NASHUA CORPORATION
NASHUA, NEW HAMPSHIRE

SPECIFICATION MANUAL

NASHUA 4415 DD SINGLE DISC CARTRIDGE

July 20, 1971 (Rev.)

NASHUA CORPORATION
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NASHUA 4415 DD DISC CARTRIDGE SPECIFICATION

CONTENTS

I. GENERAL DESCRIPTION

Scope

These requirements describe the dimensional characteristics of the Nashua 4415 DD Disc Cartridge and the mechanical and electrical characteristics of a recording surface suitable for use in the IBM 2310 or equivalent disc drives. The Nashua 4415 DD Disc Cartridge is a high speed, removable, interchangeable disc storage unit. The unit consists of a single recording disc, both surfaces of which can be used for data recording.

Under control of the using system, the 4415 DD can provide a sector structure that allows any number of sectors of data to be recorded on each track.

Shipping packages for disc cartridges provide adequate protection to ensure that no physical damage will occur to the cartridge. Nashua's shipping package specification is that no damage to the disc cartridge shall occur if a shipping package, containing a disc cartridge, is dropped from a height of less than four feet.

Disc Cartridge Assembly

The disc cartridge assembly consists of the following (Figure 1):

- Cartridge shell, upper and lower halves
- Spring-loaded retainer
- Clamp ring
- Seal
- Recording disc
- Disc adapter
- Sector ring
- Armature plate
- Air valve

The disc cartridge weight is approximately 4.5 pounds.

