A REVIEW OF GERMAN DIN STANDARDS ON SOUND RECORDING AND REPRODUCING WITH MAGNETIC TAPE

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The German Industrial Standards (DIN) prescribe most of the important mechanical and electrical characteristics of magnetic tape recording equipment, and the appropriate measuring methods. The thirteen pertinent standards which are reviewed might well serve as a guide for developing comparable standards in the USA.

1. INTRODUCTION

The precise definition of terms, methods of measurement, electrical and mechanical characteristics, and minimum performance requirements are important to both the designers and the users of sound recording equipment, in order that they be able to communicate with each other, and also so that the records, the medium (tape), and the equipment itself be interchangeable. This paper will review the German DIN Standards on Sound Recording and Reproducing that apply to Magnetic Tape Equipment,[1] to familiarize American readers with the scope and the more important details of the procedures used in Germany, since American standards do not exist in many of these areas, and since, even where American standards do exist, the German procedures often differ from those used in the USA. [The German Industrial Standards (DIN) are established by the German Standards Committee (DNA), a governmental body which formulates standards on all sorts of industrial products.]

The Table 1 is a numerical listing of the pertinent DIN Standards.[2,3] We hope to publish our translations of the complete standards at a later time.

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1. A complete review in German of these German Standards is given by F. Winckel (Ed.) in Technik der Magnetspeicher, (Springer-Verlag, Berlin, 1960). See especially the chapters by F. Krones, "Herstellung und elektro-akustiche Eigenschaften von Magnetbandspeichern für die Schallaufzeichnung" and H. Schiesser, "Die Normung in der Magnetspeichertechnik".

2. The DIN standards are available from the American Standards Association, 10 East 40th Street, New York 16, New York. All are available in German, and some are also available in very literal English translations.

3. The DNA (German Standards Committee) is continually in the process of adding new standards and revising old ones. Therefore, some of the standards shown in the table are approved, and some are only proposals. The dates shown are those of the standards which we obtained from the American Standards Association in October, 1961, and may not be the latest available.

TABLE 1

NUMERICAL LIST OF DIN STANDARDS ON
SOUND RECORDING AND REPRODUCING WITH MAGNETIC TAPE

DIN NUMBER	TITLE	DATE
45 503	Measurement of Nonlinear Distortion in Electroacoustics:	
	Part 1: Definitions, measurement, procedure, application, and weighting.	March, 1961
	Part 2: Harmonic method	March, 1960
	Part 3: Difference-tone method	March, 1960
	Part 4: Intermodulation method	March, 1960
45 405	Subjectively Weighted Noise Meter for Electroacoustic Transmission	Feb. 1960
45 507	Measuring Equipment for Frequency Variations ("Flutter"): Characteristics	Oct. 1956
45 507	Measuring Equipment for Frequency Variations ("Flutter") in Sound Recording Equipment: Instructions	Feb. 1961
45 510	Magnetic Recording Definitions	July, 1955
45 511	Magnetic Tape Recording and Reproducing Equipment: Specifications	March, 1955*
45 512	Magnetic Tapes:	
	Part 1: Mechanical Properties	March, 1955
	Part 2: Recording-performance Characteristics	Feb. 1959
45 513	DIN Standard Tapes	
	Part 1: Nr. 76 (for 30 ips)	Jan. 1959
	Part 2: Nr. 38 (for 15 ips)	Jan. 1959
	Part 3: Nr. 19 (for 7.5 ips)	June, 1955
	Part 4: Nr. 9 (for 3.75 ips)	June, 1955
	Part 5: Nr. 4.75 (for 1.87 ips)	Dec. 1960

TABLE 1 (Cont'd)

DIN NUMBER	TITLE	DATE
45 514	Magnetic Tape Equipment: Reels	May, 1955
45 515	Magnetic Tape Equipment: Hub	March, 1955
45 517	Magnetic Tape Equipment: "Disassemble-able" (NAB) Reel	
	Part 1: Hub, flange, screw, and nut	Jan. 1960
	Part 2: Adaptors	Jan. 1960
45 519	Measuring Methods for Tapes:	
	Part 1: Print-thru	Oct. 1955
	Part 2: Signal to dc-Noise Ratio	Oct. 1955
45 520	Magnetic Tape Equipment: Method for Measuring the Absolute Magnitude and the Frequency Response of the Remanent Magnetic Flux of Magnetic Recording Tape	Sept. 1957

* A rather extensive revision (1960) reached us too late for incorporation into this review.

