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ISO/IEC 11694-4

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Identification cards — Optical memory cards — Linear recording method —

Part 4: Logical data structures

Cartes d'identification — Cartes à mémoire optique — Méthode d'enregistrement linéaire —

Partie 4: Structures de données logiques

Reference number
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Contents

Page

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to the national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 11694-4 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Identification cards and related devices*.

ISO/IEC 11694 consists of the following parts, under the general title *Identification cards - Optical memory cards - Linear recording method:*

- *Part 1: Physical characteristics*
- *Part 2: Dimensions and location of the accessible optical area*
- *Part 3: Optical properties and characteristics*
- *Part 4: Logical data structures*

Annexes A and B form an integral part of this part of ISO/IEC 11694.

Introduction

This part of ISO/IEC 11694 is one of a series of standards describing the parameters for optical memory cards and the use of such cards for the storage and interchange of digital data.

The standards recognize the existence of different methods for recording and reading information on optical memory cards, the characteristics of which are specific to the recording method employed. In general, these different recording methods will not be compatible with each other. Therefore, the standards are structured to accommodate the inclusion of existing and future recording methods in a consistent manner.

This part of ISO/IEC 11694 is specific to optical memory cards using the linear recording method. Characteristics which apply to other specific recording methods shall be found in separate standards documents.

This part of ISO/IEC 11694 defines the logical data structures and the extent of compliance with, addition to, and/or deviation from the relevant base document ISO/IEC 11693.

The user's attention is called to the possibility that compliance with this part of ISO/IEC 11694 may require use of an invention covered by patent rights and/or other material covered by copyrights. By publication of this part of ISO/IEC 11694, no position is taken with respect to the validity of this claim or of any patent rights or copyrights in connection therewith.

Identification cards - Optical memory cards - Linear recording method -

Part 4:
Logical data structures

1 Scope

This part of ISO/IEC 11694 defines the logical data structures for optical memory cards necessary to allow compatibility and interchange between systems using the linear recording method.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 11694. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this part of ISO/IEC 11694 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of ISO and IEC maintain registers of currently valid international standards.

ISO/IEC 11693:1994, *Identification cards - Optical memory cards - General characteristics.*

ISO/IEC 11694-1:1994, *Identification cards - Optical memory cards - Linear recording method - Part 1: Physical characteristics.*

ISO/IEC 11694-2:1995, *Identification cards - Optical memory cards - Linear recording method - Part 2: Dimensions and location of the accessible optical area.*

ISO/IEC 11694-3:1995, *Identification cards - Optical memory cards - Linear recording method - Part 3: Optical properties and characteristics.*

3 Definitions

For the purposes of this part of ISO/IEC 11694, the definitions given in ISO/IEC 11693, ISO/IEC 11694-1, ISO/IEC 11694-2, ISO/IEC 11694-3 and the following definitions apply.

3.1 data bit: An area which represents data on an optical memory card. A mark which has a different reflectivity and/or phase difference from the background reflectivity. One mark can define one or two data transitions dependent on the modulation method selected.

3.2 data track: The area located between adjacent track guides where data are written and/or read.

3.3 error correction code (ECC): A code designed to correct certain kinds of errors in data.

3.4 error detection and correction (EDAC): A family of methods in which redundancy is added to a message block, at the time the message block is recorded, in known fashion. Upon read back, a decoder removes the redundancy and uses the redundant information to detect and correct erroneous channel symbols.

3.5 modulation code: A system for coding which transforms information bits into some physical representation for recording onto the optical memory card.

3.6 pitch: The distance between corresponding points on adjacent data spots.

3.7 sector: The minimum unit of data that can be accessed on a card for any read and/or write command.

4 Reference points

The reference track and reference edges defined in ISO/IEC 11694-2 apply unless otherwise specified.

4.1 First data bit

The first data bit shall be located on the reference track and is part of the track ID. The location may vary dependent on the track layout selected. See annex A or annex B.

5 Track layout

Track layout information shall be preformatted on cards during manufacture and/or written to cards prior to use.

The total number of tracks may vary dependent on the application requirements; however, in all cases, tracks shall be arranged in order, and numbered sequentially, beginning with the reference track. See annex A or annex B for actual track layouts and numbering sequences.

5.1 Track layout options

See annex A or annex B for information concerning data structures that support the optional card layouts described in ISO/IEC 11694-2.