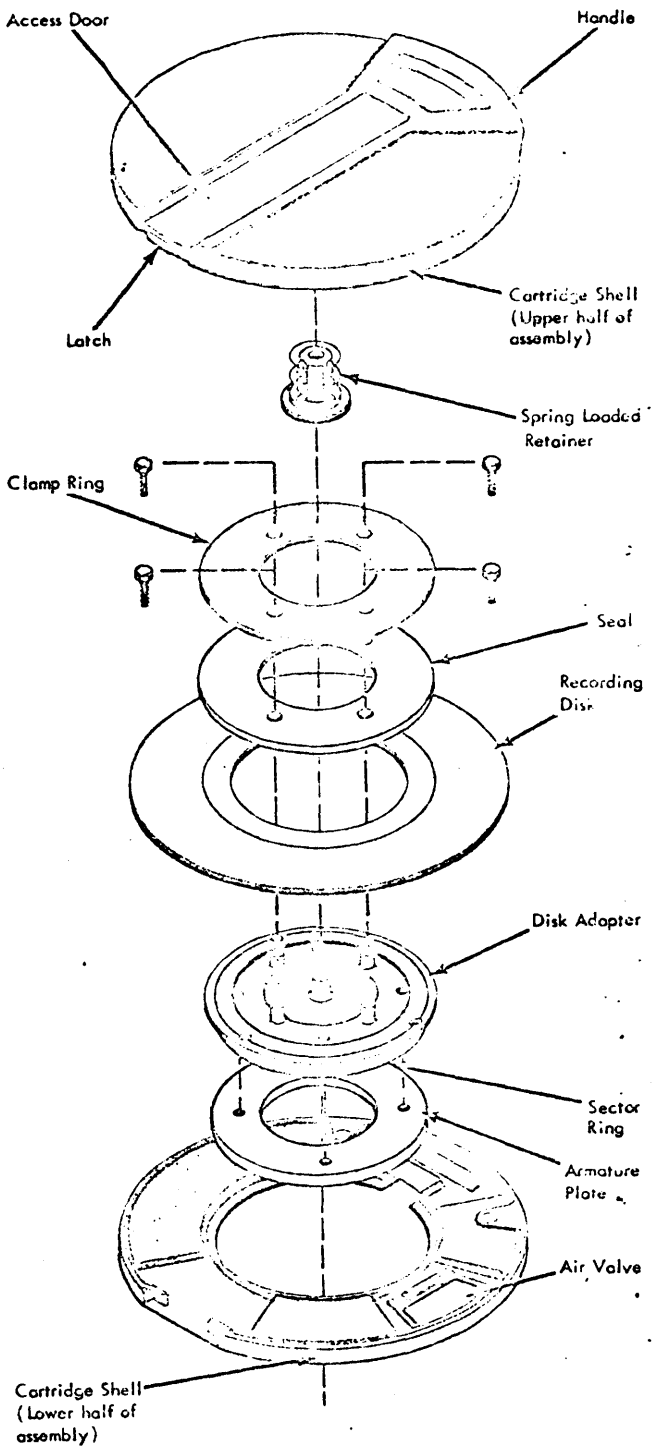


Figure 1. Disk Cartridge Assembly

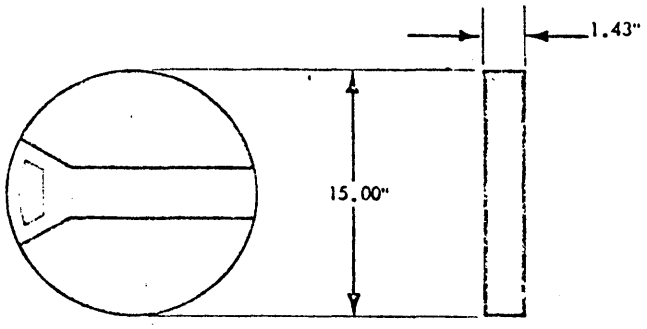


Figure 2. External Measurements

The materials and construction of the Disc Cartridge shall be compatible for normal temperature variations. Aluminum is used throughout the construction of the disc assembly except for the armature plate, which is steel. This construction is compatible with the operating temperatures of the aforementioned disc drives. The construction must also minimize particle generation that could cause head or disc damage.

The force exerted by the clamping ring shall be sufficient to prevent shifting between the recording disc and the disc adapter. The access door is unlatched and opened automatically to allow the magnetic read/write heads to enter the cartridge as the cartridge is inserted into the disc drive. The spring-loaded retainer depresses the disc adapter when the cartridge is removed from the disc drive to prevent contact between the recording surface and the cartridge housing.

The air valve located on the bottom side of the cartridge allows air to enter and circulate within the cartridge. The air circulating within the cartridge helps to prevent contaminants from entering through the access door. Disc surfaces shall be free of any contaminants that could cause head-to-disc interference.

The foam rubber seal is to prevent contaminants from entering the cartridge through the disc adapter assembly. Cleaner for the discs should be 91% isopropyl (9% water) alcohol gently applied with a soft, non-linting swab.

DIMENSIONAL INFORMATION

Disk Drive Spindle

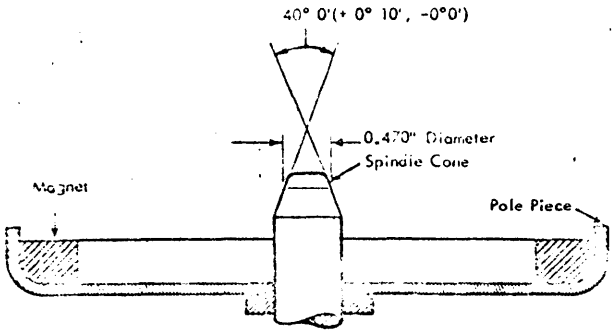
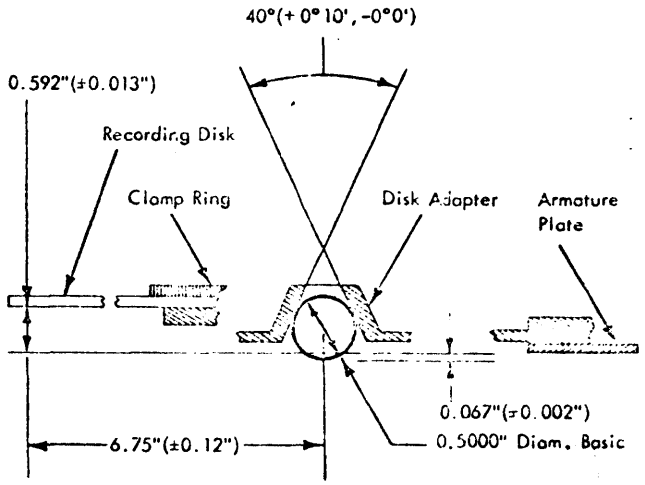
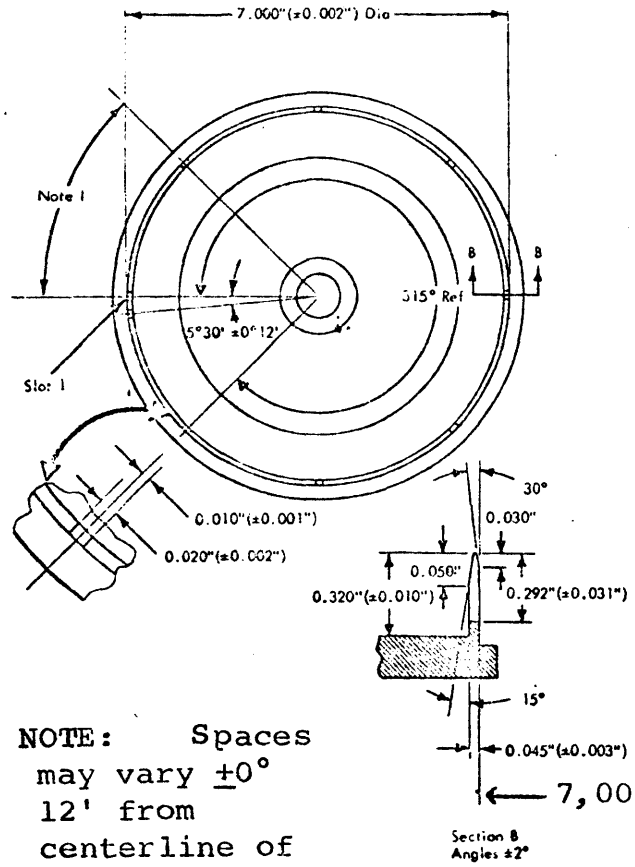