For the sake of an organized review of the DIN Standards, the more important details will be discussed by topic, rather than by the particular standard from which they were drawn.

MECHANICAL CHARACTERISTICS

Let us first review the standards on mechanical characteristlstics. These are listed by topic in Table 2, for those who would like to refer to the original sources for more details.

TABLE 2

TOPICAL LIST OF DIN STANDARDS ON SOUND RECORDING AND REPRODUCING WITH MAGNETIC TAPE:

MECHANICAL CHARACTERISTICS

TOPIC		CONTENTS*	DIN NUMBER
TRANSPORT:	Speed	M	45 507
		P	45 511
	Speed variations ("flutter")	M	45 507
		P	45 511
	Track placement and direction	P	45 511
	Head azimuth alignment	P	45 513
TAPE:	Mechanical characteristics	P	45 512, Part 1
REELS:	Reel (small center hole)	P	45 514
	Hub	P	45 515
	Reel (large center hole: NAB)	P	45 517

* M - methods of measurement
P - performance characteristics, nominal and tolerances

Speed Classes

All magnetic tape recording equipment, and the tape itself, is classified into five Classes, according to the speed at which it is to be used. (Classes 30 and 15 are considered to be for studio equipment, and Classes 7.5, 3.75, and 1.87 for home equipment.) These Classes are shown in Table 3, along with the maximum permissible deviation in transport speed from the nominal value, measured during a one minute time interval.

Transport Speed Variations

The original standard (1956) provided for an unweighted measurement, using a test frequency of either 3 kc or 5 kc. The average speed error (i.e., deviation rates 0 to 0.5 cps) and direction were to be measured. Also, the peak value of the frequency variations (rates of 0.5 to 120 cps) was to be indicated, the maximum allowable values being as shown in Table 4.

TABLE 3

DIN CLASSES, CLASSES BY SPEEDS IN IPS, AND AVERAGE SPEED PERFORMANCE

DIN CLASS[1]	CLASS[2]	MAXIMUM SPEED DEVIATION, %
76	30	0.2
38	15	0.3
19	7.5	0.8
9	3.75	2.0
4.75	1.87	(not det'd.)

1. Corresponding to speed in cm/sec.
2. Corresponding to speed in inches/sec.

TABLE 4

FREQUENCY VARIATION PERFORMANCE

CLASS CLASS	MAXIMUM FREQUENCY VARIATION, %PEAK
30	±0.2
15	±0.3
7.5	±0.3
3.75	±0.5
1.87	(not det'd)

The newer standard (1961) specifies that a test frequency of 3.15 kc ± 2% be recorded, and its variation during reproduction be measured. Direction and amplitude of the average-speed error (0 to 0.2 cps) are to be indicated as one measurement. A weighted speed variation measurement is also made in order to indicate the subjective effect of the pitch variations produced thereby;[4] the weighting curve falls from a reference frequency of 4 cps, to -3 dB at approximately 1.3 and 13 cps, -10 dB at approximately 0.55 and 40 cps, and -20 dB at approximately 0.3 and 140 cps; a quasi-peak rectifier is used with specified indications for specified pulse lengths; and the peak value is indicated. Performance requirements by this method have not been published as yet.

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4. This method is similar in object to the "Flutter Index" method described by F. Comerci, "The Flutter Index Concept", J. Soc. Motion Picture and TV Engrs. 71, 1-8, (Jan. 1962).

2.3 Track Placement and Direction

For half track recordings, the tracks are placed so that, facing the coated side, track one is above, beginning at the left and ending at the right; track two is below, starting at the right, and ending at the left.[5] The only dimensional standard is that the distance of the inner edge of each erasing head gap be 6 to 10 mils from the center line of the tape.

For stereo (two track) recording, the tracks are placed so that, facing the coated side, the left channel is above and the right channel below, with the beginning of the tape to the left.[5] No dimensions are specified.

2.4 Head Azimuth Alignment

The Standard Tape contains a 60 second recording of a high frequency, to be used to align azimuth of the recording and reproducing heads. The angle between the centerline of the tape and this recording is 90° ± 3'. The frequencies for the different Classes are shown in Table 5.

