TECHNICAL REPORT

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Information technology — Technical aspects of 130 mm optical disk cartridge write-once recording format

Technologies de l'information — Aspects techniques relatifs au format d'enregistrement pour les cartouches de disque optique de diamètre 130 mm, *non réinscriptible*

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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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC TR 10091, which is a Technical Report of type 3, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology,* Subcommittee SC 23, *Optical disk cartridges for information interchange*.

Information technology — Technical aspects of 130 mm optical disk cartridge write-once recording format

Section 1 - General

1 Scope

This Technical Report is a complement to ISO/IEC 9171-2 for the Type A and B formats.

This Technical Report covers the figures that characterize each format, the relationship between these figures, and the technological background used to reach decisions concerning the formats; in addition it gives some examples of implementation.

2 References

ISO/IEC 9171-1:1990, *Information technology -130mm optical disk cartridge, write once, for information interchange - Part 1: Unrecorded optical disk cartridge*

ISO/IEC 9171-2:1990, *Information technology -130mm optical disk cartridge, write once, for information interchange - Part 2: Recording format*

3 Recording area and control track

The recording area and control tracks are divided as given in table 1. The dimensions are for reference only, they are nominal positions (see ISO/IEC 9171-2 clause 4).

Table 1 - Formatted Zone

-Reflective Zone	27,00 mm to 29,00 mm
-Control Track PEP Zone	29,00 mm to 29,50 mm
-Transition Zone for SFP	29,50 mm to 29,52 mm
-Inner Control Track SFP Zone	29,52 mm to 29,70 mm
-Inner Manufacturer Zone	29,70 mm to 30,00 mm
-Guard Band	29,70 mm to 29,80 mm
-Manufacturer Test Zone	29,80 mm to 29,90 mm
-Guard Band	29,90 mm to 30,00 mm
-User Zone	30,00 mm to 60,00 mm
-Outer Manufacture Zone	60,00 mm to 60,15 mm
-Outer Control Track SFP Zone	60,15 mm to 60,50 mm (maximum)
-Lead-Out Zone	60,50 mm to 61,00 mm

The inner radius of the Formatted Zone shall be at least 27,0 mm to avoid interference with the Clamping Zone.

The format of the Reflective Zone is not specified but it shall have the same reflective recording layer as the rest of the Recording Zone. Servo information (grooves or pits) is not required in the Reflective Zone.

The width of the PEP Zone is determined by the requirements for the accuracy of the drive head positioning system. The width of 0,5 mm for the PEP Zone is sufficient for stable operation of the drive actuator mechanism. Since grooves are not required in the PEP Zone, the track pitch may be changed to make it easier to read out the PEP without using a tracking servo.

A Transition Zone for SFP is provided to enable the optical head to move from the PEP Zone to the SFP Zone, which requires a period for changing the translation mode of the optical head at the transition point from the PEP Zone to the SFP Zone in the mastering process. The Transition Zone for the SFP Zone can be an unrecorded area.

Considering the accuracy of control of the media mastering equipment, the starting position of the outer SFP is to be determined relative to the starting position of the inner control track and the tolerance built-up over the mastered area.

Within the Manufacturer Test Zone, it is recommended to have the same header format as that of the User Zone.

There shall be no pre-recorded information on tracks between 60,50 mm and 61,00 mm.

4 Physical control track format

There are two recording methods for the control track information to be placed into three different areas (PEP Zone, Inner and Outer SFP Zones). The first method shall be used for the PEP (Phase Encoded Part) and the second method for the SFP (Standard Format Part).

The PEP is recorded at the innermost radius and is recorded independently of the format (A or B) chosen for the rest of the disk. This common PEP recording method allows a drive that is set up for either format A or format B to read the PEP information. The PEP is intended to be read without requiring that servo tracking be established by the drive.

The SFP Zones must be recorded in the same format as the rest of the disk, (either format A or format B). It contains additional information plus a duplication of the information in the PEP, so there is no requirement that the PEP be read by every drive.

4.1 General aspects

The control track areas provide information about the media that may be used to optimize the read and write characteristics of the drive.

The innermost recorded zone, PEP, is recorded using low frequency phase encoded modulation, which can be read independently of the characteristics of the servo method of the drive.

