International Standard ISO 7487/3

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on two sides — Part 3 : Track format B

Traitement de l'information — Échange de données sur cartouches à disquette de 130 mm (5,25 in) *utilisant un enregistrement à modulation de fréquence modifiée à* 7 958 ftprad, 1,9 tpmm (48 tpi), *sur deux faces — Partie 3 : Schéma de piste B*

First edition — 1984-11-01

63 Ref. No. ISO 7487/3-1984 (E)

processing, information interchange, magnetic disks, flexible disks, track formats, layout, specifications, quality.

Price based on 10 pages

This standard has been adopted for Federal Government use.

Details concerning its use within the Federal Government are contained in Federal Information Processing Standards Publication 117, 130 mm (5.25 in) Flexible Disk Cartridge Track Format Using Modified Frequency Modulation Recording at 7958 bprad on Two Sides — 1.9 tpmm (48 tpi) for Information Interchange. For a complete list of the publications available in the Federal Information Processing Standards Series, write to the Standards Processing Coordinator (ADP), Institute for Computer Sciences and Technology, National Bureau of Standards, Gaithersburg, MD 20899.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7487/3 was prepared by Technical Committee ISO/TC 97, *Information processing systems*.

Contents

Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on two sides — Part 3 : Track format B

0 Introduction

ISO 7487 specifies the characteristics of 130 mm (5.25 in) flexible disk cartridges recorded at 7 958 ftprad on both sides using modified frequency modulation (MFM) recording.

ISO 7487/1 specifies the dimensional, physical, and magnetic characteristics of the cartridge so as to provide physical interchangeability between data processing systems.

ISO 7487/2 specifies an alternative track format for data interchange.

Together with the labelling scheme specified in ISO 7665, ISO 7487/1 and ISO 7487/3 provide for full data interchange between data processing systems.

1 Scope and field of application

This part of ISO 7487 specifies the quality of recorded signals, the track layout, and a track format to be used on such a flexible disk cartridge, which is intended for data interchange between data processing systems.

NOTE — Numeric values in the SI and/or Imperial measurement system in this International Standard may have been rounded off and therefore are consistent with, but not exactly equal to, each other. Either system may be used, but the two should be neither intermixed nor re-converted. The original design of this part of ISO 7487 was made using SI units.

2 Conformance

A flexible disk cartridge shall be in conformance with ISO 7487 when it meets all requirements either of parts 1 and 2 or of parts 1 and 3 of ISO 7487.

3 References

ISO 646, *Information processing — ISO 7-bit coded character set for information interchange.*

ISO 2022, *Information processing — ISO 7-bit and 8-bit coded character sets — Code extension techniques.*[1]

ISO 4873, *Information processing — ISO 8-bit code for information interchange — Structure and rules for implementation.*[2]

ISO 7487, *Information processing — Data interchange on* 130 mm (5.25 in) *flexible disk cartridges using modified frequency modulation recording at* 7 958 ftprad, 1,9 tpmm (48 tpi), *on two sides —*

Part 1 : Dimensional, physical and magnetic characteristics.

Part 2 : Track format A.

ISO 7665, *Information processing — File structure and labelling of flexible disk cartridges for information interchange.*

4 Track format

4.1 General requirements

4.1.1 Mode of recording

The mode of recording shall be Modified Frequency Modulation (MFM) for which the conditions are

a) a flux transition shall be written at the centre of each bit cell containing a ONE;

b) a flux transition shall be written at each cell boundary between consecutive bit cells containing ZERO's.

Exceptions to this are defined in 4.1.12.

1) At present at the stage of draft. (Revision of ISO 2022-1982.)

2) At present at the stage of draft. (Revision of ISO 4873-1979.)

4.1.2 Track location tolerance of the located flexible disk cartridge

The centrelines of the recorded tracks shall be within ± 0,085 mm (0.003 3 in) of the nominal positions, over the range of operating environment specified in ISO 7487/1. This tolerance corresponds to twice the standard deviation.

4.1.3 Recording offset angle

At the instant of writing or reading a magnetic transition, the transition may have an angle of 0° ± 18′ with the radius. This tolerance corresponds to twice the standard deviation.