TABLE 5

FREQUENCY OF AZIMUTH ALIGNMENT TONES

CLASS	FREQUENCY OF ALIGNMENT TONE[1]
30	10 kc
15	10 kc
7.5	8 kc
3.75	6 kc
1.87	6.3 kc

1. Frequency tolerance, ±5% except for Class 1.87, which is ±3%.

2.5 Tapes

Tape width is specified as 246 ± 2 mils, with a total thickness not to exceed 2.36 mils. Tensile strength, elongation, flexibility and inflammability are also specified. The backing of the tape must be marked over the entire length of the tape, identifying the manufacturer, tape type, and date or batch number. A leader must be attached to the beginning of each tape; the oxide-side mat, and the backing side glossy; the leader color also distinguishes tapes for Class 30 (non-colored leader) from tapes for the other Classes (green leader). A trailer must be attached to the end of each tape: oxide side mat, backing side glossy red. The mat sides of the leader and trailer are for identification of the record.

5. This is identical to the placement and direction used in the USA.

2.6 Reels

Plastic or metal reels are described, with 0.32" center holes, in seven sizes with maximum diameters from approximately 3 to 10 inches. The usual method of handling tape for professional recording purposes is on a hub without flanges. This hub is approximately 4 inches in diameter. The NAB-style reel is also recognized, along with adaptors for using it on transports designed for the hub previously mentioned.

3. ELECTRICAL AND MAGNETIC CHARACTERISTICS

A magnetic tape recorder converts incoming electrical signals into a magnetic pattern on a piece of tape; then the reproducer converts this magnetic pattern back into an electrical signal. Since most persons designing and servicing magnetic recorders have electrical measuring equipment, but do not have magnetic measuring equipment; and since the electromagnetic transduction sensitivities of magnetic recording and reproducing heads are not usually known, it is usual for some laboratory which is equipped to make accurate and precise magnetic measurements to produce "test tapes" or "Standard Tapes". These contain known magnetic quantities: a Reference Level Recording, and a recording with a known frequency response, for adjusting the reproducing system to a known characteristic. Then, with the aid of the calibrated reproducing system and the Reference Medium (another section of the "Standard Tape") the levels and frequency response of the recording system are adjusted. The Reference Medium is also used as a reference against which to compare other tape samples, as we will see later.

Table 6 is a topical list of the Standards on electrical and magnetic characteristics.

3.1 Establishing a Magnetic Reference.

Methods are needed to measure the absolute magnitude and frequency response of the remanent flux; then a "Standard Tape" can be made with which the user adjusts his equipment.

3.1.1 The absolute value of the remanent flux may be measured in the laboratory by any of three methods:

a) Static method: While recording on a normal tape recorder using the usual operating bias current, a known value of dc is applied to the recording head, thereby recording a dc flux on the tape. The value of this remanent flux is then measured with a search coil and fluxmeter, or else by measuring the magnetic moment by suspending a piece of tape in a known uniform magnetic field and measuring its deflection.

This tape whose dc flux is now known may be used to calibrate a magnetometer with a gap (e.g., a flux sensitive reproducing head) which may be used in turn to measure unknown tape flux levels at long wavelengths, with the tape stationary.

b) Dynamic method: The procedure of (a) also tells us the sensitivity of the recording head and the tape: i.e., we know the remanent flux produced by a given recording current. Since the sensitivity of the recording head will certainly be the same for medium and low ac frequencies as it was for dc, we can now produce a tape recorded with a known ac flux level. This recording may be used in turn to calibrate a normal reproducing head; i.e. to find its sensitivity in milliVolts per milliMaxwell. Now this calibrated reproduce head may be used to measure the absolute

TABLE 6

TOPICAL LIST OF DIN STANDARDS ON SOUND RECORDING AND REPRODUCING WITH MAGNETIC TAPE:

