



**TAPE SPECIFICATIONS FOR IBM
ONE-HALF INCH TAPE DRIVES AT:
556 AND 800 BPI AND 3200 FCI**

May, 1970

Fourth Edition

This manual is a revision of, and supercedes A32-0006-2. This edition also obsoletes 570-0295-2, A32-0001-0, and all other tape specifications.

Specifications contained herein are subject to change without notice.

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This manual provides the specifications and requirements for magnetic tape to be used on IBM Tape Drives. The specifications are presented in two parts: General Information and Tape Properties Essential for IBM Tape Drive Use. The latter section covers minimum properties required for tape used on all IBM Tape Drives.

In the text, the term 24XX is used to mean all models of IBM 2401, 2402, 2403, 2404, 2415, and 2420 Tape Drives. Also used is 240X, which is defined as all models of the IBM 2401, 2402, 2403, and 2404 Tape Units.

I. GENERAL INFORMATION

This section contains information regarding compatibility, testing environment, and recording densities.

A. Compatibility Test

A tape total surface tested at 3200 fci must also operate at 800 bpi on seven- or nine-track drives and at 556 bpi on seven-track drives. A tape tested at 3200 fci for nine-track drives must also operate at 800 bpi on nine-track drives. A tape tested for 800 bpi for seven- or nine-track drives must also operate at 556 bpi on seven-track drives.

B. Conditioning Prior to Testing

Tapes will be conditioned by exposure to the testing environment for 24 hours prior to testing.

C. Testing Environment

All tests will be performed in a room held at $70^{\circ} + 10^{\circ}$, -5°F and 50 percent ± 10 percent RH, unless otherwise specified.

D. Recording Density

When testing, all recording densities, 556 bpi, and 800 bpi, and 3200 flux changes per inch will be held to a tolerance of ± 5 percent when measured with continuous tape motion.

II. TAPE PROPERTIES ESSENTIAL FOR IBM TAPE DRIVE USE

Section two contains those minimum properties deemed essential for a tape to satisfactorily operate on IBM Tape Drives. These specifications have been developed in the testing of magnetic tape and experience has demonstrated that the tape which meets these test specifications will usually perform satisfactorily on IBM Tape Drives.

Further testing experience may indicate revisions in these specifications and, as a consequence, they may be revised by IBM from time to time without notice.

A. Physical Properties

1. Tape Assemblies

Description – The tape assembly consists of a reel, tape, tape end retainer, write enable ring, and appropriately located reflective markers.

Requirement – The reel dimension must fall within the envelope defined by Table 1 and Figure 2. The write enable ring should conform to the dimensions specified in Figure 3. The winding tension and the size and location of the reflective markers received from the manufacturer should be those in Figure 1. The tape reel specified by Table 1 and Figure 2 must be an integral unit upon completion of fabrication.

2. Discontinuity

Definition – Any interruption in the tape such as that produced by splicing or perforations.

Requirement – There will be no discontinuities.

3. Width

Definition – The width of the tape measured at right angles to the edges.

Requirement – The width of the tape will be 0.498 inch ± 0.002 inch.

4. Thickness

Definition – The thickness of the different layers comprising the tape.

Requirement – The total thickness of the tape will be between 1.6 and 2.2 mils. Nominal base thickness will be 1.5 mils.

5. E Value

Definition – The radial distance by which the reel flanges extend beyond the outermost layer of tape.

Requirement – The E value will be greater than 1/8 inch. For drives using automatic loading cartridges, the E value must be greater than 1/4 inch, but no greater than 5/8 inch.

6. Surface Resistance

Definition – The electrical resistance of the coating.

Requirement – Between 5×10^5 and 5×10^8 ohms per square.

Procedure – Under 160 ± 16 grams tension, a length of 1/2 inch wide tape will be stretched across gold-plated electrodes, and the surface resistance will be determined by the current flow from a 500-volt potential. See also, ASTM D257 (American Society for Testing and Materials Manual).

7. Curvature

Definition – A longitudinal deviation from a straight line in the plane of the tape.

