 5) shall be assigned by the manufacturers of the mastering and downloading equipment in consultation with the registration office.

Example:

AD_{21}	"P"		Mastering equipment manufacturer ID ("P" = Philips in ASCII code)
AD_{22} AD_{23}	62321		Administration or serial number of Philips mastering equipment (in 16 bit binary code)
AD_{24} AD_{25} AD_{26}	DU "PRS"		Duplicator ID (PRS = PolyGram Record Services in ASCII code)
AD_{27}	"P"		Downloading equipment manufacturer ID ("P" = Philips in ASCII code)
AD_{28} AD_{29}	61211		Administration or serial number of Philips downloading equipment (in 16 bit binary code)
AD_{30}	9	2	Year in BCD code
AD_{31}	1	0	Month in BCD code
AD_{32}	0	8	Day in BCD code
AD_{33}	"0"		Reserved
AD_{34} AD_{35}			Optional information code of duplicating company

15. APPLICATION RULES SYSINFO AND AUX DATA ON PRERECORDED CASSETTES

Prerecorded cassettes are defined in chapter 5.

15.1 Classification

Two types of prerecorded tape formats are defined: the 2-Sector tape format and the 4-Sector format (see 12.1).

15.1.1 The 2-Sector tape format

2-Sector prerecorded tape is classified as follows:

Sysinfo : (see 13.2)

Format ID	: Mandatory "0000"
Copyright bits (CP1,CP2)	: Mandatory "11" or "01"
Tape Type bits (TT1,TT2)	: Mandatory "11" (identifies 2-Sector tape)
Character recording(ITTS)	: Mandatory - see 13.2.1.1

Auxiliary data : (see also 14)

Format ID	: Mandatory "0000"
Block address	: Mandatory - see 14.2.1
Lead-in	: Mandatory - see 15.3.1
Lead-out	: Mandatory - see 15.3.2
Start marker	: Mandatory - see 15.4
L-ID	: Acc. to 15.3.1, 15.3.2 and 15.4
SH-ID	: Mandatory "0" (no Skip marker applied)
F-ID	: Mandatory "0" (no Fade marker applied)
M-ID	: Mandatory "0" (no Mute marker applied)
TOC-ID	: Mandatory "1"
SCM-ID	: Acc. to 15.3
PAU-ID	: Acc. to 15.3.6 and 15.4
SU-ID	: Mandatory "0"
ML-ID	: Mandatory "0"
Track number	: Mandatory - see 15.5
Index/Chapter number	: Mandatory - see 15.5
A-time	: Mandatory - see 15.6.3
T-time	: Mandatory - see 15.6.4
R-time	: Mandatory - see 15.6.5
RT-time	: Mandatory - see 15.6.6
SOB	: Mandatory "0"
TOC	: Mandatory - see 15.7
ISRC	: Mandatory according to ISO 3901 - see 14.2.6
Identification number	: Mandatory - see 14.2.6
Duplicator identification code	: Mandatory - see 14.2.6
Recording date	: Mandatory - see 14.2.6

For a survey of the recorded items refer to table 17.1 of chapter 17.
An example of a 2-Sector tape can be found in fig. 15.1.

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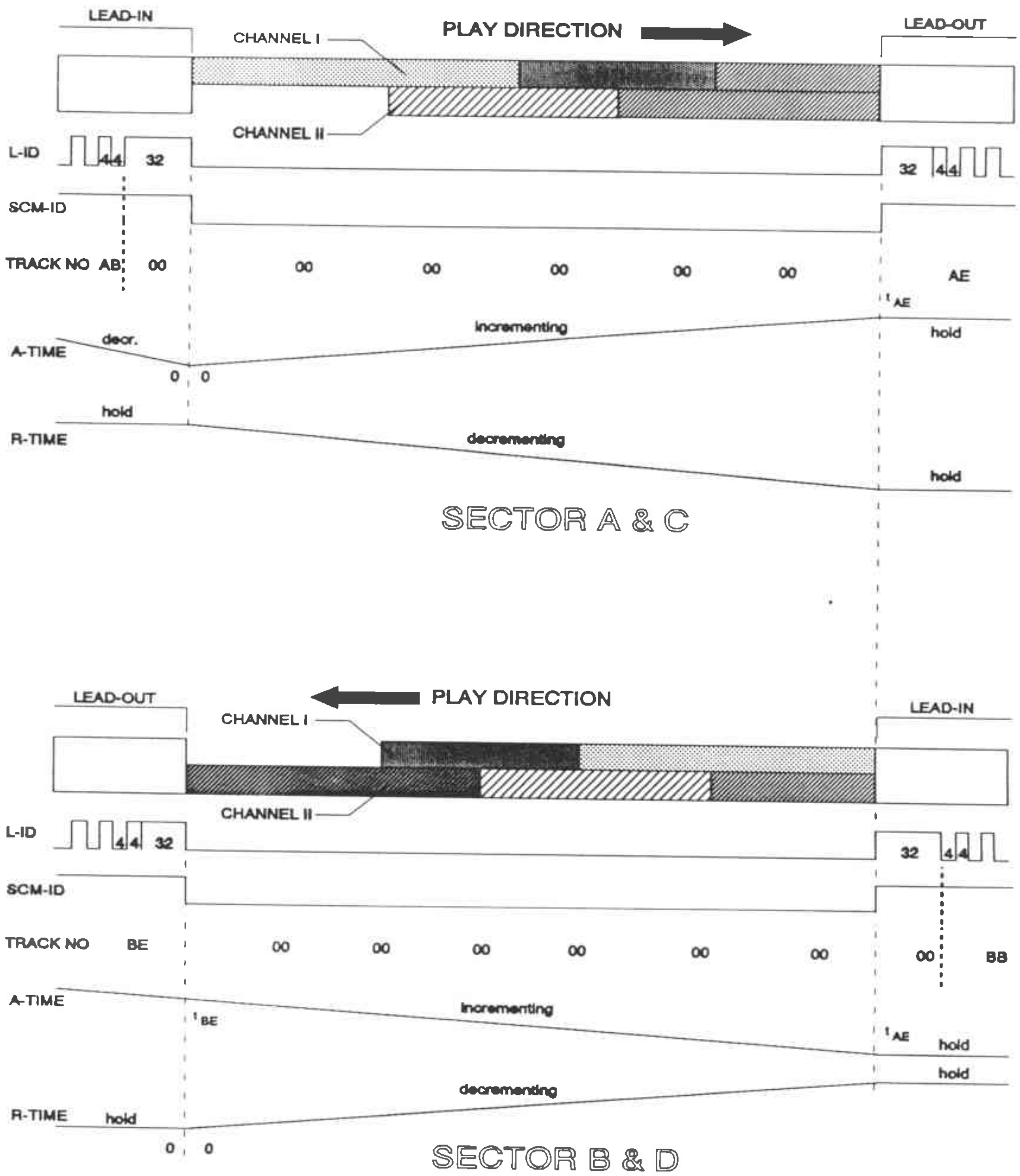

Figure 15.2 : Example of prerecorded 4-Sector tape format

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15.2 General format of prerecorded tape

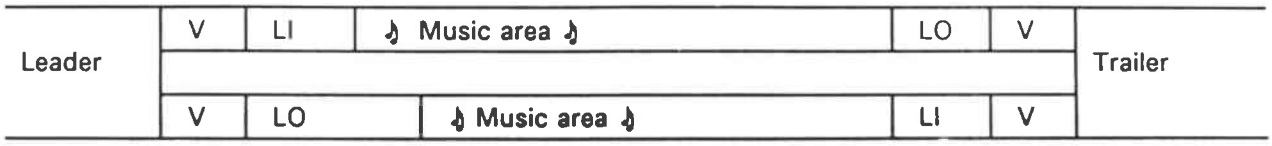
15.2.1 Prerecorded 2-Sector tape format

2-Sector tape is recorded in the stereo mode (see 12.1). Both Sectors A and B are considered to be part of the same program. Therefore track numbering and A-time (R-time) will continue to increment (decrement) at the sector B. The music programming of the tape shall be such that the end of sector A and the beginning of sector B coincide according to the rules in section 15.3.4. In order to have the end of sector A and the beginning of sector B coincide two cases are defined.

Case I : program part on Sector A longer than program part on Sector B

In this case the tape will be organized as follows:

Sector A ——— play direction ———>



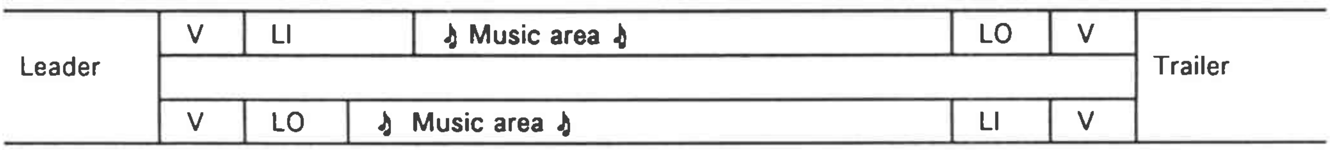
Sector B <——— play direction ———

Leader/Trailer	=	transparent tape
V	=	virgin magnetic tape
LI	=	'Lead-in' area
LO	=	'Lead-out' area

Case II : program part on Sector A shorter than program part on Sector B

In this case the tape will be organized as follows:

Sector A ——— play direction ———>



Sector B <——— play direction ———

For Sector alignment refer to section 15.3.3 and 15.3.4. It is recommended that both Sectors are recorded simultaneously.

Note: Case I is the preferred way of programming.

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Virgin tape

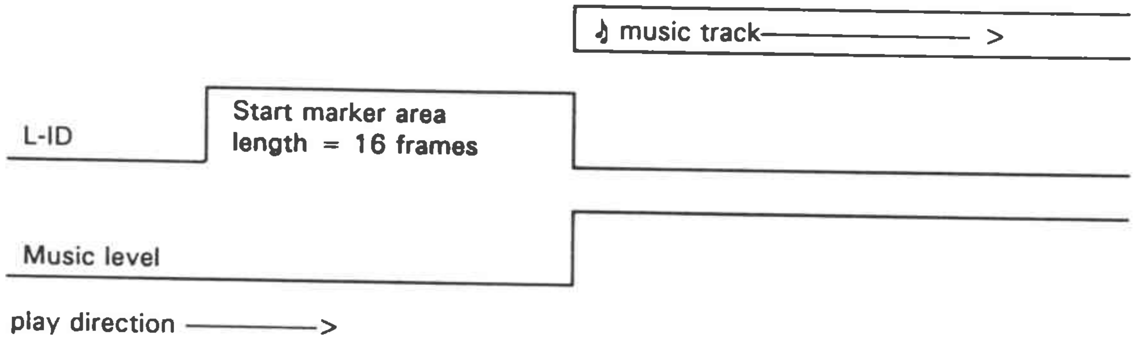
Virgin tape is defined as:
- non-magnetized tape, or
- tape recorded with non-decodable Main data and non-decodable Aux data, while the Aux data is not Labelled at the same time.

Two types of markers are defined for prerecorded 2-Sector tape:

Sector markers (Lead-in, Lead-out)

The function of these markers is to define the start and the end of the program area.

- **Start markers**
  Start markers, except the start markers for the first music track on each Sector, are located in the program area and have a length of 16 frames. The start of a music track coincides with the falling edge of the start marker as indicated below:



Between two start markers the Label ID will be '0' for at least 16 frames.

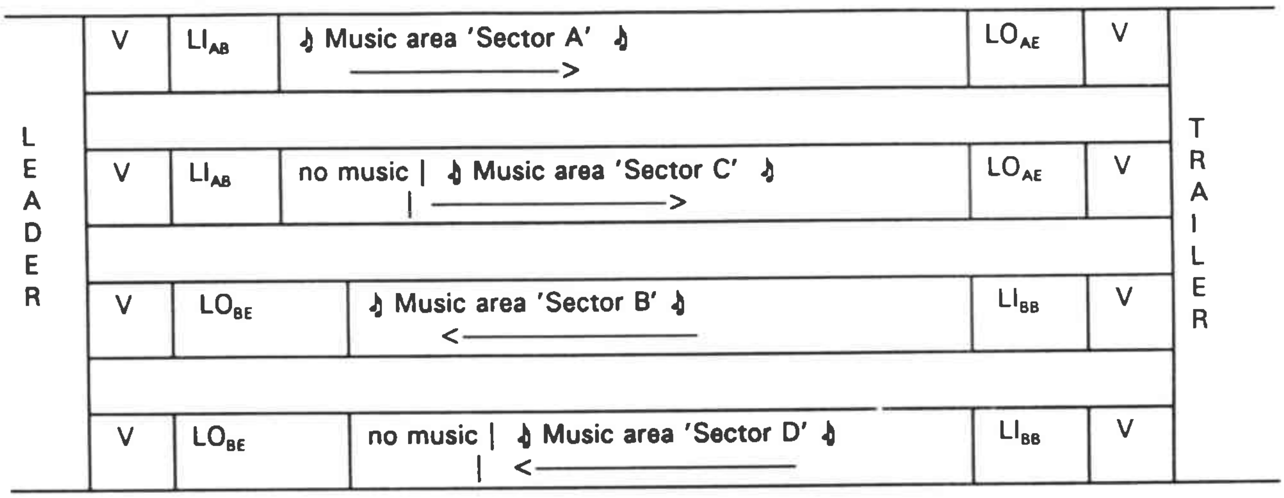
The start marker for the first music track on each Sector has a length of 32 frames and is formed by the last 32 frames of the Lead-in. If the first music track starts with a pause of ≥ 32 frames, the start marker does not coincide with the lead-in, but an additional start marker of 16 frames is added before the start of the music.

15.2.2 Prerecorded 4-Sector tape format

4-Sector tape will be recorded using the "2-channel mono" mode (see 12.1). This allows for four Sectors of monophonic music program to be recorded. The total playing time of a cassette therefore is doubled. The general format of the 4-Sector tape is similar to the format of prerecorded 2-Sector tapes. However, all music programs shall be aligned towards the end of Sector A. The Sector length for a direction is defined as the length of the longest music program in that direction. The same two cases as for 2-Sector tape apply.

The longest music program can be recorded on any of the 4 'Sectors' A...D. No valid track numbers are recorded, except during Lead-in and Lead-out areas. Since the 'Sector C' and the 'Sector D' can not have separate Sector markers, the Sector begin is to be derived from the time information of the TOC, as is the case for track beginnings.

Example:



The playback sequence is defined as:

Sector A - channel I; 'Sector A'
Sector B - channel I; 'Sector B'
Sector A - channel II; 'Sector C'
Sector B - channel II; 'Sector D'

Markers on 4-Sector tape
Only one type of marker is defined on 4-Sector tape, Sector Markers. Lead-in and Lead-out define the music area for sector A & C and sector B & D.

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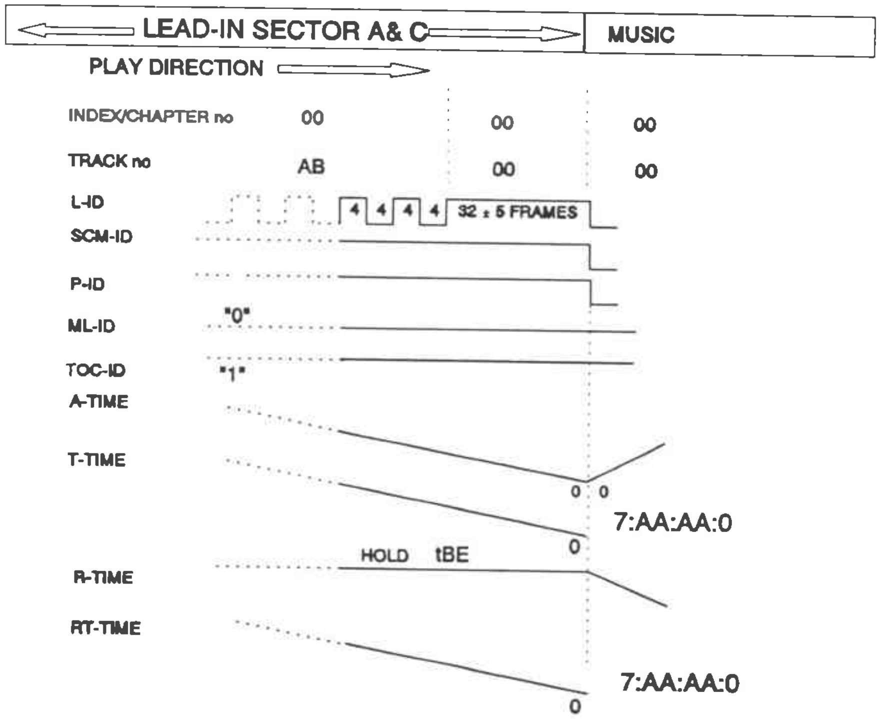
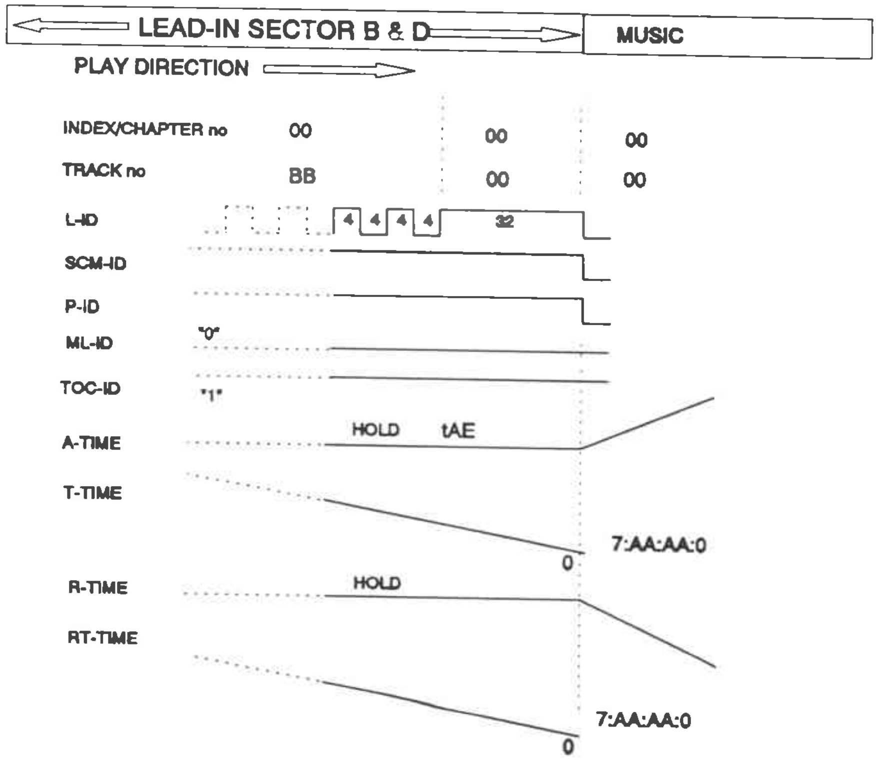
LEAD-IN 4-SECTOR TAPE





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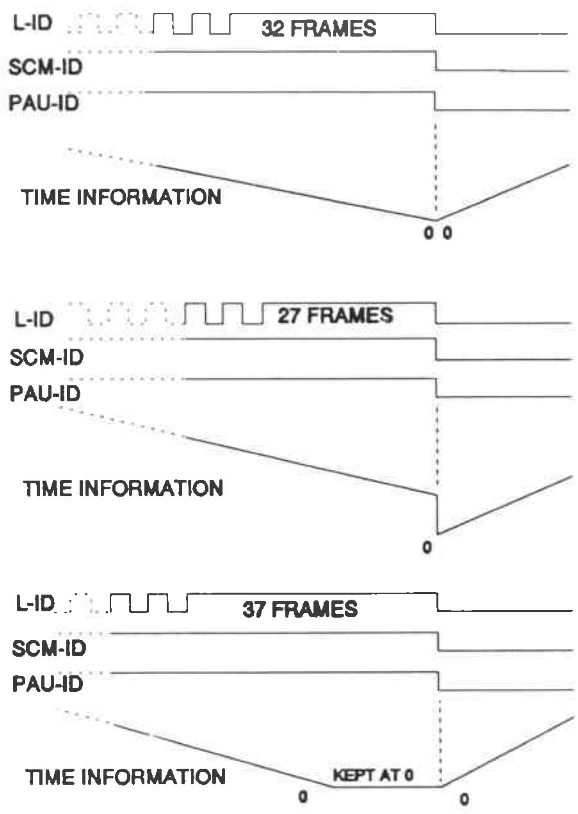
15.3.1 Lead-in on Sector A

The Lead-in on Sector A indicates the start of Sector A, and is nominal 48 frames (at least 43 frames) long. The Lead-in ends with nominal 32 frames (a tolerance of +5/-5 frames is allowed) continuously labelled (L-ID ="1"), preceded by at least 16 frames according to the pattern: 4 frames labelled, 4 frames not labelled (L-ID="0"), ending with 4 frames not labelled. The SCM-ID is recorded "1". The PAU-ID will be "1". The T-Time is decrementing towards "0".



If the last part of the Lead-in (the 32 frames nominal) is longer than 32 frames the absolute time is kept 0 for some frames. If the length is less than 32 the absolute time will not decrease to exactly 0.

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15.3.2 Lead-in on Sector B

The Lead-in on Sector B indicates the start of Sector B, and is minimal 48 frames long. The Lead-in ends with 32 frames continuously labelled (L-ID ="1"), preceded by at least 16 frames according to the pattern: 4 frames labelled, 4 frames not labelled (L-ID="0"), ending with 4 frames not labelled. The SCM-ID is recorded "1". The PAU-ID will be "1". The T-Time is decrementing towards "0".

15.3.3 Lead-out

The Lead-out indicates the end of the music area on a Sector. During the Lead-out the Label-ID will be recorded "1" for 32 frames and will then continue, alternating "1" for 4 frames and "0" for 4 frames, starting with 4 frames "1". The SCM-ID will be recorded "1". The PAU-ID is "0". The T-Time is incrementing from 0:00:00:0 onwards. The Lead-out area can be detected in playback and search modes.

For a survey of data recorded during the Lead-out of 2-Sector tape and 4-Sector tape, please refer to the following pages.

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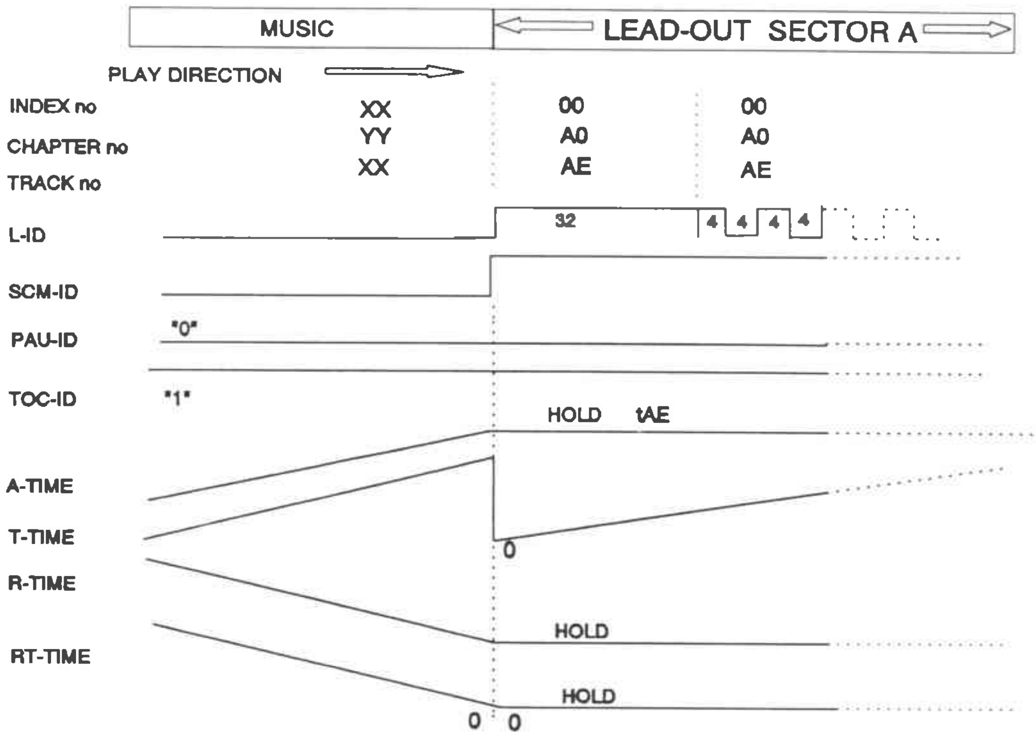
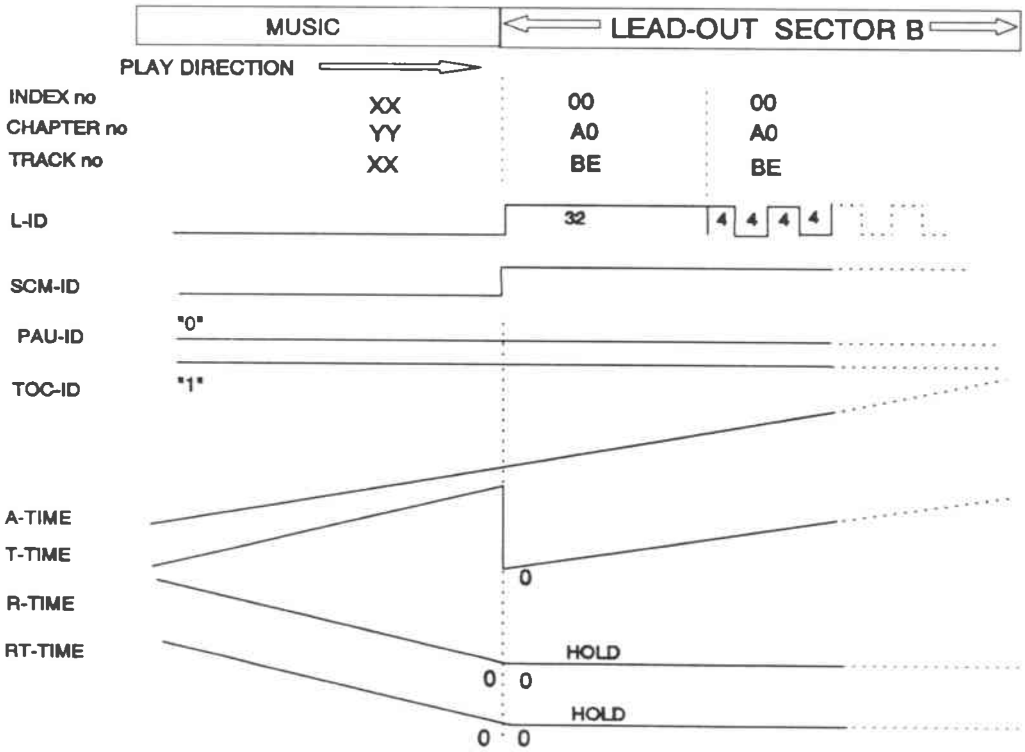
LEAD-OUT 2-SECTOR TAPE





