Information processing — Data interchange on 200 mm (8 in) flexible disk cartridges using two-frequency recording at 13 262 ft/prad, 1,9 tp/mm (48 tpi), on one side — Part 2 : Track format

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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. Each 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 5654/2 was prepared by Technical Committee ISO/TC 97, Information processing systems.

ISO 5654/2 was first published in 1982. This second edition cancels and replaces the first edition, of which it constitutes a minor revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.
Contents

0 Introduction ............................................. 1
1 Scope and field of application ...................... 1
2 References ............................................. 1
3 General recording requirements ..................... 1
4 General format requirements .......................... 2
5 Track layout after the first formatting .......... 3
6 Track layout of good tracks on a cartridge 
   for interchange ....................................... 4
7 Track layout of a bad track on a cartridge 
   for interchange ....................................... 5

Annexes
A EDC implementation ...................................... 7
B Procedure and equipment for measuring flux 
   transition spacing ..................................... 8
0 Introduction

ISO 5654 specifies the characteristics of 200 mm (8 in) flexible disk cartridges recorded at 13 262 ftprad, 1.9 tpmm (48 tpi), on one side using two-frequency recording.

ISO 5654/1 specifies the dimensional, physical and magnetic characteristics of the cartridge, so as to provide physical interchangeability between data processing systems.

Together with the labelling scheme specified in ISO 7665, ISO 5654/1 and ISO 5654/2 provide for full data interchange between data processing systems.

1 Scope and field of application

This part of ISO 5654 specifies the quality of recorded signals, track layout and the track format to be used on the above-mentioned 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 part of ISO 5654 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 was made using the Imperial measurement system.

2 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.

ISO 4873, Information processing — ISO 8-bit coded character set for information interchange.

ISO 5654/1, Information processing — Data interchange on 200 mm (8 in) flexible disk cartridges using two-frequency recording at 13 262 ftprad, 1.9 tpmm (48 tpi), on one side — Part 1 : Dimensional, physical and magnetic characteristics.

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

3 General recording requirements

3.1 Mode of recording

The mode of recording shall be two-frequency where the start of every bit cell is a clock flux transition. A ONE is represented by a data flux transition between two clock flux transitions.

3.2 Track location tolerance of the recorded flexible disk cartridge

The centrelines of the recorded tracks shall be within ± 0.085 mm (0.003 3 in) of the nominal positions, when measured in the testing environment specified in ISO 5654/1. This tolerance corresponds to twice the standard deviation.

3.3 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.

3.4 Density of recording

3.4.1 The nominal density of recording shall be 13 262 ftprad, 1.9 tpmm (48 tpi). The resulting nominal spacing between two clock flux transitions, the nominal bit cell length, is 151 μrad.

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

NOTE — It is recognized that at extremes of supply frequency encountered on computer sites the deviation may be ± 5 % in exceptional circumstances. Successful data interchange may still then be possible provided that formatting of the cartridge and subsequent writing of data are not carried out at the opposite limits of this range.

3.4.3 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.
3.5 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 read amplifier (see annex B).

3.5.1 The spacing between two clock flux transitions surrounding a data flux transition or between two data flux transitions surrounding a clock flux transition shall be between 90 % and 140 % of the nominal bit cell length.

3.5.2 The spacing between two clock flux transitions not surrounding a data flux transition or between two data flux transitions surrounding a missing clock flux transition shall be between 60 % and 110 % of the nominal bit cell length.

3.5.3 The spacing between a data flux transition and the preceding clock flux transition (when not missing) or between a clock flux transition and the preceding data flux transition (when not missing) shall be between 45 % and 70 % of the nominal bit cell length.

3.6 Average signal amplitude

The average signal amplitude on any non-defective track of the interchanged flexible disk cartridge shall be less than 160 % of the standard reference amplitude for track 00 and more than 40 % of the standard reference amplitude for track 76.

4 General format requirements

4.1 Byte

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

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

4.2 Sector

All tracks are divided into 26 sectors.

4.3 Data capacity of a track

The data capacity of a track shall be 3 328 bytes.

4.4 Hexadecimal notation

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

\[(00) \text{ for (B8 to B1)} = 00000000\]
\[(FF) \text{ for (B8 to B1)} = 11111111\]
\[(FC) \text{ for (B8 to B1)} = 11111100\]
\[(FE) \text{ for (B8 to B1)} = 11111110\]
\[(FB) \text{ for (B8 to B1)} = 11111011\]
\[(F8) \text{ for (B8 to B1)} = 11111000\]

where the clock transitions of B6 and B4 are missing.

4.5 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 the generator polynomial:

\[X^{16} + X^{12} + X^5 + 1\]

(See also annex A.)