4.1.4 Density of recording

4.1.4.1 The nominal density of recording shall be 7 958 ftprad. The nominal bit cell is 125,5 µrad.

4.1.4.2 The long-term average bit cell length shall be the average bit cell length measured over a sector. It shall be within ± 3,5 % of the nominal bit cell length.

4.1.4.3 The short-term average bit cell length, referred to a particular bit cell, shall be the average of the lengths of the preceding eight bit cells. It shall be within ± 8 % of the long-term average bit cell length.

4.1.5 Flux transition spacing (see figure 1)

The instantaneous spacing between flux transitions may be influenced by the reading and writing process, the bit sequence recorded (pulse crowding effects), and other factors. The locations of the transitions are defined as the locations of the peaks in the signal when reading. Tests should be carried out using a peak-sensing amplifier.

4.1.5.1 The spacing between the flux transitions in a sequence of ONE's shall be between 80 % and 120 % of the short-term average bit cell length.

4.1.5.2 The spacing between the flux transition for a ONE and that between two ZERO's preceding or following it shall be between 130 % and 165 % of the short-term average bit cell length.

4.1.5.3 The spacing between the two ONE flux transitions surrounding a ZERO bit cell shall lie between 185 % and 225 % of the short-term average bit cell length.

4.1.6 Average signal amplitude

For each side the average signal amplitude on any non-defective track (see ISO 7487/1) of the interchanged flexible disk cartridge shall be less than 160 % of SRA_{1f} and more than 40 % of SRA_{2f}.

4.1.7 Byte

A byte is a group of eight bit-positions, identified B1 to B8, with B8 the most significant and recorded first.

The bit in each position is a ZERO or a ONE.

4.1.8 Sector

All tracks are divided into 16 sectors.

4.1.9 Cylinder

A pair of tracks, one on each side, having the same track number.

4.1.10 Cylinder number

The cylinder number shall be a two-digit number identical with the track number of the track of the cylinder.

4.1.11 Data capacity of a track

The data capacity of a track shall be 4 096 bytes.

4.1.12 Hexadecimal notation

Hexadecimal notation shall be used hereafter to denote the following bytes :

(00) for (B8 to B1) = 00000000

(01) for (B8 to B1) = 00000001

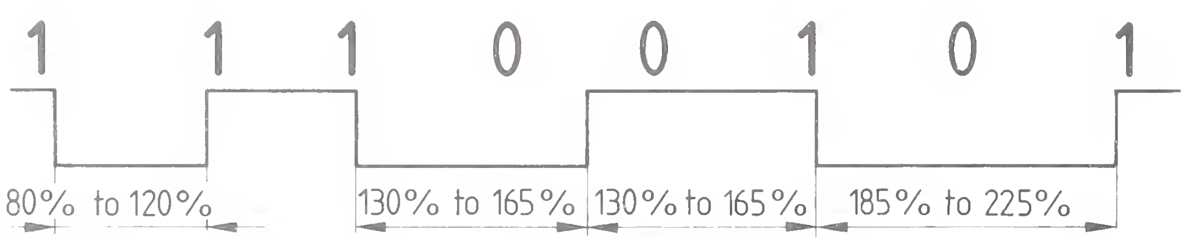

Figure 1

(4E) for (B8 to B1) = 01001110

(FE) for (B8 to B1) = 11111110

(FB) for (B8 to B1) = 11111011

(F8) for (B8 to B1) = 11111000

(A1)* for (B8 to B1) = 10100001

where the boundary transition between B3 and B4 is missing.

4.1.13 Error detection characters (EDC)

The two EDC-bytes are hardware generated by shifting serially the relevant bits, specified later for each part of the track through a 16-bit shift register described by

$$X^{16} + X^{12} + X^{5} + 1$$

(See also annex A.)

4.2 Track layout after the first formatting for all tracks

After the first formatting, there shall be 16 usable sectors on each track. The layout of each track shall be as shown in figure 2.

During formatting the rotational speed of the disk, averaged index to index, shall be 300 ± 6 r/min.