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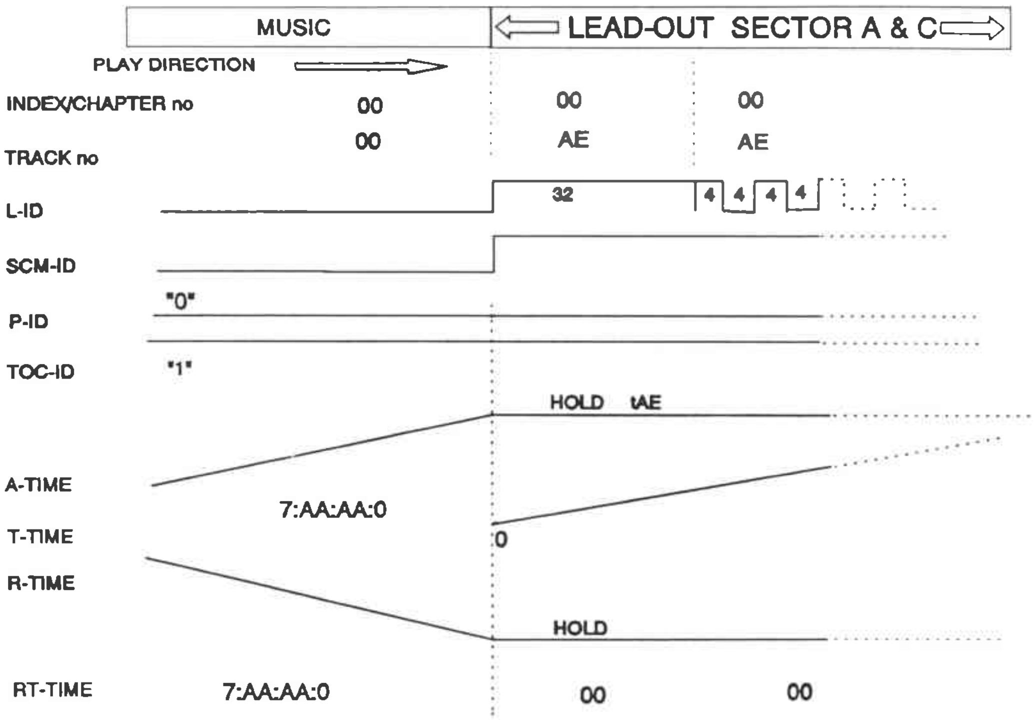
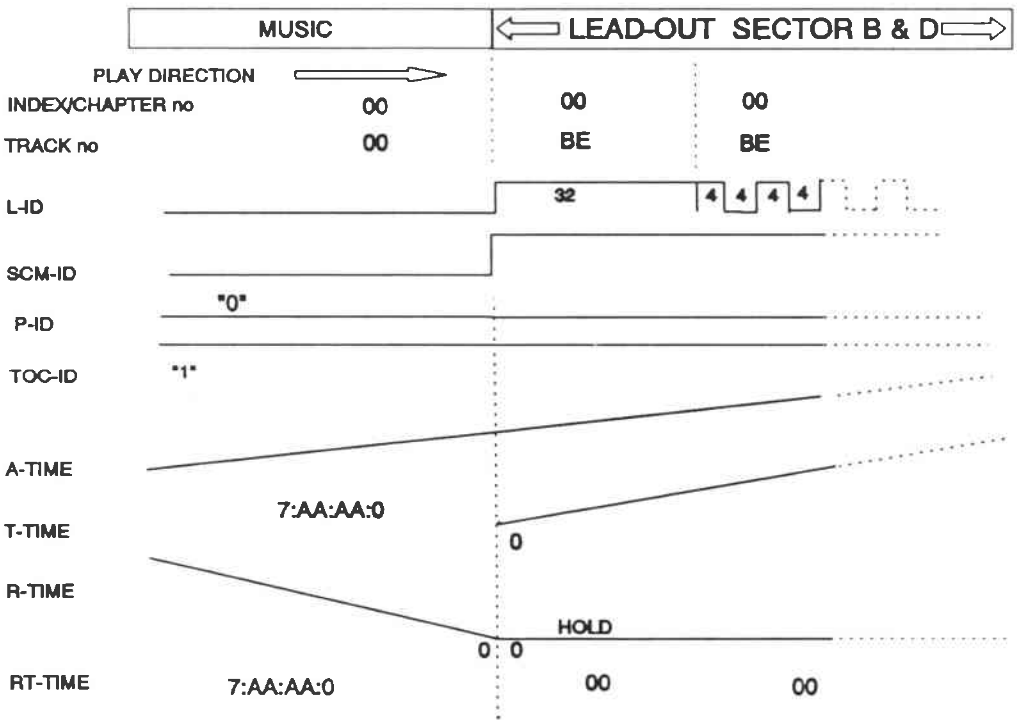
LEAD-OUT 4-SECTOR TAPE





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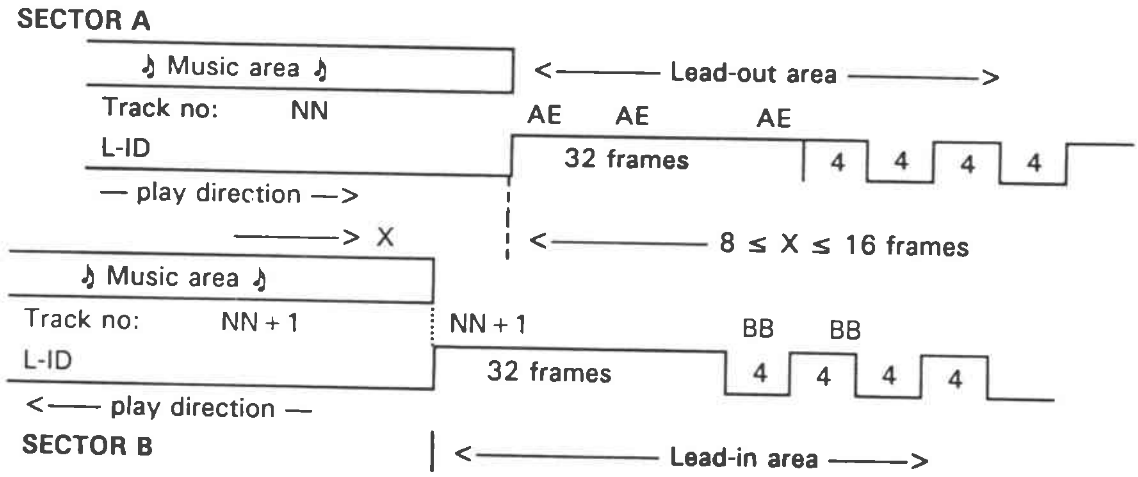
15.3.4 Alignment of Lead-in and Lead-out on 2-Sector and 4-Sector tape

The Sector markers at the end of Sector A and the Sector marker at the beginning of Sector B should be aligned as shown below:

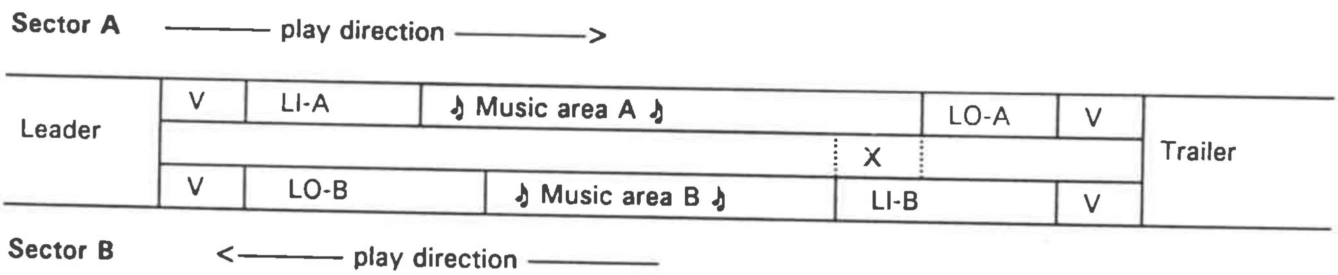


The position of the rising edge of the L-ID at the end of Sector A should be at least 8 frames, and a maximum of 16 frames before the start of the first track on Sector B.

15.3.5 Alignment of Sectors A and B on 2-Sector and 4-Sector tape

The number of frames of both Sectors must be aligned according to the following formulae:

1- $\text{Lead-in}_A + \text{Music}_A = \text{Lead-out}_B + \text{Music}_B + X$ where $8 \le X \le 16$ frames
2- $\text{Lead-in}_A + \text{Music}_A + \text{Lead-out}_A = \text{Lead-in}_B + \text{Music}_B + \text{Lead-out}_B$



The virgin tape areas should be as short as possible, but may not be longer than 50 cm, including dummy frames.

Leader/Trailer	= Non-magnetic tape.
V	= Virgin magnetic tape or tape which is recorded with non-decodable Main data or Aux data.
LI-A, LI-B	= Lead-in area.
LO-A, LI-B	= Lead-out area.

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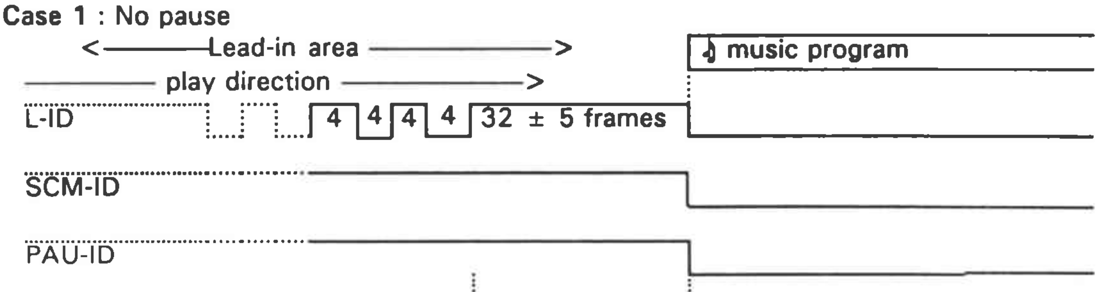
15.3.6 Application of Pause/no Pause (PAU-ID) at Sector begin on 2-Sector tape

The start of a Sector can be defined in three alternative ways:
- Lead-in, immediately followed by the first music track (case 1)
- Lead-in, followed by a pause of less than 32 frames (case 2)
- Lead-in, followed by a pause of more than or equal to 32 frames (case 3)

See also the drawings in section 15.3.2

Case 1 : No pause

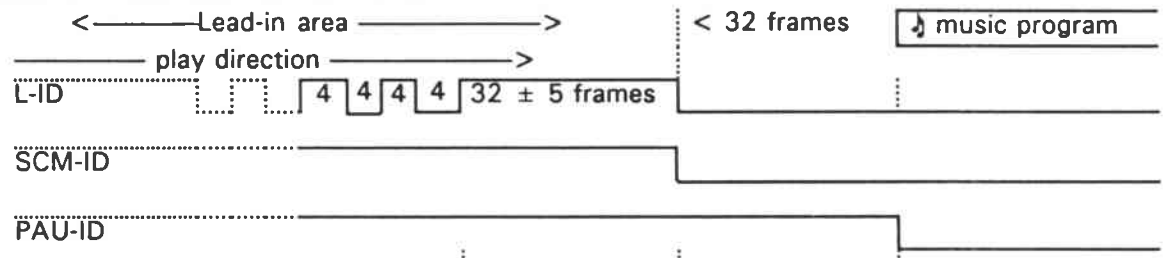


Track no:(Sector A)	AB	01	01
Track no:(Sector B)	BB	N+1	N+1
Index no:	00	00	01
or Chapter no:	A0	A0	PP

The track number is set at the beginning of the start marker in the Lead-in.

Note: The tolerance figures for the amount of frames is only valid for Sector A.

Case 2 : Pause less than 32 frames



Track no:(Sector A)	AB	01	01	01
Track no:(Sector B)	BB	N+1	N+1	N+1
Index no:	00	00	00	01
or Chapter no:	A0	A0	PP	PP

The track number is set at the beginning of the start marker in the Lead-in, the Index number is set to "00" during the pause.

Note: The tolerance figures for the amount of frames is only valid for Sector A.

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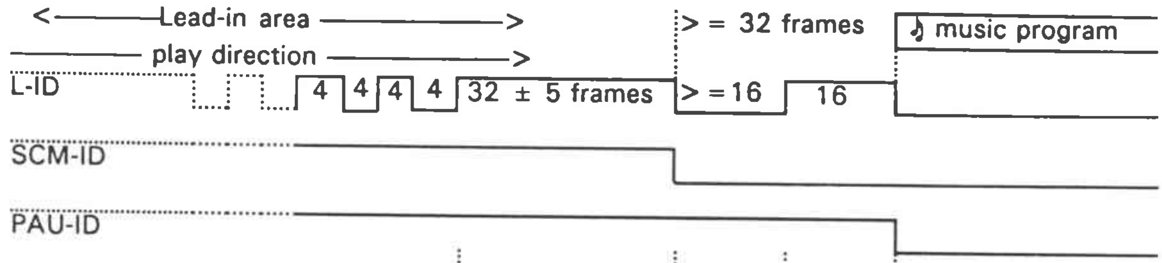
15.3 Lead-in and Lead-out areas on 2-sector and 4-sector tapes

Case 3 : Pause is more than or equal to 32 frames

If a pause of more than 32 frames is applied a separate startmarker must be applied before the start of the music.



Track no:(Sector A)	AB	01	01	01	01
Track no:(Sector B)	BB	N+1	N+1	N+1	N+1
Index no:	00	00	00	00	01
or Chapter no:	A0	A0	PP	PP	PP

A start marker of 16 frames must be recorded. The track number changes immediately after the Lead-in. Index and Chapter numbers are treated in the same way as in case 2.

Note: The tolerance figures for the amount of frames is only valid for Sector A.

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15.4 Start markers

On 2-Sector tape start markers must be recorded to indicate the beginning of every music track. They must be used on sector A and sector B. Start markers are defined by setting the L-ID to "1" and the SCM-ID to "0" for 16 frames. At the beginning of the sector the startmarkers are combined with the Lead-In. They are defined by the L-ID = "1", the SCM-ID = "1" and a track number in the range "01" .. "99".

They can be detected in playback and in the search mode. Because of its shape, they can be found in search mode by envelope detection of the Aux data track. It is mandatory to maintain a minimum spacing distance of 16 frames between the ending point of a marker and the starting point of the next one. The start of the music coincides with the first frame after the start marker. Search for a startmarker is defined to be completed at the start of the music track, i.e. at the trailing edge of the startmarker.

See the example in Fig 15.1 for the use of start markers.
No start markers are recorded on 4-Sector tape.

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15.5 Track and Index/Chapter numbering

15.5.1 Track and Index/Chapter numbering on 2-Sector tape

Track numbers will be recorded in ascending order. The preferred Track number for the first track of Sector A is "01". However, another number can be used if the tape is one of a set of tapes that contain a related music program, e.g. a long concert.
The highest Track number for Sector A is "98". Sector B will start with a Track number that is equal to the last track number of Sector A plus one, i.e. valid Track numbers for Sector B range from "02" to "99".

A prerecorded tape can contain either Index or Chapter numbers.

- Index numbers are used to specify subdivisions of a music track. A track number "NN" may start with a Pause period which shall be recorded as Index "00". If Index numbers are recorded, then they may change during the music track at a maximum rate of once per second. They will be recorded in ascending order. The first Index number of a music track is "01". The highest Index "99" will be held until the end of the track. During Lead-in, Lead-out areas and pause the Index numbers will be "00".

- If Chapter numbers are recorded, then they may only change at the start of a new music track, (i.e. in the first frame after a start marker, if no pause is applied. If a pause is applied the Chapter number may change where the PAU-ID becomes "1". Chapter numbers will be recorded in ascending order. The first Chapter should preferably be numbered "A1". However, it is permissible to use another number, if the tape is one of a set of tapes that contain a related music program, e.g. several concerts by the same composer. The maximum Chapter number is "F9" (Hex).

Note: During the Lead-in and Lead-out of Sector A and Sector B the Chapter number will always be "A0"

Track and Index/Chapter numbers will be recorded continuously during the music tracks.

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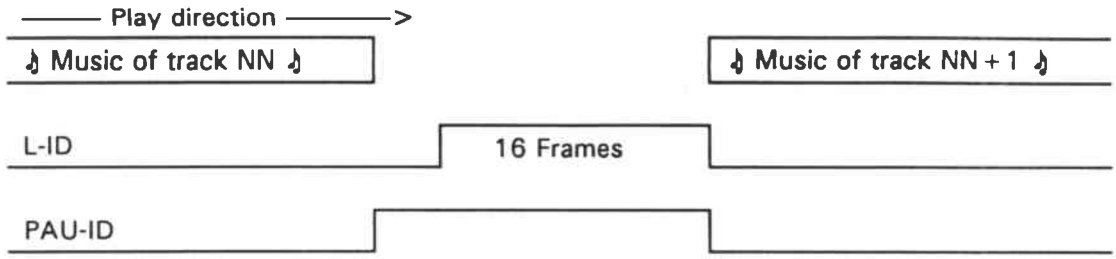
15.5.1.1 Numbering when Pause applied between two subsequent tracks

Between two subsequent tracks a pause may be applied. In this case the PAU-ID is set to "1".



Track no.:	NN	NN+1	NN+1
Index no.:	MM	00	01
or Chapter no.:	PP	PP+1	PP+1

The trailing edge of the L-ID coincides with the trailing edge of the P-ID.
The application of the PAU-ID between tracks is intended to indicate that the audio information is different from both the previous and the next track, e.g. "siience", or e.g. the audience applauding. The track number of the music track that is about to start will commence at the raising edge of the PAU-ID. If applied, the Index number will be set to "00" during the pause. The music track will start with an Index of "01". If applied, the Chapter number may only change at the first frame of the pause.

Note: The PAU-ID may be set to "1" for less than 16 frames with a minimum of 1 frame. The change-over of the track number shall still be at the rising edge of the PAU-ID. In this case the Track number will change during L-ID = "1".

The next figure gives an example of how startmarkers can be applied in combination with PAU-ID (also the behaviour of other recorded items is shown).

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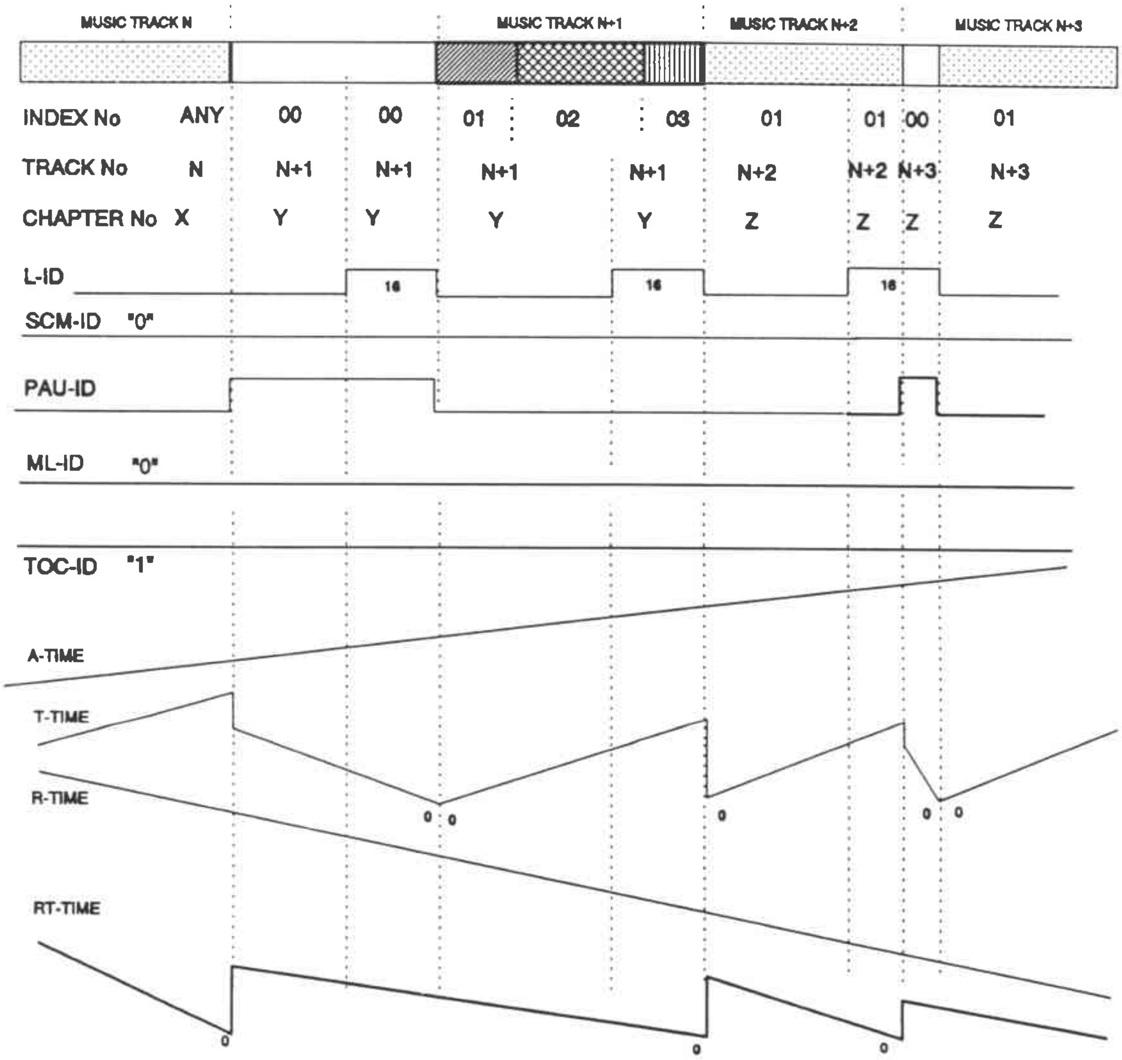
RECORDED DATA DURING START MARKERS

PREREORDED 2-SECTOR TAPE



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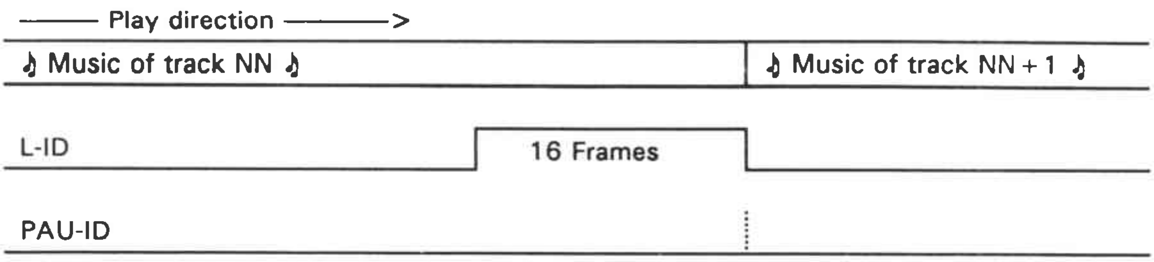
15.5.1.2 Numbering when no Pause applied between two subsequent tracks



Track no.:	NN	NN	NN + 1
Index no.:	MM	MM	01
or Chapter no.:	PP	PP	PP + 1

In this case track NN is followed immediately by track NN + 1. The PAU-ID remains 0 during this change. The audio information may be continued from track NN to track NN + 1. If applied, track NN + 1 will start with Index number "01". If applied, the Chapter number may change in the same frame in which the track number changes.

Note: In this case the track number recorded during the start marker of track NN + 1 is equal to NN!

15.5.2 Track and Index/Chapter numbering on 4-Sector tape

The Track and Index/Chapter number fields will be "00" on 4-Sector tape, except for the track number if the SCM-ID = "1". The track positions however are available via the table of contents.

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15.6 Time recording

15.6.1 Time recording on 2-Sector tape

Four time modes will be recorded on prerecorded 2-Sector tape:

- Absolute time (A-time)
- Track time (T-time)
- Remaining time (R-time)
- Remaining track time (RT-time)

15.6.2 Time recording on 4-Sector tape

Two time modes will be recorded on prerecorded 4-Sector tape:
- Absolute time
- Remaining time

As the time information is recorded for a combination of 2 channels, the A-time and R-time for the "Sector" C and the "Sector" D can be calculated from the TOC.

15.6.3 A-time on 2-Sector and on 4-Sector tape

A-time will be recorded as shown below:

———— play direction ————>

A-time:	decrementing	0 incrementing to F	hold at F	
SECTOR A	Lead-in	♪ Music area ♪	Lead-out	V

SECTOR B	Lead-out	♪ Music area ♪	Lead-in	V
A-time:	incrementing	M incrementing F+1	hold at F	

<———— play direction ————

In the Lead-in of Sector A the A-time will decrement to 0:00:00:0 until the final frame of the Lead-in area, with an accuracy of -0/+ 5 frames (the time information may not be negative). It will be recorded in ascending order from there on, until the last frame of the music area, whose A-time is indicated here by "F".
In the Lead-out of Sector A this A-time will be held, i.e. during the Lead-out of Sector A the same A-time ("F") will be recorded.

In the Lead-in of Sector B the A-time will also be held at "F". It will be recorded in ascending order from the start of the music area, starting with the A-time "F"+1, until the last frame of the music area, whose A-time is indicated by "M". In the Lead-out of Sector B this A-time will continue to increment.

Sector identification will be recorded according to the current Sector.

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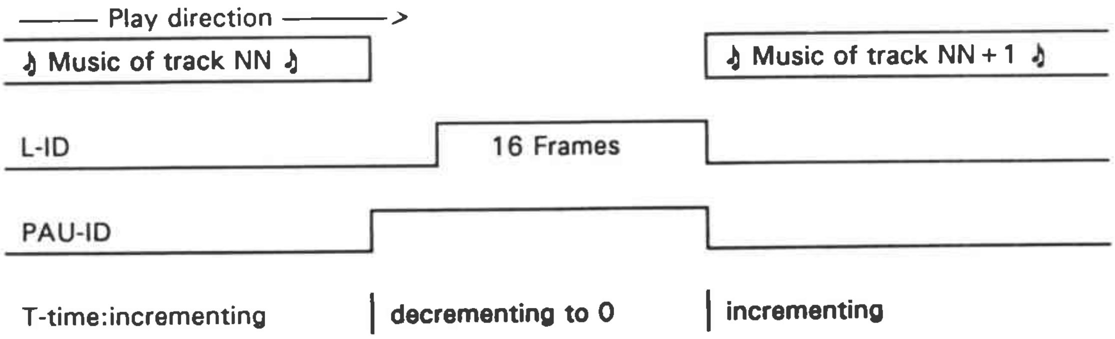
15.6.4 T-time on 2-Sector tape

During Lead-in on Sectors A and B the T-time will count down to 0:00:00:0, thus counting the length of the remaining Lead-in area. The accuracy on sector A will be - 0/+ 5 frames. On sector B no inaccuracy is allowed. The time information may not be negative.

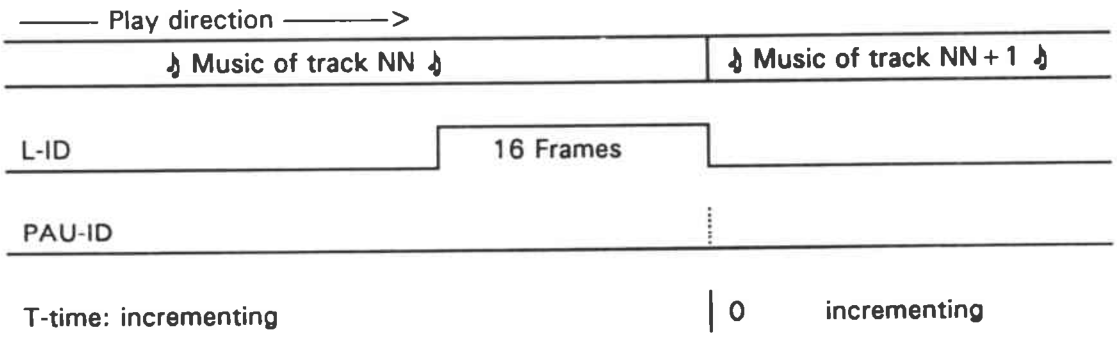
During the Lead-out the T-time will start at 0:00:00:0 and counts upwards.
The T-time will be recorded during the music track as shown below (see also the figure in 15.5.1.1):

Case 1: Between the music tracks the PAU-ID is set to "1":



The T-time will increment up to the raising edge of the PAU-ID. Then the T-time will indicate the Pause-time by counting down toward 0:00:00:0 during the pause, and will be 0:00:00:0 at the falling edge of the L-ID, in the last frame just before the start of the music track. The T-time will start at 0:00:00:0 in the first frame of the music track. and will be recorded in ascending order from then on, until the end of the track.

