
INTERNATIONAL STANDARD



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**Magnetic tape for instrumentation applications —
Standardization of analogue modes of recording**

Bande magnétique pour l'enregistrement de mesures — Normalisation des modes d'enregistrement analogique

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

International Standard ISO 3615 was drawn up by Technical Committee ISO/TC 97, *Computers and information processing*, and circulated to the Member Bodies in March 1975.

It has been approved by the Member Bodies of the following countries :

Australia	Italy	Turkey
Belgium	Japan	United Kingdom
Czechoslovakia	Poland	U.S.A.
France	Romania	U.S.S.R.
Germany	South Africa, Rep. of	Yugoslavia
Hungary	Switzerland	

No Member Body expressed disapproval of the document.

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ISO/TC 97/SC 12 is concerned with the preparation of International Standards in the field of magnetic tape for instrumentation applications. The programme of work envisages an inter-related series of International Standards concerning I) Reels, II) Unrecorded magnetic tape, III) Recorded magnetic tape and IV) Recording methods. This International Standard forms part of that series and should be read accordingly.

STANDARDS PUBLISHED AND IN PREPARATION

ISO/R 1858, *General purpose hubs and reels with 76 mm (3 in) centrehole, for magnetic tape used in interchange instrumentation applications.*

ISO 1859, *Information processing — Unrecorded magnetic tapes for interchange instrumentation applications — General dimensional requirements.*

ISO 1860, *Information processing — Precision reels for magnetic tape for interchange instrumentation applications.*

ISO 2690, *Unrecorded magnetic tapes for instrumentation applications — Physical properties and test methods.*

ISO 3413, *Information processing — Recorded magnetic tapes for interchange instrumentation applications — Standard tape speeds and track configurations.*

ISO . . . , *Interchange practices and test methods for unrecorded instrumentation magnetic tape.*

ISO . . . , *Interchange practices and test methods for recorded magnetic tape.*

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Magnetic tape for instrumentation applications — Standardization of analogue modes of recording

1 SCOPE AND FIELD OF APPLICATION

This International Standard provides for the standardization of analogue modes of recording on magnetic tape for instrumentation applications (Direct, Single-Carrier FM, and Multiple-Carrier FM Modes). It includes standards for record and reproduce set-up procedures, tape speed control and flutter compensation.

NOTE — This International Standard covers most of the requirements for commonly used recording modes, but may not guarantee that all interchange requirements for telemetry systems will be met. A more comprehensive International Standard covering additional telemetry interchange requirements is under development.

2 DIRECT RECORDING

2.1 Bandwidths

2.1.1 For the purposes of this International Standard, four bandwidths are designated, as follows :

- a) Low band : Signals having a minimum recorded wavelength on the tape of $15,2 \mu\text{m}$ ($600 \mu\text{in}$).
- b) Intermediate band : Signals having a minimum recorded wavelength on the tape of $6,1 \mu\text{m}$ ($240 \mu\text{in}$).

c) 1,5 Wide band : Signals having a minimum recorded wavelength on the tape of $2 \mu\text{m}$ ($80 \mu\text{in}$).

d) 2,0 Wide band : Signals having a minimum recorded wavelength of $1,5 \mu\text{m}$ ($60 \mu\text{in}$).

Interchange of recorded tapes between wide band machines and low or intermediate band machines is not recommended.

2.1.2 The frequency or pass band of direct recorded data as a function of tape speed is given in table 1.

In measuring this response, signals throughout the specified pass band are recorded at Normal Record Level (see 2.3.1) and the $\pm 3 \text{ dB}$ pass-band response is referenced to the reproduced output at the Record Level Set Frequency.

2.2 Bias

2.2.1 Frequency

The high frequency bias signal for low and intermediate band records shall have a wavelength on the tape less than $1,5 \mu\text{m}$ ($60 \mu\text{in}$).

For wide band recorders the bias frequency shall be greater than 3,4 times the highest direct record frequency for which the system is designed.

