

Specification for

Helical-scan video tape cassette system using 12.65 mm (0.5 in) magnetic tape — Type M2

The European Standard EN 61118:1993 has the status of a
British Standard

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National foreword

This British Standard has been prepared under the direction of the Electronic Equipment Standards Policy Committee and is the English language version of EN 61118:1993 *Helical-scan video tape cassette using 12,65 mm (0,5 in) magnetic tape — Type M2*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 1118:1993, published by the International Electrotechnical Commission (IEC).

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 74, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Descriptors: Magnetic recording, video recording, audio recording, recording apparatus, video tape recorders, magnetic tapes cassettes, dimensions, recording characteristics, interchangeability

English version

Helical-scan video tape cassette using 12,65 mm (0,5 in) magnetic tape — Type M2

(IEC 1118:1993)

Système de magnétoscope à cassette à
balayage hélicoïdal utilisant la bande
magnétique de 12,65 mm (0,5 in) de type M2
(CEI 1118:1993)

Videoband-Kassettensystem mit
Schrägspuraufzeichnung auf
Magnetband 12,65 mm (0,5 in) Typ M2
(IEC 1118:1993)

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European Committee for Electrotechnical Standardization
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Foreword

The text of document 60B(CO)135, as prepared by Subcommittee 60B: Video recording, of IEC Technical Committee 60: Recording, was submitted to the IEC-CENELEC parallel vote in May 1992.

The reference document was approved by CENELEC as EN 61118 on 22 September 1993.

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- latest date of publication of an identical national standard (dop) 1994-07-01
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Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given only for information. In this standard, Annex A is informative and Annex ZA is normative.

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Section 1. General

1.1 Scope

This International Standard is applicable to magnetic video recording using 12,65 mm (0,5 in) tape cassettes on helical-scan video tape recorders and defines the basic M2 format video cassette system.

This standard also specifies two different audio recording modes:

- 1) common audio mode and
- 2) pulse code modulation audio mode.

PCM audio mode has a limited interchangeability. FM audio recording shown in this standard is optional.

The object of this International Standard is to define dimensions and other characteristics of equipment which are necessary to ensure the interchangeability of recorded cassettes. The requirements given relate to 525 line-60 field and 625 line-50 field systems.

1.2 Normative references

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

IEC 94-1:1981, *Magnetic tape sound recording and reproducing systems — Part 1: General conditions and requirements*.

IEC 461:1986, *Time and control code for video tape recorders*.

EBU R-50:1989, *Conservation of the polarity of audio signals in radio and television production installations*.

1.3 Environment and test conditions

1.3.1 Environment

Tests and measurements made on the system to check the requirements of this International Standard shall be made under the following conditions unless otherwise specified:

Temperature (drum diameter):	20 °C ± 0,5 °C
Temperature (all other tests):	20 °C ± 1 °C
Relative humidity:	50 % ± 2 %
Barometric pressure:	86 kPa to 106 kPa
Conditioning before testing:	24 h

1.3.2 Reference tape

Blank tape to be used for reference recordings may be purchased from the manufacturers listed in Annex A. Electromagnetic compatibility parameters and their specifications shall be specified by the manufacturer and controlled accordingly.

Electromagnetic compatibility parameters and their specifications are indicated in Annex A.

1.3.3 Calibration tape

Calibration tapes satisfying the following requirements will be available for purchase from manufacturers of video tape recorders and players in accordance with this format specification.

1.3.3.1 Record locations and dimensions

In principle, 50 % reduction in the tolerances shown in Table 1 shall be applied to calibration tapes to be used for the purpose of calibrating the mechanical accuracy of recorders or players in accordance with this format specification. If necessary, the record locations and dimensions may be specially modified for some calibration tapes in order to avoid certain calibration errors or to facilitate certain calibration work.

1.3.3.2 Calibration signals

Two classes of signals shall be recorded on the calibration tapes:

- a) A series of conventional analogue component test signals for video tape recorders.

<i>Video</i>	<i>Audio</i>
— Colour bars	— 1 kHz – 0 VU
— Multi-burst	— 15 kHz – 0 VU
— Bowtie	— 20 or 40 Hz – 10 VU
— Pulse and bar	— 1 kHz – 10 VU
	— 7,5 kHz – 10 VU
	— 10 kHz – 10 VU
	— 15 kHz – 10 VU

AFM

- 1 kHz, 70 kHz deviation.

- b) Special test signals developed by each manufacturer for product alignment. These signals are not universally applicable to the products from each manufacturer and are not specified in this International Standard.

Section 2. Video tape cassette

2.1 Mechanical parameters

2.1.1 Cassette type

There are two cassette types, characterized by the outside dimensions shown below:

- large cassette: 106 mm × 188 mm × 25 mm
- small cassette: 87 mm × 130 mm × 25 mm

2.1.2 Dimensions of cassettes

The dimensions permitting the interchangeability of cassettes shall be in accordance with Figure 1 to Figure 5 and Figure 7 to Figure 11.

2.1.3 Cassette dimension datum system

2.1.3.1 Datum holes

These shall be holes serving for the reference when loading a cassette into the video tape recorder, and shall also be the reference for the cassette dimensions (see Figure 2, Figure 4, Figure 8 and Figure 10).

2.1.3.2 Datum plane Z

This shall be a plane containing three datum positions A, B and C on the bottom of the cassette (see Figure 4 and Figure 10).