To facilitate drive compatibility with various media types, there is a hierarchy of information supplied, beginning with the cartridge. The cartridge identifier sensor holes supply information to read the PEP. The PEP supplies enough information to read the SFP, and the SFP supplies information to optimize write and read operations on user data. A drive can then be adjusted by using each source of information in turn leading to the ability to read and/or write user data with optimal efficiency.

The number of sectors per track in the SFP area equals the number of sectors per track at track No. 0. The outer SFP area begins at track No. N+96 where N is the track number of the last track of the User Zone, and continues until radius 60,5 mm.

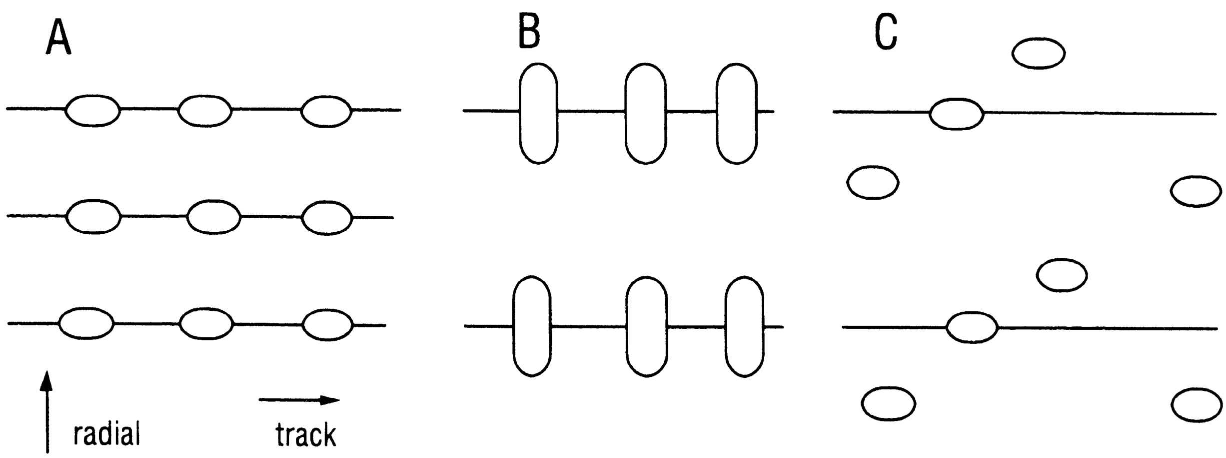
4.2 Phase Encoded Part (PEP)

The maximum power applied to the media to read the PEP Zone of the Control Track shall not exceed 0,50 mW.

The low density of the PEP allows a high tolerance for media defects and permits decoding the information with a microprocessor instead of a dedicated circuit. The loss of cross-track signal is limited in the PEP area in order to allow off-track reading. Three methods to reduce the loss of cross-track signal are given in figure 1.

Taking into consideration the various methods, the loss of cross-track signal is defined as the maximum amplitude of the read signal from channel one from three successive marks on the media, divided by the minimum amplitude of the read signal from one revolution of the media (ignoring any effects from defective areas on the media).

This cross track ratio shall not exceed 2,0.



legend:

A : small track pit pattern

B : wide pit pattern

C : wobble pit pattern

Figure 1 - Example of pit recording in PEP

The recording sequence throughout the International Standard shall be MSB (most significant bit) first and from byte 0 to byte n.

The PEP Control Track information in bytes 0 to 9 and byte 18 is mandatory for optical disks in order to conform to the International Standard.

The bit assignment of the PEP is summarized in table 2. In order to show correct bit assignment, the following example is given:

In 4/15 modulation bit 2 in byte 0 must be a ONE.

The definition of the lowest value for the amplitude of Pre-formatted data in byte 4 is as follows;

The lowest value in the type A format will be obtained by the recorded data pattern (33). The lowest value in the type B format is obtained by the pattern (C0). All signal levels should be measured at the Inner SFP Zone.