4.2.1 Index gap

At nominal density this field shall comprise not less than 32 bytes and not more than 146 bytes, the content of which is not specified except that there shall be no (A1)*-bytes.

4.2.2 Sector identifier

This field shall be as given in table 1.

4.2.2.1 Identifier mark

This field shall comprise 16 bytes :

12 (00)-bytes

3 (A1)*-bytes

1 (FE)-byte

4.2.2.2 Address identifier

This field shall comprise 6 bytes.

4.2.2.2.1 Track address

This field shall comprise 2 bytes :

a) Cylinder address (C)

This field shall specify in binary notation the cylinder address from 00 for the outermost cylinder to 37 for the innermost cylinder.

b) Side number (Side)

This field shall specify the side of the disk. On side 0, it shall be (00) on all tracks. On side 1, it shall be (01) on all tracks.

4.2.2.2.2 Sector number (S)

The 3rd byte shall specify in binary notation the sector number from 01 for the 1st sector to 16 for the last sector.

Table 1

Sector identifier							
Identifier mark			Address identifier				
			Track address		S		EDC
			C	Side			
12 bytes (00)	3 bytes (A1)*	1 byte (FE)	1 byte	1 byte (00) or (01)	1 byte	1 byte (01)	2 bytes

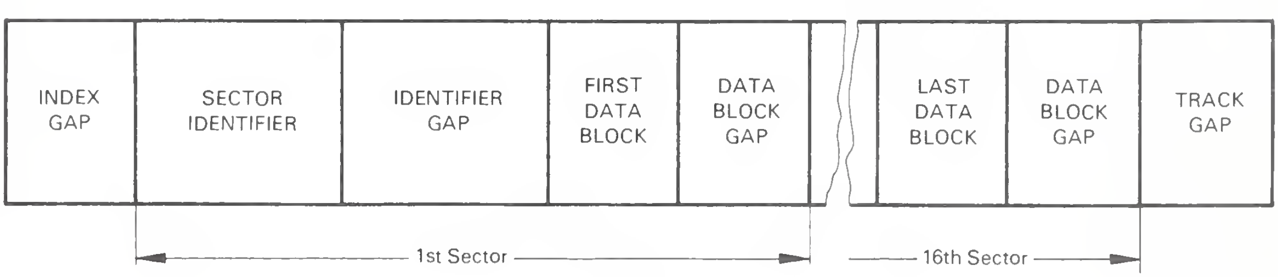

Figure 2

The sectors shall be recorded in the natural order :

1, 2, 3 ... 15, 16

4.2.2.2.3 4th byte

The 4th byte shall always be a (01)-byte.

4.2.2.2.4 EDC

These two bytes shall be generated as defined in 4.1.13 using the bytes of the sector identifier starting with the first (A1)*-byte (see 4.2.2.1) of the identifier mark and ending with the 4th byte (see 4.2.2.2.3) of the sector address.

4.2.3 Identifier gap

This field shall comprise 22 initially recorded (4E)-bytes.

4.2.4 Data block

This field shall be as given in table 2.

Table 2

Data block				
Data mark			Data field	EDC
12 bytes (00)	3 bytes (A1)*	1 byte (B)	256 bytes	2 bytes

4.2.4.1 Data mark

This field shall comprise

12 (00)-bytes

3 (A1)*-bytes

1 (FB)-byte

4.2.4.2 Data field

This field shall comprise 256 bytes. No requirements are implied beyond the correct EDC for the content of this field (see also 4.3.4.2.4.2).

4.2.4.3 EDC

These two bytes shall be generated as defined in 4.1.13 using the bytes of the data block starting with the first (A1)*-byte of the data mark (see 4.2.4.1) and ending with the last byte of the data field (see 4.2.4.2).

4.2.5 Data block gap

This field shall comprise 54 initially recorded (4E)-bytes. It is recorded after each data block and it precedes the following sector identifier. After the last data block, it precedes the track gap.

4.2.6 Track gap

This field shall follow the data block gap of the last sector. (4E)-bytes are written until the index hole is detected, unless it has been detected during writing of the last data block gap, in which case there shall be no track gap.