Case 2: No PAU-ID applied between the music tracks:



The T-time will start at 0:00:00:0 in the first frame of the music track, and will be recorded in ascending order from then on, until the end of the track.

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15.6.5 R-time on 2-Sector and on 4-Sector tape

The R-time will be recorded as shown below:

——— play direction ———>

R-time:	hold at M + 1	M decrementing to G	hold at G	
SECTOR A	Lead-in	♪ Music area ♪	Lead-out	V

SECTOR B	Lead-out	♪ Music area ♪	Lead-in	V
R-time:	hold 0	0 decrementing G-1	hold at G	

<——— play direction ———

The R-time will be held at the total playing time M+1 in the Lead-in area of Sector A. It will start with M in the first frame of the music area of Sector A, and will decrement from then on, until the end of Sector A. From then on the R-time of the final frame of the music program area ("G") will be held during the Lead-out area.
The R-time will be held at G in the Lead-in area of Sector B. It will start with "G-1" in the first frame of the music area of Sector B and will continue to decrement from then on, until the end of Sector B.
From then on the R-time will be recorded 0:00:00:0.
In principle it is possible to calculate the R-time in the music area from the A-time with the following formula:

R-time = M - A-time

In which M is the total playing time, as shown in 15.6.3.

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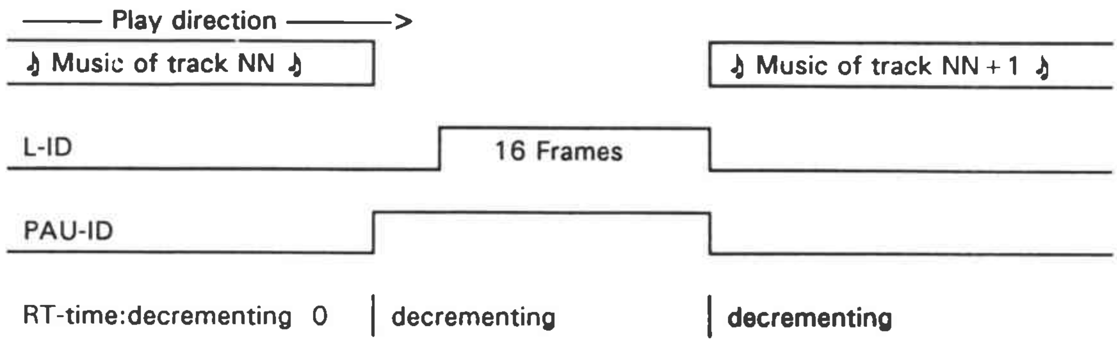
15.6.6 RT-time on 2-Sector tape

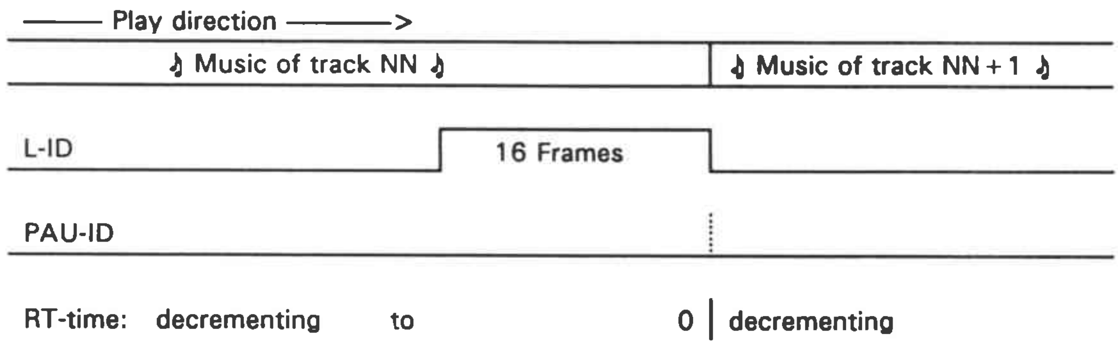
During the Lead-in on Sectors A and B the RT-time will count down to 0:00:00:0, thus counting the length of the remaining Lead-in area. This is similar to the T-time.
The accuracy will be -0/+ 5 frames. The time information may not be negative.
During the Lead-out areas the RT-time will be 0:00:00:0.
The RT-time is defined as indicated below (see also the figure in 15.5.1.1).

Case 1: Between the music tracks the PAU-ID is set to "1":



The RT-time will start with the total time of the music track, including the pause time. The RT-time will decrement towards 0:00:00:0 at the rising edge of the PAU-ID. Then the RT-time will start the count down of Track NN+1 including the pause time between music track NN and NN+1.

Case 2: No PAU-ID applied between the music tracks:



The RT-time will start with the total time of the music track, including the time of any pauses or silent periods. The RT-time will decrement towards 0:00:00:0 at the falling edge of the L-ID. The total playing time of the next track will then start to decrement.

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15.7 Table of contents

15.7.1 TOC on 2-Sector tape

A TOC must properly reflect the contents of the tape. TOC sequences are continuously repeated over the recorded area, i.e. in Lead-in, on music area and Lead-out of both Sectors.

All TOC sequences must be identical over all the tape on both Sectors A and B.
The first TOC entry of a TOC sequence must have TOC item = 0A.
Next the information from Sector A is presented in the order it appears on tape, i.e. in items with TOC items of 01...98, containing all track and Index/Chapter start positions. Sector A information is completed with an "AE" item.

This is followed by information from Sector B with TOC items of 02...99: all track and Index/Chapter start positions. The TOC ends with a "BE" item.
After this the sequence is recorded again.

Track and Index/Chapter start positions (including Index "00") will specify the A-time of the first frame at which the combination of Track and Index/Chapter number is recorded. In the case of Index/Chapter numbering, the change in PAU-ID (at the start of a pause) should also be included in the TOC: this will give a double entry for the same track and Chapter number combination.

The "AE" ("BE") item will specify the A-time of the final frame in the music area of Sector A (B).

The TOC items identified by 0A, AE, BE and 01...99 can be used on prerecorded 2-Sector tapes.
The TOC items identified by CC, EE, FF, AF, BF and DA may not be used on prerecorded tapes.

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Example of TOC sequence, index numbering:

entry	TOC bytes	S/HR:MN:SE:FR	comment
0	0A,01,08,00,15		TOC partitioning
1	01,01,00,00,00	0/00:00:00:0	start of track 1, Index 1
2	01,02,40,01,25	0/00:01:25:4	track 1, Index 2
3	02,01,30,05,32	0/00:05:32:3	track 2, no pause
4	03,01,20,09,59	0/00:09:59:2	track 3
5	04,00,00,15,11	0/00:15:11:0	track 4, pause
6	04,01,20,15,15	0/00:15:15:2	track 4, Index 1
7	04,02,50,21,37	0/00:21:37:5	track 4, Index 2
8	04,03,20,27,06	0/00:27:06:2	track 4, Index 3
9	AE,00,10,31,44	0/00:31:44:1	end of Sector A
10	05,01,A0,31,44	1/00:31:44:2	beginning Sector B of track 5
11	06,01,D0,38,24	1/00:38:24:5	track 6
12	07,01,B0,43,22	1/00:43:22:3	track 7
13	08,01,D0,49,56	1/00:49:56:5	track 8, Index 1
14	08,02,A0,55,13	1/00:55:13:2	track 8, Index 2
15	BE,00,91,01,34	1/01:01:34:1	total playing time

Example of TOC sequence, chapter numbering:

entry	TOC bytes	S/HR:MN:SE:FR	comment
0	0A,01,08,00,10		TOC partitioning
1	01,A1,00,00,00	0/00:00:00:0	start of track 1
2	02,A1,30,05,32	0/00:05:32:3	track 2
3	03,A1,20,09,59	0/00:09:59:2	track 3
4	04,A2,00,15,11	0/00:15:11:0	track 4
5	AE,00,10,31,44	0/00:31:44:1	end of Sector A
6	05,A2,A0,31,44	1/00:31:44:2	beginning Sector B of track 5
7	06,A2,90,38,24	1/00:38:24:1	track 6
8	07,A3,A0,43,22	1/00:43:22:2	track 7
9	08,A3,C0,49,56	1/00:49:56:4	track 8
10	BE,00,91,01,34	1/01:01:34:1	total playing time

This shows that tracks 1,2 and 3 belong to Chapter 1, tracks 4,5 and 6 to Chapter 2, and tracks 7 and 8 to Chapter 3.

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15.7.2 TOC on 4-Sector tape

The table of contents will carry information for four Sectors, in the order :

Sector A - channel I;
Sector B - channel I;
Sector A - channel II;
Sector B - channel II.

Each one of the four individual music channels is considered as a 'Sector' on its own. The information for each 'Sector' can be identified with the help of the Index/Chapter field of the TOC items (see clause 14.2.5). The 4 most significant bits of the Index/Chapter field will identify the "Sector" :

Sector A - channel I : 'Sector A'
Sector B - channel I : 'Sector B'
Sector A - channel II: 'Sector C'
Sector B - channel II: 'Sector D'

The remaining 4 bits can be used to identify a Chapter. So the number of Chapters is limited to 9 : 1 ... 9 . The value "0" is recorded if the Chapter identification is not used.

Example of TOC sequence, 4-sector tape:

entry	TOC bytes	S/HR:MN:SE:FR	comment
0	0A,01,16,00,19		TOC partitioning
1	01,A1,00,00,00	0/00:00:00:0	Sector "A" : track 1
2	02,A1,30,05,32	0/00:05:32:3	track 2
3	03,A1,20,09,59	0/00:09:59:2	track 3
4	04,A2,00,15,11	0/00:15:11:0	track 4
5	AE,00,10,31,44	0/00:31:44:1	end of Sector A
6	05,B2,A0,31,44	1/00:31:44:2	Sector "B" : track 5
7	06,B2,D0,38,24	1/00:38:24:5	track 6
8	07,B3,B0,43,22	1/00:43:22:3	track 7
9	08,B3,A0,49,56	1/00:49:56:2	track 8
10	BE,00,D1,01,34	1/01:01:34:5	end of Sector B
11	09,C3,30,01,24	0/00:01:24:3	Sector "C" : track 9
12	10,C4,40,06,45	0/00:06:45:4	track 10
13	11,C4,10,15,33	0/00:15:33:1	track 11
14	12,C5,40,24,06	0/00:24:06:4	track 12
15	13,D5,A0,31,44	1/00:31:44:2	Sector "D" : track 13
16	14,D6,B0,37,56	1/00:37:56:3	track 14
17	15,D6,90,47,23	1/00:47:23:1	track 15
18	16,D6,D0,54,34	1/00:54:34:5	track 16
19	DE,D6,A0,59,32	1/00:59:32:2	end of track 16 and Sector D

This shows that tracks 1, 2, 3 and 4 belong to 'Sector A', tracks 5, 6, 7 and 8 to 'Sector B', tracks 9, 10, 11 and 12 to 'Sector C' and tracks 13,14,15 and 16 belong to 'Sector D'.

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15.8 Character recording

Character recording on prerecorded tapes is implemented in the Sysinfo data area and specified in chapter 13.2.1.

15.9 Duplicator identification code

This number is unique to the prerecorded cassette manufacturer. The number is recorded in the Aux data (AIS = FF). A Duplicator identification code number can be applied for at Philips Consumer Electronics B.V. (see Preface).

15.10 Example of prerecorded 2-Sector tape format

The example can be found in Figure 15.1

15.11 Example of prerecorded 4-Sector tape format

The example can be found in Figure 15.2

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16. APPLICATION RULES SYSINFO AND AUX DATA ON CONSUMER RECORDED CASSETTES

Consumer-recorded cassettes are defined in chapter 5.

16.1. Classification

Two tape formats are defined for consumer recorded tapes: Super-user and User tape format (see 14.2.1 (SU-ID) and 13.2 (TT_1, TT_2)).

16.1.1 Super-user tape is classified by the following:

System info :(see 13.2)

Format-ID	: Mandatory "0000"
Copyright bits (CP1,CP2)	: According to the rules of ch. 20.
Tape type bit (TT1,TT2)	: Mandatory "0X"
Setmakers signature	: Mandatory - see 13.2.6.6.

Auxiliary data :(see also 14.1)

SU-ID	: "1" see clause 14.2.1 (identifies Super-user tape)
Format-ID	: Mandatory "0000"
Block address	: Mandatory see 14.2.1
Lead-in Sector A	: Mandatory - see 16.3
Lead-in Sector B	: Optional - see 16.3
Start marker	: Mandatory - see 16.4.1
F-ID	: Optional - see 16.4.9 (identifies the use of the Fade marker)
M-ID	: Optional - see 16.4.8 (identifies the use of the Mute marker)
PAU-ID	: Mandatory "0",except during Lead-in
TOC-ID	: Optional - see 16.8
ML-ID	: Mandatory - see 14.2.4
SH-ID	: Optional - see 16.4.10 (identifies the use of the Skip marker)
Reverse Marker	: Optional - see 16.4.6
Temporary reverse marker	: Optional - see 16.4.7
Next Sector Marker	: Optional - see 16.4.5
Home Marker	: Optional - see 16.4.2
Stop Marker	: Optional - see 16.4.3
Use again Marker	: Optional - see 16.4.4
Track number	: Mandatory- see 16.7
Index/Chapter number	: Optional - see 16.7
A-time	: Mandatory - see 16.6.1
T-time	: Mandatory (valid in Marker area, elsewhere "7:AA:AA:0")
R-time	: Not applicable, but if AIS=02 then "7:AA:AA:0"
RT-time	: Not applicable, but if AIS=02 then "7:AA:AA:0"
TOC	: Optional - see 16.8
ISRC	: Not recorded because AIS is not "01"
Identification number	: Not recorded because AIS is not "01"
Duplicator ident. code	: Not recorded because AIS is not "FF"
Recording date	: Optional
Character recording	: Optional - see 16.9

For a survey of the recorded items refer to table 17.1 of chapter 17.

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16.1.2 User tape format

For User tape the following items differ from Super user tape:

Auxiliary data : (see also 14.1)

SU-ID	: "0" see section 14.2.1 (identifies User tape)
TOC-ID	: Mandatory "0"
Lead-in Sector A	: Optional
Track number	: Mandatory "00 "
A-time	: Mandatory "7:AA:AA:0"
TOC items	: Mandatory "00"

For a survey of the recorded items refer to Table 17.1 of chapter 17.

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16.2 General format of consumer recorded tape

16.2.1 Consumer recorded tape programming

Consumer recorded tape is always recorded in 2-Sector stereo mode (see 12.1). Consumer recorded mode is indicated by the Tape Type bits TT1 and TT2 (see 13.2).
If a TOC is applied, there will only be one TOC which contains information of both the Sectors A and B.

The program over the two sectors is specified for two cases,

- case 1: The start of Sector B coincides with the end of sector A, like with the pre-recorded format. In this case a Reverse marker is used to indicate the end of Sector A.
- case 2: Sector B starts directly after the trailer tape, independent from the end of Sector A. In this case either a Next marker is used to indicate the end of Sector A or no marker is applied to indicate the end of Sector A.

The end of the entire program can also be indicated with a marker.

16.2.2 Consumer recorded tape formats

Three types of consumer tape formats are specified, User format, Super user format and Hybrid format. Other tape formats are not available for consumer recording. The format specified in chapter 15 (prerecorded tape) is not specified for use on blank DCC-cassettes as defined in chapter 5 and therefore cannot be used on these cassettes.

Super-user format is different from the User format because:
- A non-interrupted A-time is recorded over the entire length of the music program area.
- Music tracks can have consecutive track numbers.

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16.2.2.1 User tape format

The User format is defined by the setting of the SU-ID as specified in 16.1.1.
The User format is the most simple DCC tape format. The music tracks on User format do not carry a unique track number but carry all number "0". No time information is recorded, the A-time fields contain non-valid values.
The User format indication defines that the DCC player shall disregard tracknumber and (A)-time information. Search on a User format tape is by means of counting start markers (relative tracknumbers).
Available options on User format tape are defined in 16.1.
The User tape format according to the two cases mentioned in 16.2.1 is shown in the following two examples:

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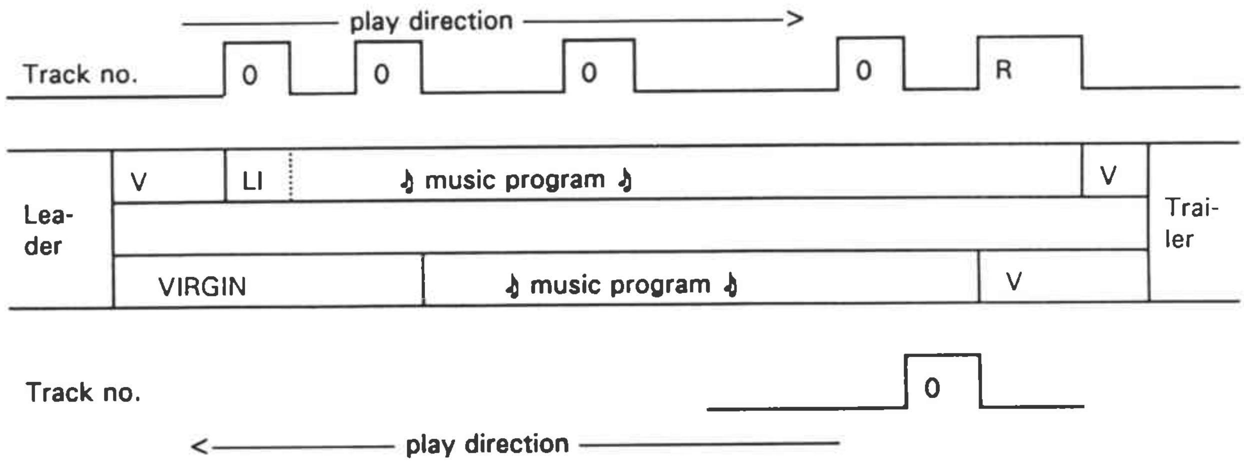
Example I: User tape with REVERSE marker (case 1 in 16.2.1)

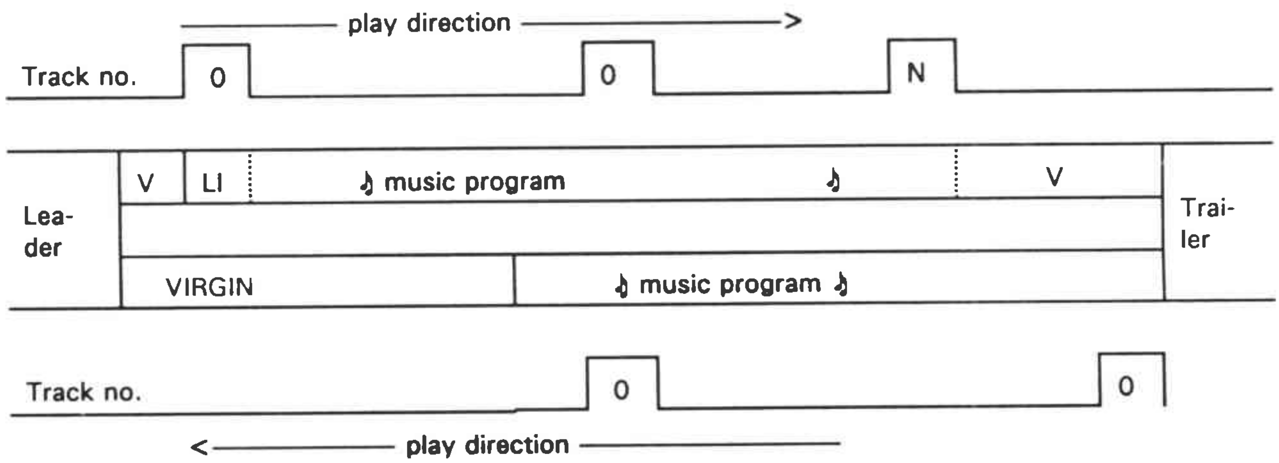
On this User tape format a 'Reverse Marker' (R) is used at the end of Sector A. The beginning of Sector B is expected to be positioned such that play back can continue immediately after the change of playback direction. Track numbering and A-time are not applicable for this format. The tape can be organized as follows:



The alignment of the reverse marker with the start of the music on sector B is described in 16.2.2.2.

Example II: User tape with NEXT SECTOR marker (case 2 in 16.2.1)

On this User-tape format a 'Next Sector Marker' is used at the end of Sector A. The beginning of Sector B shall be positioned at the tape start of the Sector B. The tape can be organized as follows:



16.2.2.2 Super-user tape format

The Super-user format is defined by the setting of the SU-ID as specified in 16.1.1.
The Super-user format contains additional information in the Aux data to allow for superior search procedures on consumer recorded cassettes. The Super-user indication signals to a DCC-player that the tape contains, as a minimum, correct tracknumbers, correct A-time information and a Lead-in of sector A.

Correct tracknumbers are defined as:
- tracks carry consecutive numbers, the first track carries number 1.
- alternatively tracks may carry no number, indicated with number "0".
- no two tracks may carry the same tracknumber, except for the number "0".

Correct A-time information is defined as a non-interrupted, continuously increasing time, which starts at 0:00:00:0 at the begin of sector A.

The SU-ID must be kept in accordance with the (local) status of the A-time and tracknumber. Therefore the rule to have the correct SU-ID on tape is:

- SU-ID = "1" as long as A-time and tracknumber is correct
- SU-ID = "0" if the information is incorrect or unknown.

Optionally Super-user format tapes may contain a TOC at the begin of Sector A and Sector B (see 16.7).

Available options on Super-user format tape are defined in 16.1.

To facilitate the recording of Super-user tapes the "Append recording" function is defined (see 17.3.1.4). To facilitate the "repair" of Super-user tapes with tracknumbers "0" the "Renumber" function is defined (see 17.3.1.5).

The Super-user tape format according to the two cases mentioned in 16.2.1 is shown in the following two examples:

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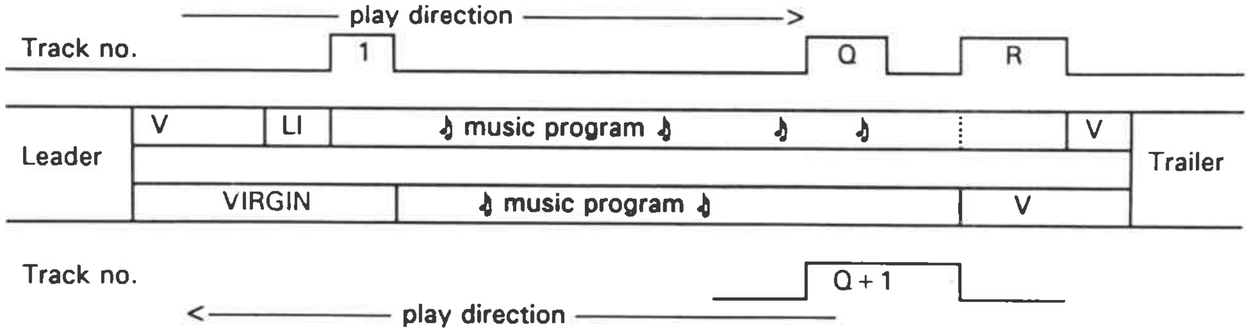
Example I: Super-User tape with REVERSE marker (case 1 in 16.2.1)

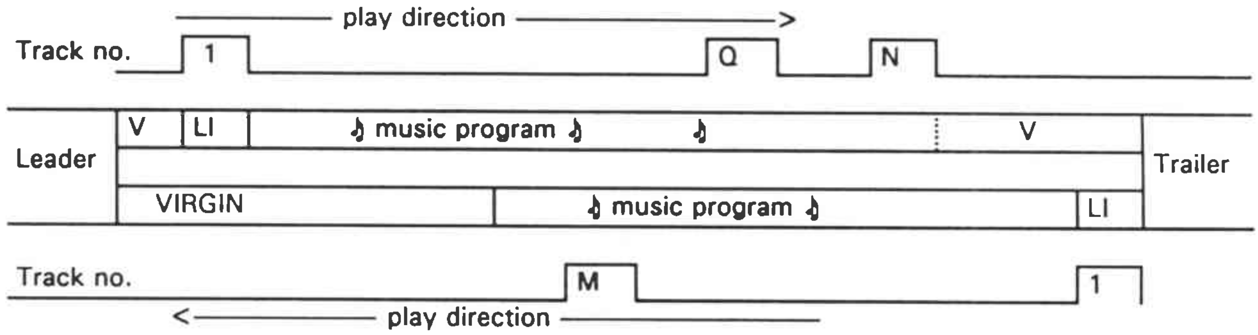
On this super-user tape format a 'Reverse Marker' (R) is at the end of Sector A. The beginning of Sector B should be positioned such that playback can continue immediately after the change of the playback direction.
The tape will be organized as follows :



The A-time code shall be recorded without interruption, i.e. virgin tape areas in between the music programs may not occur. Track numbering and A-time must continue from Sector A to Sector B. The first track on Sector B will have a track number that is equal to the track number of the last track on Sector A plus one (Q+1). Trailer is recommended as Reverse Marker.

Example II: Super-User tape with NEXT SECTOR marker (case 2 in 16.2.1)

On this super-user tape format a 'Next Sector Marker' (N) is used at the end of Sector A. The beginning of Sector B shall be positioned at the tape start of Sector B. The tape will be organized as follows:



Track numbering shall start at both Sectors with 1. The A-time shall start at either Sector from "0:00:00:0". The SOB bit will be "1" on sector B.

Note: The Next Sector marker may be used on Sector B also.