2.2.2 Current (see figure)

Record bias current for low and intermediate band recorders shall be adjusted for maximum reproduced output with a signal at the Record Bias Set Frequency (see table 1) and at a level 5 to 6 dB below Normal Record Level (see 2.3.1); it shall then be increased until an output level 3 dB below the maximum value is obtained.

For wide band recorders the bias current shall be adjusted for maximum reproduced output at a signal level 5 to 6 dB below Normal Record Level and then increased until an output level is obtained which is 1 dB below the maximum value for 1,5 wide band and 2 dB below the maximum value for 2,0 wide band.

2.3 Record characteristics

2.3.1 Normal Record Level is the level of recording at the Record Level Set Frequency (see table 1), which results in a

reproduced level from the tape having 1 % third-harmonic distortion after equalization and correction for allowable equalization variations.

2.3.2 A record characteristic is required which provides constant-signal flux on the tape for all frequencies in the pass band. To achieve this a constant record-head current versus frequency characteristic shall be provided, upon which is superimposed a compensation characteristic to correct for loss of record-head efficiency with frequency.

For the test described in the annex the difference in the response curves normalized to the 0,02 band edge frequency shall be no greater than the values given below :

Fraction of band edge frequency	dB difference
0,1	0,5
0,5	1,0
0,8	1,6
1,0	2,0

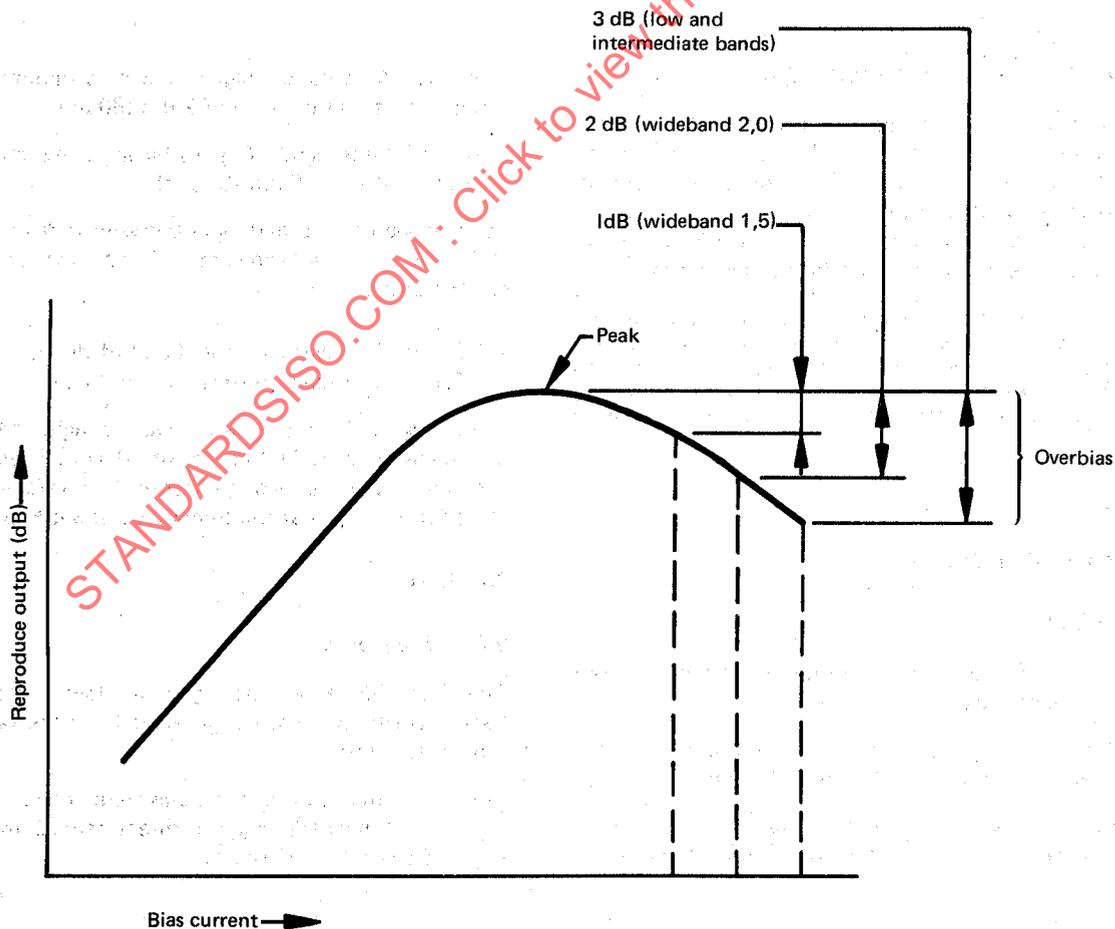


FIGURE – Standard bias current setting for direct record bias set frequency

3 SINGLE-CARRIER FM RECORDING

3.1 Bandwidths

3.1.1 For the purposes of this International Standard, four bandwidths are designated, as follows :

- a) Low band : Carriers at centre frequency having a nominal recorded wavelength on the tape of $28,2 \mu\text{m}$ ($1\,110 \mu\text{in}$).
- b) Intermediate band : Carriers at centre frequency having a nominal recorded wavelength on the tape of $14,1 \mu\text{m}$ ($555 \mu\text{in}$).
- c) Wide band group I : Carriers at centre frequency having a nominal recorded wavelength on the tape of $7,1 \mu\text{m}$ ($278 \mu\text{in}$).