2.1.3.3 Datum plane X

- Large cassette: This shall be a plane orthogonal to datum plane Z and containing the centre lines of datum holes A and B (see Figure 2 and Figure 4).
- Small cassette: This shall be a plane parallel to the long side face of the cassette orthogonal to datum plane Z and containing the centre line of datum hole A (see Figure 8 and Figure 10).

2.1.3.4 Datum plane Y

This shall be the plane orthogonal to both datum planes X and Z and containing the centre line of datum hole A (see Figure 2, Figure 4, Figure 8 and Figure 10).

2.1.4 Window and label-pasting faces

- Large cassettes shall conform to Figure 1.
Small cassettes shall conform to Figure 7.

2.1.5 Identification holes

Various holes shall be provided for identifying cassette conditions (see Figure 2 and Figure 8). Each hole may be set in the closed state or the open state.

Closed state: The hole depth shall be 0 mm to 0,25 mm; be able to withstand the normal load of 0,5 N

Open state: The hole diameter shall be $3^{+0,3}_{-0,1}$ mm; The hole depth shall be 5 mm or more.

2.1.5.1 Erasure prevention identification hole

Large cassettes shall be defined by Figure 2.

Small cassettes shall be defined by Figure 8.

The erasure prevention identification hole shall be coupled to the erasure prevention mechanism shown in Figure 1 and Figure 7 and may be changed between the closed state and the open state. Each state shall be defined as follows:

Identification hole closed: Ready to record.

Identification hole open: Not ready to record.

2.1.5.2 Tape type identification hole

Large cassettes shall be defined by Figure 2.

Small cassettes shall be defined by Figure 8.

The closed state of the identification hole shall be defined as follows:

Identification hole closed: Metal tape.

(Coercive force: approximately 120×10^3 A/m).

2.1.5.3 Tape thickness identification hole

Large cassettes shall be defined by Figure 2.

Small cassettes shall be defined by Figure 8.

The closed state of the identification hole shall be defined as follows:

Identification hole closed: Tape total thickness is $13,5 \mu\text{m} \pm 0,5 \mu\text{m}$.

2.1.5.4 Extra identification holes

These holes are provided for future usage. The positions of these holes shall be as shown below:

Large cassettes shall be as defined in Figure 2 (five holes).

Small cassettes shall be as defined in Figure 8 (two holes).

2.1.6 Dimensions of reels

Dimensions of the reels shall be in accordance with Figure 5 and Figure 11.

2.1.7 Tape windings

The tape winding method and path shall be in accordance with Figure 6 and Figure 12.

2.1.8 Unlocking of lid

The lid shall be unlocked when a force of not more than 0,15 N in the case of the large cassette, or a force of not more than 0,30 N in the case of the small cassette is applied to the unlocking clutch as indicated in note 8 of Figure 1 and note 6 of Figure 7.

2.1.9 Opening of lid

The force necessary for opening the lid shall be not more than 1 N until the lid is opened to the maximum.

2.1.10 Releasing of reel brake

The reel brakes shall be released by a force of not more than 0,7 N by means of a reel brake unlocking pin as shown in note 4 of Figure 3 and note 3 of Figure 9.

2.1.11 Automatic stop

At the end of the tape, transparent leader and trailer tapes are provided for either automatic shut-off or automatic rewind.

Section 3. Video cassette recorders

3.1 Definitions

For the purpose of this International Standard, the following definitions apply.

3.1.1

scanner

a mechanical assembly containing a drum, rotating pole tips and the tape-guiding elements used to record and reproduce video, FM audio and PCM audio signals

3.1.2

drum

a cylindrical column around which the tape is at least partially wrapped in order to form the head-to-tape interface of the video tape recording system

3.1.3

upper drum

that part of the drum which does not contact the reference edge of the tape (see Figure 14a)

3.1.4

lower drum

that part of the drum which contacts the reference edge of the tape and provides tape-guiding functions (see Figure 14a)

3.1.5

effective drum diameter

the value of drum diameter which yields the actual video and PCM audio record dimensions in a theoretical calculation. This value is greater than or equal to the actual drum diameter

3.1.6

helix angle

the angle formed between the path of the rotating heads and the tape reference edge guiding system

3.1.7

track angle

the angle formed between the video record and the reference edge of the tape

3.2 Drum diameter and structure

The track angle is determined by parameters such as effective drum diameter, tape tension, helix angle and tape speed. Different methods of design and/or minor variations in drum diameter and tape tension will produce equivalent recordings for interchange purposes.

3.2.1 Actual upper drum diameter

The actual upper drum diameter shall be the dimension specified in Figure 14a.

3.2.2 Actual lower drum diameter

The actual lower drum diameter shall be the dimension specified in Figure 14a.

3.2.3 Upper drum section

The upper drum section shall rotate together with the video heads.

3.3 Scanner pole tips

Four circumferential pole tips shall be located as shown in Figure 13.

3.3.1 Pole tip projection

Each pole tip shall project radially 0,035 mm (nominal value) above the upper drum surface.

3.3.2 Pole tips

3.3.2.1 Luminance pole tips

Two pole tips circumferentially arranged $180^\circ \pm 0,003^\circ$ apart shall be provided for the luminance signal.

3.3.2.2 Chrominance pole tips

Each luminance pole tip shall have an associated pole tip for the time compressed chrominance signal and the FM audio signal.

3.3.3 Chordal distance between luminance and chrominance pole tips

The chordal distance shall be as shown in Figure 14b.

3.3.4 Axial distance between luminance and chrominance pole tips

The axial distance shall be as shown in Figure 14b.