Requirement – The curvature will not exceed 1/8 inch within a 36-inch length of tape when a roll of tape is allowed to unroll and assume its natural curvature on a flat surface.

8. Secant Modulus (Elasticity)

Definition – The ratio of stress to strain at a specified point on the stress-strain curve.

Requirement – The secant modulus will be greater than 3.25×10^5 psi based on a 10-inch sample length, a 2 - 10 inch per minute crosshead speed, and the slope of the curve between 2.5 and 7.5 pounds load. Also, see ASTM D882 and ASTM D638.

9. Yield Strength

Definition – The first stress level on the stress-strain curve at which the slope of the curve becomes zero when tested on a machine with constant crosshead movement. A marked increase in strain occurs at this level without a stress increase.

Requirement – When tested according to ASTM D638, the yield strength will be a minimum of 10,000 psi.

10. Stress Relaxation

Definition – The time dependent change in stress resulting from the application of constant total strain.

Requirement – Using a five-pound initial load and a 10-inch sample length, the stress relaxation will be less than one pound after 15 minutes.

Procedure – At 0.5 inch per minute crosshead speed, apply total strain to a 10-inch long sample that results in a five-pound load. Maintain this strain for 15 minutes. Stress relaxation is the difference between the initial load and the load after fifteen minutes. See also, ASTM D674.

11. Stiffness

Definition – Ability of tape to resist bending.

Recommendation – Load scale reading should be between 14 and 32, measured at 20° angular deflection on a stiffness tester with a 0.005 inch-pounds moment and a 0.14-inch span length.

Procedure – Clamp a short piece of tape in the stiffness tester, allowing 1/8 inch of tape to overlap the bending plate. Perform test per ASTM D747, excluding limitations on thickness of sample. Take stiffness measurement at 20° , using a plot of angular deflection vs. load scale reading (corrected so that the maximum slope passes through zero).

12. Reel Moment of Inertia

Requirement – The reel moment of inertia complete with tape and write enable ring should not exceed 0.091 inch-pound sec^2 .

B. Drive Performance

1. Undesirable Characteristics

Certain tape characteristics can contribute to poor drive performance. These properties include cupping, poor edge conditions, excessive tape wear products, interlayer slippage, tendency for oxide coating to transfer to the back of the reel's next layer, as well as any tendency for tape constituents to separate and cause deposits leading to tape stick or inhibiting proper performance of other tapes. Tapes which exhibit these characteristics may not give satisfactory performance and may result in excessive errors.

2. Standardization

Section B relates to testing and measurements performed on appropriate models of IBM 24XX or 729 series tape transports. Individual transports should be adjusted to their engineering specification. Signal level should be adjusted using the IBM Standard Signal Level Tape, part 461108A, and all amplitude comparisons will be referenced to this tape.

3. Signal Level

Definition – The average of all peak pulse amplitudes (without regard for polarity) over any one inch of tape throughout the length of the tape.

Requirements – Tape tested for use at 556 bpi will have an average signal level within ± 10 percent of that of the IBM Standard Signal Level Tape, part 461108A, when compared at 556 bpi.

Tape tested for use at 800 bpi will have an average signal level within ± 10 percent of that of the IBM Standard Signal Level Tape, part 461108A, when compared at 556 bpi and 800 bpi respectively.

Tape tested for use at 3200 fci will have an average signal level within +25 percent, –10 percent of that of the IBM Standard Signal Level Tape, part 461108A, when compared at 3200 fci. This tape also will have an average Signal Level within ± 10 percent of the IBM Standard Signal Level Tape when compared at 556 bpi or 800 bpi.

An interchange tape may have an average signal level of +50 percent, –20 percent of that of the IBM Standard Signal Level Tape, when compared at 3200 fci on the drive receiving the interchange tape. Tapes within the preceding tolerances will operate reliably on IBM drives.

Due to the equipment differences (such as in the write systems, components, tape speeds and forward-backward ratios), exchange tapes exceeding the tolerance specified in the preceding paragraphs cannot be assured of working reliably.