- d) Wide band group II : Carriers at centre frequency having a nominal recorded wavelength on the tape of $3,4 \mu\text{m}$ ($133 \mu\text{in}$).

3.1.2 The FM carrier frequencies and data signal pass bands (modulating frequencies) as a function of tape speed are given in table 2.

3.2 Carrier deviations

3.2.1 For low band, intermediate band and wide band group I recording, the full-scale FM carrier deviation shall be $\pm 40 \%$.

For wide band group II recording, the full-scale FM carrier deviation shall be $\pm 30 \%$.

3.2.2 Increasing positive voltage shall give increasing frequency. However, telemetry predetection recordings have the reverse deviation direction because of the translation techniques employed. Care should therefore be exercised when interchanging predetection tapes with other wide band group II tapes.

3.3 Record characteristics

Single-carrier FM records may employ either direct recording or saturation recording techniques.

4 MULTIPLE-CARRIER FM RECORDING (FREQUENCY DIVISION MULTIPLEXING)

4.1 Subcarrier channels

Table 3 lists 29 FM proportional-bandwidth subcarrier channels. The channels identified with letters permit $\pm 15 \%$ subcarrier deviation rather than $\pm 7,5 \%$ deviation, but use the same centre frequencies as the eight highest numbered channels. The channels shall be used within the limits of maximum subcarrier deviation.

Table 4 lists 36 FM constant-bandwidth subcarrier channels. The letters A, B and C identify the channels for use with maximum subcarrier deviations of $\pm 2 \text{ kHz}$, $\pm 4 \text{ kHz}$ and $\pm 8 \text{ kHz}$ respectively, along with maximum frequency responses of 2 kHz , 4 kHz and 8 kHz respectively. The channels shall be used within the limits of maximum subcarrier deviation.

4.2 Subcarrier channel spacing

There is a ratio of approximately 1,33 to 1 between the centre frequencies of adjacent $\pm 7,5 \%$ proportional-bandwidth channels except between $14,5 \text{ kHz}$ and 22 kHz , where a larger gap is left to provide a 60 Hz amplitude-modulated 17 kHz carrier for tape speed control. (See 5.2.) The use of an additional FM subcarrier between $14,5 \text{ kHz}$ and 22 kHz is not permissible.

4.3 Record characteristics

Direct recording techniques must always be used for multiple-carrier FM recording.