6 Track guides

Track guides shall be uniformly spaced across the card and shall extend the length of the accessible optical area. The accumulated tolerances across the width of all track guides shall be less than or equal to 24 μm at 25° C. See annex A or annex B for specific dimensions.

7 Guard tracks

There shall be 20 guard tracks, ten located directly above and ten directly below the user data area to enable the optics to locate the user data tracks and prevent the optical head from over running the accessible optical area if auto-tracking is lost.

Guard tracks may contain data relating to card type, physical data format, specific application and/or card drive autodiagnosis and calibration. See annex A or annex B.

8 Data tracks

Written and/or preformatted data shall be located within data tracks and centred between adjacent track guides to a tolerance of $\pm$ 0,5 μm in the y-axis. See annex A or annex B.

9 Track ID

Written and/or preformatted track ID shall identify the physical address of each data track. See annex A or annex B for specific configuration and location.

10 Sectors

Sectors are defined by the amount of user data in bytes and the number of sectors which can be written to a single data track. See annex A or annex B for specific types/sizes.

All sectors within a given track shall be identical in type and partially written tracks shall only be appended with sectors of the same type as those previously written on the track unless otherwise specified in annex A or annex B.

NOTE - Sector types/sizes have been defined to maximize the efficiency of data storage on a track and may vary by modulation code.

11 Data encoding

To encode data requires the use of a modulation code. See annex A or annex B for acceptable modulation codes.

NOTE - The user data on any single optical card shall only be encoded using one modulation code.

Annex A
(normative)
8-10 NRZI modulation code, PWM recording method

A.1 Scope

This annex defines the logical data structures specific to optical cards using a pulse width modulation recording method and an 8-10 NRZI modulation code.

A.2 Definitions

For the purpose of this annex, the following definitions apply:

A.2.1 carrier/burst modulation code: A form of FM modulation code which makes *1,0* information correspond to a different frequency.

A.2.2 NRZI: Non-return-to-zero-inverse; a specific modulation method to make *1* corresponding to inverse and *0* to non-inverse.

A.2.3 Reed-Solomon code: A byte error detection and/or correction code which is generally used in optical and magnetic storage.

A.3 Reference points

The first bottom guard track (*LPT9*) is the reference track and shall be located 5,4 mm ± 0,3 mm from the reference edge.

NOTE - This dimension is tighter yet still falls within the tolerance range specified by dimension *D* of ISO/IEC 11694-2.

A.3.1 First data bit

The first data bit closest the left edge of the card shall be located at 12,50 mm ± 0,40 mm in the x-axis. The distance between the first data bit closest the left edge of the card and the first data bit closest the right edge of the card shall be 60,6 mm ± 0,1 mm in the x-axis.

A.4 Track layout

Tracks shall be arranged in order beginning with the reference track and shall be numbered sequentially beginning with track -10, the reference track.

Track description	Track #	Hex
Guard track LPT9 (first bottom)	-10	FFF6
: :	:	:
Guard track LPT0 (last bottom)	-1	FFFF
First user data track	0	0000
: :	:	
Last user data track	n	
Guard track UPT0 (first top)	n+1	
: :	:	
Guard track UPT9 (last top)	n+10	

NOTE - Because the total number of tracks may vary dependent on the application requirements, the last user data track and the top guard tracks are expressed in parametric form.

A.5 Track layout options

This section provides information concerning data structures that support the optional card layouts described in ISO/IEC 11694-2.

A.5.1 Cards with moderate data capacity

This layout shall contain 2 520 data tracks, of which 2 500 shall be user data tracks. Tracks shall be numbered sequentially beginning with track -10, the reference track.

NOTE - This layout supports the inclusion of a magnetic stripe and/or signature panel.

A.5.2 Cards with options, no embossing

This layout shall contain 1 128 data tracks, of which 1 108 shall be user data tracks. Tracks shall be numbered sequentially beginning with track -10, the reference track.

NOTE - This layout supports the inclusion of a magnetic stripe, IC chip with contacts, and/or signature panel.

A.5.3 Cards with options, no IC chip

This layout shall contain 1 128 data tracks, of which 1 108 shall be user data tracks. Tracks shall be numbered sequentially beginning with track -10, the reference track.

NOTE - This layout supports the inclusion of a magnetic stripe, embossing, and/or signature panel.