4.6 Representation of characters

Characters shall be represented by means of the 7-bit coded character set (see ISO 646) and, where required, by its 7-bit or 8-bit extensions (see ISO 2022) or by means of the 8-bit coded character set (see 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 2

<table>
<thead>
<tr>
<th>Bits of the 7-bit combination</th>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
<th>b1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit-positions in the byte</td>
<td>B8</td>
<td>B7</td>
<td>B6</td>
<td>B5</td>
<td>B4</td>
<td>B3</td>
<td>B2</td>
</tr>
</tbody>
</table>

Figure 2

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 3

<table>
<thead>
<tr>
<th>Bits of the 8-bit combination</th>
<th>b8</th>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
<th>b1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit-positions in the byte</td>
<td>B8</td>
<td>B7</td>
<td>B6</td>
<td>B5</td>
<td>B4</td>
<td>B3</td>
<td>B2</td>
<td>B1</td>
</tr>
</tbody>
</table>

Figure 3

4.7 Track assignment

Track 00 shall be used for labels only. Of the remaining 76 tracks, only 74 may be used for the recording of data, leaving the possibility of one or two defective tracks.

5 Track layout after the first formatting

After the first formatting, the track layout shall be as shown in figure 4

5.1 Index gap

At nominal speed this field shall comprise 73 bytes as follows:

- 40 (FF)-bytes
- 6 (00)-bytes
- 1 (FC)*-byte
- 26 (FF)-bytes

Writing the index gap is started when the index hole is detected. Any of the first 20 bytes may be ill-defined due to subsequent overwriting.

5.2 Sector identifier

This field shall be as given in table 1.

Table 1

<table>
<thead>
<tr>
<th>Identifier mark</th>
<th>Address identifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 bytes</td>
<td>1 byte</td>
</tr>
<tr>
<td>(00)</td>
<td>T</td>
</tr>
<tr>
<td>1 byte</td>
<td>2nd byte</td>
</tr>
<tr>
<td>(FE)*</td>
<td>S</td>
</tr>
<tr>
<td>1 byte</td>
<td>4th byte</td>
</tr>
<tr>
<td>(00)</td>
<td>EDC</td>
</tr>
<tr>
<td>1 byte</td>
<td>2 bytes</td>
</tr>
</tbody>
</table>

5.2.1 Identifier mark

This field shall comprise 7 bytes

- 6 (00)-bytes
- 1 (FE)*-byte

5.2.2 Address identifier

This field shall comprise 6 bytes.

5.2.2.1 Track address (T)

The track address is the first byte of the address identifier. It shall represent in binary notation the track address from 00 for the outermost track to 74 for the innermost track.

5.2.2.2 Second byte of the address identifier

The second byte shall always be a (00)-byte.

5.2.2.3 Sector number (S)

The third byte shall represent in binary notation the sector number from 01 for the first sector to 26 for the last sector.

The 26 sectors shall be recorded in the natural order

1, 2, 3, ..., 25, 26.
5.2.4 Fourth byte of the address identifier
The fourth byte shall always be a (00)-byte.

5.2.5 EDC
These two bytes shall be generated as defined in 4.5 using the bytes of the sector identifier starting with the (FE)*-byte (see 5.2.1) of the identifier mark and ending with the fourth byte (see 5.2.2.4) of the address identifier.

5.3 Identifier gap
This field shall comprise 11 initially recorded (FF)-bytes.

5.4 Data block
This field shall be as given in table 2

Table 2

<table>
<thead>
<tr>
<th>Data mark</th>
<th>Data field</th>
<th>EDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 bytes (00)</td>
<td>1 byte (FB)*</td>
<td>128 bytes</td>
</tr>
</tbody>
</table>

5.4.1 Data mark
This field shall comprise
6 (00)-bytes
1 (FB)*-byte

5.4.2 Data field
This field shall comprise 128 bytes. No requirements are implied beyond the correct EDC for the content of this field (see also 6.4.2).

5.4.3 EDC
These two bytes shall be generated as defined in 4.5 using the bytes of the data block starting with the seventh byte of the data mark (see 5.4.1) and ending with the last byte of the data field (see 5.4.2).

5.5 Data block gap
This field shall comprise 27 initially recorded (FF)-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.

5.6 Track gap
This field shall follow the data block gap of the 26th sector. (FF) 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.

6 Track layout of good tracks on a cartridge for interchange

6.1 Index gap
Description: see 5.1.

6.2 Sector identifier

6.2.1 Identifier mark
Description: see 5.2.1.

6.2.2 Address identifier
Description: see 5.2.2.

6.2.2.1 Track address (T)
The track address is the first byte of the address identifier. It shall represent in binary notation the track address from 00 for the outermost track to 74 for the innermost track.

NOTE — A unique track number is associated with each track. Two of these tracks are intended for use only when there are one or two defective tracks. Each good track possesses a unique track address; a defective track does not possess a track address. Track addresses are assigned consecutively to the good tracks in the ascending sequence of track numbers.

6.2.2.2 Second byte of the address identifier
Description: see 5.2.2.2.

6.2.2.3 Sector number (S)
The third byte shall represent in binary notation the sector number from 01 for the first sector to 26 for the last sector.