5 TAPE SPEED CONTROL AND FLUTTER COMPENSATION

5.1 Types of control signal

Two types of sinusoidal speed-control signal are designated in this International Standard — Amplitude Modulated and Constant Amplitude — and either may be specified by a user.

Constant-amplitude signals may also be used for flutter compensation if required.

5.2 Amplitude-modulated speed-control signal

This shall have the following characteristics :

Carrier frequency	$17,0 \text{ kHz} \pm 0,5 \%$
Bandwidth required	$16,5 \text{ to } 17,5 \text{ kHz}$
Percentage modulation	$45 \text{ to } 55 \%$
Modulating frequency	$60 \text{ Hz} \pm 0,01 \%$

In single-carrier FM recording a separate track is always required for the speed-control signal.

In multiple-carrier FM recording the speed-control signal may be mixed with subcarriers on the same track. Proportional-Bandwidth Channel A or Constant-Bandwidth Channel 1A cannot be used on the same track as the speed-control signal because they may interfere with the control signal.

When recorded on a separate track, the amplitude-modulated speed-control signal shall be recorded at Normal Record Level. (See 2.3.1.)

5.3 Constant-amplitude speed-control signal

Table 5 lists constant-amplitude speed-control signal frequencies as a function of tape speed.

In single-carrier FM recording a separate track is always required for the speed control signal. In other types of recording, speed-control signals may be mixed with other signals if recording requirements so demand and system performance permits. Table 5 shows the guard band about each signal frequency which must be left free of other signals in order to give proper operation.

Mixing of the speed-control signal with certain types of signal may degrade system performance. When using high performance servo systems, signals higher than the control signal frequency should not be mixed with the control signal. The level of individual extraneous signals, including spurious harmonics and noise, must be 40 db or more below the level of the speed-control signal. For optimum servo speed correction, constant-amplitude speed-control signals should be on a separate track.

For use on the same track as multiple-carrier FM subcarriers, the criteria given in table 6 apply to the speed-control signal (reference frequency).

TABLE 1 — Direct-record parameters

Bandwidth	Tape speed		± 3 dB pass band	Record bias set frequency	Record level set frequency
	cm/s	in/s	kHz	kHz	kHz
Low band	304,8	120	0,1 to 200	200 ± 10 %	20,0 ± 10 %
	152,4	60	0,1 to 100	100 ± 10 %	10,0 ± 10 %
	76,2	30	0,1 to 50	50 ± 10 %	5,0 ± 10 %
	38,1	15	0,1 to 25	25 ± 10 %	2,5 ± 10 %
	19,05	7 1/2	0,1 to 12	12 ± 10 %	1,2 ± 10 %
	9,52	3 3/4	0,1 to 6	6 ± 10 %	0,6 ± 10 %
	4,76	1 7/8	0,1 to 3	3 ± 10 %	0,3 ± 10 %
	2,38	15/16	0,1 to 1,5	1,5 ± 10 %	0,15 ± 10 %
Intermediate band	304,8	120	0,3 to 500	500 ± 10 %	50,0 ± 10 %
	152,4	60	0,3 to 250	250 ± 10 %	25,0 ± 10 %
	76,2	30	0,2 to 125	125 ± 10 %	12,5 ± 10 %
	38,1	15	0,1 to 60	60 ± 10 %	6,0 ± 10 %
	19,05	7 1/2	0,1 to 30	30 ± 10 %	3,0 ± 10 %
	9,52	3 3/4	0,1 to 15	15 ± 10 %	1,5 ± 10 %
	4,76	1 7/8	0,1 to 7,5	7,5 ± 10 %	0,75 ± 10 %
	2,38	15/16	0,1 to 3,8	3,8 ± 10 %	0,38 ± 10 %
1,5 wide band	304,8	120	0,4 to 1 500	1 500 ± 10 %	150 ± 10 %
	152,4	60	0,4 to 750	750 ± 10 %	75 ± 10 %
	76,2	30	0,4 to 375	375 ± 10 %	37,5 ± 10 %
	38,1	15	0,4 to 187	187 ± 10 %	18,7 ± 10 %
	19,05	7 1/2	0,4 to 93	93 ± 10 %	9,3 ± 10 %
	9,52	3 3/4	0,4 to 46	46 ± 10 %	4,6 ± 10 %
	4,76	1 7/8	0,4 to 23	23 ± 10 %	2,3 ± 10 %
	2,38	15/16	0,4 to 11,5	11,5 ± 10 %	1,15 ± 10 %
2,0 wide band	304,8	120	0,4 to 2 000	2 000 ± 10 %	200 ± 10 %
	152,4	60	0,4 to 1 000	1 000 ± 10 %	100 ± 10 %
	76,2	30	0,4 to 500	500 ± 10 %	50 ± 10 %
	38,1	15	0,4 to 250	250 ± 10 %	25 ± 10 %
	19,05	7 1/2	0,4 to 125	125 ± 10 %	12,5 ± 10 %
	9,52	3 3/4	0,4 to 62,5	62,5 ± 10 %	6,25 ± 10 %
	4,76	1 7/8	0,4 to 31,25	31,2 ± 10 %	3,12 ± 10 %
	2,38	15/16	0,4 to 15,63	15,6 ± 10 %	1,56 ± 10 %