Table 2 - PEP summary

PEP Sector Data field summary

Byte \ Bit	7	6	5	4	3	2	1	0
0	Format	0	0	0	0	Modulation Code		
1	0	ECC TYPE			0	Number of User bytes		
2	Number of sectors in track No.0							
3	Baseline reflectance at 825nm wavelength							
4	L or G	Amplitude and polarity of pre-formatted data						
5	Amplitude and polarity of user recorded data							
6	Max read power for SFP Zone at 825nm and 30Hz rotation							
7	0	0	0	1	0	0	0	0
8	Starting track address of Outer SFP Zone, (MSB)							
9	Starting track address of Outer SFP Zone, (LSB)							
10	Reserved, (FF)							
11	Reserved, (FF)							
12	Reserved, (FF)							
13	Reserved, (FF)							
14	NOT SPECIFIED (Ignored in interchange)							
15	NOT SPECIFIED (Ignored in interchange)							
16	NOT SPECIFIED (Ignored in interchange)							
17	NOT SPECIFIED (Ignored in interchange)							
18	CRC, (Covers bytes 0-17)							

4.3 Standard Formatted Part (SFP)

The type of mark used for the SFP is a phase pit, and the recording format is identical with that of the Users Data area. Only the first 512 bytes in a sector are used for recording the SFP data. If a 1024 byte sector is used, the remaining 512 bytes are recorded as (FF). All unused bytes in the SFP shall be recorded as (FF).

Section 2 : Type A format

5 CCS

The continuous servo tracking format, also called the Continuous Composite Servo, (CCS) tracking format, is explained in this section. The Type A format is based on a CCS tracking method (see ISO/IEC 9171-2 clause 5).

6 Track Format

In the push-pull tracking and signal detection scheme, d.c. and low frequency component offsets caused by disk skew and non-concentric tracking must be compensated for, including worst case end-of-life conditions. To resolve these problems, a low frequency tracking offset correction scheme may be used. This correction scheme is not always necessary, but it is required in case of large amounts of tilt, as may happen at the end-of-life of media.

7 Sector Format

The Sector Format consists of the following fields:

(1) Sector Mark

(2) VFO1, VFO2, VFO3

(3) Address Mark

(4) ID field

(5) Postamble

(6) Offset detection flag

(7) Gap

(8) Flag

(9) ALPC area

(10) Sync

(11) Data field

(12) Resync

(13) Buffer

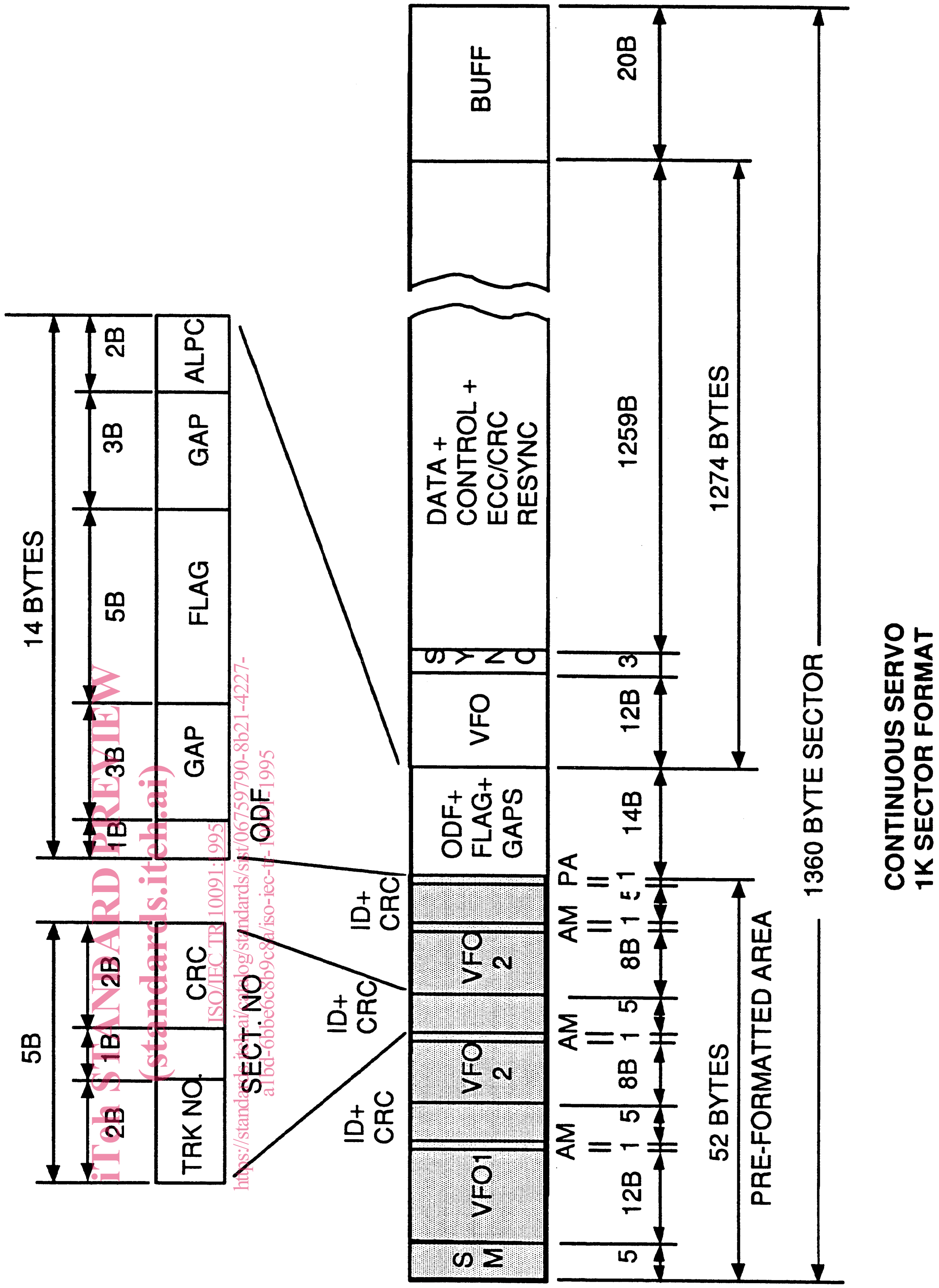
A sector for 1 024 user bytes consists of 52 bytes for the preformatted header area, 14 bytes for flag, gap, ALPC and ODF field, 1274 bytes for the data and other fields and 20 bytes for the buffer.