4. Signal Quality

Definition – The consistency of the peak amplitudes of individual read pulses.

The following requirements must be met:

- (a) For tape tested for use at 556 bpi, no read pulse will have a peak amplitude less than 50 percent of the signal level of the IBM Standard Signal Level Tape, part 461108A, when compared at 556 bpi.
- (b) For tape tested for use at 800 bpi, no read pulse will have a peak amplitude less than 50 percent of the signal level of the IBM Standard Signal Level Tape, part 461108A, when compared at 800 bpi.
- (c) For tape tested for use at 3200 fci, no two successive read pulses will have peak amplitudes less than 35 percent of the signal level of the IBM Standard Signal Level Tape, part 461108A, when compared at 3200 fci.

5. Start Time

Definition – The average time required for the tape to initially reach 90 percent of nominal velocity from go after a five-second go down time.

Requirement – To be tested, tape must accelerate at 90 percent of final speed on a clean IBM 240X series Model 3 or 6 Drive within 3.3 milliseconds, and be within ± 10 percent of final speed after five milliseconds.

To be tested, tape must accelerate to 90 percent on a clean IBM 240X series Model 1 or 4 Drive within 4.0 milliseconds, and be within ± 10 percent of final speed after 15 milliseconds. Drives used in this test will have start times adjusted with used (10 to 100 passes) IBM Series/500 Tape or Dynexcel.

6. Noise

Definition – The spurious signals in a tape written at 800 bpi after erasure with a magnetic field of a uniform intensity of 1000 oersteds.

Requirements – The average peak pulse output (without respect to polarity) will be less than 4 percent of the signal level at 3200 fci of the IBM Standard Signal Level Tape, part 461108A, and no individual noise pulse will have a peak amplitude that exceeds 10 percent of this signal level.

7. Phase Shift

Definition – A pulse time displacement that occurs at the transition from a low density recorded signal to a higher density, or from a high density signal to a lower density.

Requirement – The phase shift will not exceed 400 nanoseconds of a 2.8 microsecond flux change period.

Procedure – Using an IBM 240X Model 6, write a repetitive phase-encoded pattern 0, 0, 0, 1. Measure pulse time displacement at the frequency transition region. Test is to be performed in a read while write mode with continuous tape motion.

8. Wear of Transport

Definition – The tendency of the tape to wear the tape transport is measured by head wear.

Recommendation * – Head wear will not exceed 800 microinches after 1000 full reel passes (see test procedure). The rate of wear will not exceed 26 microinches per 100 passes after the first 800 passes.

Test Procedure – Take a profile trace of a new head mounted on head and guide assembly, IBM part 2514548 or 2507452,** using a Taylor Hobson Model 4 Talysurf, or equivalent. Take the profile at both the read and write gaps. Mount the head assembly on an IBM 240X series Model 6 Tape Drive,*** and cycle the tape under test for 200 full reel (2400 feet) passes cleaning at the end of each 50 passes. At the completion of the 200 passes, take another profile trace and determine the depth of wear at the deepest point of each gap. The deeper of the two measurements is the criterion measurement. Using the same head with four additional tapes, clean the transport and repeat this procedure, giving a total of 1000 passes.

9. Dynamic Skew

Definition – Using the standard recording procedure, the time variation between the two outside track read signals during the writing process.

Requirement – The time variation between the two outside track read signals will not exceed 2.0 microseconds. This test is referenced to the seven-track NRZI Read/Write Standard at a density of 800 bpi and a tape speed of 112.5 ips.

* This recommendation becomes a requirement for tape to be used on IBM 240X series Model 6 and IBM 2420 Model 7 Tape Drives.

** 2514548 – This assembly contains a head that meets the complete specifications.

2507452 – This part number is assembled with a head that meets the mechanical specification.

*** An IBM 729 Model 4 or 6 or 240X Model 3 Tape Drive may be substituted using IBM part 2514548 or 2507452.

C. Safety and Environmental Requirements

1. Toxicity

Definition – The ability of any tape component to cause bodily harm by contact, inhalation, or ingestion during the normal use of the tape.