3.3.5 Channel identification

Suitable means, such as a pulse generator producing one pulse per drum revolution, shall be provided for identifying the head pair which records Field 1. This pair is identified as channel 1, and the other pair is identified as channel 2.

3.4 Helix angle

The helix angle formed by the scanner and all associated tape guides shall be $4,250^\circ \pm 0,001^\circ$.

3.5 Dimensions and locations of records

3.5.1 Test environment

3.5.1.1 In addition to the environmental and general test requirements of clause 1.3, the following additional conditions shall be met in order to meet requirements of clause 3.5.

Tape tension: $0,31 \text{ N} \pm 0,05 \text{ N}$.

3.5.1.2 Conditioning of the tape stock before recording and testing shall be as follows:

environment: established to the conditions specified in 3.5.1.1;

tape tension: wound on a reel at $0,4 \text{ N} \pm 0,1 \text{ N}$;

conditioning time: 24 h.

3.5.1.3 The reference edge of the tape for dimensions specified in this standard shall be the lower edge as shown in Figure 15 to Figure 18, where the magnetic coating faces are shown.

3.5.2 Tape speed

The tape speed shall be as follows:

525 line-60 field system: 67,693 mm/s, basic;

625 line-50 field system: 66,295 mm/s, basic.

3.5.3 Record locations and dimensions

3.5.3.1 The locations of the common audio mode record shall be as specified in Figure 15.

3.5.3.2 The locations of the PCM audio mode shall be as specified in Figure 16. Under this condition, only one longitudinal audio record shall be available.

3.5.3.3 The record locations of luminance (Y) and chrominance (C) signals shall be as specified in Figure 17 for the 525 line-60 field system.

3.5.3.4 The record locations of luminance (Y) and chrominance (C) signals shall be as specified in Figure 18 for the 625 line-50 field system.

3.5.3.5 The record dimensions shall be as specified in Table 1.

3.5.3.6 The dimensions specified in Table 1 are for the tensioned tape; therefore, the elasticity of the tape shall be taken into account for the direct measurements of the tape without tension.

3.5.4 Video record curvature

The center line of the video and PCM audio records shall be within two parallel straight lines 0,006 mm apart.

3.5.5 Gap azimuth

3.5.5.1 The azimuth of the audio, time-and-control codes and tracking control head gaps shall be perpendicular to the tape transport direction (see Figure 15 and Figure 16).

3.5.5.2 The azimuth of the video head gaps for the luminance signal shall be -15° and for the chrominance signal shall be $+15^\circ$ to the perpendicular to the head moving direction (see Figure 17 and Figure 18).

3.6 Recording characteristics

The recording characteristics of video tape recorders shall be in accordance with the requirements specified in section 5.

Table 1 — Record locations and dimensions

Item	525 line-60 field			625 line-50 field		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A: Time code track lower edge	0	0	0	0	0	0
B: Time code track upper edge	400	450	500	400	450	500
C: Colour track width	34	36	38	34	36	38
D: Y-C track pitch	40,7	42,2	43,7	49,2	49,7	50,2
E: Control track lower edge	850	900	950	850	900	950
F: Control track upper edge	1 250	1 300	1 350	1 250	1 300	1 350
G: Video track lower edge	1 469	1 503	1 537	1 471	1 499	1 527
H: Video track upper edge	10 601	10 634	10 668	10 611	10 640	10 668
J: Audio 1 lower edge	10 830	10 850	10 870	10 830	10 850	10 870
K: Audio 1 track upper edge	11 400	11 450	11 500	11 400	11 450	11 500
L: Audio 2 track lower edge	11 900	11 950	12 000	11 900	11 950	12 000
M: Audio 2 track upper edge	12 500	12 550	12 650	12 500	12 550	12 650
N: Y track width	42	44	46	54	56	58
O: Lead signal overlap	3H ref.			3,5H ref.		
P: Y-C track offset	4 505 (=10H) ref.			4 533 (=12H) ref.		
Q: Video track pitch	84,5 ref.			99,4 ref.		
R: Video track length	11 8254,3 (262,5H) ref.			11 8058,3 (312,5H) ref.		
W: Video area effective width	8 847,1 ref.			8 847,1 ref.		
W': Video and PCM audio (CH6) area effective width	9 973,5 ref.			9 973,5 ref.		
X: Audio, time code and control track record offset	202 000			202 000		
Y: Lower limit of W	1 621	1 626	1 631	1 621	1 626	1 631
θ: Track angle	4,2906° (basic)			4,2977° (basic)		
PA: Effective PCM audio track lower edge (luminance head)	10 676	10 709	10 743	10 660	10 689	10 717
PB: Effective PCM audio track lower edge (chrominance head)	10 724	10 758	10 791	10 712	10 740	10 768
PC: PCM audio track upper edge (chrominance head)	11 660	11 693	11 727	11 652	11 680	11 709
PD: Pre-amble	360	450	541	340	416	491
PE: PCM audio data area	11 820 ref.			11 900 ref.		
PF: Post-amble	360	450	541	340	416	491

Unit: μm , unless otherwise specified.

NOTE Ref. indicates those measurements which are fixed by other parameters and are given for reference purposes only.

Section 4. Tape characteristics

4.1 Dimensions of video tape

4.1.1 Magnetic tape thickness

The thickness of the magnetic tape, including the coating, shall be $13,5 \mu\text{m} \pm 0,5 \mu\text{m}$.