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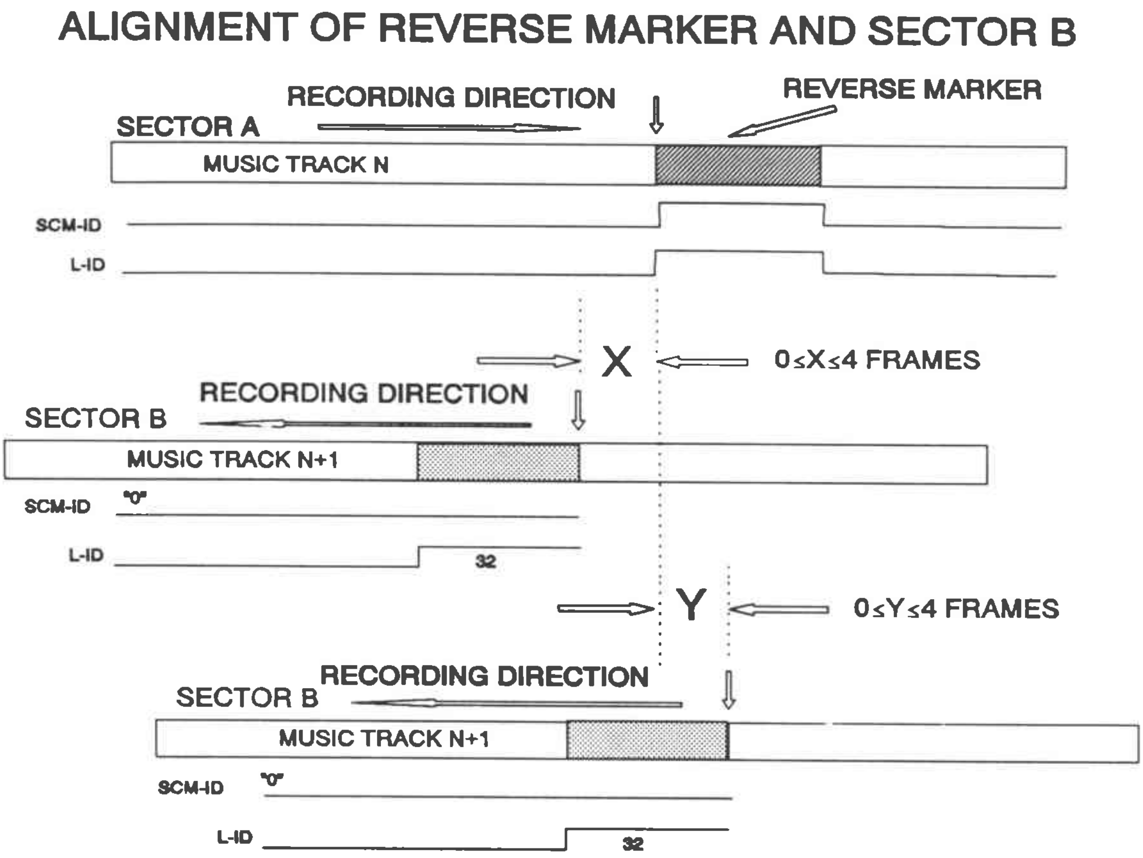
Alignment of Reverse marker and Sector B

The Reverse marker at the end of Sector A and the beginning of Sector B should be aligned as indicated below:



The position of the rising edge of the Reverse marker at the end of Sector A should be 4 frames maximum before or beyond the rising edge of the start marker of the first track on Sector B.

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16.2.2.3 Hybrid tape format

Hybrid tape formats are defined as consumer recorded tape formats which contain both (partial) Super-user format and User format. From the point where the conditions as specified in 16.2.2.2 are no longer met, the SU-ID must be recorded as "0".

If due to partial re-recording of a Super-user tape, a part of this tape is recorded with an incorrect A-time or no valid tracknumber information, the SU-ID in the re-recorded area must be recorded as "0", indicating a (local) User format.

In case of playback or search it is left to the setmaker how to understand such a local change in SU-ID, as a local indication only or onwards for the rest of the tape.

The TOC only defines the first Super-user part of the tape, up to the first User format part.

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16.3 Lead-in and Lead-out area

Lead-in and Lead-out areas are used to define the music area. On both User and Super-user tape format, the Lead-out area is defined by one of the so called sector markers (see 16.4).

The beginning of the music area is the first frame after the Lead-in area and the end of the music area is the frame just before the starting point of the Sector marker. The Lead-in area and Sector markers can be detected in playback and in search modes.
Hereafter a detailed description is given of the Lead-in area.

Lead-in Super-user tape

The Lead-in is at least 16 frames long. During the last 16 frames the Label-ID is recorded following a pattern of 4 frames labelled (L-ID="1"), followed by 4 frames not labelled
(L-ID="0"), ending with 4 frames not labelled. Both the A-time and T-time decrement to "0". The PAU-ID and the SCM-ID are both set to "1".
The Lead-in on Sector B is optional.

Lead-in for User tape

The Lead-in area on both Sectors is optional but has the same specification as for Super User tape.

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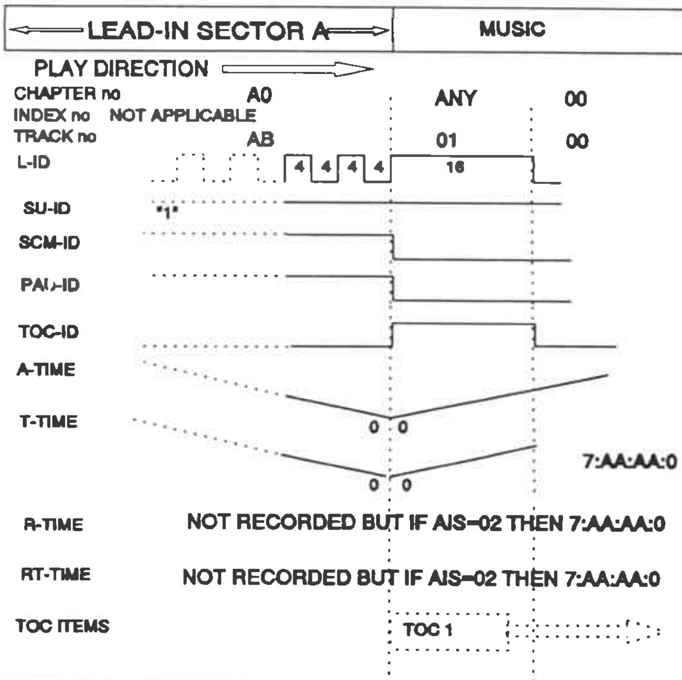
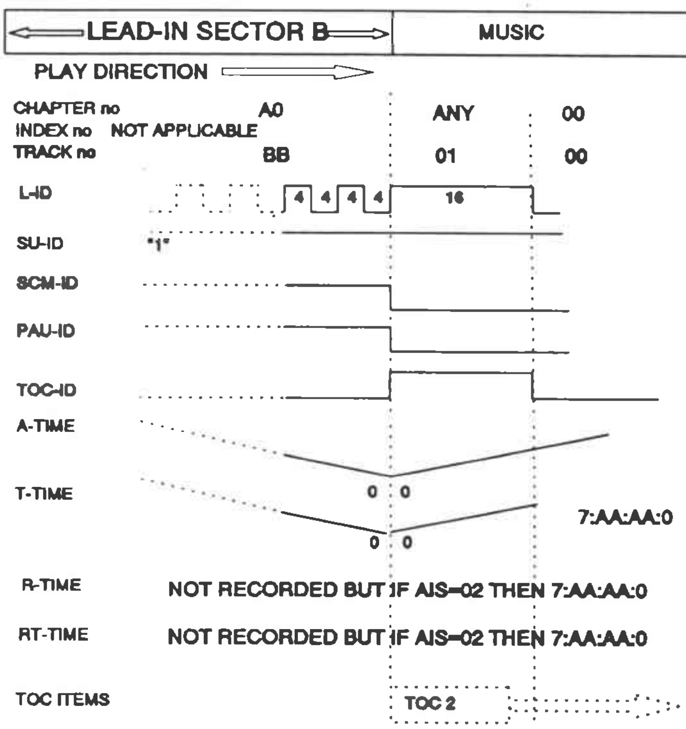
LEAD-IN SUPER-USER TAPE (+TOC)





THIS EXAMPLE DESCRIBES TWO INDEPENDENT MUSIC PROGRAMS, ONE FOR EACH SECTOR

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16.4 Markers

Three types of markers are defined:

- Start markers. These are located in the music area. Their function is to identify the start of a new music track.

- Sector markers (Next Sector, Home, Reverse, Temporary reverse, Use-Again, Stop, Lead-in). The function of these markers is to define the start (Lead-in) and the end (Next Sector, Home, Reverse, Temporary reverse, Use-Again, Stop) of the music area. Different sector markers have been defined to specify different instructions for the player (e.g. stop immediately, reverse immediately and continue, or continue at the beginning of the other sector).
  The Reverse and Temporary Reverse markers are 32 frames long, labelled (L-ID = "1").
  The other Sector markers are 16 frames long. During these 16 frames the L-ID is recorded following a pattern of 4 frames labelled (L-ID = "1"), followed by 4 frames not labelled (L-ID = "0"), ending with 4 frames not labelled.

- Feature markers (Mute, Fade, Skip). Their function is to specify the player behaviour while playing a music track (e.g Skip the remaining part of this music track and continue with the next music track).

During the Start markers and Sector markers the Track time must be recorded incrementing from "0:00:00:0", both in Super-user and User tape format.

Because of their shape the markers, except feature markers, can be found in search mode by envelope detection of the Aux data track. The specific kind of marker can be detected in playback mode. All markers may appear more than once on tape. It is recommended to maintain a minimum distance of 16 frames between the ending point of a marker and the starting point of the next one. When a marker is erased, the marker should be erased completely. Other markers next to the erased one should not be deformed. This also holds for feature markers that coincide with the marker to be removed.

Hereafter a detailed description is given of the possible markers, including their relation with data and time information.

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16.4.1 Start marker

This marker indicates the beginning of a music track. The Aux track is continuously recorded, thus creating a Labelled area (L-ID="1"). It can be detected in playback and in the search mode.
This marker can be used on Sector A and Sector B.

The start marker length will either be 16 frames (ML-ID="0") or 32 frames (ML-ID="1"). The start of the music track coincides with the first frame in which the L-ID is "1".

A Start marker with a length of 32 frames occurs only in combination with a reverse marker on sector A. It indicates the first music track on sector B that belongs is part of the music program of Sector A. This start marker with a length of 32 frames may only occur on Sector B. The length of 32 frames makes it possible to use it as an indication that from there on it is a continuation of Sector A which is especially useful in backwards search on Sector B.

If the start marker is erased, as a result this position is non-labelled, the Tracknumber is "00" and the optional consumer recorded text is removed.

See the next page for the description of the start markers with the length of 16 frames. The start markers with a length of 32 frames have the same structure, only the ML-ID must be recorded "1".

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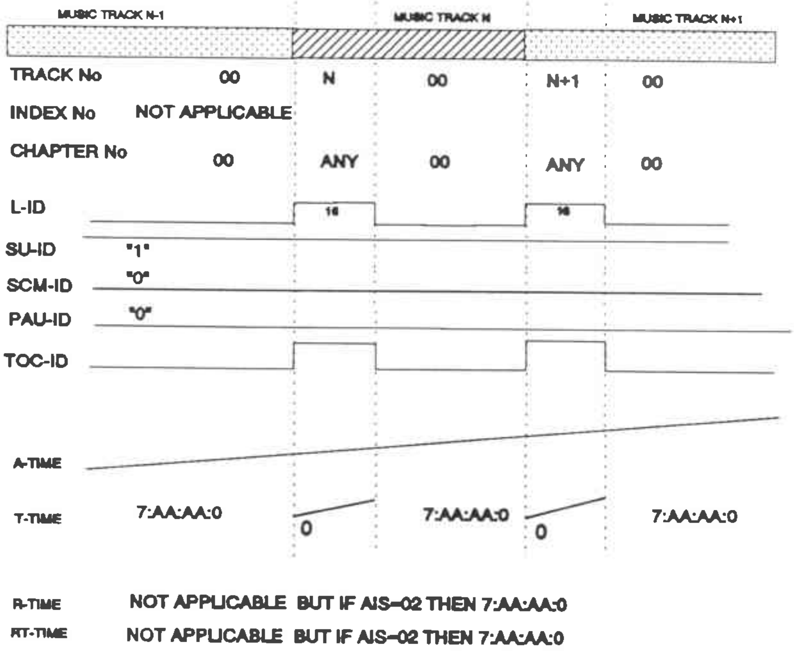
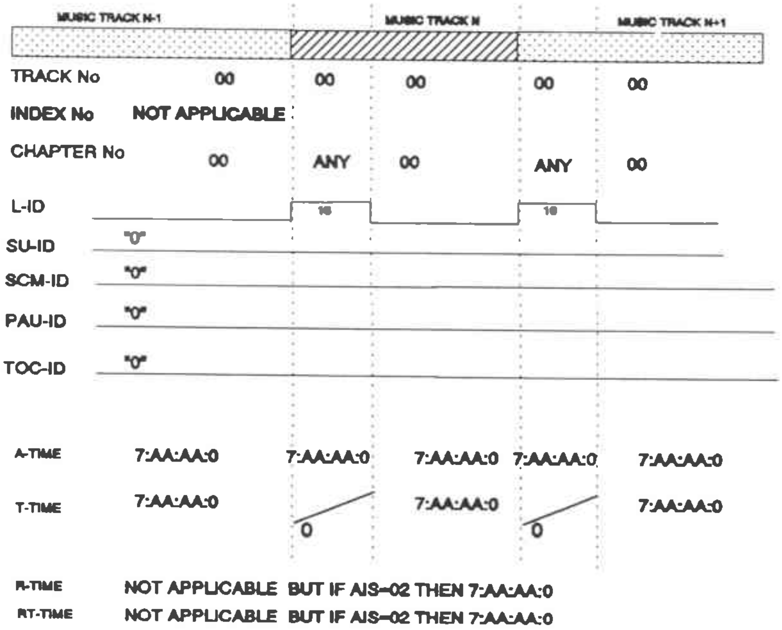
RECORDING DATA DURING START MARKERS

CONSUMER RECORDED RENUMBERED SUPER USER TAPE (+TOC)



CONSUMER RECORDED USER TAPE



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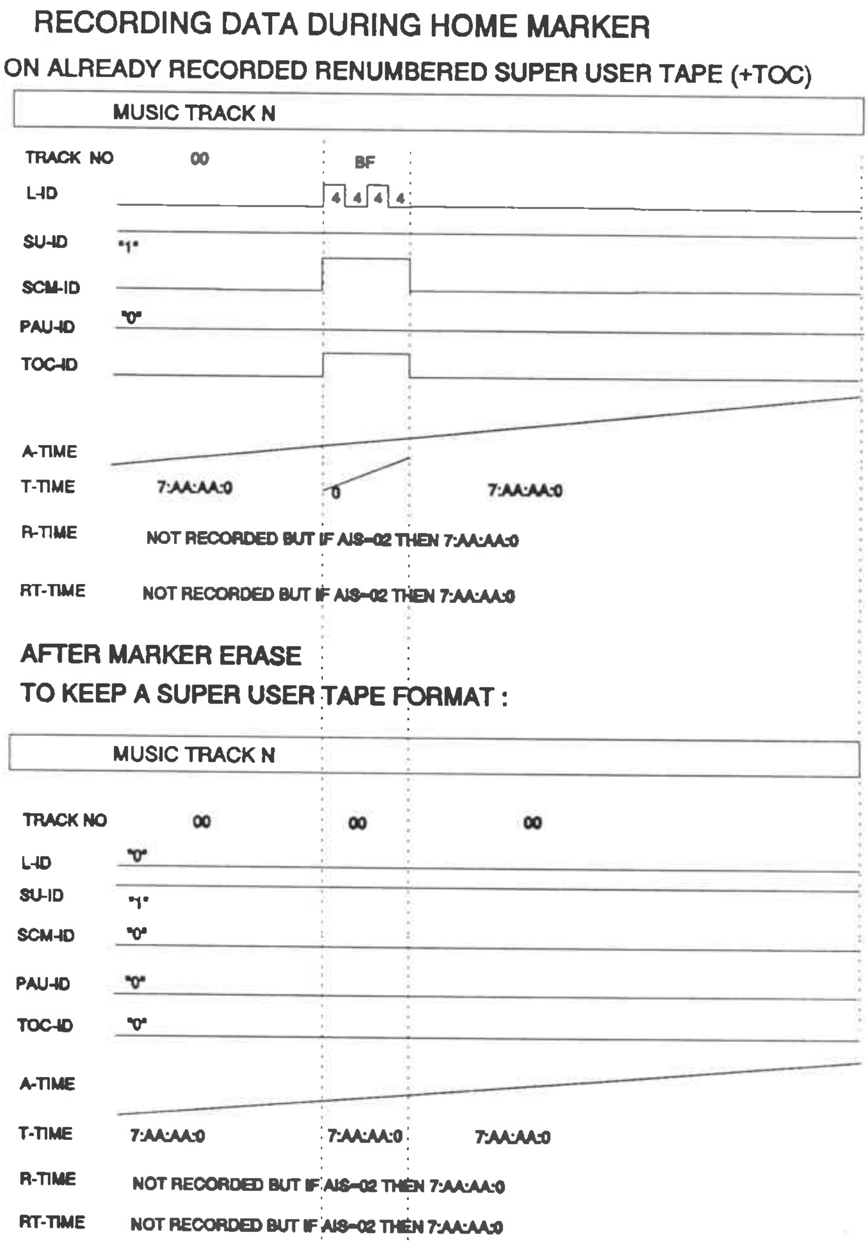
16.4.2 Home marker

The Home marker defines the end of the recorded program.
After detection, both in playback and search, a DCC player must position the deck to the beginning of the music program at Sector A.
This marker can be used on Sector A or on Sector B.
The length of this marker is 16 (4*4) frames.



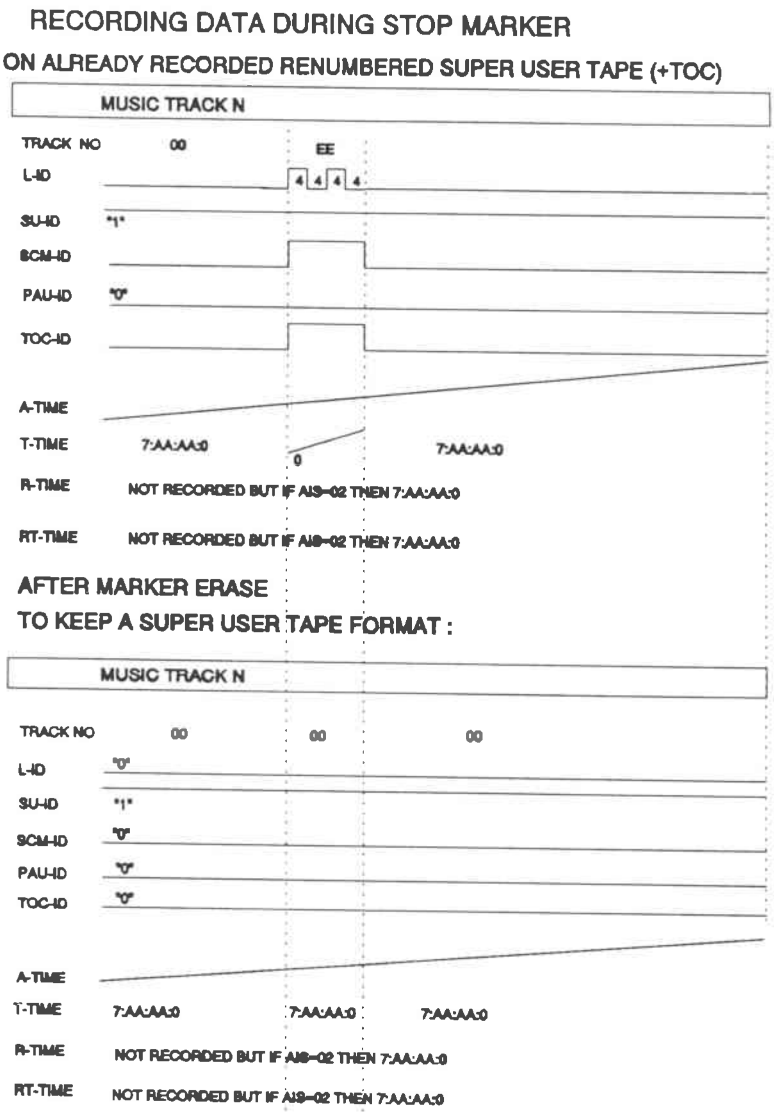
16.4.3 Stop marker

The Stop marker defines the end of the recorded program.

Upon detection of this marker during playback or search, the deck should re-position on the last frame before this marker and stop.

The marker can be used on Sector A or on Sector B.
The length of this marker is 16 (4*4) frames.

When the 'renumber' function (see 17.3.1.5) is active, this marker indicates the end of the last track of the music program.



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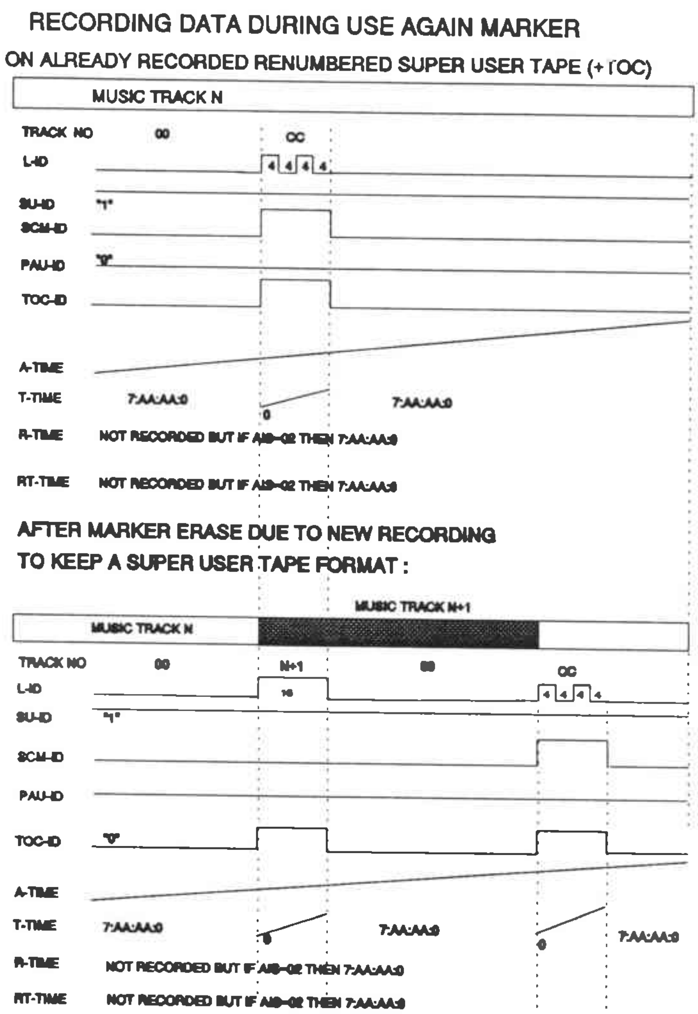
16.4.4 Use again marker

This marker indicates the end of the music area. It defines the start position for future recording. The marker may be used on Sector A and Sector B. Upon detection of this marker during playback or search it is recommended that the deck should (re)-position on the last frame before this marker and stop. If more than one Use Again marker is recorded on tape, the first one following the Lead-in area of Sector A is defined as the end of the music program area. A Use Again marker at Sector A automatically defines the remainder of Sector A **and** Sector B as obsolete music program area. When the 'renumber' function (see 17.3.1.5) is active, this marker indicates the end of the last track of the music program.

During the Use again marker, both TOC entries in the Aux data (AD10 to AD19, see 14.2) must be used to store the A-time of the last frame previously to the Use again marker, and the track number for the next track to be recorded. On a user tape the A-time is recorded 7:AA:AA:0 and the track number is recorded as 00. AD11 and AD16 contain the value for the new track number, AD12,AD13,AD14 and AD17,AD18,AD19 contain the absolute time, AD10 AD5 must contain the value CC. The two TOC entries must be identical. The length of this marker is 16 (4*4) frames.



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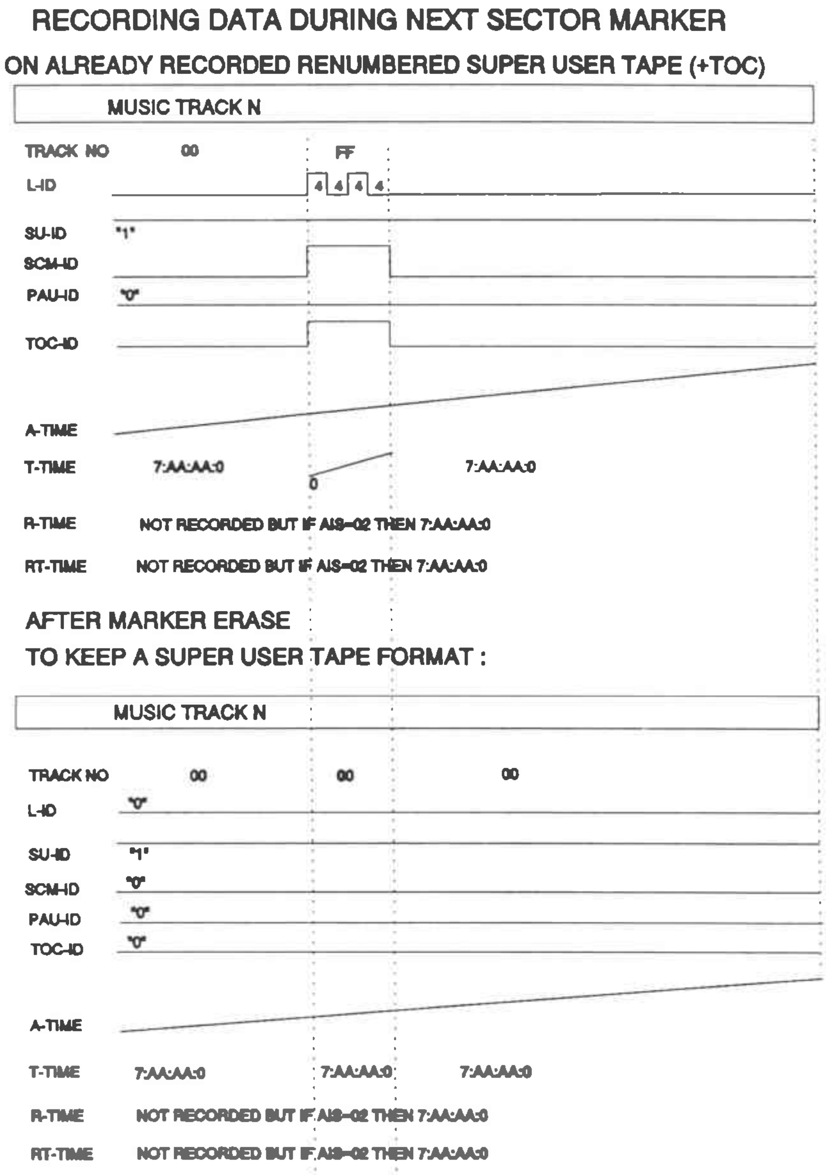
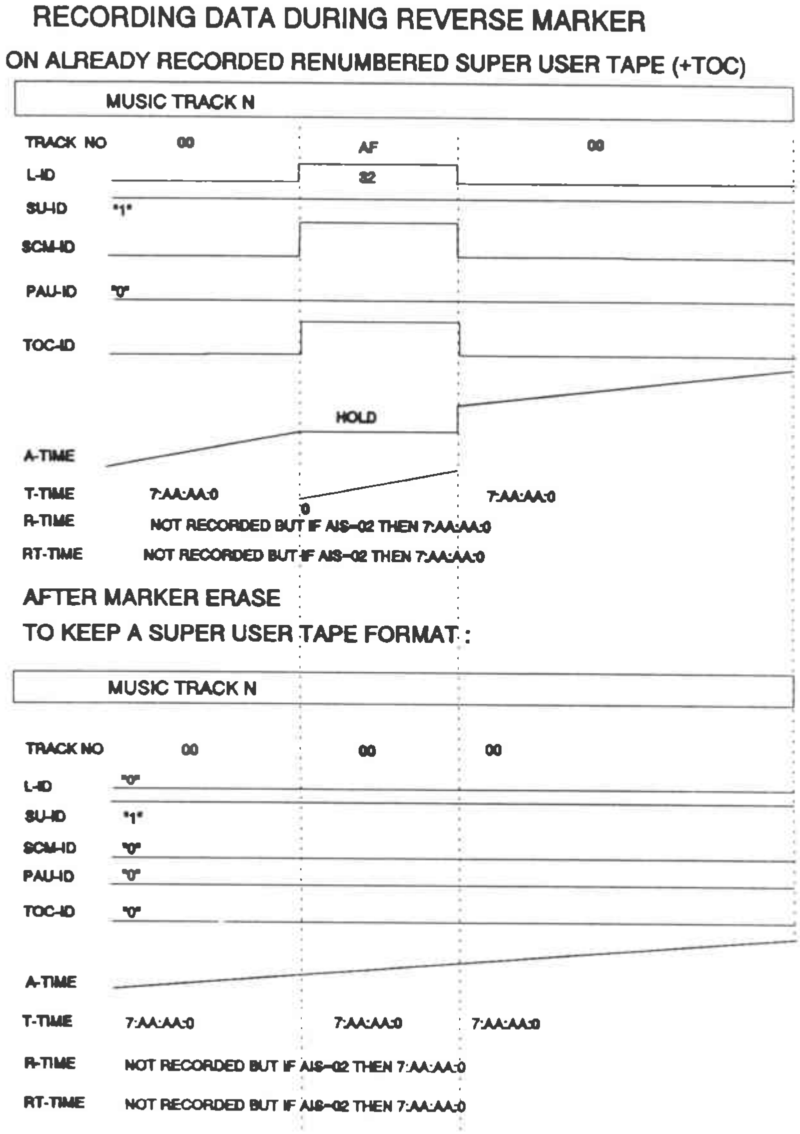
16.4.5 Next Sector marker

This marker marks the end of the music area on a Sector and indicates that the other Sector starts immediately after the trailer tape (case 2 of 16.2.1) and that track numbering restarts from 1 again and that (on Super-user format only) the A-time recording starts again from 0:00:00:0.
This marker can be used on Sector A and Sector B.
Upon detection of this marker during playback or search, the deck should search for the beginning of the music of the other Sector.
When the 'renumber' function (see 17.3.1.5) is active, this marker indicates the end of the last track of that Sector and that the track numbering on the other Sector should start incrementing from "01" again. The length of this marker is 16 (4*4) frames.