ELECTRICAL AND MAGNETIC CHARACTERISTICS

TOPIC	CONTENTS*	DIN NUMBER
ESTABLISHING A MAGNETIC REFERENCE:		
Absolute magnitude of the remanent magnetic flux	M	45 520
Frequency response of the remanent magnetic flux	M	45 520
Standard Tapes	P	45 513
THE REPRODUCER:		
Output impedance, level, and connection	P	45 511
Frequency response	P	45 511
THE RECORDER:		
Input impedance, level, and connection	P	45 511
OVERALL PERFORMANCE:		
Frequency response	P	45 511
Maximum Recording Level	M	45 503
	P	45 511
Signal-to-noise ratio	M	45 405
	P	45 511
Crosstalk	P	45 511
RECORDING PERFORMANCE CHARACTERISTICS OF TAPE:		
Tabulation of recording-performance characteristics	M	45 512, Part 2
General conditions for measurement	M	45 512, Part 2
Biasing for maximum sensitivity	M	45 512, Part 2
Tape flux at Maximum Recording Level	M	45 512, Part 2
Sensitivity	M	45 512, Part 2
Current requirement for the Maximum Recording Level	M	45 512, Part 2
Frequency response	M	45 512, Part 1
Signal to dc-noise ratio	M	45 519, Part 2
Print-thru	M	45 519, Part 1
Maximum variations of tape flux	M	45 512, Part 1

* M - methods of measurement
P - performance characteristics, nominal and tolerances

flux level of an unknown recording. (The calibration of a reproduce head can also be performed in the field by using the Reference Level section of a DIN Standard Tape, since this Tape is recorded to a specified flux level.)

c) Direct method: This is the inverse of the "dynamic method" of (b). An ac recording to be measured is reproduced with an uncalibrated reproduce head, and the output voltage is noted. This recording is erased, and a new recording made (on the same piece of tape) so that the same output voltage is measured from the uncalibrated reproduce head. The ac current required in the record head to produce this recorded level is measured. Now the equivalent dc is applied to the recording head, and a recording of a dc flux is produced. The absolute value of the flux from this dc recording is measured as in (a); this flux is equal to the flux level on the originally unknown recording.

2 Frequency response of the remanent magnetic flux.

The frequency response of the remanent magnetic flux is measured with an "ideal magnetic repsoducing head", which is defined as one whose output is proportional to frequency when reproducing a recording of variable wavelength but constant remanent tape flux.

A practical head, on the other hand, has several losses, the most important of which are gap loss and eddy current loss. Gap loss is correctable (up to 5 dB) through the use of a formula, after determining the effective gap length through a measurement of the frequency of the null in the output when reproducing a sweep frequency tone. (Careful construction and testing of the heads is necessary to prevent poorly constructed gaps.) Eddy current loss is determined through the use of a conducting loop parallel to the reproduce gap: a constant current through the loop should produce an output proportional to frequency; the difference reprosents the eddy current loss to be corrected. At long wavelengths a variation in response (known here as "head bumps" or "contour effect") occurs due to the finite contact length of the reproducing head with the tape; this must also be taken into account.

A recording whose response is to be determined is reproduced with a practical head; the losses are corrected, as described above, in order to simulate an "ideal magnetic reproducing head". The corrected head output is then compared to a 6 dB/octave line: the difference is the frequency response of the remanent magnetic flux of the recording.

3.1.3 Standard Tapes

The DIN Standard Tapes are the practical user's "Magnetic Reference". They are full track recordings with the angle between the centerline of the tape and the recording being 90° ±3'. Each Standard Tape contains four sections: a section recorded with the "Reference Level", used for adjusting the reproduce system gain; a section recorded with a short wavelength, for reproducing and recording Head Azimuth Alignment; a "Frequency Response" section recorded with known remanent flux vs frequency, for adjusting the reproduce system frequency response; and an unrecorded section of "Reference Medium", for adjusting the recording system, and also as a comparison tape when testing other tapes.

a) The characteristics of the Reference Level Recording are described in Table 7: the frequencies (called the Reference Frequencies); the absolute flux levels (determined as described in Sec. 3.1.1); the maximum allowable total harmonic distortion (THD); and the minimum signal-to-noise ratio (S/N) determined by eliminating the fundamental tone and measuring the residual signal. The duration of the Reference Level section is 30 seconds in all cases.

