American National Standard

Adopted for Use by
the Federal Government

FIPS PUB 32-1
See Notice on Inside
Front Cover

print specifications for magnetic ink character recognition

ANSI X3.2-1970 (R1976)

american national standards institute, inc.
1430 broadway, new york, new york 10018

This standard has been adopted for Federal Government use.

Details concerning its use within the Federal Government are contained in FIPS PUB 32-1, Character Sets for Optical Character Recognition (OCR). For a complete list of the publications available in the Federal Information Processing Standards series, write to the Standards Processing Coordinator, Institute for Computer Sciences and Technology, National Bureau of Standards, Washington, D.C. 20234.

ANSI®
X3.2-1970 (R1976)
Revision of
ANSI X3.2-1963

American National Standard Print Specifications for Magnetic Ink Character Recognition

Secretariat
Business Equipment Manufacturers Association

Approved October 5, 1970
American National Standards Institute, Inc

American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review and users are cautioned to obtain the latest editions.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of publication. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by

American National Standards Institute, Inc
1430 Broadway, New York, New York 10018

Printed in the United States of America

A3½M982/7

Foreword

(This Foreword is not a part of American National Standard Print Specifications for Magnetic Ink Character Recognition, X3.2-1970.)

This is a revision of American National Standard Print Specifications for Magnetic Ink Character Recognition, X3.2-1963. The material presented in this standard is a result of the combined efforts of bankers, machine manufacturers, and check printers. This standard specifies the shape, the dimensions, and the tolerances for the printed character. A separate document, American National Standard Bank Check Specifications for Magnetic Ink Character Recognition, X3.3-1970, specifies the placement and use of these characters in the proper format for use in bank checks.

Previous to 1956, a number of different mechanizations were being developed to solve the data processing problems of the banks. The particular requirements of the check collection system in the United States presented problems somewhat different from other forms of data processing and therefore stimulated several different approaches to encoding the media.

The solution to this problem, commonly known as "E-13B," was formally adopted by the American Bankers Association in December 1958. The ABA's work started in 1954 through its Bank Management Committee which appointed a Technical Committee on Mechanization of Check Handling. The ABA soon decided that magnetic ink character recognition (MICR) should be the ultimate rather than an intermediate solution. In September 1956, the ABA committee called for meetings of interested machine manufacturers in order to develop the technical details. Work on writing the standards moved rapidly with the combined efforts of the bankers, machine manufacturers, and check printers, and in November 1958, "E-13B" was the unanimous recommendation to the ABA by the OEMC (Office Equipment Manufacturers Committee) which had responded to the ABA request.

The ABA then issued ABA Publication 147, *The Common Machine Language for Mechanized Check Handling,* in April 1959. There have been subsequent revisions. The implementation program moved ahead vigorously. In a short time almost all of the bank checks in circulation in the United States were encoded with "E-13B."

The Standards Committee on Computers and Information Processing, X3, recognized the desirability of issuing the "E-13B" work as an American National Standard. It formed the X3-7 Subcommittee on MICR, and, with the assistance of the X3-7-1 technical group, the first two related American National Standards on MICR were issued in 1963.

Much of the information presented in the American National Standards is taken from the ABA publication.

As the use of "E-13B" increased, both here and abroad, there was natural interest and questions concerning the specifications and a desire to achieve international acceptance of the American National Standard. The X3 committee kept X3-7 active and endorsed X3-7's participation in the International Organization for Standardization, Technical Committee 97, Subcommittee 3 (ISO/TC 97/SC 3) on Character Recognition. A series of international meetings, beginning in 1961 and terminating in 1965, resulted in the 1969 adoption of ISO Recommendation R 1004-1969, *Print Specifications for Magnetic Ink Character Recognition.* This document includes the "E-13B" specifications as outlined in this standard in addition to another MICR character set known internationally as "CMC-7." It is a two-part international recommendation.

The continued successful use of "E-13B" in the United States and its growing use in other countries such as Australia, Canada, Columbia, Japan, the United Kingdom, and Venezuela does indeed justify the reissuance of this standard with its revisions.