Figure 3. Disk Drive Spindle Dimensions



Note: A maximum axial runout of 0.013 inches TIR, measured at a radius of 6.75 inches (± 0.12 inches), is permitted when the disk is rotated at 10 rpm (± 5 rpm).

Figure 5. Armature Plate



NOTE: Spaces may vary ±0° 12' from centerline of slot 1)

Figure 4. Hub & Sector Ring

Disk

Recording Disk Size

The outside diameter of the recording disk is 14.025 inches (±0.005 inches). The thickness of the finished disk is 0.050 inches (±0.001 inches).

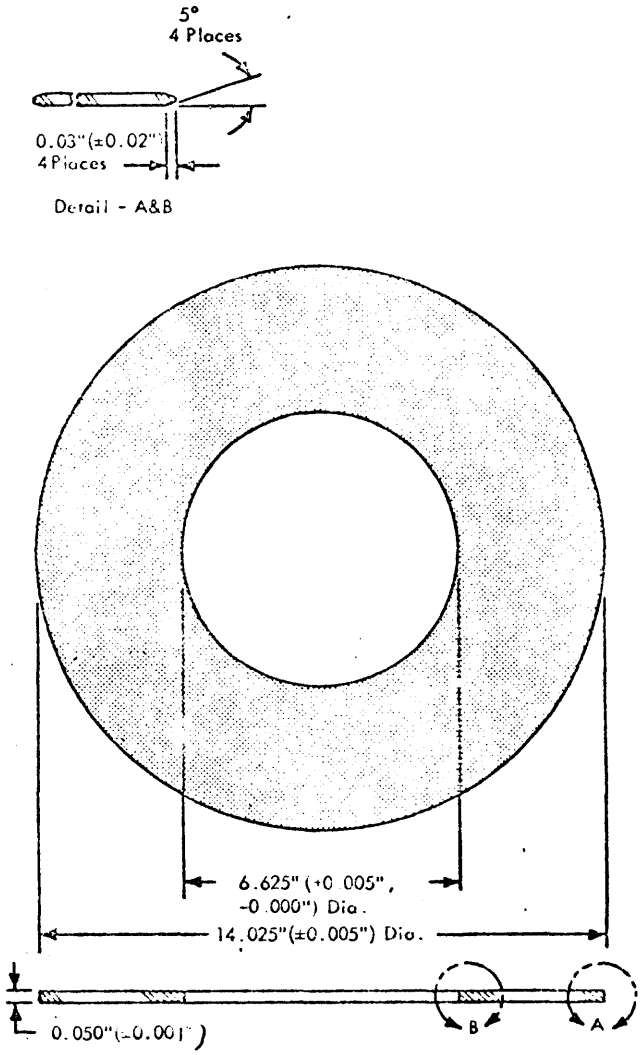


Fig. 6 - Recording Disc

1. GENERAL REQUIREMENTS

1.1 Operation and Storage Environment

1.1.1 Operation

The operation temperature shall range from -40°F to 150°F at a relative humidity of 8% to 80%. The wet bulb reading shall not exceed 85°F. Before a cartridge is placed into operation, it shall be conditioned within the covers for a minimum of 24 hours in the same environment in which the disc drive is operating.