4.1.2 Magnetic tape width

The width of the magnetic tape shall be $12,65 \text{ mm} \pm 0,01 \text{ mm}$.

4.2 Magnetic tape properties

4.2.1 Type of magnetic tape

A high coercivity metal particle tape shall be used.

4.2.2 Magnetic orientation

The magnetic coating shall be longitudinally oriented.

4.2.3 Coercivity

The coercivity shall be class 1 500 ($120 \times 10^3 \text{ A/m}$).

4.3 Leader tape and trailer tape

4.3.1 Automatic stop

The transmittance of the leader and trailer tapes shall be 50 % or more to ensure that the automatic stopping device of the machine operates properly at both ends of the magnetic tape.

4.3.2 Dimensions of leader and trailer tape

Leader and trailer tape length shall be $170 \text{ mm} \pm 15 \text{ mm}$ for the large cassette and $140 \text{ mm} \pm 10 \text{ mm}$ for the small cassette.

Leader and trailer tape thickness shall be $13 \mu\text{m}$ to $36 \mu\text{m}$ and the width shall be $12,65 \text{ mm} \pm 0,02 \text{ mm}$.

4.3.3 Splicing

The splice and the attachment of the leader and trailer tapes to the magnetic tape and the hub shall be capable of resisting a force of 20 N. The splicing gap shall be $60 \mu\text{m}$ or less.

Section 5. Recording characteristics

5.1 Video signal recording

Type M2 video tape recorder shall record component video signals. This component video recording system shall provide independent signal channels for the luminance and chrominance signals respectively. These component signals shall be recorded on two independent tracks on the video tape as frequency modulated signals. Two separate tracks shall be designated as the Y track for the luminance signals and the C track for the chrominance signals. The chrominance signals, that is, the R-Y and B-Y colour difference signals, shall be recorded in the form of a time compressed and time division multiplexed signal on the C track.

In the case of the FM audio signal recording specified in clause 5.3, it shall be recorded in the form of a frequency multiplexed signal together with the FM colour difference signal on the C track.

5.1.1 Luminance channel

5.1.1.1 A signal processing system, as specified in this standard, shall contain the following elements in the order of the signal flow:

- 1) A circuit for adding a timing burst signal to the luminance signal.
- 2) A circuit for adding a vertical interval sub-carrier when appropriate.
- 3) A luminance non-linear pre-emphasis circuit.
- 4) A luminance pre-emphasis network.
- 5) A circuit for clipping the pre-emphasized luminance signal.
- 6) A linear frequency modulator.

7) A circuit for mixing the PCM audio CH5 signal specified in clause 5.6 with the frequency modulated luminance signal.

8) A recording current amplifier for the Y track and the PCM track video heads.

5.1.1.2 Burst signal addition

The waveforms of the luminance signal with the burst signal added shall be as shown in the following figures:

525 line-60 field system: Figure 19a to Figure 19c;

625 line-50 field system: Figure 20a to Figure 20c.

Burst frequency is locked to horizontal line frequency.

5.1.1.3 Luminance non-linear emphasis

The non-linear emphasis circuits should be as shown in the following figures:

525 line-60 field system: Figure 21 or its equivalent;

625 line-50 field system: Figure 22 or its equivalent.

The typical frequency characteristics of the non-linear emphasis circuit output signal should be as shown in Table 2.

Table 2 — Frequency characteristics of non-linear emphasis

Frequency (MHz)	Relative input level (dB)					
	525 line-60 field system			625 line-50 field system		
	0	− 10,0	− 20,0	0	− 10,0	− 20,0
0,01	0	0	0	0	0	0
0,1	− 0,1	− 0,2	+ 0,1	− 0,3	− 0,50	− 0,4
0,2	− 0,4	+ 0,1	+ 0,4	− 0,65	− 0,65	− 0,1
0,5	− 0,7	+ 1,1	+ 1,7	− 0,80	+ 0,25	+ 1,7
1,0	0	+ 3,0	+ 4,0	− 0,30	+ 1,90	+ 4,3
2,0	+ 0,9	+ 4,8	+ 6,1	+ 0,15	+ 3,20	+ 6,5
3,0	+ 1,3	+ 5,5	+ 6,8	+ 0,30	+ 3,75	+ 7,6
5,0	+ 1,7	+ 6,1	+ 7,2	+ 0,35	+ 4,10	+ 8,0
NOTE 1 For the 525 line-60 field system: 0 dB means 100 % amplitude except sync signal.						
NOTE 2 For the 625 line-50 field system: 0 dB means 100 % amplitude except sync signal.						

5.1.1.4 Luminance pre-emphasis

The network and circuit parameters shall be as shown in Figure 23.

5.1.1.5 Amplitude clipping

Any positive or negative amplitude excursion exceeding the specified limits shall be clipped.

The limits determined on the basis of the blanking level shall be as shown in Table 3.

Table 3 — Amplitude clipping levels

	525 line-60 field system	625 line-50 field system
Positive limit	+ 338 ± 10 %	+ 270 % ± 10 %
Negative limit	− 190 % ± 10 %	− 170 % ± 10 %
NOTE The above clipping levels are values for the signals where blanking is at 0 % and peak white at 100 % level		

5.1.1.6 FM carrier frequency

Carrier frequencies corresponding to the reference video level shall be as shown in Table 4.