TABLE 7

REFERENCE LEVEL RECORDING OF THE STANDARD TAPE

CLASS	FREQUENCY[1] (cps)	FLUX LEVEL[2] (rms)	THD %	S/N dB
30	1000	100 mM	1	35
15	1000	200 mM	1	35
7.5	333	160 mM	1	30
3.75	166	160 mM	1	25
1.87	333	25 mM/mm	2	--

1. Frequency tolerance is ± 0.3%.
2. Flux level tolerance is ± 5%; this includes variations over the length of the recording. The values are in milliMaxwells for the entire width of the tape (6.25 mm = 0.246 inch) except for the Class 1.87 tape, which is specified in milliMaxwells per millimeter of track width.

b) Head Azimuth Alignment. The frequencies, angle, and duration of this section are described in Sec. 2.4. The level is 10 db below that of the Reference Level in all cases except for Class 1.87 which is 20 db below the Reference Level. The variation in level must be less than ± 1 dB during the length of the recording, except for Class 1.87, which must be less than ± 2 dB. An 8 second length of tone at this same level (-10 dB except for Class 1.87, which is -20 dB) and at the Reference Frequency (see (a) above) is also provided for use as a quick check on frequency response.

c) Frequency Response. The remanent magnetic flux is shown by graphs in the Standards. The remanent magnetic flux of all of the Standard Tapes except Class 1.87 is flat down to 30 cps, and falls at 6 dB/octave above the frequency shown in Table 8. (The corresponding time constant τ is also given in the Table.) The Class 1.87 Tape only has a 6 dB/octave boost at low frequencies, from 50 cps (τ = 3180 μsec.), and uses <u>two</u> high frequency droops of 6 dB/octave each.

The Frequency Response section is a series of discrete frequency tones, each of 8 seconds duration; the frequencies in cps are: Reference Frequency, 30 (or 31.5), 40, 60, 120 (or 125), 250, 500, 1000, 2000, 4000, 6000 (or 6300), 8000, 10,000, 12,000, 15,000, 18,000, and Reference Frequency again. The tolerance on frequency is ±3%. The maximum frequency used for the slower speed tapes is less than 18 kc, as shown in the Table. The level of the Frequency Response section is 20 dB below the Reference Level, except for Class 1.87 which is 30 dB below the Reference Level. The Table also shows the nominal level tolerance, and the maximum allowable variation throughout the duration of the tone on the Standard Tape.

TABLE 8

FREQUENCY RESPONSE SECTION OF STANDARD TAPE

CLASS	f^1 cps	τ^2 µsec	f_{max}^3 kc	NOMINAL LEVEL TOLERANCE, dB	MAXIMUM LEVEL VARIATION, dB
30	4550	35	18	±0.5 below 8 kc	±0.5 below 8 kc
15	4550	35		±1.0 above 10 kc	±1.0 above 10 kc
15	4550	35	18	±0.5 below 4 kc	±0.5 below 4 kc
				±1.0 above 6 kc	±1.0 above 6 kc
7.5	1590	100	12	--------- same as Class 15 ---------	
3.75	795	200	8	--------- same as Class 15 ---------	
1.87	2/2280	2/70	6.3	±1.0 below 2 kc	±1.0 below 4 kc
				±2.0 above 4 kc	±2.0 above 5 kc

1. f is the frequency at which the relative flux is -3 dB.
2. τ is the time constant equivalent to f above.
3. f_{max} is the highest test frequency appearing on the Standard Tape.

There is provision in the Standard for a frequency sweep tone, but it appears that this is gradually being eliminated.

d) Reference Medium. The Reference Medium section is an unrecorded piece of tape; its properties were not described in the earlier (circa 1955) Standards. Newer proposals (circa 1959) call for the bias current for maximum sensitivity, the recording current for Maximum Recording Level, and the Frequency Response to be within better than ±0.5 dB of those of a standard established by the government standards laboratory.

3.2 The Reproducer.

The output impedance, level, and connection of a tape reproducer must be specified, and also the frequency response when reproducing a Standard Tape.

3.2.1 Output impedance, level, and connection.

The maximum output impedances, the output voltages under load, and the output connections are shown in Table 9.

3.2.2 Reproducer frequency response.

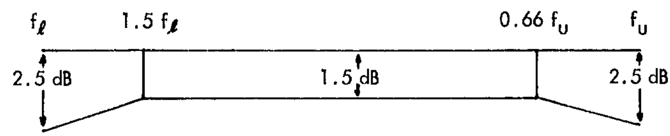
When reproducing the appropriate DIN Standard Tape, the frequency response of the reproducer must fall within the limits shown in Fig. 1.