1.1.2 Storage

Recorded and Unrecorded: the storage temperature shall lie within the range -40°F to 150°F, the wet bulb reading not exceeding 85°F.

The disc cartridge shall be able to withstand a relative humidity of 8% to 80%. The stray magnetic field intensity shall not exceed 50 gauss.

1.1.3 Test Conditions

Unless otherwise stated, measurements shall be carried out at 73 $\pm$ 5°F, 50% $\pm$ 10% R.H. after 24 hours of acclimatization.

1.2 Shock and Vibration

The disc cartridge shall withstand exposure to shock and/or vibration and still meet all dimensional and functional requirements of this specification.

1.3 Materials

Unless otherwise stated, the disc cartridge may be constructed from any suitable material so long as the dimentional, inertial and other functional requirements of this Standard are maintained.

2. DIMENSIONAL CHARACTERISTICS

The dimensional characteristics are indicated with regard to Figure 2-5.

Fig. 2 shows an upright projection of the whole cartridge.

Fig. 3 shows the disc drive spindle dimensions.

Fig. 4 shows disc hub with sector ring.

Fig. 5 shows the armature plate.

2.1 General External Dimensions

2.1.1 External diameter (Fig. 2)
The external diameter is equal to the outside diameter of the top cover

$$d = 15.00"$$

2.1.2 External height (Fig. 2)
The external height is

$$h = 1.43"$$

2.2 Disc (Fig. 6)

2.2.1 Diameter
The diameter of the disc is

$$d = 14.025" (\pm 0.005")$$

2.2.2 Thickness
The thickness of the disc is

$$t = 0.050" (\pm 0.001")$$

2.2.3 Disc Edge Chamfer: The recording discs' inner and outer edges may be chamfered as shown in Figure 6 or they may have any functionally acceptable geometry, such as parabola or ellipse, as long as the profile of the edge remains within the chamfered area in Figure 6.

2.3 Armature Plate

2.3.1 Diameter

The diameter of the armature plate is

$$d = 5.740 \begin{matrix} +.010 \\ -.000 \end{matrix}$$

2.3.2 Thickness

The thickness of the armature plate is

$$t = .092 \pm .001$$

2.3.3 Index Slot

2.3.3.1 Number

The number of index slots can be varied to requirement. Standard configuration calls for 8 sectors.

2.3.3.2 Width

The width of the index slot is

$$w = .020 \pm .002$$

2.4 Disc/Disc Hub Relationship

2.4.1 Disc height over armature plate

The height of the lower surface of the disc above the lower surface of the armature plate is

$$h = \begin{matrix} .594 \pm .002 \text{ at the Hub} \pm .10 \\ .594 \pm .011 \text{ at the } 6.75 \pm .10 \text{ radius} \end{matrix}$$

2.4.2 Axial runout of the disc (see Fig. 5)

The axial runout of the recording disc at the outer radius shall not exceed:

0.013" TIR

2.4.3 Acceleration of axial runout

The acceleration of the disc surface in axial direction shall not exceed 6.000 in/sec^2 at 2400 RPM.

2.4.4 Radial runout of discs

The total indicated radial runout is

0.002" max.

2.4.5 Angular shift between the disc and the disc hub

The angular shift between the disc and the disc hub must remain equal to zero under all conditions of use.

2.5 Drive Spindle/Disc Hub Relationship

The drive spindle is defined in Figures 3 and 5. The recording disc assembly, when installed in the disc drives, rotates counterclockwise. The maximum allowance for radial track registration error caused by a misfit between the disc assembly and spindle is 0.0005 inch. To allow clearance when the disc cartridge is installed in the disc drive, the maximum diameter of the disc cartridge is 15.00 inches and the maximum height of the cartridge is 1.43 inches.

2.6 Head Gliding Requirements

When the disc cartridge is installed in the disc drive, all recording surfaces must be free of surface irregularities or protrusions that could cause head-to-disc interference when the read/write heads are flown at a spacing of 35 to 40 microinches on the inside track, and increasing proportionally to between 40 to 45 microinches at the outside track location.

2.7 Location of Magnetic Surface

The area of the magnetic coating extends from an inside diameter of 8.960 maximum to an outside diameter of 13.025" minimum.

3. PHYSICAL CHARACTERISTICS

3.1 Balance

The rotating parts of the disc cartridge are balanced within 0.14 ounce-inches in a single plane parallel to the disc surface. This plane is located .594 in. above the Reference Line.