4.3 Track layout of a recorded flexible disk for data interchange

4.3.1 Representation of characters

Characters shall be represented by means of the 7-bit coded character set (ISO 646) and, where required, by its 7-bit or 8-bit extensions (ISO 2022) or by means of the 8-bit coded character set (ISO 4873).

Each 7-bit coded character shall be recorded in bit-positions B7 to B1 of a byte; bit position B8 shall be recorded with bit ZERO.

The relationship shall be as shown in figure 3.

Each 8-bit coded character shall be recorded in bit-positions B8 to B1 of a byte.

The relationship shall be as shown in figure 4.

4.3.2 Good and bad cylinders

A good cylinder is a cylinder which has both tracks formatted according to 4.3.4.

A bad cylinder is a cylinder which has both tracks formatted according to 4.3.5.

Bits of the 7-bit combination	0	b7	b6	b5	b4	b3	b2	b1
Bit-positions in the byte	B8	B7	B6	B5	B4	B3	B2	B1

Figure 3

Bits of the 8-bit combination	b8	b7	b6	b5	b4	b3	b2	b1
Bit-positions in the byte	B8	B7	B6	B5	B4	B3	B2	B1

Figure 4

4.3.3 Requirements for cylinders

Cylinder 00 shall be a good cylinder and shall have no defective sectors on side 0. There shall be at least 37 good cylinders between cylinder 01 and cylinder 39.

4.3.4 Layout of the tracks of a good cylinder

4.3.4.1 Index gap

Description : see 4.2.1.

4.3.4.2 Sector identifier

4.3.4.2.1 Identifier mark

Description : see 4.2.2.1.

4.3.4.2.2 Address identifier

Description : see 4.2.2.2.

4.3.4.2.2.1 Track address

This field shall comprise 2 bytes :

a) Cylinder address (C)

This field shall specify in binary notation the cylinder address from 00 for the outermost cylinder to 37 for the innermost cylinder.

NOTE — A unique cylinder number is associated with each cylinder (see 4.1.10). Two of these cylinders are intended for use only when there are one or two defective cylinders. Each good cylinder possesses a unique cylinder address; a defective cylinder does not possess a cylinder address. Cylinder addresses are assigned consecutively to the good cylinders in the ascending sequence of cylinder addresses.

b) Side number (Side)

Description : see 4.2.2.2.1.

4.3.4.2.2.2 Sector number (S)

Description : see 4.2.2.2.2.

4.3.4.2.2.3 4th byte

Description : see 4.2.2.2.3.

4.3.4.2.2.4 EDC

Description : see 4.2.2.2.4.

4.3.4.2.3 Identifier gap

Description : see 4.2.3. These bytes may have become ill-defined due to the overwriting process.

4.3.4.2.4 Data block

4.3.4.2.4.1 Data mark

For all tracks, this field shall comprise

12 (00)-bytes

3 (A1)*-bytes

1 byte

The 16th byte shall be

(FB) indicating that the data is valid and that the whole data field can be read;

(F8) indicating that the first byte of the data field shall be interpreted according to ISO 7665.

4.3.4.2.4.2 Data field

This field shall comprise 256 bytes as specified in 4.2.4.2.

If it comprises less than the requisite number of data bytes, the remaining positions shall be filled with (00)-bytes.

Data fields in cylinder 00 are reserved for operating system use, including labelling.

4.3.4.2.4.3 EDC

Description : see 4.2.4.3.

If the last byte of the data mark is (F8) and the 1st character of the data field is CAPITAL LETTER F, the EDC may or may not be correct, as the sector contains a defective area. If the 1st character is CAPITAL LETTER D, then the EDC shall be correct.

On cylinder 00, only CAPITAL LETTER D shall be allowed.

4.3.4.2.5 Data block gap

This field is recorded after each data block and it precedes the following sector identifier. After the last data block, it precedes the track gap.

It comprises initially 54 (4E)-bytes (see 4.2.5). These bytes may have become ill-defined due to the overwriting process.

4.3.4.2.6 Track gap

Description : see 4.2.6.

4.3.5 Layout of the tracks of a bad cylinder

4.3.5.1 Contents of the fields

The fields of the tracks of a bad cylinder should have the following contents :

4.3.5.1.1 Index gap

Description : see 4.2.1.