TABLE 9

REPRODUCER OUTPUT IMPEDANCES, VOLTAGES, AND CONNECTIONS

CLASS	MAXIMUM OUTPUT IMPEDANCE, OHMS[1]	OUTPUT VOLTAGE VOLTS[2]	LOAD IMPEDANCE OHMS	CONNECTION
30 and 15	150	0.755	150	Balanced and
	600	1.55	600	ungrounded
7.5 and 3.75	100,000	0.25	500,000	*
1.87	*	*	*	*

* No recommendations
1. This is the maximum impedance over the entire bandwidth.
2. This is the minimum voltage, and is to be measured while reproducing the "Reference Level Recording" of the appropriate DIN Standard Tape. The "Maximum Recording Level" is approximately 6 dB above the "Reference Level Recording", and these output voltages will increase similarly when referred to the "Maximum Recording Level".



Class	f_ℓ	$1.5\ f_\ell$	$0.66\ f_u$	f_u
30 and 15	40	60	10,000	15,000
7.5	50	75	6,800	10,000
3.75	100	150	4,000	6,000
1.87		No recommendation		

Figure 1. Reproduce frequency response tolerance

3.3 The Recorder.

The input impedance, level, and connection of the recorder are shown in Table 10.

3.4 Overall Performance.

3.4.1 Overall frequency response.

The overall response of a recorder/reproducer is the frequency response as measured from the input of the recording amplifier to the output of the reproducing amplifier; it must fall within the limits shown in Fig. 2. The recording should be made at approximately 20 dB below the Reference Level.

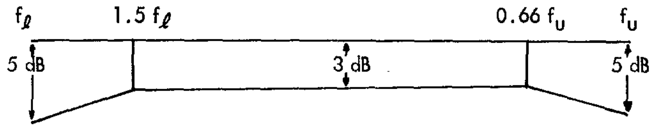
TABLE 10

RECORDER INPUT IMPEDANCES, LEVELS, AND CONNECTIONS

CLASS	MINIMUM INPUT IMPEDANCE, OHMS[1]	INPUT VOLTAGE[2]	CONNECTION
30 and 15	1,000	1.0V	Balanced and ungrounded
7.5 and 3.75	250,000	5 mV	*
1.87	*	*	*

* No recommendations.

1. This is the minimum impedance over the entire bandwidth.
2. This is the maximum voltage, to be measured while recording to the "Maximum Recording Level" at the "Reference Frequency".



Class	f_l	$1.5 f_l$	$0.66 f_u$	f_u
30 and 15	40	60	10,000	15,000
7.5	50	75	6,800	10,000
3.75	100	150	4,000	6,000
1.87	No recommendation			

Figure 2. Overall frequency response tolerance

3.4.2 Maximum Recording Level.

The "Maximum Recording Level" of a recorder is defined as that recording level on the "Reference Medium" section of the DIN Standard Tape, at a frequency of 333 cps, which results in a harmonic distortion of 3% for Classes 30 and 15; and 5% for Classes 7.5 and 3.75. (The "Maximum Recording Level" is used primarily as a reference for signal-to-noise and crosstalk measurements.)

3.4.3 Signal-to-background-noise ratio.

The "signal" reference for s/n measurements is the "Maximum Recording Level", as described in Sec. 3.4.2; this is approximately 6 dB above the "Reference Level Recording" of the Standard Tapes. The "background noise" is that measured when reproducing a tape previously recorded in the normal manner, except that the input of the recording amplifier is short-circuited. In addition to the usual unweighted s/n, a weighted value is determined by measuring the noise with a quasi-peak reading meter incorporating a frequency weighting network whose response corresponds to that of the ear; the response of the specified network is 0 dB at 1000 cps, falling to -30 dB at 70 cps; the response rises above 1 kc to +8.4 dB at 5 kc, then drops to 0 db at 9 kc and -10 db at 10 kc, and -21 db at 16 kc.

The Signal-to-Unweighted Background Noise must be 55 dB for Class 30, and 50 dB for Class 15; the Signal-to-Weighted Background Noise must be 65 dB for Class 30, and 60 dB for Class 15. There are no recommendations for the other Classes.