Requirement – There will be no toxic hazard.

2. Flammability

Definition – The behavior of the tape after exposure to flame.

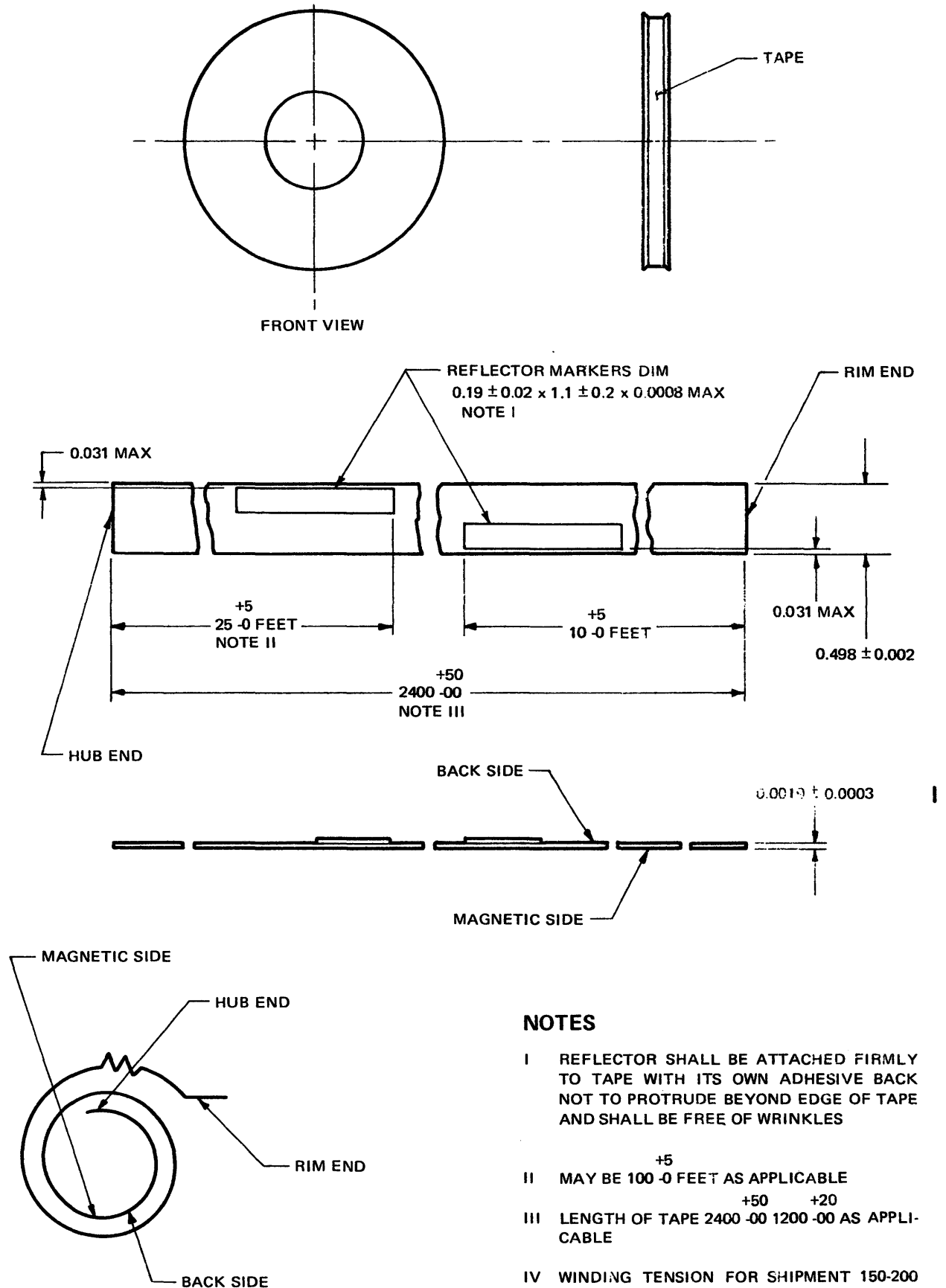
Requirement – The tape must be self-extinguishing in a still carbon dioxide atmosphere.