Table 4 — Carrier frequencies corresponding to reference video levels (MHz)

	525 line-60 field system	625 line-50 field system
100 % white	7,70 (nominal)	9,20 (nominal)
50 % level	6,95 (nominal)	8,30 (nominal)
Blanking	6,20 $\pm$ 0,05	7,40 $\pm$ 0,05
Sync tip	5,60 (nominal)	6,63 (nominal)
Video deviation	1,50 $\pm$ 0,05	1,80 $\pm$ 0,05

5.1.1.7 Recording head current

5.1.1.7.1 The amplitude of the record current for the Y track shall be such that the maximum level of remanent flux on the tape is produced when recording the Y signal with 50 % average picture level.

5.1.1.7.2 The amplitude of the Y track record current shall decrease with increasing frequency according to a straight line in the range of 2 MHz to 10 MHz contained within limit lines as shown in Figure 30. This method ensures optimum recording irrespective of video head material.

5.1.2 Chrominance channel

5.1.2.1 A signal processing system, as specified by this standard, shall contain the following elements in the order of the signal flow:

- 1) A circuit for adding a horizontal sync pulse and the timing burst signals to the chrominance signal.
- 2) A circuit to individually adjust the R-Y and B-Y levels in the ratio specified.
- 3) A circuit to perform the time compression and the time division multiplexing of the R-Y and B-Y colour difference signals.
- 4) A chrominance non-linear pre-emphasis circuit.
- 5) A chrominance pre-emphasis network.
- 6) A circuit for clipping the pre-emphasized chrominance signal.
- 7) A linear frequency modulator.
- 8) A high-pass filter to reduce the amplitude of low frequency components to allow for the mixing of the optional FM audio signals.
- 9) A circuit to mix the optional FM audio signals with the chrominance signal.
- 10) A circuit for mixing the PCM audio CH6 signal specified in clause 5.6 with the frequency modulated chrominance signal.
- 11) A recording current amplifier for the C track and the PCM track video heads.

5.1.2.2 Addition of the burst and sync signals

Resultant signal waveforms shall be as shown in the following figures:

525 line-60 field system: Figure 19a, Figure 19b, Figure 19d and Figure 19e;

625 line-50 field system: Figure 20a, Figure 20b, Figure 20d and Figure 20e.

5.1.2.3 Time compression and multiplexing

The time compression factor shall be one half.

The time compressed R-Y and B-Y signals shall be multiplexed alternately as shown in Figure 24.

The compressed and multiplexed R-Y and B-Y signals shall be delayed by one horizontal line with respect to the luminance signal.

5.1.2.4 Chrominance non-linear emphasis

The non-linear emphasis circuits shall be as shown in the following figures:

525 line-60 field system: Figure 21 or its equivalent;

625 line-60 field system: Figure 22 or its equivalent.

The typical frequency characteristics of the non-linear emphasis circuit output signal shall be as shown in Table 5.

Table 5 — Frequency characteristics of non-linear emphasis

Frequency (MHz)	Relative input level (dB)					
	525 line-60 field system			625 line-50 field system		
	0	− 10,0	− 20,0	0	− 10,0	− 20,0
0,01	0	0	0	0	0	0
0,1	− 0,3	− 0,3	− 0,1	− 0,3	− 0,50	− 0,4
0,2	− 0,4	+ 0,1	+ 0,4	− 0,65	− 0,65	− 0,1
0,5	− 0,2	+ 1,1	+ 1,6	− 0,80	+ 0,25	+ 1,7
1,0	+ 0,6	+ 3,0	+ 3,9	− 0,30	+ 1,90	+ 4,3
2,0	+ 1,5	+ 4,8	+ 6,0	+ 0,15	+ 3,20	+ 6,5
3,0	+ 1,9	+ 5,5	+ 6,6	+ 0,30	+ 3,75	+ 7,6
5,0	—	—	—	+ 0,35	+ 4,00	+ 7,90

NOTE 1 For the 525 line-60 field system: 0 dB means the peak-to-peak value of 100/7.5/77/7.5 colour-bar signal except sync signal

NOTE 2 For the 625 line-50 field system: 0 dB means the peak-to-peak value of 100/0/100/0 colour-bar signal except sync signal.

5.1.2.5 Chrominance pre-emphasis

The network and circuit parameters shall be as shown in Figure 25.

5.1.2.6 Amplitude clipping

Any positive or negative amplitude excursion exceeding the specified limits shall be clipped.

The limits determined on the basis of the blanking level shall be as shown in Table 6.

Table 6 — Amplitude clipping level

	525 line-60 field system	625 line-50 field system
Positive limit	+ 147,7 ± 10 %	+ 200 % ± 10 %
Negative limit	− 180,2 % ± 10 %	− 200 % ± 10 %

NOTE 1 100 % indicates the peak-to-peak amplitude of the compressed 100/7.5/77/7.5 colour-bar signal for the 525 line-60 field system.
NOTE 2 100 % indicates the peak-to-peak amplitude of the compressed 100/0/100/0 colour-bar signal for the 625 line-50 field system.

5.1.2.7 FM carrier frequency

Carrier frequencies corresponding to reference video levels shall be as shown in Table 7.

Table 7 — Carrier frequencies corresponding to reference video levels (MHz)

	525 line-60 field system (100/7.5/77/7.5)		625 line-50 field system (100/0/100/0)	
	R-Y	B-Y	R-Y	B-Y
Peak of positive excursion	6,20	6,00	7,00	7,00
Peak of negative excursion	4,80	5,00	5,40	5,40
Blanking	5,50	5,50	6,20	6,20
Sync tip	4,20	—	4,71	—
Maximum peak-to-peak deviation	1,40	1,00	1,60	1,60
Deviation peak-to-peak tolerance	± 0,02	± 0,015	± 0,016	± 0,016
Blanking carrier tolerance	± 0,05	± 0,05	± 0,05	± 0,05

NOTE Unit MHz

5.1.2.8 *C track record head current*

5.1.2.8.1 The amplitude of the record current for the C track shall be such that the maximum level of remanent flux on the tape is produced when recording the chrominance blanking level.