3.4.4 Crosstalk

On a multi-track tape, the Crosstalk Ratio is defined as the ratio of the reproduced voltage from a track which has been recorded to its Maximum Recording Level to that of an unrecorded adjacent track. For double track recording in opposite directions the Crosstalk Ratio must be at least 40 dB for all Classes. The Crosstalk Ratio for stereo recording has not been determined.

3.5 Recording-performance Characteristics of Tape

The recording-performance characteristics of tapes are determined relative to those of the "Reference Medium" section of the DIN Standard Tape. Table 11 indicates the properties to be determined, and the form of presentation of the data. The methods of measurement are described, but standards of performance are not specified.

TABLE 11

TABULATION OF RECORDING-PERFORMANCE CHARACTERISTICS
OF A MAGNETIC TAPE

Magnetic tape per DIN 45 512, for Class	________
Relative bias current for maximum sensitivity	________ dB
Relative tape flux at Maximum Recording Level	________ dB
Relative sensitivity	________ dB
Relative recording current required for Maximum Recording Level	________ dB
Relative frequency response	________ dB
Signal to dc-noise ratio	________ dB
Print-thru	________ dB
Maximum tape flux variations	________ dB

3.5.1 General conditions for measurement.

Tapes for Classes 30 and 15 are measured at 15 ips on a recorder/reproducer having a 1.1 mil recording head gap length, and 0.55 mil reproducing head gap length. A DIN Standard Tape 38 (15 ips) is used to set the reproducer response, which must be ± 1 dB of the Reference Frequency (1 kc) response over the entire band. The Overall Response with the Reference Medium section of this Standard Tape, at a level 20 dB below the Maximum Recording Level, must be adjusted to be zero dB at 1 kc and also at 10 kc.

Tapes for Classes 7.5, 3.75, and 1.87 are measured at 3.75 ips on a recorder/reproducer having recording and reproducing head gap lengths of 0.28 mil each. A DIN standard Tape 9 (3.75 ips) is used to set the reproducer response, which must be ± 1 dB of the

Reference Frequency (166 cps) response over the entire band. The Overall Response with the Reference Medium section of this Standard Tape, at a level 20 dB below the Maximum Recording Level, must be adjusted to be zero dB at 166 cps and also at 10 kc for Class 7.5 tapes, or at 5 kc for Classes 3.75 and 1.87 tapes.

The bias frequency should be 80 kc ± 10%. The bias current is adjusted for each test sample, to give the maximum sensitivity of the actual sample being measured: this is the "Reference Bias" for that sample. The pressure of the tape on the head face should be 1 ± 0.3 psi.

3.5.2 Bias current for maximum sensitivity

The bias current for maximum sensitivity at 1 kc (i_{br}) is the "Reference Bias" for a tape; it is determined for the test sample (i_{brT}) and for the Reference Medium (i_{brR}); the relative bias current is then their ratio, or 20 log (i_{brT}/i_{brR}), in dB.

3.5.3 Tape flux at Maximum Recording Level

The Maximum Recording Level for a tape is defined as the level at which the third harmonic distortion of the output voltage is 3% for Classes 30, 15, and 7.5; and 5% for Classes 3.75 and 1.87. This is measured at the Reference Frequency, using the sample's own Reference Bias. The output voltage for Maximum Recording Level (E_o) is measured for the test sample (E_{oT}) and the Reference Medium (E_{oR}), and the relative tape flux at Maximum Recording Level is then their ratio, or 20 log (E_{oT}/E_{oR}), in dB.

A measure of third harmonic distortion vs bias current, and of the compression of a specified high frequency tone when recorded at Maximum Recording Level, are suggested in the Standard as additional measurements to indicate the nonlinear characteristics of the test sample.

3.5.4 Sensitivity

The sensitivity of a tape is defined as the ratio of the reproduced output voltage to the recording current to produce this output voltage. The Reference Frequency is recorded at a level about 20 dB below the Maximum Recording Level, using the sample's own Reference Bias. The sensitivity of the test sample (s_T) and of the Reference Medium (s_R) are measured, and the relative sensitivity is then their ratio, or 20 log (s_T/s_R) in dB.