The reference edges for this layout shall be the top edge and the right edge of the card. See ISO/IEC 11694-2.

For this layout, the first data bit closest the right edge of the card shall be located at 12,50 mm ± 0,40 mm in the x-axis. The distance between the first data bit closest the right edge of the card and the first data bit closest the left edge of the card shall be 60,6 mm ± 0,1 mm in the x-axis.

The track layout for these type cards shall be displayed from the top to the bottom of the card, beginning with the reference track.

A.5.4 Cards with maximum data capacity

This layout shall contain 3 593 data tracks, of which 3 573 shall be user data tracks. Tracks shall be numbered sequentially beginning with track -10, the reference track.

NOTE - This layout supports the inclusion of a magnetic stripe and/or signature panel.

A.6 Track guides

The width of the track guides shall be 2,3 μm ± 0,3 μm. The distance from the centre of one track guide to the centre of an adjacent track guide shall be 12,0 μm ± 0,2 μm.

No track guides shall have any breaks exceeding 180 μm.

A.7 Guard tracks

All guard tracks shall contain preformatted track-ID and card-type data and/or card-ID field data. Cards shall not be issued with these tracks left blank nor shall these tracks be made available to the application for writing.

Each guard track shall contain two track ID areas, one to the left, the other to the right of the card-type data and/or card-ID field. See A.10.

NOTE - It is expected that card drive units will have the ability to read guard tracks whether preformatted with card-type data or pre-recorded with card-ID field data.

A.7.1 Card-type data

Card-type data are pre-set indicia that denote the physical data format, the number and location of tracks and/or a specific type application. There shall be two blocks per track each containing the same card-type pattern repeated eight times. See figure A.1 and table A1.

Card-type data shall be preformatted using a carrier/burst modulation code. These tracks shall not be made available to the application for writing nor shall cards be issued with these tracks left blank.

The carrier/burst pattern shall consist of an *L*-pattern (denotes *0* data) and an *S*-pattern (denotes *1* data), the only difference between patterns being the pattern-pitch. The *L*-pattern pitch shall be 240 μm ± 5 μm and the *S*-pattern pitch shall be 120 μm ± 5 μm. See A.12.2, figure A.1 and table A.1.

The length, or x-axis dimension, of preformatted data bits shall be 6,0 μm ± 0,6 μm; the width, or y-axis dimension, shall be 2,5 μm ± 0,5 μm; the bit pitch shall be 12,0 μm ± 0,3 μm. See figure A.1.

The distance between the first data bit of the left track ID closest the left edge of the card and the first data bit of the card type pattern closest the left edge of the card shall be 14,9 mm ± 0,1 mm in the x-axis.

A.7.2 Unique card identification (ID) field

For those applications requiring unique card serialization, guard tracks *LPT1* (track -2) and *LPT0* (track -1) shall be used as a card-ID field. If using this option, information related to the application and other issuer information may be included in these tracks along with the card serialization data.

Card-ID field data shall be pre-recorded during the manufacturing process. These tracks shall not be made available to the application for writing nor shall cards be issued with these tracks left blank.

A.7.2.1 Content

Figure A.2 shows the structure and data content of the card-ID field. Data shall be pre-recorded using a type-2 sector as defined in A.11.1 and table A.2. The same information shall be repeated in each sector of each track, that is four times in two tracks.

NOTES

1 It is not permissible to set all data fields to *OFF* hex.

2 If no components of the card-ID field are used, these two tracks must be preformatted with card-type data. See A.7.1.

Field components include:

- **Application identifier (AID)**: The AID shall consist of 16 bytes of alpha/numeric data, which data shall be agreed to by the card manufacturer and card issuer. If the AID is not implemented, these 16 bytes shall be set to *OFF* hex.

  NOTE - Card manufacturers shall have the responsibility to manage the information to ensure AID's are not duplicated between different card issuers.

- **Unique identifier (UID)**: The UID shall consist of six bytes, one byte containing the card manufacturer identifier (CMID), and five bytes containing a unique card identifier (UCID). If the UID is not implemented, these six bytes shall be set to *0FF* hex.

NOTES
1 The card manufacturer shall have the responsibility to ensure only one UID is contained in their card products.
2 Since different card manufacturers can use the same UCID, it is recommended that the entire UID (CMID + UCID) be used.