16.4.6 Reverse marker

This marker marks the end of the music area on Sector A and is used to indicate that Sector B contains the remaining part of the music program.
This marker may be used on Sector A only.
Upon detection of this marker during search, the deck should switch over to Sector B and continue to search.
Upon detection of this marker during playback, the deck should switch over to Sector B and continue in the play back mode.
When the 'renumber' function (see 17.3.1.5) is active, this marker indicates the last track number of Sector A and also that the tracknumbering on Sector B continues incrementing from there.
The length of this marker is 32 frames.

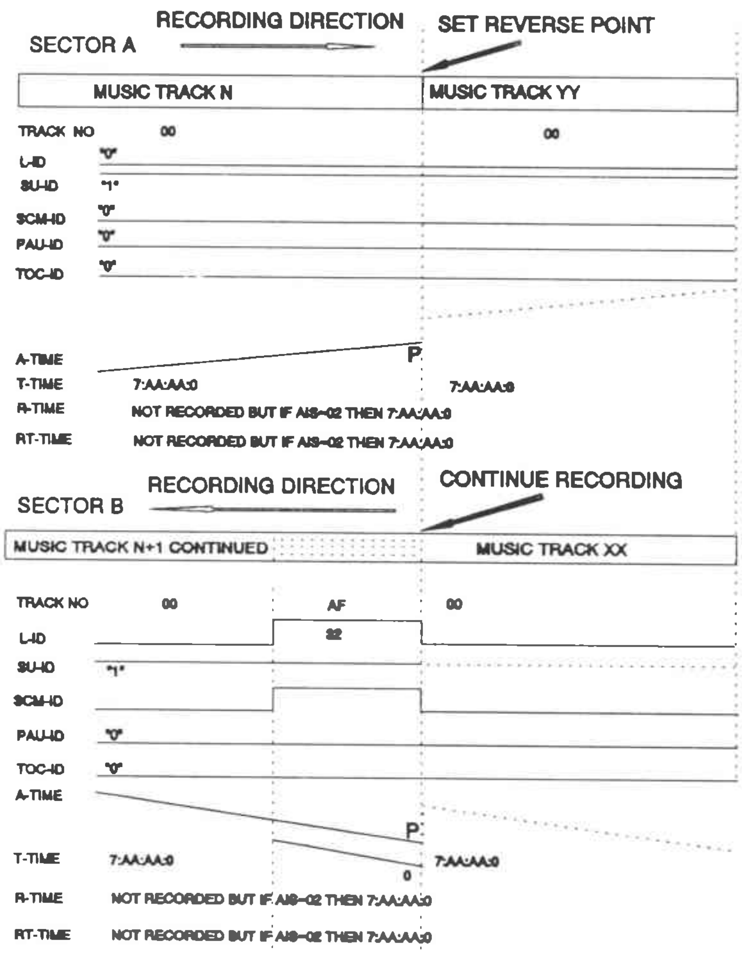


16.4.7 Temporary Reverse marker

This marker marks the beginning of the remaining part of the music program on Sector B.
This marker should be recorded automatically when no Reverse marker could be written at the end of Sector A, caused by the change of a Sector during recording. The length of this marker is 32 frames. Upon detection of this marker during playback, the deck continues in the play mode.
Upon detection of this marker during search forward, the deck behaves as if this was a Start marker.
Upon detection of this marker during search reverse, the deck behaves as this was a Start marker and switches over to Sector A when necessary.
When the 'renumber' function (see 17.3.1.5) is active, this marker indicates the end of the last track of Sector A and also that the track numbering on Sector B should continue. At the same time this marker is overwritten by a Start marker of 32 frames (ML-ID="1") and a Reverse marker is recorded on Sector A.

RECORDING DATA DURING TEMPORARY REVERSE MARKER

ON ALREADY RECORDED SUPER USER TAPE

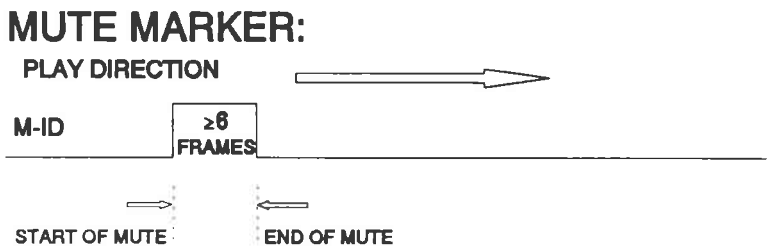


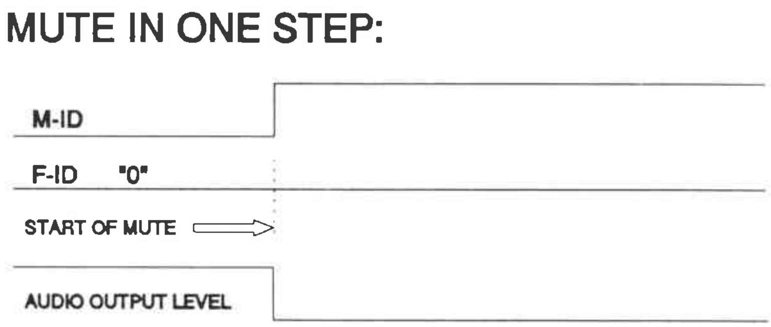
16.4.8 Mute marker

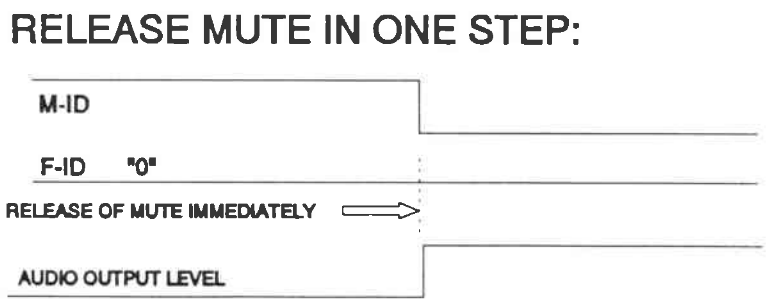
This marker indicates the player to mute the audio signal during the time the marker lasts and can be used together with the Fade marker. This marker can be used on Sector A and Sector B. Upon detection of this marker during playback the audio signal is muted in one step or gradually depending on the simultaneously existence of a Fade marker:

- Fade-out starts from the point where the Mute marker is detected while the F-ID is "1".
- Fade-in occurs from the point where the end of the Mute marker is detected while the F-ID is "1".
- The audio signal is muted in one step from the point where the Mute marker is detected while the F-ID is "0".
- The audio signal is released in one step from the point where the end of the Mute marker is detected while the F-ID is "0".

This marker can not be detected during search mode. When the 'renumber' or 'after recording' function is active, this marker may not be destroyed. The length of this marker is 6 frames minimum.







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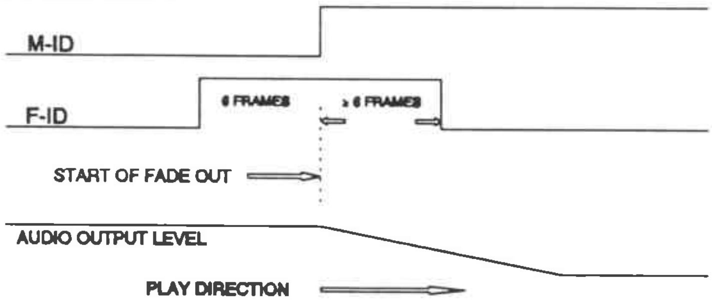
16.4.9 Fade marker

This marker indicates the player to fade the audio signal during play back, starting from the begin or end position of the Mute marker. Without the simultaneous existence of a Mute marker, fading will not occur. If a Fade marker is recorded then a Mute marker must be recorded also.
This marker can be used on Sector A and Sector B.
Upon detection of this marker during playback the audio signal is muted:

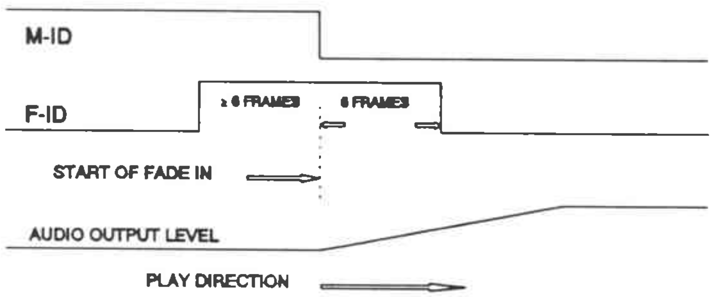
- Fade-out starts from the point where the Mute marker is detected while the F-ID is "1".
- Fade-in occurs from the point where the end of the Mute marker is detected while the F-ID is "1".

This marker cannot be detected during search mode.
When the 'renumber' or 'after record' function is invoked, this marker may not be destroyed.
The minimum length of this marker is 12 frames.

FADE OUT:



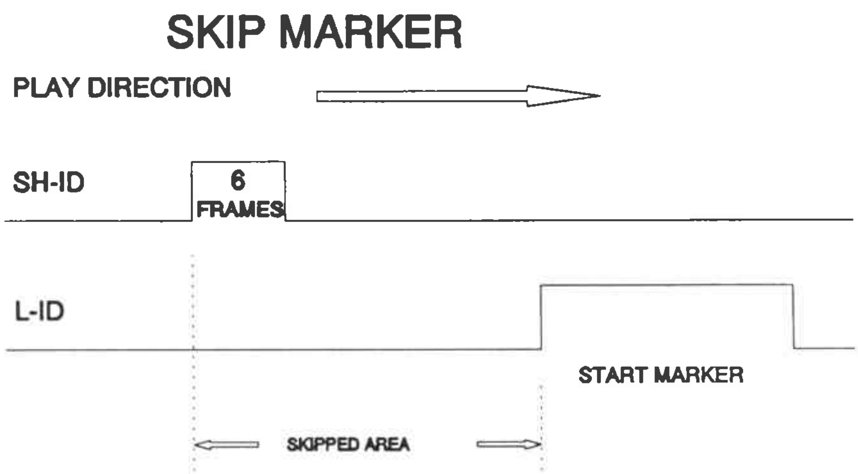
FADE IN:



FADE IN + FADE OUT :

16.4.10 Skip marker

This marker marks the position from where the remaining part of the current music track should be skipped.
This marker can be used on Sector A and Sector B.
Upon detection of this marker during playback, the deck searches for the next Start marker, mutes the audio in the meanwhile and continues to play the next music track.
This marker cannot be detected during search mode.
When the 'renumber' or 'after recording' function is active, this marker may not be destroyed.
The length of this marker is 6 frames.



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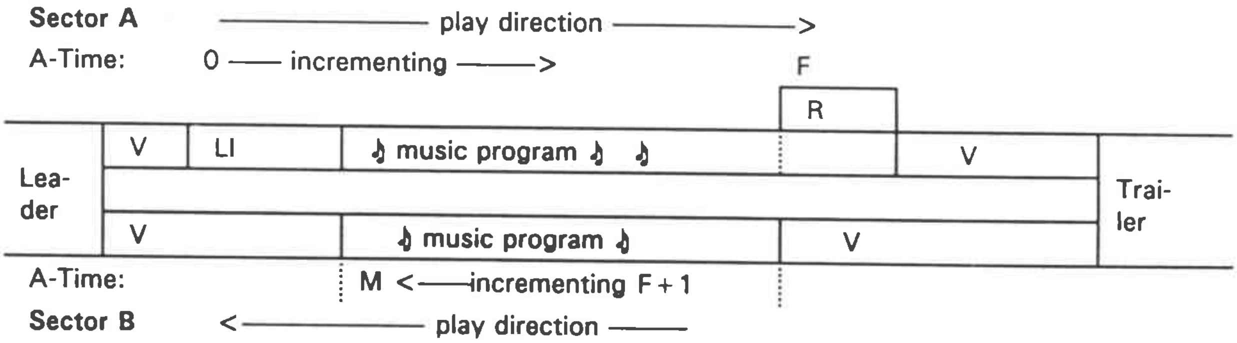
16.5 Time recording

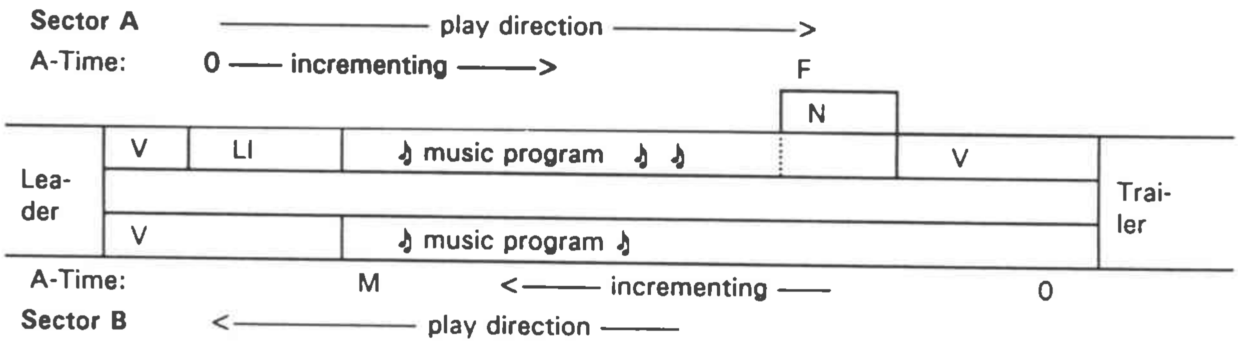
On consumer recorded tapes T-time is recorded during the Start markers and the Sector markers only.
On Super user tapes the A-time is also recorded. Other time modes are not recorded.

16.5.1 A-time (Super user tape only)

The A-time code shall be recorded without interruption, i.e. it may not be interrupted by virgin tape areas. The A-time will always be recorded in ascending order except during the Lead-in, (decrementing) and during a Reverse marker (hold). It starts from "0:00:00:0" at the beginning of the music program of Sector A.
When a Reverse marker has been used (case 1 of 16.2.1), the A-time will continue at Sector B with the final value of the Sector A. SOB="0".
The A-time will then be recorded as indicated below:



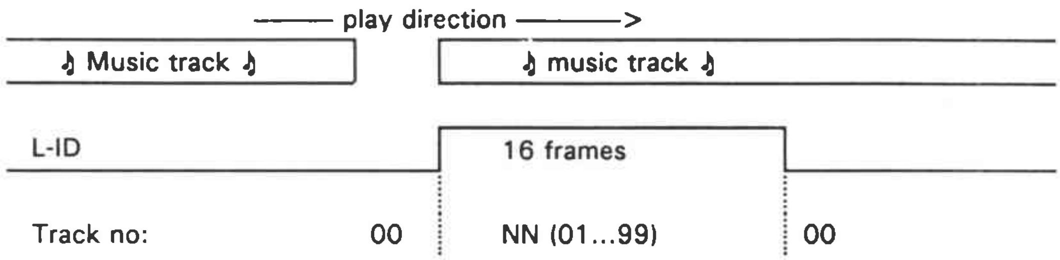
When a Next sector marker has been used (case 2 of 16.2.1), the A-time will start at the Sector B from "0:00:00:0". The SOB-ID is recorded "1".
A-time will then be recorded as indicated below:



16.5.2 T-time

During Start markers and Sector markers the T-time must be recorded starting at ":00:00:0"0 and incrementing. During Lead-in the T-time must be recorded decrementing towards "0:00:00:0" at the end of the Lead-in area.

16.6 Track numbering



Track numbering is applicable for Super-user tapes only. On user tapes the track numbers are recorded "00". Track numbers will be recorded in ascending order. The first track of a music program will have track number "01". Track numbers may only be recorded if the position in the sequence is known. The Use Again marker can be used to store the next Track number to be used for a new recording (see 16.4.4). In the absence of information, "00" has to be recorded: an example is a recording started in the middle of a previously recorded tape without using the append function.
Track numbers "01...99" will only be recorded during start markers. During the remainder of the music track, track number "00" is recorded.
The PAU-ID remains "0" for all of the tape, except during the Lead-in area.

Optionally, Chapter numbers may be recorded during start markers. They can be used to indicate that tracks are related, however if chapter numbers are recorded then during Sector markers the value "A0" must be recorded.
Chapter numbers will be recorded in ascending order. In between start markers the Index/Chapter field will contain "00".

Note: It is not specified that the audio information includes a silent period between tracks; music tracks may be continued from one track to another.

The first track number at the Sector B following a Reverse marker at the Sector A shall either be the last track number of the Sector A plus 1 or have the value "00", even if the same music program continues on Sector B.

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16.7 Table of contents and TOC-ID

See also section 14.2.5.

A single TOC sequence may be recorded only at the start of each Sector of Super-user tape. The first TOC item will be recorded in the first frame of the Start marker of the first track of that Sector. The length of the recorded area of the TOC may be longer than, or shorter than the length of a Start marker.

A TOC sequence starts with a "0A" item (TOC partitioning). Next the information of the entire program on both sectors is presented in the order it appears on tape, i.e. in items with TOC ID's of 01...99, containing all track start positions. If Sector markers are recorded, their location must be included in the TOC. The information of a Sector is completed with the item for the total playing time, i.e. item "AE" for Sector A or item "BE" for Sector B.
Track start positions will specify the A-time of the first frame of the Start marker at which the music track is recorded.
The "AE" ("BE") item will specify the A-time of the final frame in the music program area of Sector A (B).
If implemented the TOC will be recorded automatically after the renumber function has been completed. The renumber function will also record a TOC-ID equal to "1" in the Start markers of the tracks and in the Sector markers that will be included in the TOC. Otherwise, the TOC-ID will be recorded as "0".
Optionally the 'Date of last renumbering' may be included in the TOC (TOC item = DA).

The TOC sequence on Sector A must be identical to the TOC sequence on sector B.

Example of toc sequence:

entry	TOC bytes	S/HR:MN:SE:FR	comment
0	0A,01,08,00,13		TOC partitioning
1	01,A1,00,00,00	0/00:00:00:0	start of track 1
2	02,A1,30,05,32	0/00:05:32:3	track 2
3	03,A1,20,09,59	0/00:09:59:2	track 3
4	04,A2,00,15,11	0/00:15:11:0	track 4
5	AF,00,10,31,44	0/00:31:44:1	Reverse marker
6	AE,00,00,31,44	0/00:31:44:0	end of Sector A
7	05,A2,A0,31,44	1/00:31:44:2	start of Sector B
8	06,A2,D0,38,24	1/00:38:24:5	track 6
9	07,A3,B0,43,22	1/00:43:22:3	track 7
10	08,A3,D0,49,56	1/00:49:56:5	track 8
11	CC,00,91,01,34	1/00:01:34:1	Use Again marker
12	BE,00,81,01,34	1/01:01:34:0	total playing time
13	DA,90,12,31,24		Date of last renumbering

This shows that tracks 1, 2 and 3 belong to Chapter 1, tracks 4, 5 and 6 to Chapter 2 and tracks 7 and 8 to Chapter 3.

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16.8 Consumer character recording

Character recording on consumer-recorded tape may be implemented in the Additional information field of the Aux data.
See also section 14.2.6.

16.9 Example of consumer recorded user tape format

The example can be found in Fig. 16.1.

16.10 Example of consumer recorded super user tape format

The example can be found in Fig. 16.2.

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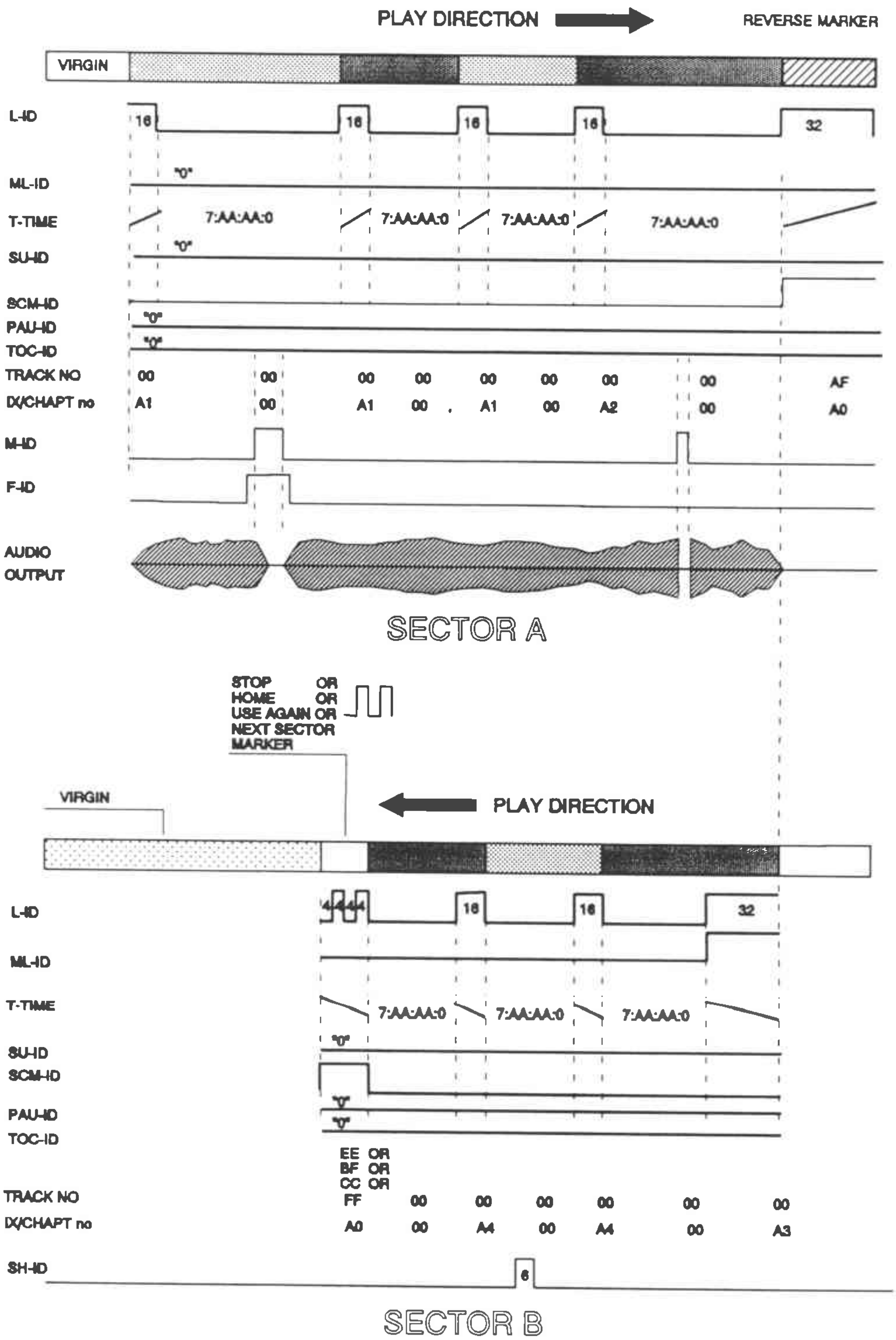

Fig 16.1: Example of consumer recorded user tape format

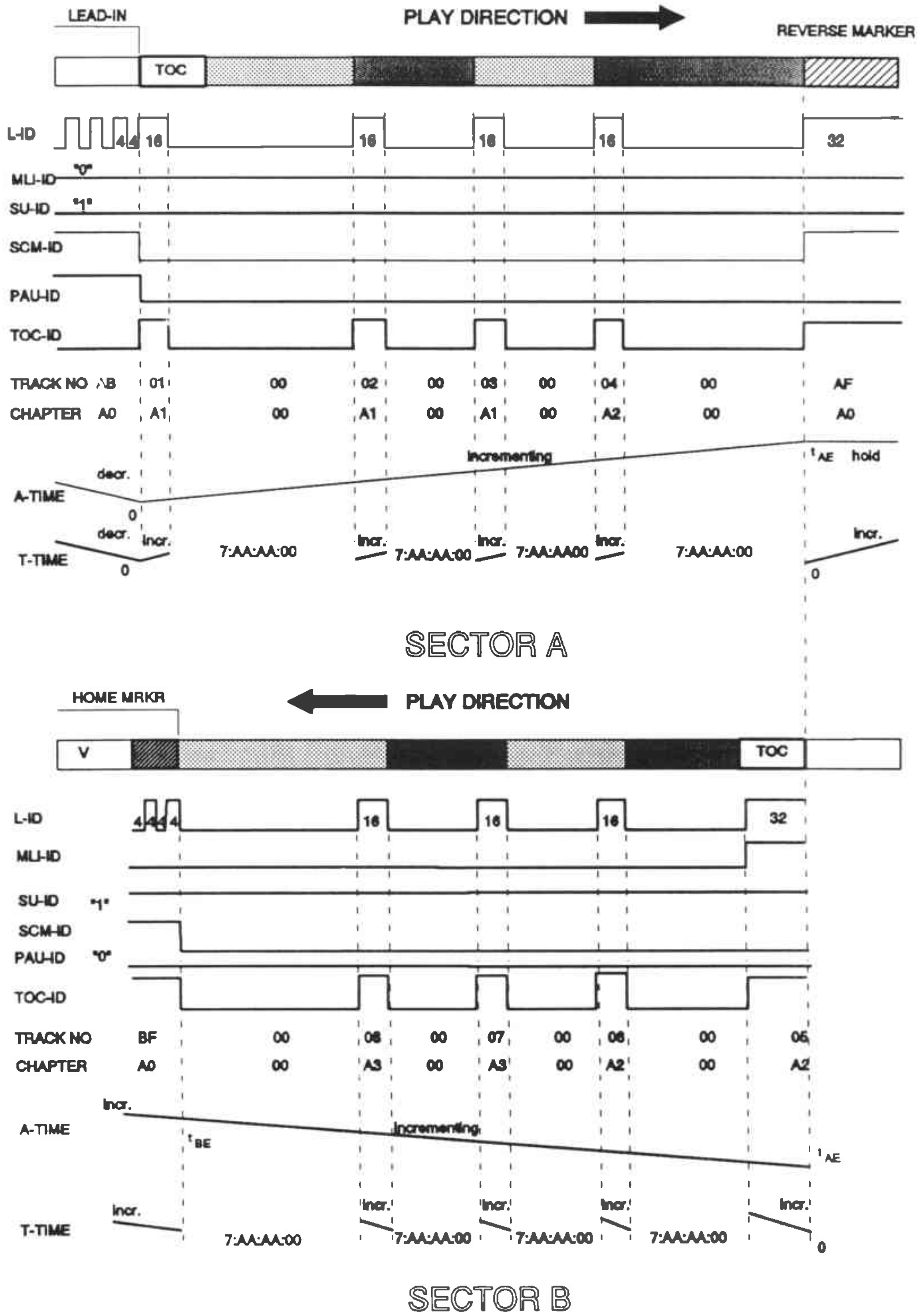

Fig 16.2: Example of consumer recorded super user tape format
After renumbering and recording a TOC

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17. APPLICATION REQUIREMENTS PLAYBACK/RECORDING EQUIPMENT

See also Table 17.1.