The revisions do not "change" the original standard. The alignment specification was simply relaxed. The details concerning the signal level reference documents were updated to show that the Bank Administration Institute (BAI) is handling their distribution. Residual signal level specification has been added for those who are concerned with the erasing or eradication of the magnetic ink. The Appendix has been enlarged to illustrate the updated amplifier circuitry and includes new illustrations of the BAI signal level reference document and the waveforms produced by the printed image.

It is expected that the printers of bank checks with "E-13B" will continue to exercise careful concern for all of the considerations specified in this standard in order to ensure maximum performance and continued success.

Finally, it should be noted that the application of this standard is not limited to banking and bank checks. The "E-13B" MICR concept can be employed in other applications such as sales promotion coupons, credit cards, passenger tickets, insurance premium receipts, billing, etc.

This revision was approved as an American National Standard by the American National Standards Institute on October 5, 1970.

Suggestions for improvement gained in the use of this standard will be welcome. They should be sent to the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

The Standards Committee on Computers and Information Processing, X3, had the following members at the time it approved this standard:

Charles A. Phillips, *Chairman* Alexander C. Grove, *Secretary*†

Organization Represented	*Name of Representative*
Administrative Management Society	C. S. Everhardt
Air Transport Association	Frank C. White
American Bankers Association	John C. Houhoulis
American Gas Association	Joseph A. Pinnola
American Institute of Certified Public Accountants	Noel Zakin
American Library Association	David L. Weisbrod
American National Standards Committee on Office Machines, X4 *(Liaison)*	C. E. Ginder†
American Newspaper Publishers Association	W. D. Rinehart
American Petroleum Institute	F. A. Gitzendanner
American Society of Mechanical Engineers	George C. Finster
Association of American Railroads	R. A. Petrash
Association for Computing Machinery	John A. N. Lee
Association for Educational Data Systems	J. J. Fast, Jr
Business Equipment Manufacturers Association	Larry Avanzino
	R. W. Bemer
	T. H. Bonn
	A. C. Brown
	Stanley Buckland
	D. J. Daugherty
	U. S. C. Dilks
	Stanley Erdreich
	R. W. Green
	W. S. Humphrey
	R. J. LaManna
	R. J. Mindlin
	Glen Poorte
	Donald J. Reyen
Data Processing Management Association	Donald MacPherson
Edison Electric Institute	H. D. Limmer
Electronic Industries Association	Howard H. Smith
General Services Administration	Delbert Shoemaker
Insurance Accounting and Statistical Association	William Bregartner
International Communications Association	Charles L. Hutchinson
Institute of Electrical and Electronics Engineers	G. W. Patterson
Joint Users Group	Theodore Wiese
Life Office Management Association	Edwin L. Luippold
National Bureau of Standards	J. O. Harrison
National Machine Tool Builders Association	Arnold F. Griswold
National Retail Merchants Association	Ethel Langtry
Printing Industries of America	Lawrence Chvany
Scientific Apparatus Makers Association	H. T. Hoffman
System and Procedures Association	E. Tomeski
Telephone Group	V. N. Vaughan, Jr
U.S. Department of Defense	Robert A. Raup

† Deceased.

The members of the X3-7 Subcommittee on Magnetic Ink Character Recognition, which was responsible for the review of the 1963 standard and the development of this first revision, were as follows:

E. D. Spina, *Chairman*

R. E. Maxwell, *Vice-Chairman*

L. Avanzino
J. D. Blankenship
A. D. Bowen
B. F. Burch, Jr
D. E. Dykaar
R. L. Fortune
C. B. Henchey
H. O. Loewer
R. H. Long
R. J. Mindlin
A. L. Raiche
J. L. Rose
C. N. Rudnick
T. N. Stack

Others who have contributed to the recent work of the X3-7 Subcommittee were as follows:

R. D. Armstrong
C. L. Comegys
F. Dewitt
U. C. S. Dilks
A. T. Doig
L. M. Fenner
R. W. Green
M. A. Harris
W. E. Holmes
J. C. Houhoulis
D. A. Johnson
R. C. Kolb
J. D. Kopec
O. Kroger
F. Byers Miller
L. Miller
W. D. Morgan
R. E. Mumma
R. G. Neville
H. M. Preston, Sr
D. J. Reyen
R. E. Rosell
R. W. Ruff
A. A. Sargent
F. C. Schiller
G. H. Schneider
R. E. Schultz
A. T. Sims
A. Sniderman
T. L. Speak
N. Stone
W. A. White