- **Number of issuer data bytes (NID)**: The NID shall consist of two bytes which specify the number of bytes used in the ISSUER portion of the card-ID field. If the NID is not implemented, these two bytes shall be set to *0FF* hex.

- **Optional issuer data (ISSUER)**: The ISSUER shall consist of 488 bytes and shall be reserved for the exclusive use of the card issuer. Any unused bytes in this area shall be set to *0FF* hex.

NOTE - Since card-ID field data are pre-recorded, the ISSUER data must be pre-recorded at the time of card manufacture.

A.8 Data tracks

Each data track can contain a maximum of 60,7 mm of written and/or preformatted data, including the gaps between sectors.

A.8.1 Data bits

Use of the 8-10 NRZI modulation code requires that written and/or preformatted data bits consist of four different sizes. The length, or x-axis dimension, shall be 3,0 μm ± 0,6 μm, 6,0 μm ± 0,6 μm, 9,0 μm ± 0,6 μm or 12,0 μm ± 0,6 μm; the width, or y-axis dimension, shall be 2,5 μm ± 0,5 μm.

The minimum distance from the centre of one data bit to the centre of an adjacent data bit shall be 6,0 μm ± 0,3 μm.

A.9 Track components

A.9.1 Pre-amble (PRE)

A series of 60 consecutive bits laid out from the left edge direction of the card. The PRE bit-pattern shall be 1010101010... or 0101010101... See figure A.3.

NOTE - The PRE generates the data clock required by the card drive's phase-lock-loop (PLL) circuit when an optical card is read from left to right.

A.9.2 Sync marker

A specific 10-bit pattern which does not show up as a read-output signal when the 8-10 NRZI modulation code is implemented on the track ID and/or user data.

NOTE - When asynchronization occurs during reading, data can be re-synchronized after sensing successive sync markers.

The sync marker shall be set on the border of the data matrix, created when implementing the Reed-Solomon code, to divide the user data into multiple blocks. See figure A.4.

The first sync marker from the left edge of the card, in every sector and in both track ID's, shall be 1100010001 prior to NRZI modulation. All other sync markers shall be either 1100010001 or 0100010001 prior to NRZI modulation.

Thus all written sync markers shall become either 1000011110 or 0111100001 after NRZI modulation.

A.9.3 Post-amble (PST)

A series of 60 consecutive bits laid out from the left edge direction of the card. The PST bit-pattern shall be 0101010101... or 1010101010... See figure A.3.

NOTE - The PST generates the data clock required by the card drive's PLL circuit when an optical card is read from right to left.

A.10 Track ID

Track ID shall be preformatted at the right and left side of each data track. See figures A.3 and A.5.

NOTE - The structure allows the track ID to be read from either direction, that is from left to right or right to left.

A.10.1 Content

The track ID shall consist of 75 bytes of information and the length shall be 2,25 mm ± 0,02 mm. The track ID shall consist of the PRE, sync markers, track numbers, ECC and the PST. See A.12.3 and figure A.3.

The track number itself shall be repeated twice per track ID with the most significant bit (MSB) positioned closest the left edge of the card.

A.11 Sectors

Every sector shall contain a PRE, sync markers, user data, ECC and a PST and shall be separated from adjoining sectors by a gap, that is an unrecorded area. See figures A.4 and A.5.

User data shall be written within a sector and arranged from left to right regardless of the writing direction implemented.

NOTE - Sectors can be written in either direction, that is, from left to right, the forward direction, or from right to left, the reverse direction.

The accumulated tolerances across any sector shall be less than ± 3% of the sector length.

A.11.1 Types of sectors

Sector types shall be as defined in figure A.6 and table A.2.

NOTE - The sector lengths shown in figure A.6 are the maximum allowed when taking into consideration up to a 3% deviation in the velocity of the card drive mechanism which is anticipated in the actual use of optical card systems.

All sectors, regardless of sector type, shall be located relative to the first bit position of the left track ID. The MSB shall always be placed at the edge of each sector closest the left edge of the card.

A.12 Data encoding

This section describes the method for encoding and storing data on optical cards using the various sector types.

A.12.1 Modulated data

All track ID's and user data along with their associated ECC shall be modulated using the 8-10 NRZI modulation code. See figures A.7, A.8, A.9 and table A.3.