To ensure compatibility every DCC player has to meet the minimum requirements as described in clauses 17.1 and 17.2 for playback of prerecorded and consumer-recorded tapes. Recording is an option, but if implemented, recording must meet the rules as described in chapter 17.3. Track search is an option, but if implemented, track search must be according to section 17.1.1. See also section 12.1.1 for the specification when the output must be muted. The digital I/O is an option, but if the digital I/O is present, the SCMS rules of chapter 20 must be applied.

Definition of tape velocity modes:

- Fast forward (FF)
  In this mode the deck moves the tape in the play direction at maximum speed. The tape is not in contact with the head. Reading tape data is not possible.

- Fast reverse (FR)
  In this mode the deck moves the tape in the opposite of the play direction at maximum speed. The tape is not in contact with the head. Reading tape data is not possible.

- Search forward (SF)
  In this mode the deck moves the tape in the play direction at high speed. The tape is in contact with the head. It shall be possible to detect the markers and identify Start, Reverse and Sector markers. Identification of the different sector markers might require reduction of tape speed up to playback speed.

- Search reverse (SR)
  In this mode the deck moves the tape in the opposite of play direction at high speed. The tape is in contact with the head. It is possible to detect the markers and identify Start, Reverse and Sector markers. Identification of the different sector markers might require reduction of tape speed up to playback speed.

17.1 Application requirements for playback of prerecorded tapes

General

Every DCC player must be able to play back :

- Prerecorded 2-sector tapes which are recorded with a sampling frequency of 44.1 kHz coded in stereo and/or Joint stereo mode as defined in chapter 12.

- Prerecorded 4-sector tapes which are recorded with a sampling frequency of 44.1 kHz coded in 2-channel mono mode as defined in chapter 12.

- Prerecorded analogue compact cassettes (CC) according to IEC 94.

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Player reactions on incorrect data

If a prerecorded tape contains information in bytes which are reserved, or contains information which is not equal as described in this DCC System Description, the player must react as follows:

AD_0 bits 7...4 are not "0000"	: The player ignores the Aux info of this Tape frame
SI_0 or SI_2 bits 7...4 are not "0000"	: The player mutes the audio output
SI_1 or SI_3 bits 7...4 are not "0001"	: The player ignores the remaining Sysinfo bytes of this Tape frame

If the Sysinfo mode ID = "0001" (Text mode) while:

Sysinfo header

SI_6...SI_7 are not "00h"	: These bytes are ignored

ITTS text packet or tracklist header

Byte 0 bit 7 = "0"	: The entire packet must be ignored
Byte 0 bits 3210 are not 0,1,7,8 or 9h	: The entire packet must be ignored
Byte 3 bits 765 are not "01h", "02h", or "04h" (not tracklist)	: The entire packet must be ignored
Byte 3 bits 43210 are not "00001" (not tracklist)	: The entire packet must be ignored : special players may also accept "00010"
Byte 5 bits 76543 is 22...27 or 30/31	: Do not show text on the 21-line display
Byte 5 bits 210 = "100" or "110"	: React as if these bits were "111"
Byte 5 bits 210 = "011"	: Do not show this line on the 2-line display
Byte 6 bits 654 = "011"	: React as if 654 = "000"
Byte 6 bits 654 = "100" or "101"	: Do not show on the 21-line display
Byte 7 bits 7654	: If in conjunction with GS0..GS3 a not supported character set is selected, a blank space or a marking to indicate that the character is not displayed, must be displayed
Byte 7 bits 3210 is not "0000"	: React as if these bits were "0000"

Serial attributes

04,05,06,07,0A,0B	: Ignore these attributes
10,12,13,14,16,1D,1E,1F	: Ignore these attributes

Instruction packet header

Byte 0 bit 7 = "0"	: The entire packet must be ignored
Byte 3 is not "01h", "02h" "03h" or "04h"	: The entire packet must be ignored
Byte 5 bits 765 is not "000"	: The entire packet must be ignored
Byte 5 bits 43210 is not 1,2 or 3h	: The entire packet must be ignored
Byte 6 bits 7654 is not "0000"	: React as if 7654 = "0000"
Byte 7 is not "00h"	: React as if byte 7 = "00h"

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Reserved codes in CLUT definition

Bytes 8,9 and 10	: Must be ignored by the decoder.
Byte 14 bits 765 is "001","010" or "011"	: React as if these bits were "000"
Byte 14 bits 765 is "100","101" or "110"	: React as if these bits were "111"
Byte 15 bits 765	: React as if these bits were "000"
Bytes 16,18,20...46, bits 7654	: React as if these bits were "0000"
Bytes 32 and 33	: React as if these bytes were "00h"

Reserved codes in the interactive commands

Byte 2 of all IC's is not "00h","05h", "06h","10h","13h" or 1Bh"	: Ignore all interactive commands.
IC00 Bytes 3...7	: React as if these bytes were "00h"
IC05 Bytes 5...7	: React as if these bytes were "00h"
IC06 bytes 0 or 1 are not "00 00h"	: The instruction is linked to the corresponding packet.
IC06 bytes 3,6 or 7	: React as if these bytes were "00h"
IC06 bytes 4 or 5 contain a non-defined number	: The command must be ignored
IC16 byte 3, bits 7...3	: React as if these bits were "00000"
IC16 byte 4	: If this byte does not contain "00h" the IC16 must be ignored
IC19 byte 6 bits 765 are "001","010" or "011"	: React as if these bits were "000"
IC19 byte 6 bits 765 are "100","101" or "110"	: React as if these bits were "111"
IC19 byte 7 bits 765	: React as if these bits were "000"
IC27 byte 7	: React as if this byte were "00h"

Reserved character codes in columns 0 and 1
Reserved character codes and control codes in the character sets are to be ignored and to be regarded as blank spaces.

17.1.1 Search strategy (See fig 17.1)

Track search in forward mode

On prerecorded tapes the position to be searched for is continuously available via the TOC. In addition start markers are recorded prior to the beginning of the music tracks. The transition from forward search to play back must be direct without a change of the tape direction. It is therefore recommended that the search strategy is based on application of the start positions indicated in the TOC.

Track search in reverse mode

In line with the search forward strategy, the search in reverse direction shall be done such that playback will take place immediately at the track start; the search direction may only change once.

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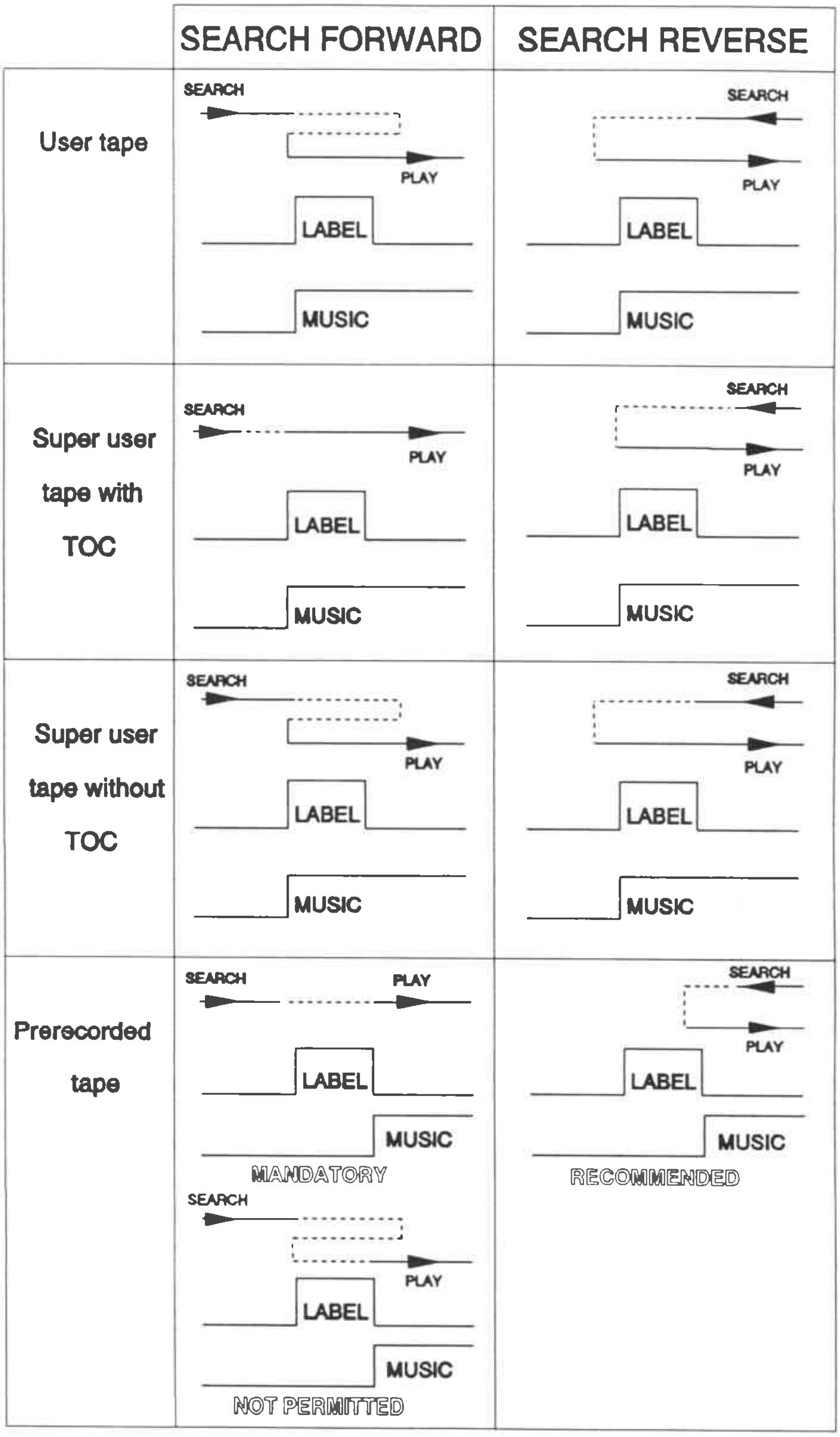

Fig 17.1 Search strategy

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17.1.2 Display

A display on a DCC-player is an option. If a display is used, the four types of information can be displayed:

1) Track and Index/Chapter number
2) Time information
3) Text information
4) TOC contents information

The following rules are defined to harmonise display of status information.

Track and Index/Chapter number display

During the Lead-in and Lead-out of prerecorded tapes no Track or Index/Chapter numbers shall be displayed.
If during search the track or Index/Chapter number(s) which are to be searched is displayed, this number(s) have to be displayed with an indication that a search action is being performed (e.g. blinking).

Time display

The display of the A-time, T-time and/or Remaining (track) time should be possible at any position of the tape, also during the Lead-in and Lead-out areas.

TOC contents display

If the TOC contents are displayed the items 0A, AE and BE should give a clear indication of their meaning, e.g.

TOC item	extra message
0A	'total numbers'
AE	'playing time A'
BE	'total playing time'

Display ITTS text mode

If the ITTS decoder of a DCC player is menu driven, it is recommended that at power-up of the player and when a new prerecorded DCC cassette is loaded, the Topic coded with "FF" is displayed on a 21-line display. If this Topic is not available the Topic coded with "01" is recommended to be displayed.

It is recommended that at power-up of the player and when a new prerecorded DCC cassette is loaded, the Topic coded with "01" is displayed on a 1-line display or on a 2-line display.

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17.1.3 Lead-in and lead-out

Playback equipment which includes one or more search functions, e.g. "Next", "Previous" must also support automatic execution of the various sector marker commands.

If such a playback unit detects that the tape is positioned at the Lead-in or Lead-out area, it will start to search for specific positions on the tape :

Current mode	Detected	Action
Play	Lead-in A	(SF) to first track on A & play
Play	Lead-out A	(SF) to first track on B & play
Play	Lead-in B	(SF) to first track on B & play
Play	Lead-out B	(SF) to first track on A & stop
SR	Lead-in A	(SF) to first track on A & stop
SF	Lead-out A	Change Sector & (SF)
SR	Lead-in B	Change Sector & (SR)
SF	Lead-out B	(SF) to first track on A & stop, or change Sector & (SR) to first track and stop.
SR	Lead-out A	(SR)

17.1.4 Prerecorded 4-sector tape

Four-sector tape will be played back as a tape with four 'Sectors' instead of two sectors. The playback sequence is defined in 15.2.2.

Sector select
Sector select is an option, e.g. by means of a reverse command. If sector select is available, it automatically selects between the sector A and B on 2-Sector tape, and between 'Sectors' A, B, C and D on 4-Sector tape.

On prerecorded 4-Sector tape no start markers are recorded. The search strategy can therefore only be based on the start positions of the music tracks which are indicated in the TOC.

Optional time display is available by means of calculation of TOC information and the A-time information recorded on tape. Sectors 'C' and 'D' will continue to increment with the maximum value of the 'B' or 'C' sector.

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17.2 Application requirements for playback of consumer-recorded tapes

General

Every DCC player must be able to play back:
- consumer-recorded User tapes
- consumer recorded Super-user tapes
- mixtures of User and Super-user tapes

All recorded with a sample frequency of 32 kHz, 44.1 kHz, or 48 kHz coded in stereo.

Additionally it must be able to play back consumer recorded analogue CC.

If functions are implemented which make use of markers, then every player must respond to all types of markers as described in chapter 16, including feature markers with the exception of the Fade markers.
If the Fade function is not implemented, the player must mute at the position of the related Mute marker.
Pitch control is an option; the maximum range is +/- 10%.
Consumer players may only show the setmakers signature in a dedicated service mode. The player must react as if this packet is a text packet.

17.2.1 Search strategy

See Fig. 17.1

Track search in forward mode

The start of music tracks coincides with the leading edge of the start markers. If a TOC is available the TOC information must be used for the search process.

Terminate search

Detection of virgin areas shall be possible during play back: it is recommended to terminate the search mode after a time-out caused by playing virgin parts of 3 seconds on Super-user tape and of 20 seconds on User tape.

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17.2.2 Sector markers on user tape

If during search forward or search reverse on user tape a sector marker is detected, the specific kind of sector marker needs to be identified, e.g. by means of switching to play-back mode to read what kind of marker was detected in search. Further actions depend on the kind of marker and should follow the specification of chapter 16. A sector may have a Lead-in sector marker before the start of the music track.
The Reverse marker can be identified in search mode.
Sector markers can be after recorded or erased selectively, without affecting the music.

17.2.3 Fade-in/fade-out

The Fade-in and Fade-out markers in combination with the mute ID determine the positions at which the fading begins.
If the Fade option is implemented, the attenuation of the audio signal will be faded in a logarithmic shape so that the audio signal will be influenced by at least 60 dB in a time period of 4 seconds.

17.2.4 Shortening play

Shortening play is an option, a player may be equipped with a shortening play (skip) ON/OFF selection.

17.2.5 Display

A display on a DCC player is an option. If a display is used, the following rules are defined to harmonise the display of status information.

Track number display

If the track number is unknown or '00', no track number will be displayed. The display should preferably show : "--". This may happen e.g. if a cassette is inserted in the middle of a music track. At this position no valid track numbers are recorded. Track numbers may be displayed for a tape with super-user status, if read correctly from within the start marker area.
Alternatively, track numbers calculated correctly from counting the start markers can be indicated. An indication of *Absolute Track* is defined to rely on valid information.
This mode shall display : "--" for a track that has a start marker with track number '00'.

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Relative track number display

Relative track numbers may be displayed if a clear indication is provided. Preferably this should be a sign (+ or -) with a track number. The numbers are calculated relative to the insertion position of the cassette, or to a 'reset' position.

Chapter number display

Chapter number display will be performed in a similar way to track number display.

Time display

As an option the A-time, or alternatively calculated (relative) time, relative track and/or remaining (track) time of any position of the tape can be displayed.
The A-time and R-time can only be displayed from super-user tape.
The Remaining (track) time should be calculated from the TOC information and the current A-time.
The Relative time will be calculated relative to the insertion position of the cassette or to a 'reset' position.
The Track time will be calculated relative to the start of the music track. No track time will be displayed immediately after the insertion of the cassette in the middle of a music track, as the position of the start marker is unknown. It should then be indicated that this mode is not available, preferably by showing --:--:-- on the display.
Optional various time modes can be displayed based on reel calculation and additional marker information.
If the A-time display is selected and the Abs. time is hold, e.g. in either Lead-in of sector B or the Lead-out of sector A, the display shall indicate this hold value in a flashing mode.
If the R-time display is selected and the tape is in either Lead-in or Lead-out, where the R-time is on hold, the display shall indicate this hold value in a flashing mode.

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TOC contents display

TOC contents may be displayed. If used however, items should give a clear indication of their meaning, e.g.

TOC item	Extra Message
0A	'Total numbers'
AF	'Play time A'
BF	'Total play time'
CC	'Use Again marker'
DA	'Date of last renumbering'
EE	'Stop marker'
FF	'Next marker'

Character display

The type of display which shows the consumer-recorded characters is not defined. Text can be displayed depending on the control characters recorded with the text. Text is recorded in the Additional Information channel (see section 14.2.6)

17.3 Application requirements for recording of consumer-recorded tapes

If the record function is incorporated, the following table is applicable:

Recording options and requirements

	Minimum	Option	Not allowed
Sample freq.	44.1 kHz	32 kHz 48 kHz	32 kHz and/or 48 kHz without 44.1 kHz
Audio mode	stereo	analogue CC mode	2-channel mono
Tape speed	normal	high speed copy of 2* nom. speed	other than nominal or twice nominal speed

See chapter 16 for recording of the mandatory and optional data in the Sysinfo and the Aux data channels.
High-speed copying is an option. If implemented, the speed must be 9.52 cm/sec.

17.3.1 Additional recording requirements

17.3.1.1 Marker recording

To ensure that markers are 16 frames long, it will not be possible to interrupt the recording of a marker, except in the case of power down and eject.

17.3.1.2 Recording of auxiliary and system information

During recording of a copy from CD or another DCC cassette, the Auxiliary and System information on the new recording will be generated by the set that records. It will NOT copy the information from the source, as this may lead to incorrect numbers and other incorrect information on the new tape. The only information from the source that can be used is the information in the 'Marker Mode' message of the digital audio interface as specified in chapter 18. The Setmakers Signature written on consumer recorded tapes is recorded in the Sysinfo data.

17.3.1.3 User character recording

This mode is optional. Characters may be recorded in the Aux. data channel by consumers to identify their consumer-recorded user and super-user tapes. See chapter 14.
The characters recorded in the Sysinfo area of prerecorded tape may not be copied to a consumer recorded tape.

17.3 Application requirements for recording of consumer-recorded tapes

17.3.1.4 Append recording

The Append function is defined to facilitate the recording of the super-user format. The append function shall search for the end of the music program, before making a new recording. This will enable the recording of the A-time and maybe also track numbers can be continued from the old to the new recording.
In the case of a blank cassette, the recording for Super user tape shall start at the beginning of Sector A with a Lead-in and the A-time decrementing to 0.

Example:

Situation prior to append recording:

——————— Play direction ————>

Leader	V	LI	old recording	V	Trailer
A-time:		0	0 T		

Situation after append recording:

——————— Play direction ————>

Leader	V	LI	old recording	new recording	V	Trailer
A-time:		0	0 T	T+1 E		

The A-time is T at the end of the old recording.
The new recording starts with T+1 (+/-4 frames). The old and the new recordings are not separated by virgin tape areas.

The following append positions may be used :
- Virgin tape
- Home marker
- Stop marker
- Next sector marker
- Use again marker

Of all these positions the Use again marker is normally used to perform the append recording, because this allows the continuation of track numbers.

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17.3.2 Requirements for re-recording and after-recording

Re-recording is defined as:

A: Recording new music tracks and related auxiliary data (including markers) on a previously recorded tape.

After-recording is defined as one of:

B: Recording new additional markers (Start markers, Reverse markers, Next sector markers, Home markers, Mute/Fade markers or Stop markers) on a previously recorded tape;
C: Erasing markers from a previously recorded tape.

After-recording and re-recording activities can be considered as a kind of editing in order to change the structure of a tape and by doing so, also change the system behaviour during playback. The editing activities can be done during recording but many of them also during playback. It is recommended to restrict updating of Auxiliary information to very short periods (e.g. start markers) to avoid mis-alignment (see section 11.1).
After-recording and re-recording can only be done on consumer recorded tapes, i.e. on Super User tapes and User tapes.

On Super User tapes the A-time and track numbers are recorded in the auxiliary data. During after-recording and re-recording one should try to keep these data consistent with the data that were recorded previously in order to maintain a Super User tape. This may imply that before the recording starts, auxdata have to be read from the tape.

For User tapes time and track number information are not relevant. Therefore re-recording and after recording on User tapes will not be discussed further.

Ad A Recording new music tracks (re-recording)

If the A-time is known at the start of a recording, the A-time should be continued from this start value. The SU-ID must be set to "1" (SU) and during the Start marker the T-time must increment from 0:00:00:0. Outside the Start marker the T-time should have the value 7:AA:AA:0.

In general the track number of this new track will not be known, unless recording starts at a Use-Again marker (this marker may contain the value of track number for the next track to come) or at the end of the Lead-in (the first track will have track number 01). Therefore the track number must be recorded as "00" if not known, and else with a value between "01" and "99".

Index/chapter number must have the value 00. During the Start marker another value is allowed. The TOC-ID must be set to 0.

Ad B Recording of markers (after-recording)

Different types of markers can be added, Start markers, sector markers, and feature markers. The recording of Aux data in each of these cases is slightly different:

Start markers

- track number 00.
- continue the A-time if known or record as "7:AA:AA:0" if not known.
- SU-ID set to 1 if valid A-time is recorded, otherwise 0.
- TOC-ID set to 0.
- PAU-ID set to 0
- T-time recorded from 0:00:00:0 and incrementing.
- SCM-ID set to 0.
- L-ID set to 1.
- Index/Chapter set to 00.

Next, Stop, Home and Use-again markers

- continue the A-time if known or record as "7:AA:AA:0" if not known.
- T-time recorded from 0:00:00:0 and incrementing.
- TOC-ID set to 0.
- PAU-ID set to 0.
- SU-ID set to 1 if valid A-time is recorded, otherwise 0.
- SCM-ID set to 1.
- L-ID alternately set to 1 (4 frames) and 0 (4 frames).
- Chapter/Index set to 00.

Reverse marker on Sector A

- hold the A-time if known, otherwise record as "7:AA:AA:0".
- T-time recorded from 0:00:00:0 and incrementing.
- TOC-ID set to 0.
- PAU-ID set to 0.
- SCM-ID set to 1.
- L-ID set to 1.
- Chapter/Index set to 00.
- SU-ID set to 1 if valid A-time is recorded, otherwise 0.

Feature markers (Mute/Fade, Skip)

- keep the Aux data as they were, except the F-ID, M-ID and/or SH-ID.

Note: The reason that one can only say that the Aux data may not be changed (although they have to be recorded) is that the Fade/Mute and Skip markers may be combined with other markers (e.g. a Skip marker may be located in a Start marker or a Mute marker may start in a Start marker).

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18. DIGITAL AUDIO INTERFACE

The format of IEC document 958 will be used. The contents of the fields will be as follows (section numbers refer to the IEC document):

18.1 Audio sample words

Sample words section (3.1.2): this will contain 2's complement samples with msb at time slot 27.

18.2 Auxiliary samples

Auxiliary sample bits, section (3.1.3): these will not be used, and will be '0'.

18.3 Channel status

Channel status section (3.1.5): this will be according to section (4.2.2.2), 'channel status data format (Mode 0) for digital audio equipment for consumer use'.
The following applies:

- bits 0 to 7 according to section (4.2.2.1)
- category code = 1 1 0 0 0 0 1 L

The bit indicated with L is the 'generation status' bit, which is specified as follows :
0 - no indication
1 - commercially released prerecorded software

- Bits 16 to 191 according to section (4.2.2.2).

18.3.1

Channel status during recording from analog source of playback or ACC cassette.

In this case the following applies:

category code = 0 1 1 0 0 0 0 1
copyright indication bit is '0'

not recommended but allowed is:

category code = 1 1 0 0 0 0 1 1
copyright indication bit is '0'

18.4 User data

User data, section (3.1.6).
Two modes are available, marker mode and extended mode. Both use the same definition of messages. Marker mode is mandatory, extended mode is optional.
A message consists of one or more information units (IU). An information unit contains 8 bits. The first bit is always a logical '1' and is called the IU start bit. The remaining 7 bits contain information. Information units that belong to the same message are separated by less than or equal to 8 logical '0' bits. Different messages are separated by more than 8 logical '0' bits.

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18.4 User data

18.4.1 Marker mode

This mode allows just one message which contains the most important information. This message consists of 1 information unit, which is shown below:

msb							lsb
1	0	LAB	SH	FAD	MUT	STP	SCM
start bit	mode bit						

The bits have the following definition:

The first bit is the start bit as defined above.
The second bit indicates that this is a Marker mode message.

LAB: gives an indication of the position of the L-ID. The following rules apply:

during playback a set should:

1) set the LAB-bit to '1' for 16 frames at the start of a new track, the '0' to '1' transition coincides with the track start (on pre-recorded tapes a track start is indicated by the '1' to '0' transition of the L-ID and on the recorded tapes by the '0' to '1' transition of the same bit);
2) set the LAB-bit to '0' of the SCM-ID (and SCM-bit in the marker mode) is '1';

during a recording a set should:

3) record an L-ID = '1' for 16 frames if it detects an SCM bit '1' to '0' transition;
4) record an L-ID = '1' for 16 frames if it detects a LAB-bit '0' to '1' transition.