3. Operating Environment

The operating environment will be 60^o to 90^oF and 20 percent to 80 percent RH, with a maximum wet bulb temperature of 78^oF.

4. Shipping and Storage Requirements

During shipping and storage, the tape may be exposed to conditions outside the operating environment. These conditions must not damage nor destroy the tape properties and performance previously specified.



● Figure 1. Tape/Reel ASM
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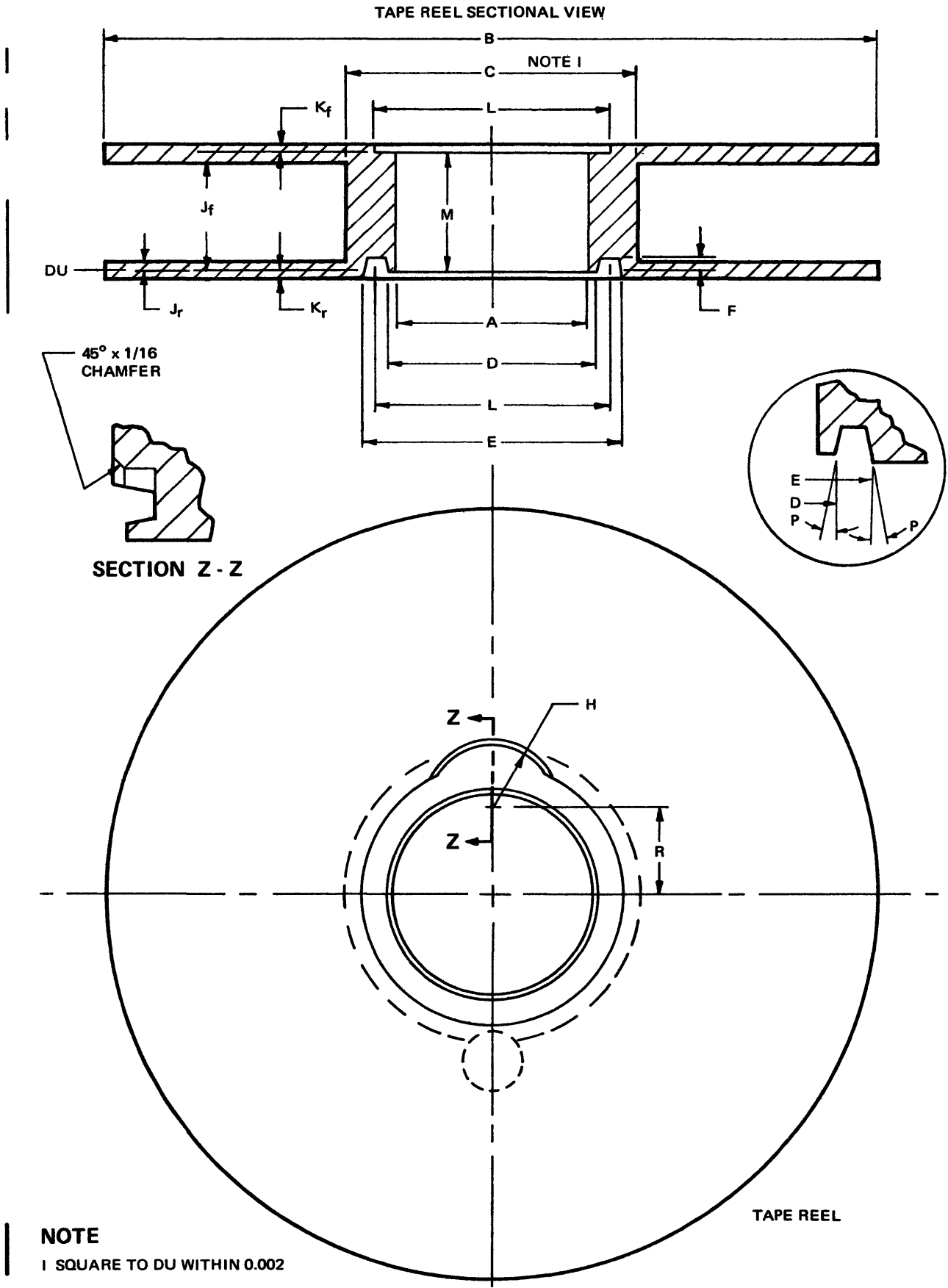
TABLE I