NOTE - When encoding, ten bits are assigned to every eight bits of actual data using the 8-10 modulation table. When reading, the original eight bits are retrieved/demodulated from the corresponding 10-bit data pattern.

A.12.2 Carrier/burst modulation code

All card-type data shall be preformatted using the carrier/burst modulation code. See A.7.1, figure A.1 and table A.1.

NOTE - In the read mode, this modulation code permits card-type information found in the guard tracks to be demodulated with software, eliminating the influence from the variable velocity, if any, of the optical card drive.

A.12.3 Error correction code

Each track ID and every sector of written data shall be encoded using the Reed-Solomon ECC generated by the following generator polynomial:

$$G(x) = (X - \alpha^3)(X - \alpha^2)(X - \alpha)(X - 1)$$

where

$$x^8 + x^4 + x^3 + x^2 + 1 = 0$$

α is a primitive element of $GF(2^8)$.

The Reed-Solomon code arranges every track ID and every sector of user data into a matrix as shown in figure A.10 and then applies the ECC based on the generator polynomial, resulting in the addition of four parity bytes to the matrix.

EXAMPLE - Track ID are encoded using a C1 (6,2), C2 (5,1) Reed-Solomon code. As a result, 28 parity bytes are added to the original two bytes which make up the track ID.

EXAMPLE - Encoding a sector type 7 using the Reed-Solomon ECC.

Write 16 bytes of data containing the following integer values in hexadecimal:

00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

Arranging the bytes into an 8 x 2 matrix, the data becomes:

00	01	02	03	04	05	06	07
08	09	0A	0B	0C	0D	0E	0F

Encoding each row of the matrix using the generator polynomial $G(x)$, the above matrix becomes:

00	01	02	03	04	05	06	07	2C	84	05	AD
08	09	0A	0B	0C	0D	0E	0F	D8	4E	65	F3

Encoding each column of this matrix using the generator polynomial $G(x)$, the matrix becomes:

00	01	02	03	04	05	06	07	2C	84	05	AD
08	09	0A	0B	0C	0D	0E	0F	D8	4E	65	F3
78	14	A0	CC	D5	B9	0D	61	EE	FB	DB	CE
AD	CC	6F	0E	34	55	F6	97	18	91	77	FE
E7	4D	AE	04	75	DF	3C	96	67	8F	E8	00
3A	9D	69	CE	9C	3B	CF	68	65	2F	24	6E

A.13 Measurement

NOTES

1 The reading/writing test conditions outlined in ISO/IEC 11694-3 apply unless otherwise specified when observing the optical characteristics.

2 An Optical Specialties, Inc. Video Linewidth System, VLS-I, or equivalent, is used for physical measurements.

A.13.1 Track guide measurement

The measurement of the track guide pitch and width shall be performed in the nine areas shown in figure A.11. Each area shall consist of ten tracks and the average value at each of the nine areas shall fall within the specified range.

A.13.2 Track ID measurement

The measurement of the track ID data bit size, bit pitch and the length of the track ID shall be performed in the six areas designated by *D* and *E* in figure A.11. Each area shall consist of ten tracks and the average value at each of the six areas shall fall within the specified range.

A.13.3 Guard track measurement

The measurement of the guard track data bit size, bit pitch and the carrier pattern pitch shall be performed in two tracks each in the areas designated *A* and *C* in figure A.11. The average value of a minimum of ten measurements taken at each location shall fall within the specified range.

A.13.4 Preformatted data characteristics

The following characteristics shall be achieved when scanning a preformatted portion of the accessible optical area containing a card-type carrier/burst pattern. See figure A.1.

To achieve the expected results, tests shall be conducted using a beam diameter of 2,5 μm and a media linear velocity of 480 mm/s ± 3%.

A.13.4.1 The low frequency recovery value shall be greater than or equal to 0,9. See ISO/IEC 11694-3.

A.13.4.2 The amplitude comparison value shall be greater than or equal to 0,8. See ISO/IEC 11694-3.

A.13.4.3 The signal overlap (S_O) divided by the high frequency amplitude (A_{HF}) shall be greater than or equal to 0,8. See ISO/IEC 11694-3.

A.13.5 Written data measurement

The measurement of the written data bit and the bit pitch shall be determined using the wave shape of the read out signal using a beam diameter of 2,5 μm, a read power of 0,1 mW ± 5% and a media linear velocity of 480 mm/s ± 0,5%.