SH, FAD, MUT and SCM are direct copies of bits 6 to 4 and 2 in the marker info byte (AD_1) of the Auxiliary code.

STP = '1' if no audio signal is available due to search actions or when playback is stopped. Otherwise it is '0'.

This message must be sent at least once for every DCC tape frame.
It is recommended that the information is sent simultaneously with the audio information.

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18.4.2 Extended mode

In this mode several messages are defined. The first IU of a message is as follows:

1	1	M	M	M	M	M	M
start bit	mode bit						

The mode bit is '1' to identify the extended mode.

Message Number 0 0 0 0 0 0 : Current status

Implementation of this message is optional. If implemented a message must be sent at least once every Tape Frame.

This message will contain information on the current status of the deck. Three bytes of information will be made available: Deck status, Track Number and Index Number. The three bytes will be carried in 4 Information Units (IU). The layout of the whole message will be as follows:

1 (Start)	1 (Ext. Mode)	0	0	0	0	0	0
1 (Start)	Error Flag	Stat $_7$	Stat $_6$	Stat $_5$	Stat $_4$	Stat $_3$	Stat $_2$
1 (Start)	Error Flag	Stat $_1$	Stat $_0$	Track $_7$	Track $_6$	Track $_5$	Track $_4$
1 (Start)	Error Flag	Track $_3$	Track $_2$	Track $_1$	Track $_0$	Index $_7$	Index $_6$
1 (Start)	Error Flag	Index $_5$	Index $_4$	Index $_3$	Index $_2$	Index $_1$	Index $_0$

The Error Flag can be used to indicate whether the information in the IU is possibly in error: "0" - no error, "1" - possible error in remaining 6 bits.

The Deck status is carried msb first. It is a BCD coded 2 digit message. The following numbers apply:

00	STOP	deck stopped, no information read from tape
01	PAUSE	deck in pause mode, no information read from tape
02	EJECT	cassette ejected, ITTS and Aux info not available from tape
11	PLAY-A	playback of Sector A, information read from tape
12	PLAY-B	playback of Sector B, information read from tape
13	PLAY-C	playback of Sector C, information read from tape
14	PLAY-D	playback of Sector D, information read from tape
18	CC-PLAY	a CC cassette is played back, no information from tape
21	WIND	wind (forward in time), no information read from tape
22	REWIND	rewind (backwards in time), no information read from tape
23	SEARCH-F	forward search, track number estimated from markers
24	SEARCH-B	backward search, track number estimated from markers
30	REC-PAU	rec + pause mode, ITTS and Aux info not available from tape
31	REC	recording, ITTS and Aux info not available from tape

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Mode indications 30 and 31 will only be available during recording from analog sources. Recording from digital sources implies that the information from the digital source will be copied on the digital output.

The Track and Index information is copied from the Auxiliary data, or may be estimated during search and during playback of tapes with track numbering. During playback of tapes without track numbering or Compact Cassettes the Track and Index number is unknown ('00'). Both bytes are BCD coded with msb first.

Message Numbers 000001, 000010, 000011 : ITTS packet message

The 48 bytes of an ITTS packet will be coded in a similar way to the method used for coding the three bytes of the Current Status message, using 4 IUs for every 3 bytes, bytes coded msb first. If a message does not contain a multiple of 3 ITTS bytes, the remaining bits in the IU that contain the last bits of the final ITTS byte, will be padded with '0' bits (e.g. for a message of 2 ITTS bytes, 3 Information Units will be used in which the 2 final bits of the third Information Unit contain '0'). Addition of a IU fully padded with '0' bits is not allowed; this would make detection of an ITTS byte with all zero's impossible.

In total the extended message will consist of a maximum of 66 IUs: 1 to indicate extended message, 1 message content identification and a maximum of 64 for the ITTS packet data, including error flags and start bits.

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18.4 User data

The following is an example of a complete ITTS packet extended message:

1 (Start)	1 (Ext.Mode)	0	0	0	0	0	1
1(Start)	IU $Count_6$	IU $Count_5$	IU $Count_4$	IU $Count_3$	IU $Count_2$	IU $Count_1$	IU $Count_0$
1(Start)	Error Flag	Byte 1_7	Byte 1_6	Byte 1_5	Byte 1_4	Byte 1_3	Byte 1_2
1(Start)	Error Flag	Byte 1_1	Byte 1_0	Byte 2_7	Byte 2_6	Byte 2_5	Byte 2_4
1(Start)	Error Flag	Byte 2_3	Byte 2_2	Byte 2_1	Byte 2_0	Byte 3_7	Byte 3_6
1(Start)	Error Flag	Byte 3_5	Byte 3_4	Byte 3_3	Byte 3_2	Byte 3_1	Byte 3_0
...	...	...	...	...	...	...	...
1(Start)	Error Flag	Byte 46_7	Byte 46_6	Byte 46_5	Byte 46_4	Byte 46_3	Byte 46_2
1(Start)	Error Flag	Byte 46_1	Byte 46_0	Byte 47_7	Byte 47_6	Byte 47_5	Byte 47_4
1(Start)	Error Flag	Byte 47_3	Byte 47_2	Byte 47_1	Byte 47_0	Byte 48_7	Byte 48_6
1(Start)	Error Flag	Byte 48_5	Byte 48_4	Byte 48_3	Byte 48_2	Byte 48_1	Byte 48_0

The Information Unit Count (IU Count 6...0) indicates how many Information Units will follow and can range from 0 (no ITTS info available) to 64 (complete ITTS packet).
IU $Count_6$ = msb, IU $Count_0$ = lsb, binary coded.

The Error Flag is optional and can be used to indicate whether the information in the IU is in error: "0" - no error detected, "1" - error in remaining 6 bits.

Bytes 46 to 48 represent here the 3 last character codes in an ITTS packet.

Partial ITTS packets may be sent in similar fashion. The message number may need to be changed according to the contents: start, continuation or end. Several combinations are possible.

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18.4 User data

Examples

I) complete ITTS packet transfer:

message number	IU Count	Total message length	ITTS bytes
0 0 0 0 0 1 start	64	66	48

II) one ITTS packet as 2 messages:

message number	IU Count	Total message length	ITTS bytes
0 0 0 0 0 1 start	32	34	24
0 0 0 0 1 1 end	32	34	24

III) one ITTS packet as 3 messages:

message number	IU Count	Total message length	ITTS bytes
0 0 0 0 0 1 start	11	13	8
0 0 0 0 1 0 continu	43	45	32
0 0 0 0 1 1 end	11	13	8

Note: **the number of ITTS bytes transferred in a message in the examples above may be changed, as long as the total number of ITTS bytes remains 48 and the IU count is adjusted accordingly :**

message number	IU Count	Total message length	ITTS bytes
0 0 0 0 0 1 start	12	14	9
0 0 0 0 1 0 continu	40	42	30
0 0 0 0 1 1 end	12	14	9

It is also allowed to mix ITTS messages with marker mode and other extended mode messages, as long as the ITTS packet sequence is maintained.

VI) one ITTS packet as 8 messages with marker mode and current status:

first byte	IU Count	Total message length	ITTS bytes
1 1 0 0 0 0 0 1 start	8	10	6
1 1 0 0 0 0 1 0 continu	8	10	6
1 1 0 0 0 0 1 0 continu	8	10	6
1 1 0 0 0 0 1 0 continu	8	10	6
1 0 x x x x x x marker	-	1	-
1 1 0 0 0 0 0 0 cur.status	-	5	-
1 1 0 0 0 0 1 0 continu	8	10	6
1 1 0 0 0 0 1 0 continu	8	10	6
1 1 0 0 0 0 1 0 continu	8	10	6
1 1 0 0 0 0 1 1 end	8	10	6

Other message numbers are reserved for future use.

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19. RULES FOR COPYRIGHT MANAGEMENT

19.1 Scope

This chapter is applicable to the Digital Compact Cassette system. It specifies what can and cannot be recorded. It also specifies the requirements for the digital output signals of DCC play-back devices, and what extra information is to be registered on tape concerning copyright status and generation status. A DCC product is any machine or device, whether or not included as a part of some other device, intended for the primary purpose of making a sound recording in the DCC format or reproducing sound from the DCC format.

19.2 Normative references

IEC 958 (1989): Digital Audio Interface. Including proposal for an amendment of IEC 84/WG11/March 1990.

For CP1-CP2 see chapter 13.
For TRO see chapter 12.

19.3 Technical requirements

Category codes and copyright status bit included in the digital input signals shall not be deleted or modified and shall be monitored continuously and acted upon accordingly.

19.3.1 Digital output signals

The digital output shall be in accordance with IEC 958. Alternative digital output, shall provide for equivalent coding, specifically with respect to category code, copyright status and generation status.

19.3.1.1 Category code

A DCC product shall provide the category code 1100001L in the channel status bits of the digital output signal. The last (L) bit of the category code shall be applied in the output signal in accordance with the status of the tape replayed.
If the replayed tape is a prerecorded musicassette, or "CP2" is "1", the "L bit" shall be "1".
If the replayed tape is not a prerecorded musicassette, e.g. a consumer-recorded cassette, or "CP2" is "0", the "L bit" shall be "0".

19.3.1.2 Copyright status bit

DCC products shall provide the copyright status bit in the channel status bits of the digital output signal. The copyright status shall be applied in the digital output signal as follows, in accordance with the status of the tape replayed.
If "CP1" is "1", the C-bit shall be set for "copyright protected", "C" is "0".
If "CP1" and TRO are "0", the C-bit shall be set for "not copyright protected", "C" is "1".

19.3.1.3 Channel status bit

DCC products for consumer audio use, as specified in this standard, shall apply according to IEC 958 the following in the channel status bits of the digital output:

for bit 0 is "0" (consumer use)
for bit 1 is "0" (audio)

19.3.2 Recording functions

Recording of digital signals is only possible if the signal format is according to IEC 958.
Recording of digital signals with an alternative format is only possible if these signals include the copyright information equivalent to IEC 958, specifically category code, copyright status and generation status. In subband coded signals according to the format defined in chapter 12, the status of TRO shall have priority over the status of CP1.

19.3.2.1

The Serial Copy Management System (SCMS) applies to consumer audio DCC recorders. Recording of digital non-consumer signals is inhibited. With channel status "bit 0" is "1" (professional source) recording is inhibited.

19.3.2.2

Recording of digital non-audio signals is inhibited. When channel status "bit 1" is "1", recording is inhibited.

19.3.2.3

For digital input signals originating from an analogue-digital converter, whether or not included as part of a DCC product, with category code "01100XXL" or originating from other sources with category code "general", "00000000", the status "copyright protected" and "prerecorded musicassette", CP1 is "1" and TRO is "1", CP2 is "1" shall be recorded on tape, independent of the status of the copyright status bit or category code L bit of the input signal. This requirement shall not be applied to the analogue-digital converter of the type specified in subsection 19.3.2.4

Note: The digital input signal referred to in this subsection does not contain correct source information of the original signal before digitization. The analogue-digital converter is of the type which does not supply (correct) source information.

19.3.2.4

For digital input signals originating from an analogue-digital converter with category code "01101XXL", which can deliver original source information on copyright status from the analogue domain, the requirement stated in sub-clause 19.3.2.3. shall not be applied. The white list specified in 19.5 includes this category code.

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19.3.2.5

In the case of a source which is without category information, e.g. without channel status bits or with an undefined category code, independent of the status of the copyright bit or the L-bit of the category code, the status "copyright protected" and "own-recorded copy", CP1 is "1" and TR0 = 1 and CP2 is "0" shall be recorded on tape.

19.3.2.6

For digital input signals with a copyright status bit set for "not copyright protected" (C-bit = "1"), the status "not copyright protected", CP1 is "0" shall be recorded on tape, except for cases specified in subsections 19.3.2.3 and 19.3.2.5.

19.3.2.7

Recording shall be inhibited for digital input signals with a copyright status bit set for "copyright protected" (C-bit = "0"), except for the cases specified in subsections 19.3.2.3, 19.3.2.5 and 19.3.2.8.

19.3.2.8

Recording shall be possible for digital input signals with a copyright status bit set for "copyright protected" (C-bit = "0") when the signal is listed in the "white list" in 19.5. The status "copyright protected" and "own-recorded", CP1 is "1" and CP2 is "0" shall be recorded on tape.

19.3.2.9

Recording shall not be possible for digital input signals with a copyright status bit alternating with a frequency from 4 to 10 Hz between "copyright protected" (C-bit = "0") and "not copyright protected" (C-bit = "1") when the category code is from a compact disc digital audio signal (10000000).

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19.3.3 Conditions for commercially released prerecorded DCC cassettes

On the tape the status "prerecorded cassette", CP2 is "1" shall be recorded. The copyright status can be recorded in accordance with the wishes of the copyright owner : either "copyright protected" or "not copyright protected".

19.4 List of defined category codes (bits 8 - 15)

The following Category Codes are defined :

00000000	General. Used temporarily
100XXXXL	Laser-optical products
010XXXXL	Digital-to-Digital converters and signal processing products
110XXXXL	Magnetic tape or disc-based products
001XXXXL 0111XXXL	Broadcast reception of digitally encoded audio signals with or without video signals
101XXXXL	Musical instruments, microphones and other sources that create original signals
01100XXL	Analogue-digital converters for analogue signals without copyright information
01101XXL	A/D converters for analogue signals which include copyright information, including "C-bit and L-bit status"
0001XXXL	Solid-state memory-based products
0000001L	Experimental products not for commercial sale

Not defined are:

111XXXXL	Reserved
0000XXXL	Reserved except 00000000 and 0000001L

19.5 White List recording permitted with limitations.

100XXXX0	Laser-optical products
010XXXX1	Digital-to-digital converters and signal-processing products
110XXXX1	Magnetic tape or disc-based products
001XXXX0 0111XXX0	Broadcast reception of digitally encoded audio signals with or without video signals
101XXXX1	Musical instruments, microphones and other sources that create original signals
01101XX1	A/D converters for analogue signals which include copyright information including "C-bit and L-bit" status
0001XXX1	Solid-state memory-based products
00000011	Experimental products not for commercial sale

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19.4 List of defined category codes (bits 8-15)

Example: Table illustrating the use of the C-bit, L-bit and Cat.code for dig. input signals on DCC according to IEC 958

Application or Signal source	Input signal DCC recorder for consumer audio use. C-channel acc.to IEC958/4.2.2.2			On DCC tape	Effect on DCC player digital output during play back
	Copy bit bit 2	Cat.code bit 8..14	L bit bit 15	CP1/ CP2	Copy bit 2 / L bit of the output
	Not copyright protected		Home copy		Recordable
General	1	0000000	0	11	bit 2=0
Laser-opt.prod.	1	100xxxx	0	00	bit 2=1
D/D converter	1	010xxxx	0	00	bit 2=1
Magnetic prod.	1	110xxxx	0	00	bit 2=1
Broadcast recept.	1	001xxxx	0	00	bit 2=1
Music.instr.	1	101xxxx	0	00	bit 2=1
Act.A/D conv.	1	01100xx	0	11	bit 2=0
Fut.A/D conv	1	01101xx	0	00	bit 2=1
Sol.state rec.	1	0001xxx	0	00	bit 2=1
Experimental	1	0000001	0	00	bit 2=1
	Not copyright protected		Pre-rec		Recordable
General	1	0000000	1	11	bit 2=0
Laser-opt.prod.	1	100xxxx	1	00	bit 2=1
D/D converter	1	010xxxx	1	00	bit 2=1
Magnetic prod.	1	110xxxx	1	00	bit 2=1
Broadcast recept.	1	001xxxx	1	00	bit 2=1
Music.instr.	1	101xxxx	1	00	bit 2=1
Act.A/D conv.	1	01100xx	1	11	bit 2=0
Fut.A/D conv	1	01101xx	1	00	bit 2=1
Sol.state rec.	1	0001xxx	1	00	bit 2=1
Experimental	1	0000001	1	00	bit 2=1
	Copyright protected		Home copy		Not recordable,bit 2=0, bit 15=0 or no output
D/D converter	0	010xxxx	0	--	Not rec./no outp.
Magnetic prod.	0	110xxxx	0	--	Not rec./no outp.
Music.instr.	0	101xxxx	0	--	Not rec./no outp.
Fut.A/D conv	0	01101xx	0	--	Not rec./no outp.
Sol.state rec.	0	0001xxx	0	--	Not rec./no outp.
Experimental	0	0000001	0	--	Not rec./no outp.
	Copyright protected		Pre-rec		Recordable Bit2=0,bit15=0
D/D converter	0	010xxxx	1	10	
Magnetic prod.	0	110xxxx	1	10	
Music.instr.	0	101xxxx	1	10	
Fut.A/D conv	0	01101xx	1	10	
Sol.state rec.	0	0001xxx	1	10	
Experimental	0	0000001	1	10	
Laser opt.prod.	0	100xxxx	0	10	
Dig.Broadcast	0	0111xxx	0	10	
Dig.Broadcast	0	001xxxx	0	10	

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19.4 List of defined category codes (bits 8-15) Figure 19.1

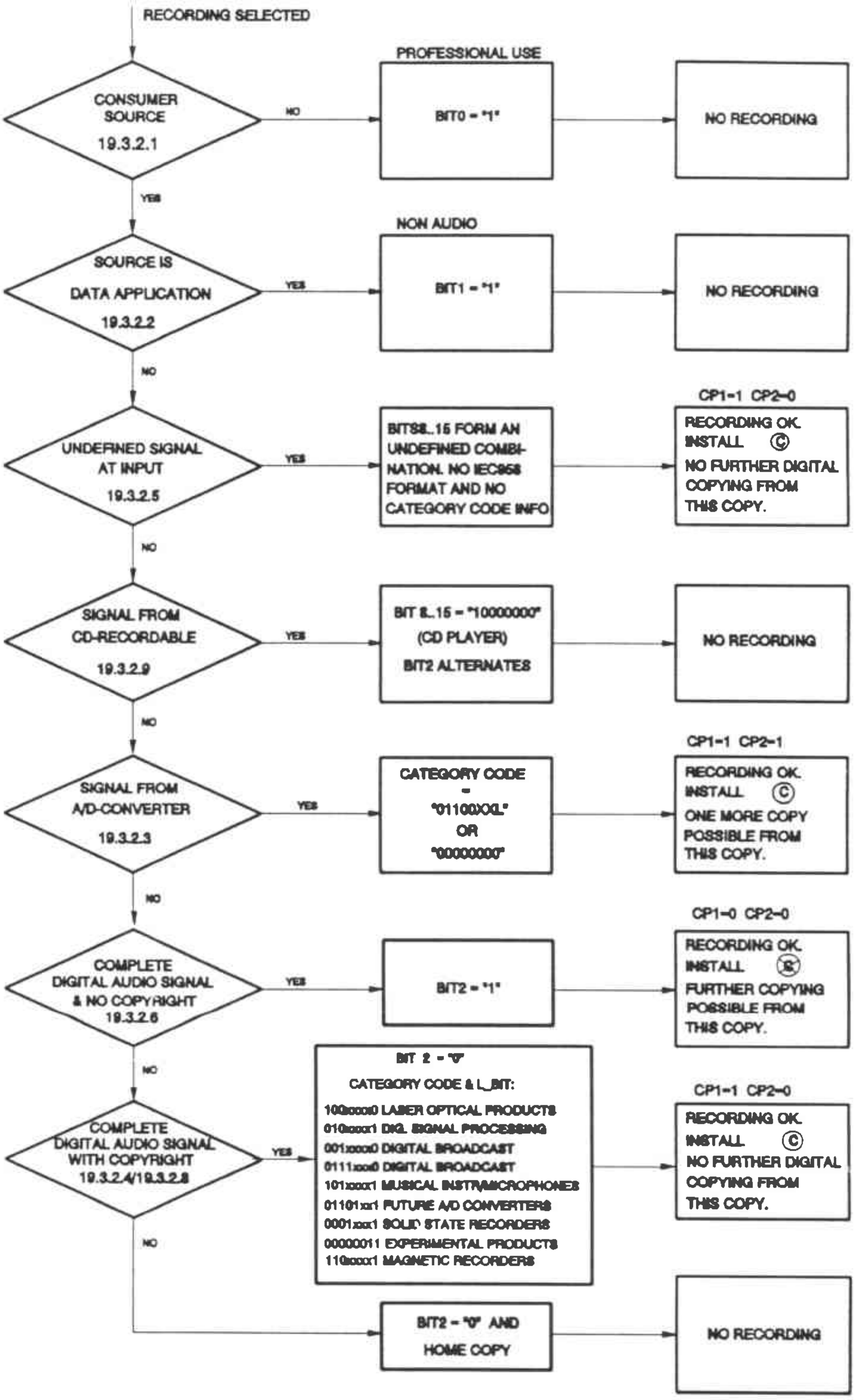

FIG 19.1 SCMS Logic diagram

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20 DCC CASSETTE BOX

20.1 Scope

This standard defines a cassette box for cassettes manufactured according to the DCC standard. This box shall be used for prerecorded cassettes. The use of the box for blank cassettes is recommended.

20.2 General box

20.2.1 Definitions

Drawing in European projection.

20.2.2 Dimensions

To guarantee interchangeability, the dimensions of the box shall be as defined in Fig. 21.1.

20.2.3 General tolerances for dimensions

Unless otherwise specified, the tolerances are:

dimension		tolerance
length (mm)	> 0 to 3	± 0.05
	> 3 to 6	± 0.06
	> 6 to 10	± 0.075
	> 10 to 18	± 0.09
	> 18 to 30	± 0.105
	> 30 to 50	± 0.125
	> 50 to 80	± 0.15
	> 80 to120	± 0.175
angle (deg)		± 1

20.2.4 Test environment

The dimensions of the finished box shall be within the tolerances before and after a temperature test +85°C, RH <40%, 8 h, recovery 4 h.

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20.3 Box structure

20.3.1 Appearance

In principle, the box shall consist of two parts. The upper part which forms the cassette receptacle shall be made from non transparent material and the lower part for inlay and booklet shall be made from colorless transparent material.

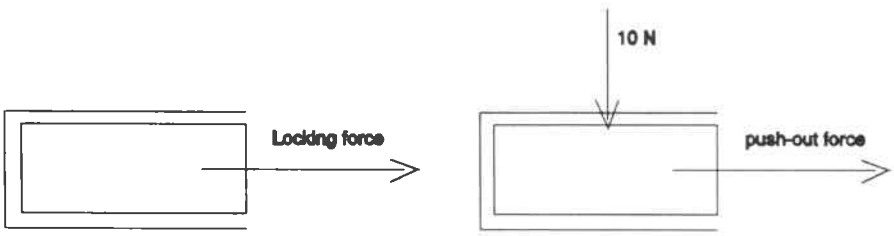
20.3.2 Cassette receptacle

The cassette receptacle shall be designed so that neither the cassette nor the box will be damaged during use.

The upper wall shall be provided with a rectangular hole in order to make the cassette accessible and the lower wall shall be provided with a rectangular hole in order to make the inlay/booklet accessible when the cassette is removed.
The depth of the cassette receptacle shall be limited as shown in Fig. 21.1.

The cassette box shall be provided with a means to hold the cassette. When inserted correctly, the cassette has to be held securely. The locking force should not be less than 2 N.

Removal of the cassette from the box should be easily achieved. When a force of 10 N is applied onto the casette, the push out force should not be above 6 N.



The design of the cassette fixing method is at the discretion of the manufacturer.

20.3.3 Inlay booklet receptacle

The dimensions of the receptacle are defined in Fig. 21.1.
The design should enable smooth insertion and a retaining rib should keep the booklet in position.

To prevent scratches, the centre area of the lower part must be recessed, see Fig. 21.1.

20.3.4 Identification

The DCC logo should be used to identify the product, complying with the specification.

The logo shall be positioned as indicated in Fig. 21.1. For use of the logo, see Annex B of the DCC standard.

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GLOSSARY OF TERMS

2-Channel mono mode	: Audio coding mode which records on Sector A 2 mono audio channels, one on L (channel I) and one on R (channel II), plus on Sector B 2 mono audio channels.
2-Line code	: Three bits controlling the position of an ITTS text line on a 2-line display.
2-Sector tape format	: Format which is used on prerecorded tapes only, using the stereo mode coding on Sector A and stereo mode coding on Sector B.
21-Line code	: Five bits controlling the position of an ITTS text line on a 21-line display.
4-Sector tape format	: Format which can be used on prerecorded tapes only, using 2-channel mono mode on Sector A and 2-channel mono mode on Sector B, obtaining 4 mono music programs to be recorded.
A-time	: Absolute time, representing the elapsed time of the music since the beginning of the music program, following the Lead-in of Sector A. This time information is recorded in the Aux data byte 4...6.
Abrasiveness	: The tendency of the tape to wear the head due to transporting the tape along the heads.
AD	: Auxiliary data, 48 bytes in the tape block body.
Adaptive allocation	: Audio coding mode where the allocation of the audio samples changes with every tape frame.
Additional information	: Optionally recorded Topic in the ITTS text mode for additional, (non-music track) related info.
After-recording	: Mode in which markers are recorded on, or erased from previously recorded User or Super user tape.
AH	: Auxiliary header, consisting of 2 unmodulated PLL words and an unmodulated Sync word.
AIS	: Additional Information Specifier in Aux data AD20. It specifies the contents of the Aux data bytes AD21...AD35.
Album/Work title	: One of the mandatory Topics to be recorded in the ITTS format, representing the name of the music album.
Allocation info unit	: Four bits containing the number of bits to be allocated to the subband samples, coded in binary.

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ALP : Azimuth Locking Pin, 2 pins located at each side of the head to improve the head/tape contact.

Append recording : A recording mode which enables the recording of a Super User tape format through searching the end of the previously recorded music track, indicated by a marker (e.g. a Use Again marker).

Application code : A 4-bits code in the header of an ITTS packet indicating the type of packet, one bit of the application code indicates the 1-line display.

Attribute : An attribute or text attribute is a code which can be inserted in an ITTS text line to change the representation of the characters following this code. e.g. colour, size etc.

Aux data : Data, recorded in the Aux track on the tape which contains sync information, search information and music track related information.

Aux data tape frame : A frame consisting of 4 Aux data tape blocks containing digital data of the Aux track.

Auxiliary samples : Samples defined in the digital audio interface IEC958, not used for DCC.

BA : Block address, two bits indicating a relative address of the Aux data block AD0.

BG attribute : A serial attribute which sets the background of an ITTS text packet or tracklist packet character at the position of this attribute till the end of the line, or till another BG attribute is inserted in the line.

BOTTOM line : One of the 2-line codes, indicates that this line must be fixed on the lower line of the 2-line display.

C1 code word : Reed Solomon code word of type RS(24,20,5)

C2 code word : Reed Solomon code word of type RS(31,26,7)

Cassette holding area : Defined area at the outer surfaces of a DCC cassette which may be used to push the cassette against the supports in the loader.

Category : A group of ITTS packets belonging to a Topic in a certain language.

Category code : A 1-byte code defined in the digital audio interface IEC985 representing the type of audio equipment connected. The last bit is called the "L" bit.