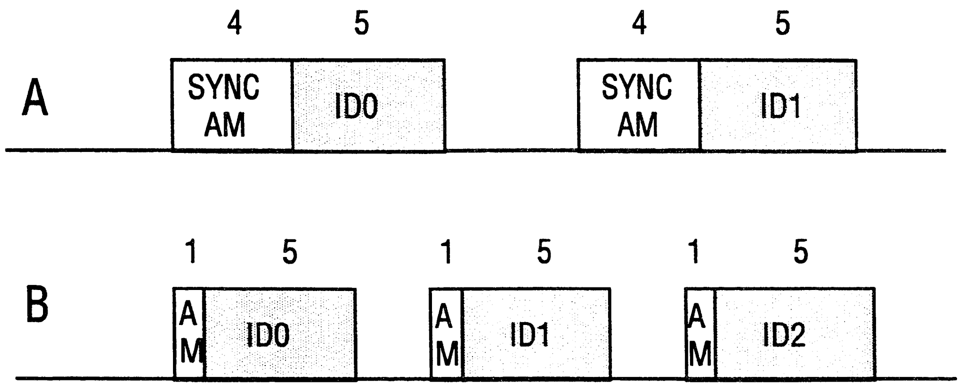
The Resync field is not a discrete field, but instead, a series of special byte patterns inserted into the Data Field to protect the data from loss due to defects and subsequent loss of byte framing by the read channel.

Each ID field has a Variable Frequency Ocilator (VFO) pattern, an Address Mark (AM) pattern and Identifier (ID) information. The sector layout is shown in table 3.

By applying three redundant ID fields, reliable ID detection can be achieved when defects are present. Experimental data used to validate the use of three ID fields is included in the annexes (especially see annex A).

Table 3 - Sector field functions





	Robustness for timing detection			Address robustness	TOTAL
	random	burst	efficiency		
A	very strong	weaker	good	weak	good
B	strong	strong	better	strong	very good

NOTE

A: 2 ID fields of 4 byte of Sync/AM

B: 3 ID fields of 1 byte of AM

Figure 2 - Comparison of robustness between two different header formats

7.1 Sector Mark

Functions

The purpose of the Sector Mark (SM) is to reliably provide a timing window to begin synchronization of the read channel. It is distinguished from address data or user data by its unique channel bit pattern and can be detected without recourse to a PLL.

Characteristics of the Pattern

The pattern does not exist in data and can be detected by a simple timing comparison. The detection of the redundant 3 and 5 channel bit time long pits is reasonably robust to the effects of short burst defects.