3.5.5 Recording current required for Maximum Recording Level.

The recording current required for Maximum Recording Level (i_o) of a tape is measured at the Reference Frequency using the sample's own Reference Bias. This is done for the test sample (i_{oT}) and for the Reference Medium (i_{oR}), and the relative recording current is then their ratio, or 20 log (i_{oT}/i_{oR}) in dB.

This is also approximately equal to the difference (in dB) of: (tape flux at Maximum Recording Level) - (relative sensitivity).

3.5.6 Frequency response

The frequency response of a tape is the ratio of the output voltage when recording the Reference Frequency (E_R) to the output voltage at a high measuring frequency (E_M). This measuring frequency is 10 kc for Classes 30, 15, and 7.5, and 5 kc for Classes 3.75 and 1.87. Tests are performed at a level 20 dB below the Maximum Recording Level, using the sample's own Reference Bias. Since the recorder was previously adjusted to have flat response when using the Reference Medium, the measurement with the test sample is directly relative to that of the Reference Medium. The relative frequency response is then the ratio of the responses at the two frequencies, or 20 log (E_M/E_R) in dB.

3.5.7 Modulation Noise: Signal to dc-noise ratio

"Modulation Noise" is that noise arising when the desired signal is modulated due imperfections of the recording process (e.g., imperfections of the recording medium, the recording head, or the contact between the recording medium and the recording head). It does not include the noise produced by frequency modulation, nor harmonic nor intermodulation distortion. The Modulation Noise is not easily measurable directly, but the dc-noise is readily measurable and it is indicative of the Modulation Noise. The signal to dc-noise ratio is absolute for a test sample, and <u>not</u> relative to the Reference Medium.

The "dc-noise" is obtained by reproducing a recording made with the sample's own Reference Bias and a dc signal in the recording head whose current is equal to the rms signal current required for Maximum Recording Level. The noise is measured with the quasi-peak voltmeter mentioned in Sec. 3.4.3, but without the frequency response weighting network. The dc-noise is to be measured for three two minute sections of the tape, one each at the beginning, middle, and end of the tape; the worst value is to be reported.

3.5.8 Print-thru

Print-thru of a tape is defined as the ratio of the reproduced voltage from a recording medium which has been recorded to its Maximum Recording Level, to that from an unrecorded portion of the same medium which has been magnetized by the adjacent part which was recorded to the Maximum Recording Level. This measurement is also absolute for a test sample, and <u>not</u> relative to the Reference Medium.

Print-thru is always measured at 1 kc and 15 ips. A single short test recording is made at the Maximum Recording Level, with the sample's own Reference Bias; the tape should be wound on a takeup reel at approximately an eight inch diameter. The duration of the test recording should be sufficient to last for just one turn of the takeup reel. The tape is then to be stored for 24 hours; raised temperatures, magnetic fields, mechanical stresses, etc., are to be avoided during this time.

The tape is then reproduced <u>without prior rewinding</u>, i.e., the takeup reel is used as the supply reel. The reproduced signal is measured through a bandpass filter with response of 950 to 1050 cps. The value of the print-thru is then the ratio of the recorded signal to the highest value of the "copied" signal.

3.5.9 Maximum tape flux variations

A ten minute recording is made at 1 kc, with the sample's own Reference Bias, and at a level 10 dB below the Maximum Recording Level. This signal is reproduced, and its level recorded with a graphic level recorder whose response is flat to about 1 or 2 cps. The maximum variation of the flux from its average value (in dB) is then the "maximum tape flux variation" of a tape.

4. SUMMARY AND CONCLUSIONS

The DIN Standards on sound recording and reproducing with magnetic tape specify the terminology and measuring methods for, and the performance levels required of, the various important mechanical and electrical characteristics of home and studio equipment. The Standard Tape (used for adjusting the tape reproducer) is specified; then the performance of the tape reproducer when reproducing the Standard Tape. The overall performance of a recorder/reproducer is specified, and the means for determining the characteristics of a tape sample.

This information should be of interest to anyone using recorded tapes made in Germany, or to anyone buying magnetic recording equipment or blank tapes from, or selling them to, Germany. More important, these comprehensive standards might well serve as a guide for developing standards of a comparable scope in the USA, since present US standards on magnetic tape recording are comparatively limited.

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