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C bit	: Also called the Copyright status bit. This bit is defined as bit number 2 in the channel status of the digital audio interface IEC 958. This bit contains the copyright information.
CC bits	: Three bits in the Sysinfo byte 1 indicating how two ITTS packets are split-up by 2 tape frames.
CCF	: Continuity Count Flag. This bit in the Aux data AD21 if AIS=03, is used in the consumer character recording mode to indicate whether the counting sequence in the 4 times 1/4 ITTS packet is discontinuous.
CDE bit	: Category Data End. A bit in the ITTS text packet and Tracklist packet header to indicate the last packet of a certain category.
CDS bit	: Category Data Start. A bit in the ITTS text packet and Tracklist packet header to indicate the first packet of a certain category.
Changer grip	: The DCC cassette is provided with 2 grip holes to enable the handling of a cassette in an automatic changer mechanism.
Channel status	: The channel status is used in the digital audio interface IEC958 and carries information associated with the audio, such as sample word length, pre-emphasis etc.
Chapter number	: The number given to a Chapter of a music track, recorded in the Aux data AD3. A chapter is the combination of one or more music tracks.
CHARSET	: Four bits in the header of the ITTS text and tracklist packets which defines different character sets.
CLUT	: Colour Look Up Table. This table defines the components of which a colour is built-up.
CLUT definition packet	: This type of instruction packet sets new values for the colour palette (CLUT) which paints a display.
Command index	: Two bytes in the ITTS instruction packets carrying information on how and when the commands must be executed.
Consumer character recording	: A text mode used to enable consumers to record a small amount of text during the start markers of the music track.
Control info	: Four bits in the Aux data AD0 containing the Format-ID, block address and the recording direction.

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Copyright protection bits	:	Two bits (CP1/CP2)in the Sysinfo byte 0, indicating the origin and the generation code.
Copyright Status bit	:	See C bit.
Corrosiveness	:	The tendency of chemicals in the tape to corrode the head.
Credits	:	Mandatory music track related information to be recorded in the ITTS packets.
Current status	:	The message 000000 in the extended mode of the digital audio interface (IEC958).
Current track	:	The music track which is played back at that moment.
Data type	:	Five bits in the ITTS Instruction packet header containing commands which are executed at a consumer's triggering at the highlighted position of a horizontal menu.
Datum hole	:	A special shaped hole in the DCC cassette which serves as reference for the position and the height in a deck.
Datum plane	:	Three planes are defined for the DCC cassette which serve as reference for the position and the height in the deck.
dBFS	:	The maximum level represented by the digital input signal;FS=full scale.
DBH attribute	:	Double Height attribute. This attribute recorded in the ITTS text packet or Tracklist packet, sets the character following this attribute to the double height.
DBS attribute	:	Double Size attribute. This attribute recorded in the ITTS text packet or Tracklist packet, sets the character following this attribute to the double size, twice the height and twice the width.
DBW attribute	:	Double Width attribute. This attribute recorded in the ITTS text packet or Tracklist packet, sets the character following this attribute to the double width.
Demodulation table	:	A table containing code words to enable the conversion of the 10 bits data read from the tape to 8 bits data.
DRCS	:	Dynamically Redefinable Character Set.
DSV	:	Digital Sum Value. This value is obtained when of a codeword the accumulated number of ones are substracted from the accumulated number of zeroes, used together with the modulation table.

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Dummy slot : As the length of a PASC frame can vary caused by the 44.1 kHz sampling frequency, a dummy slot can be added to the PASC frame.

Duplicator identification code : A code in the Aux data (AIS=FF) formed by 15 characters to characterise the duplicator's company of the prerecorded cassettes.

Dynamic single sided edge variation : This is the value in millimeters of the peak to peak amplitude of one of the tape edges.

EAN number : Article Number recorded in the Aux data (AIS=01). This number is distributed by the International Article Numbering Association. This code characterises the recorded music track.

E control : End of 1-line display text. The E control in the ITTS text packet and tracklist packet is defined to mark the point beyond which no characters will be displayd on a 1-line display during a scrolling action.

EMRK attribute : End of Marking. A serial attribute recorded in the ITTS text packet or Tracklist packet, which ends the marking of characters following this attribute in the ITTS text line.

ENTRY line : A 2-line code depicting that this line is to be displayed when its Topic is activated.

Envelope encoding : The odd tape block bodies of the aux data may be recorded or not, causing a labelled state or non-labelled state. When reading the Aux data track, the envelope can be analysed to detect the state.

Erasure protection hole : On the blank DCC cassette this hole is defined to prevent the recorder to overwrite the music track.

Error flag : In the digital audio interface IEC958 the error flag indicates whether the Information unit is possibly in error.

Extended label area : On prerecorded cassettes areas are defined, other than on blank cassettes, which can be used to put a label.

Extended mode : The extended mode is a mode in the user data of the digital audio interface IEC958, which transfers the current status of the player and the ITTS packet messages.

Fade marker : When recorded in the Aux data byte AD1, this marker formed by the F-ID, determines at play back, together with the Mute marker the fading behaviour of the audio signal.

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FATG : Fixed Azimuth Tape Guiding. Two guiding bosses at each side of the head improve the tape movement.

Feature marker : Three types of feature markers are defined: Mute marker, Fade marker and Skip marker. Feature markers influence the player behaviour while playing the music track.

FG attribute : A serial attribute which sets the foreground of an ITTS text packet or tracklist packet character at the position of this attribute till the end of the line, or till another FG attribute is inserted in the line.

F-ID : Fade identifier. This bit in the Aux data AD1 is set during which a fade marker is present.

FILL line : A 2-line code depicting that this line is to be displayed on a free position of the display, when its Topic is activated.

FLP : First Line of a Paragraph. This is one of the SCROLAT codes in the ITTS text packet or tracklist packet header. It marks the first line of a paragraph which is to be displayed below the heading text when a scroll command is given.

FLS : First Line of a Section. This is one of the SCROLAT codes in the ITTS text packet or tracklist packet header. It marks the first line of a text section which is to be displayed as a whole when a scroll command is given.

Format-ID : The Format-ID recorded in the Sysinfo (SI0) bytes and in the Aux data (AD0) indicate the application of the Main data, for DCC both to be recorded "0".

FOT : Static Footer text. This is one of the SCROLAT codes in the ITTS text packet or tracklist packet header. It marks the line to be displayed in a footer, without scrolling.

Frame address : Three bits in the header of a tape block in the Main data are coded with the frame address.

Friction torque : The friction torque is the force to be applied to the reels of a cassette.

Full screen colour : The full screen foreground or background colour can be set by a command in the Data type bits of the ITTS instruction packet header.

Generation status bit : The "L" bit in the channel status of the digital audio interface.

Graphic font : A table containing a number of graphic characters and the belonging character codes.

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Grip slot : The cassette is provided with two grip slots which can be used by loaders.

GS attribute : This serial attribute inserted in an ITTS text packet or tracklist packet defines the character set to use after this attribute.

H control : Three "H" control bits in the ITTS text packets and tracklist packets are defined to indicate the speed with which the characters scroll on a 1-line display.

Header : Grouped data mostly consist of a header to define the contents of this group.

HET : Static Header text. This is one of the SCROLAT codes in the ITTS text packet or tracklist packet header. It marks the line to be displayed in a header, without scrolling.

High speed copying : Copy mode of a tape. The only allowed speed is twice the nominal recording speed.

Home marker : When detected the deck searches for the beginning of the music track on Sector A (home position) and stops.

Horizontal menu : Horizontally oriented separated parts of ITTS text on a display which can be selected by an user's command.

Hotspot : A part of ITTS text, highlighted or marked, to which a command is linked.

Hub : The spindle in the DCC cassette without any tape winding.

Hub lock : A mechanism on the slider to lock the reels when the slider is closed.

ICI bits : Instruction Continuity index. Two bits in the ITTS Instruction packet header depicting the decoder to which parts of the music the Instruction packets belong.

ICP bit : Instruction Command Present. One bit in the ITTS text packet header indicating that an interactive command is present in the text line.

Identification number : Identification Number recorded in the Aux data (AIS=01). This 13 digit number characterises the recorded music track.

IEC : International Electrotechnical Commission.

IFG : Inter Frame Gap. The IFG separates the successive Main data tape frames and Aux data tape frames.

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Index number	: A number, recorded in the Aux data byte 3, which can be given to a sub-division of a music track.
Instruction data code	: Field of 40 bytes in the ITTS Instruction packet, containing 5 interactive commands to control the display of the ITTS text.
Instruction packet	: One of the three types of packets which are defined in the ITTS format, contains instructions which are executed automatically or after a manual command.
Interactive command	: An ITTS command carried in the Instruction packet which controls the text display.
Interleaving	: Recording data words between other data in a defined and fixed sequence.
IPC	: ITTS Packet Count. A three bit counter, recorded in the Aux data if AIS=03 (consumer character recording), counts the sequence of the ITTS packets.
ISO	: International Organization for Standardization.
ISRC	: International Standard Recording Code. This code is standardized by the ISO. A music track may be provided wit an ISRC number, recorded in the Aux data if AIS=01.
ITTS	: Interactive Text Transmission System. The recording system for the text on prerecorded tape and for consumer recorded characters.
ITTS packet	: 48 bytes containing ITTS text or tracklist information for the display of the 40 character codes.
ITTS packet header	: Eight bytes in a ITTS text packet containing information about the character codes that follow.
IU count	: Information Unit Count. Seven bits in the Extended mode of the digital audio interface messages for ITTS packets. The data in the IU count represent the amount of IU units that follow.
IU start bit	: The first bit of an Information Unit which is recorded 1.
JIS	: Japanese Industry Standard.
Joint stereo mode	: Coding mode in the PASC system in which the L and R information in the high frequency subbands is jointly coded. The stereo information is carried in the separate scale factors.
Katakana font	: A table containing a number of japanese characters and the belonging codes.

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kPa : Kilo Pascal. The unit for air pressure.

Label area : Some areas are defined on the DCC cassette on which labels may be attached.

Labelled area : The area formed by a number of labelled tape frames. Labelling occurs when the odd and even tape blocks of a tape frame are recorded. If only the even frames are recorded, the frame is not labelled.

Language selection menu : When the ITTS text is recorded in more than one language, a menu is shown on the display to enable the consumer to select one language.

Language filter : A filter made in the ITTS decoder software to select the text package with the selected language out of the text information.

Language number : A 3-bits code in the header of an ITTS packet indicating the language number in which the ITTS text is recorded.

Latin based alphanumeric character set : A table containing a number of European characters and marks of punctuation plus the belonging codes.

L bit : The "L" bit in the generation status of the digital audio interface IEC958.

L-cover : A plastic cover attached to the DCC prerecorded cassette, behind which a label can be seen.

Lead-in : The area which is recorded at the beginning of a music program. This area starts with a periodic alternating recording of 4 frames labelled followed by 4 frames non-labelled ending with a Start marker or a Sector marker.

Lead-out : The area which is recorded at the end of a music program. This area ends with a periodic alternating recording of 4 frames labelled followed by 4 frames non-labelled, preceded by a Sector marker.

Leader : The non magnetic tape, attached to the hub at one side and to the magnetic tape at the other side. The leader is mounted at the beginning of the tape.

L-ID : L-ID or LABEL-ID. The identifier in Aux data AD1 to indicate that the frame is labelled.

Link to horizontal menu : Interactive command IC27. The ITTS packet contains commands that can be executed when a horizontal menu or hotspot is triggered by the user.

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lsb	: Least significant bit.
Main data	: The digital information in the main data tracks.
Main data tape frame	: The tape frame consisting of 32 tape blocks and an adjecent IFG.
Main data tracks	: The 8 tracks on the tape containing the Main data.
Main language	: ITTS text may be recorded in more than one language. The main language is indicated by the text packet or tracklist packet byte 0.
Main menu	: The ITTS menu mandatory recorded on tape coded with Topic code FFh. This menu shows the selectable topics such as Album title, Tracklist etc.
Major topic	: One of the optional ITTS topics containing Album information which is easily retrievable by the user.
Marker	: A marker which is recorded invokes automatic player actions. Three kinds of markers exist: Start markers, Sector markers and Feature markers.
Marker info	: The auxiliary data byte AD1 containing the identifiers for the markers.
Marker mode	: One of the two modes of the user data in the digital audio interface IEC958. This mode contains information which is relevant for the connected audio equipment. The other mode is the extended mode.
MD	: Main Data, the 48 bytes in the tape block body.
Menu re-branching	: The function in a player which anables the user to toggle between the Main menu and the Language menu.
MH	: Main data Header, consisting of a sync word, a 3 bits block address and a 5 bit block address.
M-ID	: Mute identifier. This bit in the Aux data AD1 is set during which a mute marker is present.
MLI-ID	: Marker Length Identifier. This identifier indicates wether the length of the recorded marker is 16 or 32 frames long.
Mode bit	: The second bit in the marker mode and extended mode of the digital audio interface IEC958.
Modulation	: The 8-10 modulation method which is used in DCC is the conversion of 8-bit symbols into 10-bit codewords.

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msb : Most significant bit.

Music program : A number of recorded music tracks form together a music program.

Mute defect : A defect of the tape/head combination causing uncorrectable data.

Mute marker : During this marker, which can be recorded by the user in the Aux data byte AD1, the audio is muted immediately or is muted smoothly (faded) if acting with a Fade marker.

Mutilation : The modification during re-recording of frames in the Main data such that the Reed Solomon decoder labels the information as not correctable.

Narrow band S/N : The ratio of the average signal amplitude, read from the tape, to the integrated noise in the bandwidth of 10 kHz.

Next sector marker : At the detection of this marker the deck switches over to the beginning of the music program on the other Sector.

NLS attribute : Normal Size attribute. This ITTS attribute sets the character following this attribute to the normal size.

NRZ : Non Return to Zero

NS control : No automatic Scrolling. This control bit in the ITTS text packet and tracklist packet prevents the automatic scrolling on the 1-line display of ITTS text.

Optimum recording current : The optimum recording current is the recording current which gives at 48 kHz the maximum output level at play back.

Overwrite characteristics : The behaviour of a head-tape combination when a previously recorded tape is recorded again with new data.

Packet index : The bytes 2 and 3 in the header of the ITTS text packet or tracklist packet, used for the addressing of the memory in the ITTS decoder.

Padding : The addition of dummy slots in PASC subband frames when a sampling frequency of 44.1 kHz is used.

Page oriented text : ITTS text to be displayed on a 21-line display organized such that scrolling behaves as if one selects page after page.

PASC : Precision Adaptive Subband Coding. The audio coding method used with DCC.

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PASC frame	: The PASC frame contains a number of slots, depending on the sampling frequency of the audio signal.
PASC slot	: A PASC slot is a group of 32 bits. The first slot contains the synchronization pattern and the subband coding information.
PASC decoder test	: A test tape to be used to test the compatibility of a PASC decoder.
PASC reference decoder	: A commercially available decoder which serves as reference for measuring purposes.
P control	: Loading Pause. This control bit in the ITTS text mode controls, together with the S control, that part of the 40 character wide text line which is to be displayed on a 12-character display.
PCM	: Pulse Code Modulation. A method of coding broadband audio.
P-ID	: The identifier in aux data AD1 which indicates a pause between the music tracks.
Pitch control	: With this type of control the tape speed during play back is varied by the main oscillator.
PLL symbol	: Phase Locked Loop symbol. Data to enable clock recovery, recorded in tape block header of the Aux data (AH0,AH2).
Pressure pad	: The part in the cassette which presses the tape against the head. The pad is normally made of felt material.
Pull through force	: The force necessary to pull the tape through the pressure pad and the head.
QBC	: Quarter Block Count. 4 bits in the Aux data byte AD21 form a counter to verify the recorded quarter blocks of an ITTS packet for consumer recorded characters.
RCC bit	: Reset Continuity Count. This bit, recorded in the Sysinfo byte 1, is used together with the CC bits, to reset the CC counter.
RDA	: A bit recorded in the Aux data byte 0 to indicate the direction of which the Sector A has been recorded.
RDB	: A bit recorded in the Aux data byte 0 to indicate the direction of which the Sector B has been recorded.
Recognition hole	: A number of holes are defined in the cassette to indicate the type of cassette and the length of the tape.
Reed Solomon Code	: A code defining the error detecting and correcting method.

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Reel : The composition of the hub, leader or trailer, splicing tape and the magnetic tape.

Reference cassette : A commercially available DCC cassette containing DRT1 reference tape.

Reference pin : The pin in the cassette deck which fits in the reference hole cares for the height reference of the cassette.

Reflectivity : The figure indicating the amount of light which is reflected by the tape.

Relative frequency response : The frequency response measured on a tape to be tested relative to the frequency response of the DRT1 reference tape.

Relative signal output : The signal output measured on a tape to be tested relative to the signal output of the DRT1 reference tape.

Remanence magnetism : The remaining magnetism after the recording signal is switched off.

Renumbering : A method to assign new Track numbers in the after-recording mode.

Residual elongation : The difference in length of a tape before and after the tape is subjected to a pulling force.

Reverse marker : At the detection of this marker the deck switches over to the other Sector. This marker indicates that Sector B contains the continuation of the recording of Sector A.

RH : Relative Humidity.

Row foreground/ background colour : Byte 4 in the ITTS command IC19 defines the colour to be set in the defined text area (row) of byte 4.

R-time : Remaining time, representing the time which remains from the point on tape till the end of the music program, Lead-out of Sector B. This time information is recorded in the Aux data if AIS =02.

RT-time : Remaining Track time, representing the time which remains from the point on tape till the end of the music track. This time information is recorded in the Aux data if AIS =02.

Sampling frequency : The frequency of the samples representing the audio signal.

S control : Start loading. This control bit in the ITTS text mode controls, together with the P control, that part of the 40 character wide text line which is to be displayed on a 12-character display.

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SCM-ID : The identifier in aux data AD1 which indicates that a Sector marker is recorded.

SCMS : Serial Copy Management System. This system specifies which recording may or may not be copied from the source.

Scrolat : Three bits in the ITTS text packet and Tracklist packet byte 6 control the scroll options of an ITTS text line on a display.

Scroll window : The space on the display not occupied by a header and footer, in which scrolling is possible.

SCT bit : The identifier, recorded in the Aux data AD4, indicates to what Sector the A-time relates.

Search : The deck moves the tape with a high velocity contacting the DCC head.

Search information : Information which is made by the envelope modulation of the Aux data track.

Sector : The longitudinal data tracks recorded on tape is divided into two area: Sector A and Sector B. Each Sector is composed of 8 tracks for recording Main data plus 1 track for Aux data.

Sector marker : A number of markers which all have influence on the deck movement at the boarders of a Sector. Sector markers are: Home, Stop, Reverse, Next Sector and Use Again marker.

Setmakers signature : When making a consumer recorded tape, this code is recorded automatically in the Sysinfo to identify the recorders manufacturer.

SH-ID : The identifier in aux data AD1 which indicates that a Skip marker is recorded.

Shielding plate : A metallic plate put in the DCC cassette to reduce the electro magnetic influence.

Shortening play : In this mode the deck stops to play back the music track, searches for the following track and continues in the play back mode.

Skip marker : This marker can be set (SH-ID=1) by a consumer to skip the remainder of the music track.

Slider : The metal plate covering the openings of a DCC cassette.

Slot : Two types of slots are defined: The PASC subband slot and the slot for the user main data. A Slot is a group of 32 bits.

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SMRK attribute	: Start of Marking. This serial attribute in the ITTS text packet or in the Tracklist packet starts the marking of characters following this attribute in the ITTS text line.
SOB bit	: The identifier, recorded in the Aux data AD4, indicates whether the A-time counting increments continuously till the end of Sector B or starts again incrementing from 0 at the beginning of Sector B.
Splicing tape	: The tape which connects the leader or trailer tape to the magnetic tape.
Start bit	: The first bit in the marker mode and extended mode of the digital audio interface IEC958.
Start marker	: The marker, recorded in the Aux track to indicate the beginning of a music track. On prerecorded tape this marker is recorded before the music track, on consumer recorded tapes at the beginning of the music track.
Static longitudinal curvature	: The deviation of the edge of the tape from a straight line when the tape is unrolled.
Stop marker	: This marker can be set by a consumer to stop the play back immediately.
Storage grip	: Two slots in the cassette are defined to enable fitting in a storage device.
STP bit	: The bit in the marker mode of the digital audio interface IEC958 indicating that no audio signal is available due to e.g. search or stop actions of the player.
Subband signal	: The PCM signal coming from the filter section which splits the broadband signal into 32 subbands.
SU-ID	: The identifier in aux data AD1 which indicates that the consumer recorded tape has a Super user status.
Super-user tape format	: The consumer recordings of which the time information and the track numbering is continuously recorded without interruption, have the Super user status indicated with the SU-ID and the TT1/TT2 bits.
Support area	: The area on the cassette where the cassette may be supported.
Symbol error	: A detected error, data read are not as they were recorded.
Sync pattern	: A pattern in the header of a Main data tape block and in the Aux data tape block. The 10 bits sync word (unmodulated) can be found in the modulator table.

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Synchronously sung text	: Text which is to be displayed synchronously with the music, e.g. lyrics or undertitling.
Sysinfo	: The 128 bytes per tape frame in the Main data containing tape type and copyright data plus the ITTS text information.
Sysinfo mode ID	: Identifier in the header SI1 of the Sysinfo indicating the use of this channel. For DCC ITTS text mode this ID must be recorded 0001.
T-time	: Track time, representing the time which is elapsed since the beginning of a music track. This time information is recorded in the Aux data AD 7...9.
Tape block	: A sub-division of a tape frame. A tape frame of Main data is divided into 32 tape blocks. A tape frame of Aux data is divided into 4 tape blocks.
Tape capstan slip	: This slip is calculated using the linear speed of the tape and the circumferential speed of the capstan.
Tape frame	: A unit of data consisting of 32 tape blocks for Main data and 4 tape blocks for the Aux data.
Tape type bits	: TT1 and TT2. These bits, recorded in the Sysinfo byte SI0, indicate the type of tape which is recorded.
TCI bits	: Topic Continuity Index. Two bits in the ITTS text and tracklist header byte 6, indicate the continuity state of the text contents.
T control	: Terminator for automatically scrolled text. Control bit in the ITTS text packets and tracklist packets. In the automatic scroll mode the characters following this control bit are not shown on the display, but are displayed after a manual scroll command.
Temporary reverse marker	: This marker indicates the beginning of the remaining part of the music program on Sector B. The Temporary reverse marker is recorded when no Reverse marker on Sector A could be recorded.
Text packet	: A packet of text data and attributes in the ITTS text mode.
THD	: Total Harmonic Distortion.
THD+N	: Total Harmonic Distortion plus Noise.
TOC	: Table Of Contents.
TOC entry	: Five bytes in the Aux data (AD10...AD14) or (AD15...AD19) containing information of a TOC, the first byte of each TOC entry contains the TOC item.

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TOC item : Recorded in the AUX data bytes AD10 and AD15. The TOC item is the first byte in a TOC entry which indicates the type of contents of the TOC data in the following 4 bytes.

TOC partitioning : The first item in a TOC, indicating the amount of TOC entries and the first and last track number with which the TOC is related.

Topic : Subject of the ITTS text such as Album title, performers name, etc.

Topic code : A code in the ITTS header byte 4 of an ITTS text line indicating to what kind of topic the text line belongs.

TOP line : One of the 2-line codes recorded in the ITTS text an tracklist packets, indicates that this line must be fixed on the upper line of the 2-line display.

Tracklist : A list containing the information for the user about all music tracks in the ITTS.

Tracklist packet : A packet of tracklist data and attributes in the ITTS text mode.

Track number : A number is assigned to a music track in the Aux data byte AD2.

Track search : The player can search for a music track using the "previous/next" action, search for a track number or using the information written in a TOC.

Trailer : The non magnetic tape, attached to the hub at one side and to the magnetic tape at the other side. The trailer is mounted at the end of the tape.

Transparency : The ratio of the intensity of the original light beam and the intensity of the beam when it passes the tape.

Transparent bit : TR0/TR1 These bits are recorded in the first slot of the PASC frame. TR1 is reserved, TR0 is a copy of CP1. (Copy protection bit)

TT bits : TT1/TT2 Recorded in the Sysinfo byte SI0 represent the type of recorded tape format.

Unmodulated data bit : A data bit which has not been passed through the 8-10 modulator.

UPC : Number recorded in the Aux data (AIS=01). This code characterises the recorded music track similar to the UPC code.

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Use again marker	: A marker which is used to facilitate the append recording function in a DCC recorder.
User Aux data	: The Aux data containing the 36 User aux data bytes for each tape block.
User Main data	: The channel in the Main data containing the PASC coded audio signals.
User tape format	: A tape format of which the A-time code and/or the track numbering is not consecutive.
Virgin tape	: Tape which was not recorded before or has been bulk erased or is recorded with non-decodable data.
Weighting filter	: Normalized filter used to measure THD+N.
Wide band S/N	: The ratio of the average signal amplitude, read from the tape, to the integrated noise in the bandwidth of 2 kHz to 43 kHz.
Window area	: The space on the display in which scrolling of ITTS text is possible.
Yield strength	: The force necessary to elongate the tape 1%.

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ANNEX B : INSTRUCTIONS FOR USE OF THE DCC LOGO

B.1 Scope

These instructions for use determine the way the DCC logo is to be used on the objects indicated.

B.2 Object

The DCC logo shall appear on cassette recorders, cassette players, cassettes and related packaging, accessories, advertising, printed materials, etc., to certify the conformity of the cassette recorders, cassette players and cassettes with the DCC System Description and the interchangeability among the DCC products.

B.3 Territory

The instructions for use specify the way the DCC logo is to be used in the whole world, except in those countries where such trade marks are forbidden by law.

B.4 Use of the DCC-logo

B. 4.1 Shape

The DCC logo consists of the words DIGITAL COMPACT CASSETTE and the stylized letters DCC. The DCC logo must always be used in the fixed combination and form as represented in Fig B.1. Variations and additions are forbidden.

B. 4.2 Colour

The DCC logo may be used in any one colour. Different colours may not be used for the text in the same logo.

B. 4.3 Negative and positive

If a positive or negative version of the DCC logo is used, the background colour and intensity must be uniform across the entire logo. Shadows and or graphic effects are not allowed.

B. 4.4 Clear zone

The DCC logo must be used on its own and be freestanding.
A clear zone of at least the height of the stylized letter C of DCC must be maintained between the DCC logo and other graphical or textual elements. The DCC logo may not be enclosed on its own in any kind of box or frame, nor may any text, slogan, etc. be added.

B. 4.5 Size

The DCC logo may be reduced or enlarged on condition that the same relative positions and proportions between the respective elements are maintained and that the DCC logo is always legible.

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B.5 Appearance

The DCC logo shall appear in the following positions:

a. Control panel of DCC recorders or DCC players;
b. Top (see Fig. 5.8) (not label area) of a DCC cassette;
c. Cassette case and its covering material;
d. Instruction manual of the DCC recorder or DCC player (in any way provided it appears at least on the cover of the manual);
e. Packing boxes of DCC recorders, players and cassettes;
f. Printed materials (including catalogues, posters, advertising materials, etc.).
g. Optional on the bottom of a DCC cassette.

B.6 Use of the wording Digital Compact Cassette and the acronym DCC

To refer to the system or standard, the wording Digital Compact Cassette or the acronym DCC (in capitals and in the same typeface as the rest of the text) may be used in written material on the condition that the DCC logo is also used.

The acronym DCC may also be used in plain lettering as a type indication of the product, both on players and cassettes provided that it is always followed by a number. Construed type faces for the letters DCC so making out of this letter combination a new logo type device should not be used.

B.7 Additional information

Logo artwork and more information regarding use of the DCC logo can be obtained from Philips Consumer Electronics B.V. (see Preface).

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B.5 Appearance

Figure B.1

Fig. B.1 DCC LOGO

DIGITAL
dcc
COMPACT CASSETTE

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