Example of a Detecting Circuit

Figure 3 shows an example of an SM detecting circuit, and figure 4 shows its action. The signal from the media passes an amplifier and is converted to a pulse width signal by a binarization circuit. A serial-to-parallel conversion circuit along with a time comparison outputs each pulse value at a fixed level. These parallel output signals are compared by majority logic.

As can be seen in figure 4, at most one signal pattern at a time is detected as ONE at time 0. Therefore, identifying the patterns to equal an SM requires more than two ONEs. An SM can be detected even if two output signals are missed. Since the minimum detection criteria is 3 out of 5 pulses, it is highly unlikely that a combination of defects would occur to give a false detection, and it is also unlikely a defect would destroy 3 out of the 5 patterns to cause a missed detection.

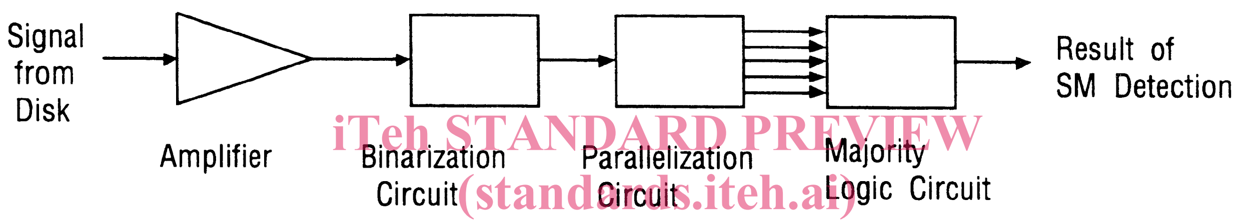


Figure 3 - SM detecting circuit

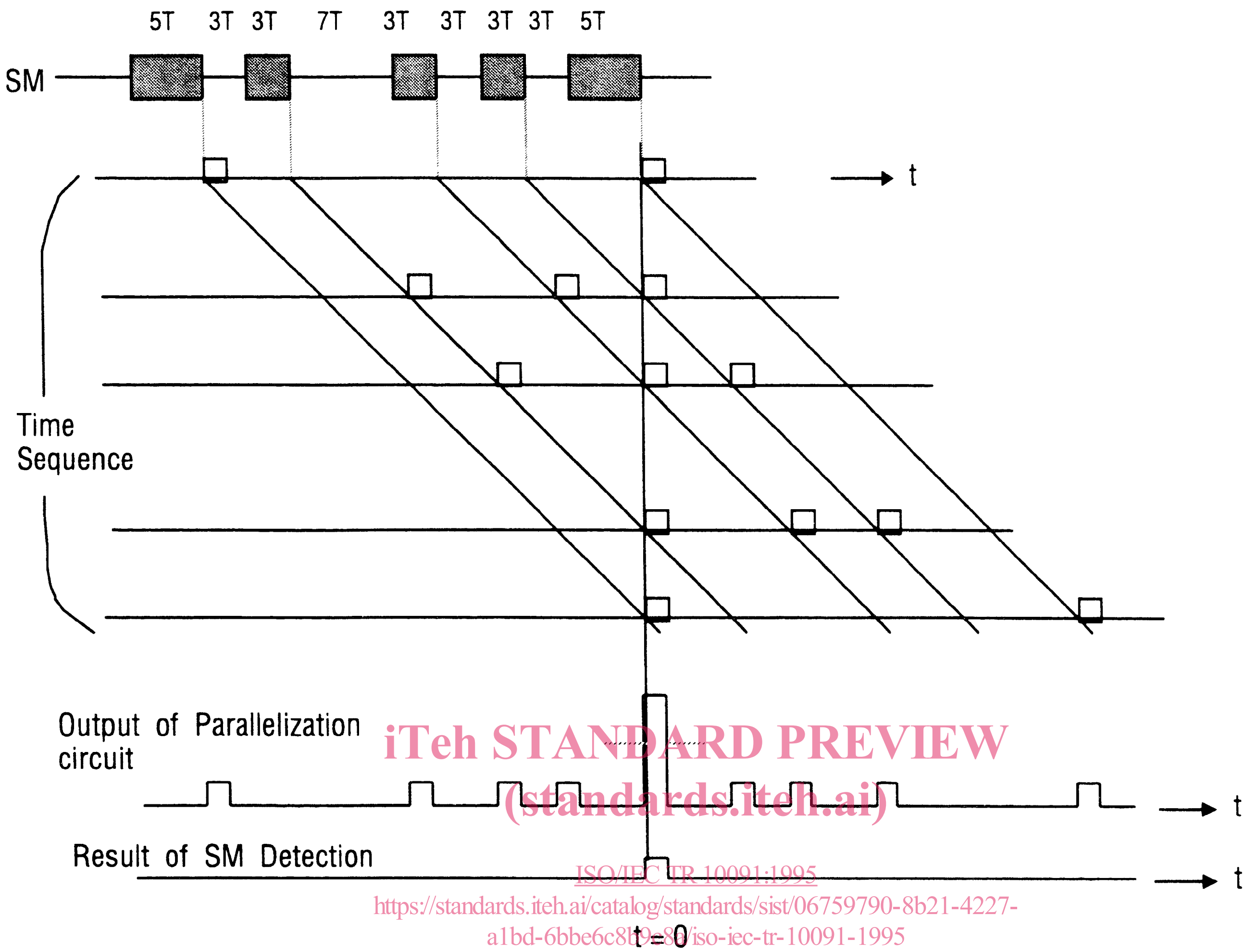


Figure 4 - SM detecting action

7.2 VFO Areas

Functions

VFO fields are not equal in length or pattern (figure 5) for several reasons. VFO1 has the functions to both stabilize the AGC (automatic gain control) and to stabilize the PLL (phase-locked loop) on the clock of the signal from the disk.

VFO2 stabilizes the PLL. As the AGC is assumed to have been stabilized already, the length of VFO2 is shorter than that of VFO1.

VFO3 stabilizes the AGC for the written data field and also stabilizes the PLL. For AGC stabilization it is assumed that a Channel bit stream from 0 to 80 Channel bits in length is necessary depending upon the circuit or method used.

Characteristics of the pattern

It is the most dense Channel bit pattern which is suitable to perform the above mentioned functions. The field size when entering the VFO area from a region of unknown or unpredictable signal is 192 Channel bits, while that for the VFO preceding ID1 and ID2 is 136 Channel bits. Since there is no gap proceeding the second and third ID fields, it is assumed that enough information remains in the preceding field to establish the AGC level of the PLL. This leaves 136 Channel bit times for the PLL to establish phase-frequency lock on the data stream.