The bit size shall be measured at the half value point and the bit pitch at the peak point of the read signal. The average value of a minimum of ten measurements shall fall within the specified range.

A.13.6 Written data characteristics

The following characteristics shall be achieved when scanning a written portion of the accessible optical area containing high frequency data (80 kHz), and low frequency data (20 kHz).

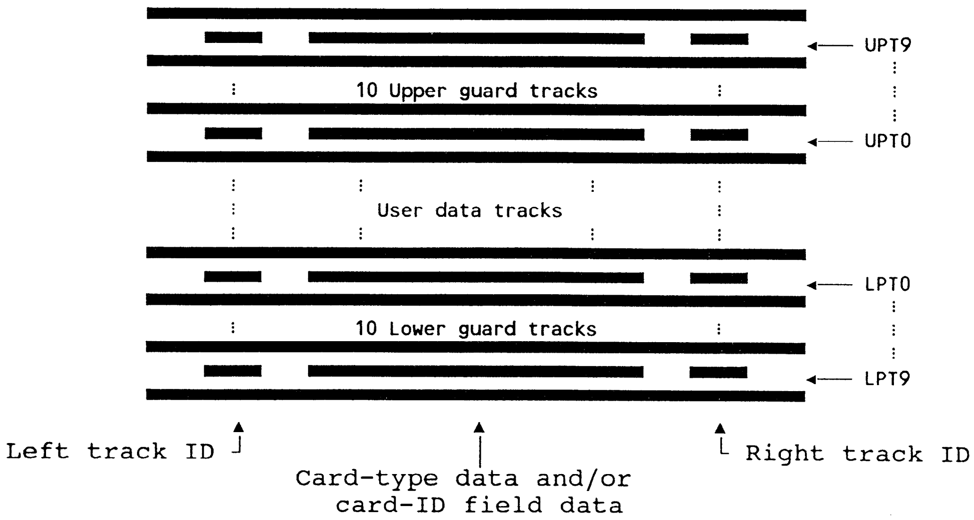
To achieve the expected results, tests shall be conducted using a beam diameter of 2,5 μm and a media linear velocity of 480 mm/s ± 3%. The write power shall be 18 mW ± 5%. A pulse width of 3,5 μs at 80 kHz, and 22 μs at 20 kHz shall be used.

A.13.6.1 The low frequency recovery value shall be greater than or equal to 0,9. See ISO/IEC 11694-3.

A.13.6.2 The amplitude comparison value shall be greater than or equal to 0,8. See ISO/IEC 11694-3.

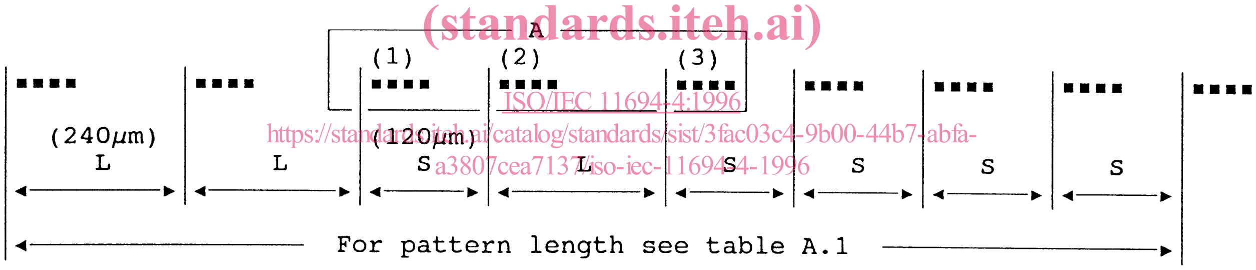
A.13.6.3 The signal overlap (S_O) divided by the high frequency amplitude (A_{HF}) shall be greater than or equal to 0,8. See ISO/IEC 11694-3.

A.13.6.4 The carrier-to-noise ratio (*C/N*) shall be greater than or equal to 40 dB when measured across a bandwidth 1 kHz at a carrier frequency of 80 kHz.