5.1.2.8.2 The amplitude of the C track record current shall decrease with increasing frequency according to a straight line in the range of 2 MHz to 10 MHz contained within limit lines as shown in Figure 30. This method ensures optimum recording irrespective of video head material.

5.1.2.9 The typical frequency characteristics of the recording current in the absence of the optional audio FM signals shall be as shown in Table 8.

Table 8 — Frequency characteristics of recording current

Frequency (MHz)	Attenuation (dB)
0,4	Greater than 30
0,7	Greater than 30
1,6	Less than 3
2,0	0 (ref.)

5.1.3 Y-C timing

5.1.3.1 *Reference of Y-C timing*

The timing difference between three signals, that is, the Y signal, and the R-Y and B-Y signals before time-base compression shall be not more than 5 ns as shown in Figure 26 or Figure 27.

5.1.3.2 *Tolerance of Y-compressed C timing*

The timing difference between the luminance and the compressed chrominance signals shall be the value as shown in Figure 19b or Figure 20b.

5.1.4 Vertical interval subcarrier (VISC)

5.1.4.1 *NTSC system*

The subcarrier frequency and phase information of a composite NTSC signal shall be recorded as the VISC signal in the vertical blanking interval of the luminance signal as shown in Figure 28.

The frequency of the VISC signal shall be equal to that of the subcarrier of the NTSC signal; the phase difference between the VISC signal and the burst of the input NTSC signal before composite-to-component conversion shall be within $\pm 5^\circ$.

5.1.4.2 *PAL system*

The subcarrier frequency and phase information of a composite PAL signal shall be recorded as the VISC signal in the vertical blanking interval of the luminance signal as shown in Figure 29.

The frequency of the VISC signal shall be equal to that of the subcarrier of the PAL signal; the phase difference between the phase of the VISC signal and the mean phase of the input PAL signal before composite-to-component conversion shall be within $\pm 5^\circ$.

5.1.4.3 *SECAM system*

The VISC signal shall not be recorded.

5.2 Longitudinal audio signal recording

5.2.1 Recording method

Recordings shall be made by an anhysteretic (bias) method.

5.2.2 Recording/Reproducing reference levels

5.2.2.1 *Recorder reference level*

For a 1 kHz sinusoidal signal recording which yields an r.m.s. short-circuit tape flux per unit track width on the record of $125 \text{ nWb/m} \pm 3 \text{ nWb/m}$, as defined in IEC 94-1, the recording volume indicator shall indicate its reference level scale mark.

5.2.2.2 Reproducer reference level

For the reproduction of 1 kHz tape record which yields an r.m.s. short-circuit tape flux per unit track width of 125 nWb/m, the reproducing volume indicator shall indicate its reference level scale mark.

5.2.3 Frequency characteristics

5.2.3.1 Record flux versus frequency characteristics

When a tape record is performed by a constant voltage applied to the input terminals, the short-circuit tape flux level in the record versus frequency characteristics $L\Phi(f)$ shall be expressed by the following equation:

$$L\Phi(f) = 10 \log_{10} \frac{1 + (f/F_l)^2}{1 + (f/F_h)^2} \quad (\text{dB})$$

where

- $L\Phi(f)$ is the relative tape flux level;
- f is the frequency at which the response is calculated;
- F_l is the low-frequency transition frequency, 50 Hz;
- F_h is the high-frequency transition frequency, 4 681 Hz.

5.2.3.2 Reproduced flux versus frequency characteristics

When a tape record having short-circuit tape flux level versus frequency characteristics given in 5.2.3.1 is reproduced, the output voltage level of the reproducer versus frequency characteristics shall remain constant.

5.2.3.3 Noise reduction characteristics

The noise reduction process, if applied, shall have the static encoding characteristics shown in Table 9.

Table 9 — Noise reduction characteristics

Frequency (Hz)	Input level (dB)						
	0	− 10	− 20	− 30	− 40	− 50	− 60
100	+ 0,2	+ 0,9	+ 2,7	+ 2,9	+ 2,9	+ 2,9	+ 2,9
200	+ 0,1	+ 1,5	+ 5,3	+ 8,0	+ 8,1	+ 8,1	+ 8,1
300	0	+ 1,6	+ 6,1	+ 10,7	+ 12,0	+ 12,0	+ 12,0
500	0	+ 1,7	+ 6,3	+ 11,8	+ 15,6	+ 16,2	+ 16,2
1 000	− 0,3	+ 1,5	+ 5,9	+ 11,4	+ 16,2	+ 19,4	+ 19,6
3 000	− 1,6	− 0,1	+ 3,7	+ 9,2	+ 13,9	+ 19,2	+ 20,7
5 000	− 2,3	− 0,6	+ 2,9	+ 8,4	+ 13,5	+ 18,7	+ 20,4
10 000	− 3,5	− 1,4	+ 2,6	+ 8,2	+ 13,6	+ 18,1	+ 19,2
15 000	− 6,3	− 3,3	+ 1,5	+ 7,3	+ 12,2	+ 15,0	+ 15,0
NOTE 1 Input level: 0 dB. The reference input level at 1 kHz							
NOTE 2 Encode level: 0 dB. The recorded reference level specified by 5.2.2.1.							
NOTE 3 Tolerance: ± 1,5 dB							

5.2.4 Track usage (common audio mode)

5.2.4.1 Non-stereo audio

The primary program audio channel shall be recorded on the audio 1 track.