TABLE 2 – Single-carrier FM record parameters

a) Low, Intermediate and Wide band group I bands

Tape speed						Carrier deviation limits			Modulating frequency	Response at band limits
Low band		Intermediate band		Wide band group I		Carrier centre frequency	Carrier plus deviation	Carrier minus deviation		
cm/s	in/s	cm/s	in/s	cm/s	in/s	kHz	kHz	kHz	kHz	dB*
2,38	15/16					0,844	1,181	0,506	DC to 0,156	± 1
4,76	1 7/8	2,38	15/16			1,688	2,363	1,012	DC to 0,313	± 1
9,52	3 3/4	4,76	1 7/8	2,38	15/16	3,375	4,725	2,025	DC to 0,625	± 1
19,05	7 1/2	9,52	3 3/4	4,76	1 7/8	6,750	9,450	4,050	DC to 1,250	± 1
38,1	15	19,05	7 1/2	9,52	3 3/4	13,50	18,90	8,100	DC to 2,500	± 1
76,2	30	38,1	15	19,05	7 1/2	27,00	37,80	16,20	DC to 5,000	± 1
152,4	60	76,2	30	38,1	15	54,00	75,60	32,40	DC to 10,000	± 1
304,8	120	152,4	60	76,2	30	108,00	151,20	64,80	DC to 20,000	± 1
		304,8	120	152,4	60	216,00	302,40	129,60	DC to 40,000	± 1
				304,8	120	432,00	604,80	259,20	DC to 80,000	± 1

* Frequency response referred to 1 kHz output for FM channels 13,5 kHz and above, and 100 Hz for channels below 13,5 kHz.

b) Wide band group II bands

Tape speed		Carrier deviation limits			Modulating frequency	Response at band limits
		Carrier centre frequency	Carrier plus deviation	Carrier minus deviation		
cm/s	in/s	kHz	kHz	kHz	kHz	dB*
4,76	1 7/8	14,062	18,281	9,844	DC to 6,25	+ 1, - 3
9,52	3 3/4	28,125	36,562	19,688	DC to 12,50	+ 1, - 3
19,05	7 1/2	56,250	73,125	39,375	DC to 25,0	+ 1, - 3
38,1	15	112,50	146,25	78,75	DC to 50,0	+ 1, - 3
76,2	30	225,0	292,5	157,5	DC to 100,0	+ 1, - 3
152,4	60	450,0	585,0	315,0	DC to 200,0	+ 1, - 3
304,8	120	900,0	1 170,0	630,0	DC to 400,0	+ 1, - 3

* Frequency response referred to 1 kHz output.