4.3.5.1.2 Sector identifier

This field should comprise an identifier mark and an address identifier.

4.3.5.1.2.1 Identifier mark

This field should comprise 16 bytes :

12 (00)-bytes

3 (A1)*-bytes

1 (FE)-byte

4.3.5.1.2.2 Address identifier

This field should comprise 6 bytes :

4 (FF)-bytes

2 EDC-bytes

These two EDC-bytes shall be generated as defined in 4.1.13 using the bytes of the sector identifier starting with the first (A1)*-byte (4.3.5.1.2.1) of the identifier mark and ending with the above 4 (FF)-bytes.

4.3.5.1.3 Identifier gap

This field should comprise 22 (4E)-bytes.

4.3.5.1.4 Data block

4.3.5.1.4.1 Data mark

This field should comprise 16 (4E)-bytes.

4.3.5.1.4.2 Data field

This field should contain 256 (4E)-bytes.

4.3.5.1.4.3 EDC

This field should comprise 2 (4E)-bytes.

4.3.5.1.5 Data block gap

This field should comprise 54 (4E)-bytes.

4.3.5.1.6 Track gap

Description : see 4.2.6.

4.3.5.2 Requirements for tracks

Each track of a bad cylinder shall have at least one of its sector identifiers with the content specified in 4.3.5.1.2. If this condition is not satisfied, the cartridge shall be rejected. All other fields of such tracks may be ill-defined.

Annex A

EDC implementation

(This annex does not form part of the standard.)

Figure 5 shows the feedback connections of a shift register which may be used to generate the EDC bytes.

Prior to the operation, all positions of the shift register are set to ONE. Input data are added (exclusive OR) to the contents of position C_{15} of the register to form a feedback. This feedback is in its turn added (exclusive OR) to the contents of position C_4 and position C_{11}.

On shifting, the outputs of the exclusive OR gates are entered respectively into positions C_0, C_5 and C_{12}. After the last data bit has been added, the register is shifted once more as specified above.

The register then contains the EDC bytes.

If further shifting is to take place during the writing of the EDC bytes, the control signal inhibits exclusive OR operations.

To check for errors when reading, the data bits are added into the shift register in exactly the same manner as they were during writing. After the data, the EDC bytes are also entered into the shift register as if they were data. After the final shift, the register contents will be all ZERO if the record does not contain errors.

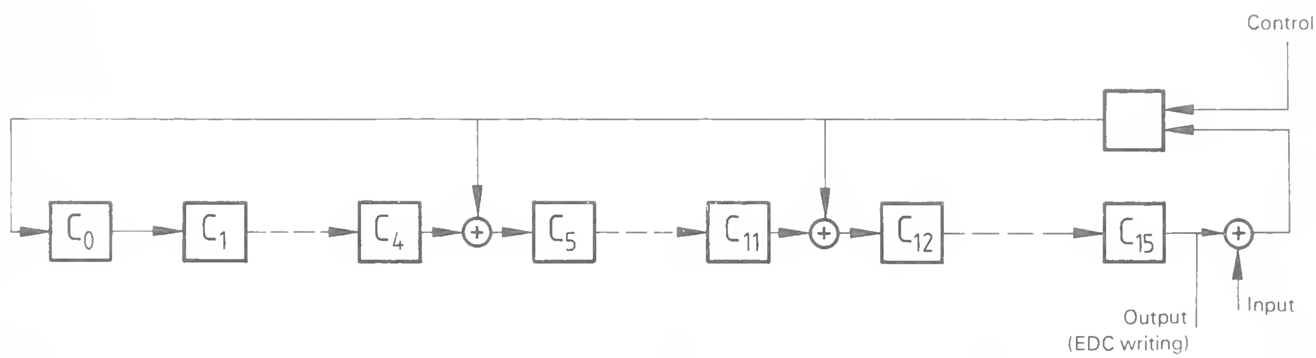

Figure 5

Annex B

Procedure and equipment for measuring flux transition spacing

(This annex does not form part of the standard.)