5.2.4.2 Stereo audio

When separate channels are used for stereo audio, the left channel shall be recorded on the audio 1 track, and the right channel on the audio 2 track.

5.2.5 Program audio head phasing

When the same signal is recorded on audio 1 and audio 2 tracks, the tracks shall be so phased that, when reproduced with a head wide enough to sense the recorded flux on both records, the result will be additive.

5.2.6 Recording polarity

When a positive going waveform is present on pin 2 with respect to pin 3 of the input circular connector which will be defined in a future IEC publication or EBU R-50, the audio head shall generate a magnetic flux so that the direction of remanent flux on the tape is from North to South, with the South pole lying in the direction of tape travel.

5.3 FM audio signal recording (optional)

Audio signals of two channels shall frequency modulate two carriers. These frequency modulated carriers shall be located in the frequency region below the lower side band of the frequency modulated chrominance signal, which is specified by 5.1.2, in order to produce a frequency multiplex signal. The resultant multiplex signal shall be recorded on the chrominance track.

A signal processing system as specified by this standard shall contain the following elements.

- 1) An audio noise reduction scheme incorporating compression.
- 2) A linear frequency modulator having constant deviation with respect to the amplitude of the modulating frequencies.
- 3) A low pass filter and an amplifier to provide the C channel record head current.
- 4) A means of adding the FM audio signals to the chrominance signal in the ratios specified.

5.3.1 Recording/Reproducing reference levels

5.3.1.1 Recorder reference level

When a 1 kHz sinusoidal signal recording is made with the reference deviation defined in 5.3.4.2, the recording volume indicator shall be adjusted to indicate its reference level scale mark.

5.3.1.2 Reproducer reference level

When a 1 kHz tape record with the reference deviation defined in 5.3.4.2 is reproduced, the reproducing volume indicator shall indicate its reference level scale mark.

5.3.2 Noise reduction

5.3.2.1 Noise reduction circuit

A noise reduction circuit should be as shown in Figure 31 or its equivalent.

5.3.2.2 Compression ratio

The compression ratio shall be 2 : 1 in the logarithmic scale.

5.3.2.3 Transient response

The transient responses shall be such that the attack time is $9,0 \text{ ms} \pm 3 \text{ ms}$ and the recovery time is $90 \text{ ms} \pm 30 \text{ ms}$.

5.3.3 Pre-emphasis

The output signal of the noise reduction circuit specified in 5.3.2 shall be pre-emphasized before the frequency modulation by a network as shown in Figure 32.

5.3.4 Frequency modulation

5.3.4.1 Carrier frequency

The left channel signal frequency shall be $400 \text{ kHz} \pm 5 \text{ kHz}$.

The right channel signal frequency shall be $700 \text{ kHz} \pm 5 \text{ kHz}$.

5.3.4.2 Frequency deviation

The reference level deviation shall be $\pm 35 \pm 0,7 \text{ kHz}$ at 1 kHz.

The maximum deviation shall not exceed $\pm 105 \text{ kHz}$.

5.3.5 Recording head current

The recording head current level shall be adjusted at $20 \text{ dB} \pm 1 \text{ dB}$ below the chrominance recording level defined in 5.1.2.8. The amplitude of the recording head current shall be constant over the frequency range from 300 kHz to 800 kHz.

5.3.6 Recording polarity

When a positive going waveform is present on pin 2 with respect to pin 3 of the input circular connector which will be defined in a future IEC publication or EBU R-50, the recording frequency for the AFM signal shall exhibit an upward tendency.

5.4 Time and control code signal recording

5.4.1 Time and control code

The time and control codes shall conform to IEC 461.

5.4.2 Recording track

The recording track shall be the time and control code track as specified in clause 3.5.

5.4.3 Recording method

The recording shall be made by an anhysteretic (bias) method.

5.4.4 Recording level

The recording level, as expressed in peak-to-peak short-circuit tape flux per unit track width, shall be $250 \text{ nWb/m} \pm 50 \text{ nWb/m}$.

5.5 Tracking control signal recording

5.5.1 Recording track

The recording track shall be the tracking control track as specified in clause 3.5.

5.5.2 Recording waveform and level

The recording waveform and level shall be a series of constant flux levels alternating in polarity at a field rate and completing one cycle per frame as shown in Figure 33.

5.5.3 Polarity of remanent magnetization

During the time interval that the video heads of channel 1 are recording, the polarity of the tracking control record flux shall be such that the S poles of the magnetic domains represent the direction of the tape travel.

5.5.4 Timing and period

The polarity of the flux described in 5.5.3 shall change to opposite polarity when the recording of the next field is started by the channel 2 video heads. This opposite polarity interval shall continue until the beginning of the subsequent field recorded by the channel 1 video heads as shown in Figure 33.

5.5.5 Colour framing information

The addition of the colour framing information shall be carried out by changing the timing of the polarity transition of the control signal recording as shown in Figure 34 (NTSC system) or Figure 35 (PAL system) or Figure 36 (SECAM system).

In the case of the NTSC system, the recording of this information is optional; in the PAL and SECAM systems, however, the recording of the control signal shall always be carried out by changing the duty ratio as shown in Figure 35 and Figure 36.