Dimension	Nominal (in inches except where otherwise noted)	Tolerance (in inches except where otherwise noted)
A	3.688	+0.005 -0.003
B	10.500	±0.020
C	5.125	±0.005
D	3.875	±0.005
E	4.388	±0.005
F	0.250	+0.010 -0.000
H	0.750	±0.015
J _f	0.622	+0.025 -0.005
J _r	0.097	+0.005 -0.025
K _f	0.125	Maximum
K _r	0.080	Maximum
L	4.125	Minimum
M	0.718	±0.005
P	4 degrees	±15 minutes of arc
R	1.677	±0.010

2420 WRAPAROUND CARTRIDGE

The differences and additions between Table 1, Figure 2, and a reel that will work in an IBM 2420 system when the wraparound cartridge is used, are included below.

1. Diameter B = 10.500 ^{+0.010}/_{-0.030} inches.
2. There will be a minimum radius of 0.035 inches on the inside edge of the outer extremity of the flange.
3. The outside cylinder surface of the hub will be concentric with the center bore within 0.010 inches.
4. Reference is made to Section II-A-5 (E Value) which is a requirement for use with the cartridge.



NOTE

I SQUARE TO DU WITHIN 0.002

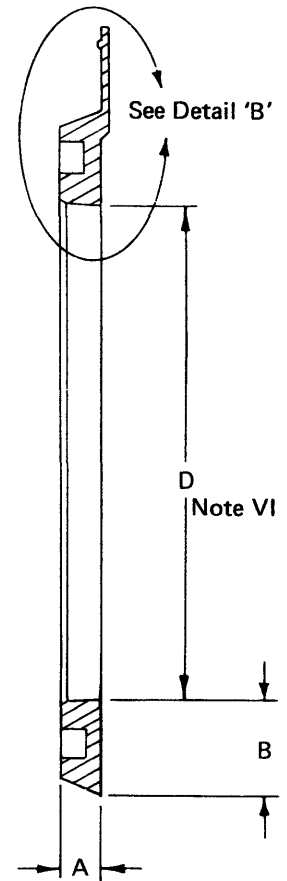
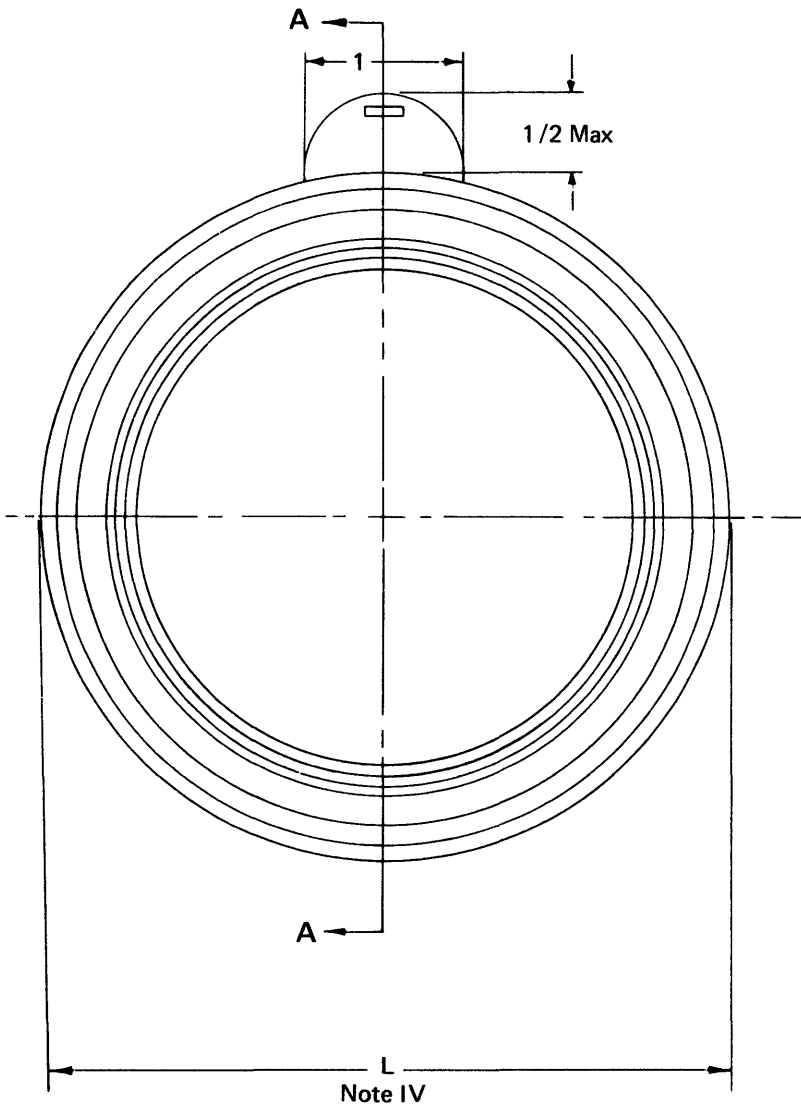
● Figure 2. Sectional View
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TABLE II