B.1 General

This annex specifies an equipment and a procedure for measuring flux transition spacing on 130 mm (5.25 in) flexible disk cartridges using MFM recording at 7 958 ftprad on two sides.

B.2 Format

The disk to be measured shall be written by the disk drive for data interchange use.

Testing shall be done on tracks 00 and 39 on both sides.

The test patterns 11011011 (DB) and 11011100 (DC) shall be written repeatedly on each test track.

B.3 Test equipment

B.3.1 Disk drive

The disk drive shall have a rotational speed of 300 r/min, with a tolerance of ± 3 r/min, averaged over one revolution.

The average angular speed taken over 64 µs shall not deviate by more than 0,5 % from the speed averaged over one revolution.

B.3.2 Head

B.3.2.1 Resolution

The head shall have an absolute resolution of 55 % to 65 % at track 39 on each side, using the reference material RM 7487, applying the calibration factor of the reference material appropriate to the side, and recording with the appropriate test recording current.

The resonant frequency of the head shall be at least 250 000 Hz.

The resolution shall not be adjusted by varying the load impedance of the head.

The resolution shall be measured at the output of the amplifier defined in B.3.3.1.

B.3.2.2 Offset angle

The head shall have a gap offset angle of 0° ± 6′ with the disk radius on the testing drive.

B.3.2.3 Contact

Care shall be taken that the heads are in good contact with the media during the tests.

B.3.3 Read channel

B.3.3.1 Read amplifier

The read amplifier shall have a flat response from 1 000 to 187 500 Hz within ± 1 dB, and amplitude saturation shall not occur.

B.3.3.2 Peak sensing amplifier

Peak sensing shall be carried out by a differentiating and limiting amplifier.

B.3.4 Time interval measuring equipment

The time interval counter shall be able to measure 4 µs to at least 10 ns resolution.

A triggering oscilloscope may be used for this purpose.

B.4 Procedure for measurement

B.4.1 Flux transition spacing measurement

The transition locations shall be measured by the locations of the peaks in the signal when reading.

The flux transition spacing shall be measured by the pulse timing intervals after the read channel amplifier defined in B.3.3.

B.4.2 Flux transition spacing for all tracks

Measure time intervals t_1 to t_5 as shown in figure 6.

Sub-clause 4.1.5.1 corresponds to t_1 and t_2.

Sub-clause 4.1.5.2 corresponds to t_3 and t_4.

Sub-clause 4.1.5.3 corresponds to t_5.

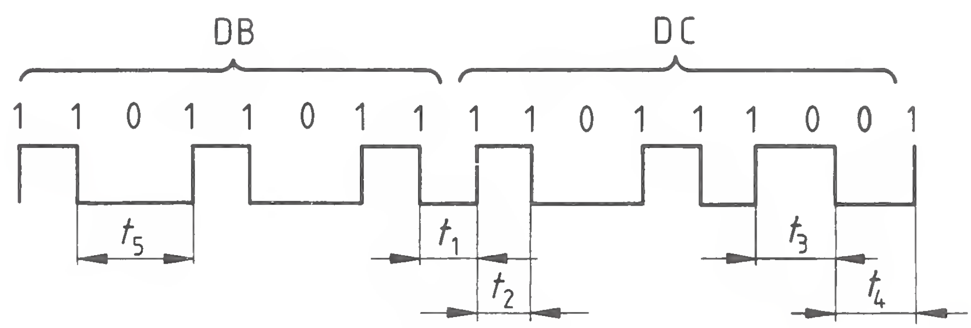

Figure 6

Annex C

Data separators for decoding MFM recording

(This annex does not form part of the standard.)

The MFM recording method gives nominal flux transition spacings of :

t for the patterns 1 1 or 0 0 0

$3t/2$ for the patterns 1 0 or 0 1

$2t$ for the pattern 1 0 1

The data separator should be capable of resolving a difference of 2 µs. To achieve this with a low error rate, the separator cannot operate on a fixed period but should follow changes in the bit cell length.

It is recognized that various techniques may be developed to achieve dynamic data separation; with present technology only an analogue data separator based on a phase-locked oscillator can provide the necessary reliability.