3.2 Maximum Speed

The rotating parts of the disc cartridge are capable of rotating at a speed of 2400 revolutions per minute counterclockwise as seen from the top.

3.3 Locking Force

The disc adapter and recording disc assembly is held to the disc drive spindle by a magnetic force of 35.0 pounds (±5.0 lbs.) which is exerted by a magnet.

3.4 Operational Grounding

The disc cartridge provides a discharge path from the disc to the drive spindle through the hub mechanism.

3.5 Thermal Time Constant

Within the conditions specified the disc cartridge thermal time constant does not exceed 1 minute. The thermal time constant is the time required to reduce an initial temperature difference between the cartridge and the drive by 2/3.

3.6 Physical Characteristics of Magnetic Surface

3.6.1 Surface Roughness

The finished magnetic surface has a surface roughness less than 3.5 microinches arithmetic average, with a maximum deviation in height of 20 microinches from the average, when measured with a 0.0001 inch stylus and a 0.030 inch cut-off range.

3.6.2 Durability of Magnetic Surface

3.6.2.1 Chemical Resistance

Magnetic surface of recording discs are not adversely effected by 91% reagent grade isopropyl alcohol mixed with 9% distilled or deionized water by volume, when used for cleaning. A lint-free swab will be moistened with the isopropyl alcohol and rubbed lightly against the rotating disc surface for the purpose of removing foreign material from the surface. This isopropyl alcohol will be used sparingly so that it has completely evaporated within one minute after cleaning a surface. No adverse effects on the magnetic or mechanical properties, as defined in other sections of this document, shall result.

3.6.2.2 Coating Adhesion

The nature of the coating is such as to assure wear resistance under operation conditions and maintenance of adhesion and abrasive wear resistance.

3.6.2.3 Abrasive Wear Resistance

The coating will withstand operational wear.

3.6.2.4 Dynamic Wear Requirement
Disc cartridges provide recovery of previously recorded data after a minimum of 4000 head loadings when operated with IBM 2314 magnetic heads or equivalent.

1.0 ELECTRONIC REQUIREMENTS

1.1 Test Areas

1.1.1 Index
The index point of each track is the starting and ending point of the track. Its location is specified with respect to the leading edge of the index notch.

1.1.2 Data Area
For the purpose of testing, the data area is defined as that area after index notch and continuing to the next index notch.

1.2 Test Conditions

1.2.1 Electronic Test Conditions for Write and Read

1.2.1.1 Write Test Circuit
For writing and reading on the Standard Unrecorded Surface, the write driver is constructed as in Figure 7A.

1.2.1.2 Read Test Circuit
The read test circuit is constructed as in Figure 7A. The amplifier has a passband flat within 5% from 100 kHz to 2 mHz.

1.2.2 Recording Frequencies

1.2.2.1 1F Frequency: This bit rate is equivalent to 2.50 megatransitions per second.

1.2.2.2 2F Frequency: This bit rate is equivalent to 5.00 megatransitions per second.

1.2.3 DC Edge Erase: DC Edge erasure is used for all tests unless otherwise indicated.

1.2.4 Magnetic Recording: Unless otherwise specified, all write operations are preceded by a DC erase.

1.3 Test Head

1.3.1 Definition

The magnetic test head for both amplitude and data tests is equivalent to IBM 2316 data test head.

1.3.2 Head Calibration Factor (CH)

The disc calibration factor for any test head and its associated test equipment, when recording or reading back on any given track, is equal to the standard voltage output obtained and the calibration factor (CD), previously derived from that standard disc track, thus:

$$CH = \frac{\text{Standard Trach Voltage}}{\text{Actual Voltage X CD}}$$

CH = Test Head Calibration Factor

CD = Test Disc Calibration Factor

1.3.3 Resolution

The resolution ratio of the test head is defined as the ratio of the 2F/1F average read amplitudes at track 200 of the Standard Reference Surface. The resolution ratio is 40% to 60%.

1.3.4 Write Current (see Appendix A)

The write current at the 1F frequency is 35 MA zero to peak. This measurement is made on the outermost track (cylinder 000) of the disc. The write current waveform conforms to Fig. 7B. The DC current supplied to the write/read coil when erasing is the same as specified previously.

1.3.5 Head Loading Force

The net head loading force will be 350 grams ± 10 grams.