5.5.6 Magnetization level

The magnitude of the tracking control recorded flux shall be at least 30 dB above the residual flux of any previous recordings.

5.5.7 Rise time

The rise time shall be the value shown in Figure 33.

5.6 PCM audio recording (PCM audio mode)

Recording location

The PCM audio signal recording is carried out on tape areas located on the video track by using helical-scan rotary heads.

Since the recording area for longitudinal audio CH-1 is also allocated for PCM recording, longitudinal audio recording can be performed only by one channel, or by CH-2.

Audio signal recording

PCM audio signal recording of two independent channels can be achieved on M2 video tape recorders. The recording of the PCM audio signal in each channel is performed by using each of the luminance and chrominance heads provided for video signal recording one track per field being allocated for each audio channel.

The recording is performed on the overlapped area on the tape produced by making the wrapping angle on the cylinder greater than 180° . The direct recording method of the time compressed digital modulation signal is employed for this purpose.

Figure 37 shows the block diagram of the PCM audio recording system.

5.6.1 Source coding

The source data comprises the audio data and the ID (identification) data.

5.6.1.1 Audio data specification

Number of channels:	Two channels (CH-5 and CH-6).
Reference level:	The input to give -20 dB full-scale at A/D converter (at 1 kHz) shall be the reference level.
Track allocation:	CH-5 shall be recorded by luminance head. CH-6 shall be recorded by chrominance head.
Stereo mode:	CH-5 for left channel. CH-6 for right channel.

5.6.1.2 Audio data coding

Sampling frequency:	48 kHz (synchronous with video signal)
Sampling order:	CH-5, CH-6 simultaneous.
Quantization:	16-bit linear.
Coding:	2 complement binary code.

5.6.1.3 ID data coding

Data capacity:	6 byte or 8 byte/field (525 line-60 field system). 24 byte/field (625 line-50 field system).
Coding:	NRZ.

5.6.1.4 Source data arrangement

The source data arrangement within one field period is shown by Figure 38 and Figure 39 for 525 line-60 field systems and Figure 40 for 625 line-50 field systems.

The 16 bit audio samples shown in Figure 38 and Figure 39 (525 line-60 field system) and Figure 40 (625 line-50 field system) are divided into each upper and lower 8 bit samples which are arranged in an order starting from suffix 0.

For 525 line-60 field systems, however, in this five field periodical constitution the data D_{800U} and D_{800L} are available in the fields between numbers 0 and 3; in number 4 field these data shall be replaced by ID6 and ID7.

5.6.1.5 ID data specification

The ID data region is open for the user, and its content is shown in Figure 41 for 525 line-60 field systems and Figure 42 for 625 line-50 field systems.

5.6.2 Signal processing

The 800 or 801 (525 line-60 field) and 960 (625 line-50 field) audio data samples per field are divided into 67 (525 line-60 field) and 81 (625 line-50 field) blocks, and the block sync signal (SYNC), block address signal (ADDRESS), block address error detecting code (CRCC) and the error correction code (ECC2 and ECC1) are added to each block. The signal format is shown in Figure 43 for 525 line-60 field systems and Figure 44 for 625 line-50 field systems, where the recording order for each data sample confirms to MSB first.

5.6.2.1 PCM signal construction

The PCM signal construction is shown in Figure 45.

Preamble area

Length: For 525 line-60 field systems, 1 horizontal line (63,5 µs).
For 625 line-50 field systems, 1,1 horizontal lines (70,4 µs).

Content: A single frequency signal of 5,0625 MHz.

Phase continuity to the front of the data block shall be established.

Postamble area

Length: For 525 line-60 field systems, 1 horizontal line (63,5 µs).
For 625 line-50 field systems, 1,1 horizontal lines (70,4 µs).

Content: A single frequency signal of 5,0625 MHz.

Phase continuity to the end of the data block shall be established.

SYNC: Specified in 5.6.2.4.

ADDRESS: Started from "00" by the sequential address for the identification of each 67 blocks (525 line-60 field) and 81 blocks (625 line-50 field).

CRCC: "CRCC" is used for ADDRESS error detection; this detected error pointer is referred to data error correction. The error detection method is based on the CRC method. The CRC code contains 8 bits and its generator polynomial $G1(x)$ is as follows:
 $G1(x) = x^2 + 1$ (preset all "1")

DATA: Data shall be arranged in the orders shown in Figure 38, Figure 39 and Figure 43 for 525 line-60 field systems and Figure 40 and Figure 44 for 625 line-50 field systems.

ECC2, ECC1: Specified in 5.6.2.2.

Transmission data rate: 11,57 Mbps per channel.

5.6.2.2 Error correction codes

The error detection and correction system shall be based on the Reed-Solomon code which contains the elements of Galois Field 2^8 , and its generator polynomial $G2(x)$ and primitive polynomial $G3(x)$ are given by:

$$G2(x) = \prod_{i=0}^3 (x - \alpha^i)$$

$$G3(x) = x^8 + x^4 + x^3 + x^2 + 1$$

The generation scheme of error correction codes ECC1 and ECC2 is shown by Figure 46 for 525 line-60 field systems and Figure 47 for 625 line-50 field systems.

5.6.2.3 Channel coding

The modulation shall conform to the 8-14 modulation method (see Table 10). This method is based on an algorithm where the DC component is minimized when the 8 bit data is converted to the 14 bit code. The data modulated by the 8-14 modulation method shall be further transformed by NRZI conversion before it is recorded.