NOTES
1 Each column of table 3 is identified by a two digit number from 01 to 13. ISO 7665 specifies a field called Sector Sequence Indicator in character positions 77-78 of the Vol. 1 Label, in which this two-digit number identifying the order in which the sectors are recorded is to be entered.
2 Table 3 lists vertically the sector numbers of the sectors as they appear sequentially on the track. For example, for order 08, the first sector of the track bears sector number 01, the following one bears sector number 09, the third one bears sector number 17, and so on until the twenty-sixth sector which bears sector number 24.
### 6.4 Data block

This field shall comprise 128 bytes. If it comprises less than 128 data bytes, the remaining positions shall be filled with (00)-bytes.

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

### 6.4.2 Data field

This field shall comprise 128 bytes. If it comprises less than 128 data bytes, the remaining positions shall be filled with (00)-bytes.

### 6.4.3 EDC

Description: see 5.4.3. If the seventh byte of the data mark is (F8)* and the first 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 first character is CAPITAL LETTER D, then the EDC shall be correct.

On track 00 only CAPITAL LETTER D shall be allowed.

### 6.5 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 27 (FF)-bytes (see 5.5). These bytes may have become ill-defined due to the overwriting process.

### 6.6 Track gap

Description: see 5.6.

### 7 Track layout of a bad track on a cartridge for interchange

The fields of a bad track should have the following contents:

#### 7.1 Index gap

This field should comprise 73 (FF)-bytes.

#### 7.2 Sector identifier

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

#### 7.2.1 Identifier mark

This field should comprise 7 bytes

- 6 (00)-bytes
- 1 (FE)*-byte

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#### Table 3 — Sequence of the sector numbers on the track

<table>
<thead>
<tr>
<th>Position of the sectors on the track</th>
<th>Sector sequence indicator</th>
<th>Sequence of the sector numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>1st</td>
<td>01</td>
<td>01</td>
</tr>
<tr>
<td>2nd</td>
<td>02</td>
<td>03</td>
</tr>
<tr>
<td>3rd</td>
<td>03</td>
<td>05</td>
</tr>
<tr>
<td>4th</td>
<td>04</td>
<td>07</td>
</tr>
<tr>
<td>5th</td>
<td>05</td>
<td>09</td>
</tr>
<tr>
<td>6th</td>
<td>06</td>
<td>11</td>
</tr>
<tr>
<td>7th</td>
<td>07</td>
<td>13</td>
</tr>
<tr>
<td>8th</td>
<td>08</td>
<td>15</td>
</tr>
<tr>
<td>9th</td>
<td>09</td>
<td>17</td>
</tr>
<tr>
<td>10th</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>11th</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>12th</td>
<td>12</td>
<td>23</td>
</tr>
<tr>
<td>13th</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>14th</td>
<td>14</td>
<td>02</td>
</tr>
<tr>
<td>15th</td>
<td>15</td>
<td>04</td>
</tr>
<tr>
<td>16th</td>
<td>16</td>
<td>06</td>
</tr>
<tr>
<td>17th</td>
<td>17</td>
<td>08</td>
</tr>
<tr>
<td>18th</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>19th</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>20th</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>21st</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>22nd</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>23rd</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>24th</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>25th</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>26th</td>
<td>26</td>
<td>26</td>
</tr>
</tbody>
</table>

**NOTE** — As after first formatting the sectors are recorded in the natural sequence, the use of the other 12 possible sequences requires reformatting.
7.2.2 Address identifier
This field should comprise 6 bytes

4 (FF)-bytes
2 EDC-bytes

These two EDC bytes shall be generated as defined in 4.5 using the bytes of the sector identifier starting with the (FE)*-byte (see 7.2.1) of the identifier mark and ending with the above 4 (FF)-bytes.

7.3 Identifier gap
This field should comprise 11 (FF)-bytes.

7.4 Data block
7.4.1 Data mark
This field should comprise 7 (FF)-bytes.

7.4.2 Data field
This field should comprise 128 (FF)-bytes.

7.4.3 EDC
This field should comprise 2 (FF)-bytes.

7.5 Data block gap
This field should comprise 27 (FF)-bytes.

7.6 Track gap
Description: see 5.6.

7.7 Requirement for bad tracks
At least one of the sector identifiers of a bad track shall have the contents specified in 7.2. 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 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.
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 equipment and a procedure for measuring flux transition spacing on 200 mm (8 in) flexible disk cartridges using two-frequency recording at 13 262 ftprad on one side.

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, 43, 44 and 76.

Write current shall be switched as provided in ISO 5654/1.

The test patterns 00100000 (20) and 11101111 (EF) 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 360 r/min, with a tolerance of ± 3 r/min, averaged over one revolution. The average angular speed taken over 32 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 76 using the reference material RM 5654, applying the calibration factor of the reference material, and recording with the appropriate test recording current.

The resonant frequency of the head shall be at least 500 000 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 375 000 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 2 μs to at least 5 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

Measure time intervals $t_1$ to $t_8$ as shown in figure 6.

Sub-clause 3.5.1 corresponds to $t_1$ and $t_2$
Sub-clause 3.5.2 corresponds to $t_3$ and $t_4$
Sub-clause 3.5.3 corresponds to $t_5$, $t_6$, $t_7$ and $t_8$

Figure 6