Two VFO patterns prior to ID1 and ID2 are needed in order to allow the last byte of CRC to achieve closure. The patterns are

"100100100.....010010" and "000100100.....010010".

Notice that the VFO fields always end in the same Channel bit pattern just before the Address Mark. The choice of initial pattern for VFO2 depends on the content of the last byte of CRC in the preceding ID field. The use of these patterns avoids the necessity of having a gap between the end of an ID field and the beginning of the next VFO field.

Detecting Circuit

Typical AGC and PLL circuits can be used. No attempt is made here to define such circuits, as ample information already exists. However, it is recommended to add a circuit similar to that in figure 6 to make the PLL more stable. Its purpose is to detect the frequency difference between the master clock and the read clock. When the difference reaches a specified criterion (3% to 4%), it reestablishes the read clock using the master clock, then resumes reading. Thus, if the PLL looses frequency synchronization due to a large burst error, reliable PLL operation can still be expected again after the defective area has passed.

Comment on the length of the VFO

Pull-in times for phase-locked loop (PLL) circuitry used in production model of optical disk drives have been measured as follows;

Company A : about 4,5 µs (48 Channel bits),
Company B : about 9 µs (96 Channel bits) in the worst case.

Therefore the length of the VFO region should not be less than 96 Channel bits. A VFO region of 136 Channel bits should be long enough for pull-in of the PLL. An experimental circuit was used for measuring the pull-in time similar to that shown in figure 6. The circuit was modified from what would be used in a production drive by reducing the allowed time for acquisition by 50%. This means that this PLL is less stable than the production version. The signals shown in figure 7 show that the pull-in response was sufficiently stable. The upper trace shows the switching signal which moves between 10,5 MHz and 10 MHz. The figure shows that the pull-in for the VFO was completed within 3 µsec (32 Channel bits).

This demonstrates that it is possible to design a PLL circuit whose pull-in time is shorter than 136 Channel bits and is still stable.