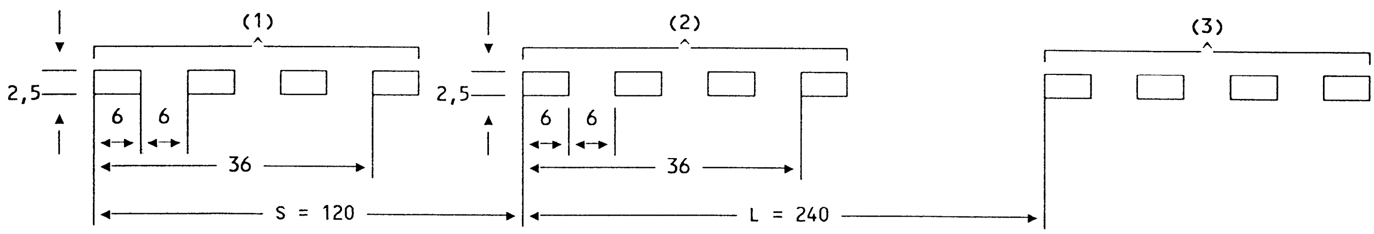
NOTE - LPT9 is the reference track as described in ISO/IEC 11694-2.

(a) Guard track layout



Detail A

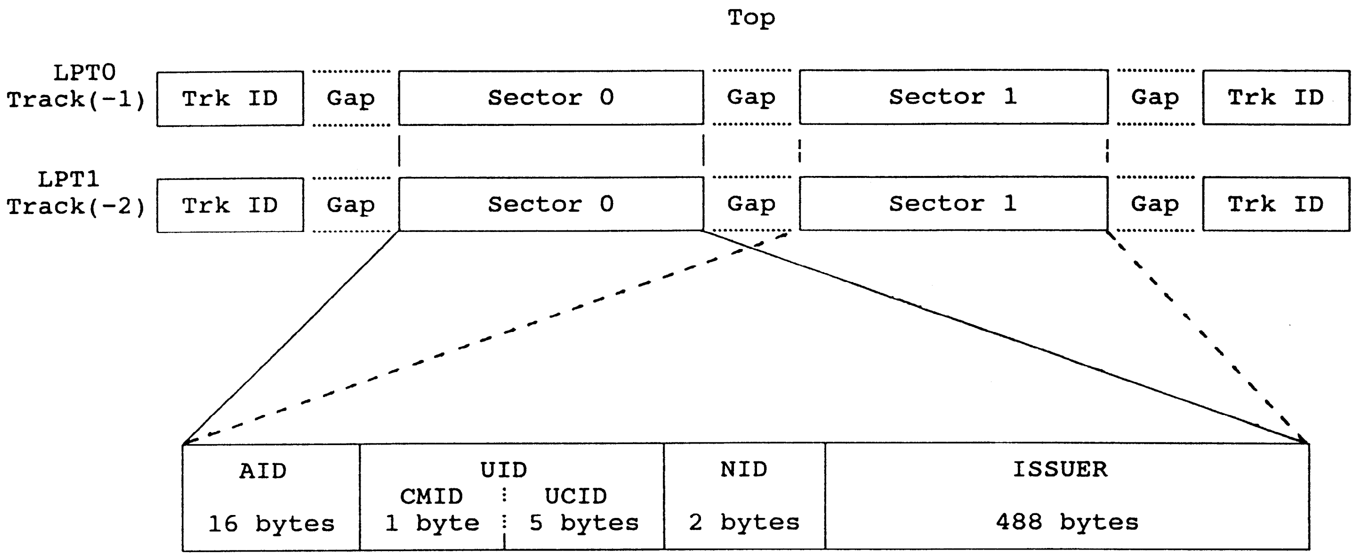
Dimensions in micrometres.



(b) Example of card-type pattern (P11) - See table A.1

NOTE - Drawings not to scale.

Figure A.1 - Guard track structure



NOTE - Type-2 sectors shall be used for card-ID field data.

(a) Structure of each sector in the card-ID field

Length	Field name	Description	Control
16	AID	Application identifier	Mfg/Isr
1	CMID	Card manufacturer identifier	Std
5	UCID	Unique card identifier	Mfg
2	NID	Number of issuer data bytes	Isr
488	ISSUER	Reserved for issuer data	Isr

NOTES
1 *Length* values are in bytes.
2 *Mfg* are fields assigned/controlled by each individual card manufacturer.
3 *Isr* are fields assigned/controlled by each individual card issuer.
4 *Std* are fields assigned/controlled by the appropriate ISO/IEC standards body.

(b) Content of the card-ID field

Figure A.2 - Structure and content of the card-ID field