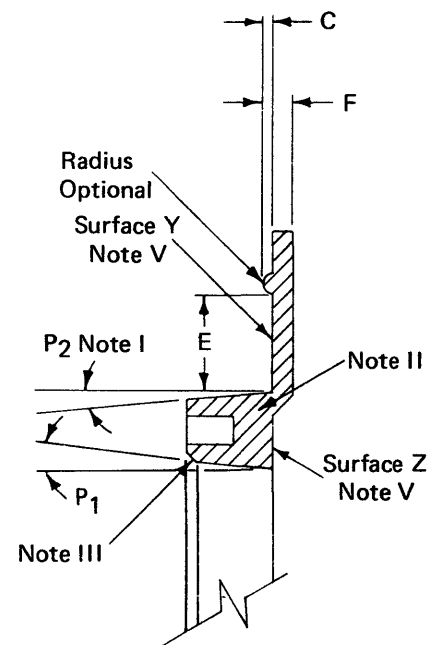
Dimension	Inches (except where otherwise noted)
A	0.235 +0.000 -0.020
B	0.230 ±0.010
C	0.040 maximum
E	0.300 minimum
F	0.060 maximum
L	4.360 maximum
P ₁	4 ±1 degree
P ₂	3 degrees minimum

WRITE-ENABLE RING

1. When installed on a standard reel, the top surface of the write-enable ring must be such that it does not protrude above the lateral mounting surface as defined by dimension L in Figure 2.
2. All rings must have a tab to facilitate removal from the groove. The shape and size of the tab are optional within the limits specified.
3. The D dimension, cross section and material used must be such that the ring may be installed and removed with reasonable effort and remain seated during normal use.
4. Dimensions and tolerances are given in Table II.



SECTION A-A



DETAIL 'B'

NOTES

- I Angle must be such that O.D. of ring does not interfere with ring groove when ring is installed.
- II Cross section optional within dimensions specified.
- III Edge relief optional: 1/32 x 45° chamfer, or 1/16 R.
- IV 'L' dimension is measured with ring installed in a standard reel.
- V The surface 'Y' must not be recessed below the plane of surface 'Z'.
- VI For 'D' see Table II, number 3.

● Figure 3. Write-Enable Ring
Revised 13MAY70

GA32-0006-3

Tape Specifications for IBM One-Half Inch Tape
Drives at: 556 and 800 BPI and 3200 FCI

Printed in U.S.A. GA32-0006-3



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Data Processing Division
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