1.4 Standard Reference Surfaces

1.4.1 Definition

The Unrecorded Reference Surface is a disc and voltage value, at the 1F and 2F, selected by Nashua Corporation to comply with the IBM Standard data disc (P/N 2267720). The reference surface has a known 1F output at track 000, and a 2F output at track 200. Deviations from these defined values in actual measurements are incorporated into the CH of the test head being used.

1.5 Functional Testing

1.5.1 Track Quality Tests

1.5.1.1 Definition

The confirmed identification of marginal data to the nominal test locations constitute a flag error.

1.5.1.2 Missing Pulse

The missing pulse check is performed at the 1F frequency. A missing pulse is defined as an amplitude reduction of a single or plurality of read pulses.

1.5.1.3 Extra Pulse

The extra pulse test is performed on a track previously written at the 1F frequency and then DC erased with the write element. An extra pulse error is defined as any spurious signal with an excessive read amplitude.

1.5.1.4 Output Modulation
This is the relationship of the lowest peak-to-peak output and the highest peak-to-peak output measured in any 50 microsecond sector of a track recorded at the 1F frequency.

1.5.1.5 Resolution Ratio
The resolution shall be measured in terms of the 2F/1F ratio of the average read amplitudes of any track. The resolution ratio is between 40% and 70%.

1.5.2 Disc Cartridge Rejection Criteria

1.5.2.1 There must be a minimum of 203 error-free tracks per surface when using the criteria established for Nashua 4411 disc packs.

APPENDIX A

Test Write Electronic Conditions

Pulse coding generators are used which permit bits to be written up to 2.5 million bits per second (± 0.1%).

Write current has the following characteristics when measured at the head cable and physically close to the head;

The quiescent-current amplitude, measured single-ended (unbalanced to ground), is 35 milliamperes (± 1.0 milliamperes).

The current switching times (Tr and Tf) measured differentially (balance to baseline) are 140 nanoseconds (±40 nanoseconds). The difference between Tr and Tf is equal to or less than 20 nanoseconds. See Fig. 7B.

The write current overshoot measured differentially (balanced to baseline) is less than 8%. See Fig. 7B.

The difference in time duration (T1 and T2, Fig. 7B) is less than 2% when measured differentially (balanced to ground).

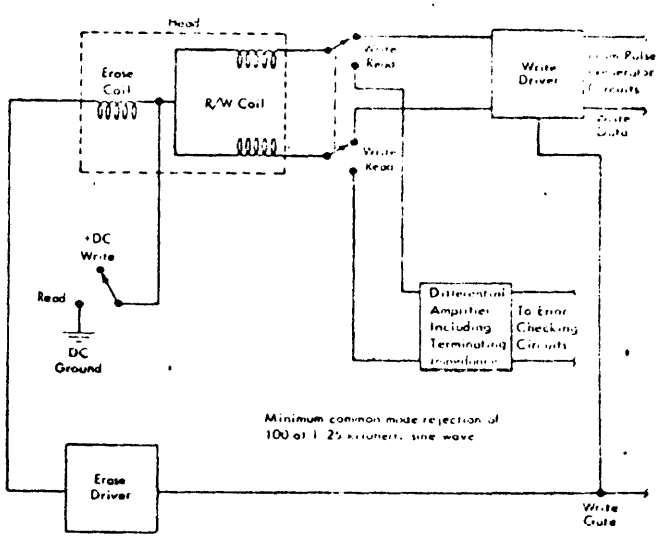


Fig. 7A - Read/Write Test Circuit Block Diagram

Frequency and Signal Response

The read electronics are capable of accepting low impedance signal levels between 3 millivolts (mv) and 30 mv peak-to-peak at frequencies between 1 kilohertz (kHz) and 600 kHz.

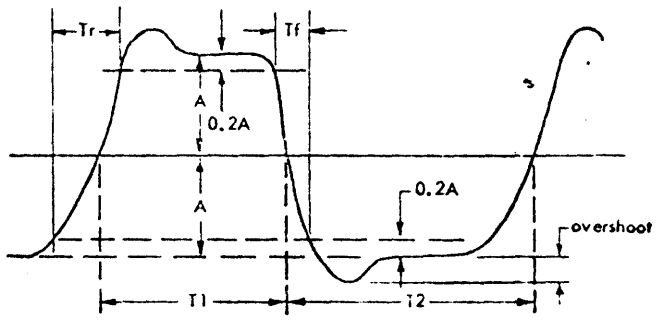


Fig. 7B - Write Current Characteristics