G. W. Wright

The original members of the X3-7 Subcommittee, and others who originally contributed to the development work for the 1963 standard, were as follows:

C. W. Allen
G. A. Baird
J. Bock
B. F. Burch, Jr
T. M. Butler
G. Cerf
P. A. Colmer
C. Comegys
A. Corr
T. F. Cull
A. B. Eckert
R. L. Edsberg
R. L. Fortune
R. W. Green
R. Hagopian
G. F. Hughes-Caley
J. A. Kley
P. Koons
Brooks Lyman
P. MacPhee
G. W. McSweeney†
R. E. Maxwell
M. E. Mengel
G. M. Miller
R. J. Mindlin
R. C. Moore
J. J. Morello
R. Mumma
F. Parenti
W. L. Poland
R. Racine
D. J. Reyen
J. L. Rose
A. A. Sargent
F. C. Schiller
E. Seif
I. M. Sheaffer
D. E. Slattery
E. D. Spiňa
A. Sutton
W. A. White
J. N. Yardis

† Deceased.

Contents

SECTION PAGE

American National Standard Print Specifications for Magnetic Ink Character Recognition

1. Scope and Purpose

1.1 Scope. This standard specifies the shape, dimensions, and tolerances for the ten digits and four special symbols printed in magnetic ink[1] and used for the purpose of character recognition. It describes the various types of printing defects and other printing considerations, together with the tolerances permitted, and also contains specifications for signal level measurement.

1.2 Purpose. The characters specified in this standard were developed initially for use in banks to permit automatic document handling for bank data processing, but they have application to other automatic handling systems as well.

2. Definitions

average edge. An imaginary line that divides the irregularities. The summation of the white areas on one side of this line is equal to the summation of the black areas on the other side. (See Fig. 19.)

character space. The space within which one and only one printed character or symbol can appear. It is measured horizontally to the left from the right-hand average edge.

common field. A field in which the information content follows a fixed format that is common to all users.

embossment. A physical impression of the type face made in the printing surface.

extraneous ink. Magnetic ink, other than the printed character, located within the 0.625-inch common language clear band. It is usually described as splatter, smear, tracking, feathering, stringing out, toning, back offset, background, etc.

[1]As used herein, the term "magnetic ink" means ink capable of being magnetized and sensed.

field. A specified portion of the clear band that is limited to a set of one or more characters that may be treated as a unit of information.

fixed format. A predetermined description or specification of information content.

magnetic ink. Ink capable of being magnetized and sensed.

saturation. The condition where the flux density of the printing can no longer be increased by increasing the applied magnetizing field in a plane parallel to the paper.

signal level. Voltage wave form obtained when dc magnetized printed characters are scanned with a magnetic reading head.

symbol. A sign or emblem used instead of words for identification or representation.

variable format. A description or specification of information content that will vary according to the needs of a user.

voids. The absence of ink within the specified outline of the printed character.

3. Character Configuration

3.1 Designation. The series of standard magnetic ink characters shall consist of ten numerals and four special symbols. They shall be identified as follows:

Name	*Designation*
Zero	Stroke 0
One	Stroke 1
Two	Stroke 2
Three	Stroke 3
Four	Stroke 4
Five	Stroke 5
Six	Stroke 6
Seven	Stroke 7
Eight	Stroke 8
Nine	Stroke 9
Symbol 1	Stroke 10
Symbol 2	Stroke 11
Symbol 3	Stroke 12
Symbol 4	Stroke 13

3.2 Dimensions. Detailed dimensions and the reference center lines of the printed characters for Strokes 0 through 13 are shown in Figs. 1 through 14. Fig. 15 illustrates the character design matrix. Dimensions are as follows:

(1) Character height: 0.117 inch.

(2) Character widths: 0.052, 0.065, 0.078, and 0.091 inch.

(3) Width of horizontal and vertical bars: 0.013 inch.

(4) Minimum width of horizontal bars (this specification does not apply to vertical bars; see 5.5): 0.011 inch.

(5) Corner radii (except Stroke 0; see Fig. 1): 0.0065 inch.

(6) Tolerance (average edge) ± 0.0015 inch.

4. Character Spacing and Alignment

4.1 Spacing

4.1.1 *Common Fields (Fixed Format)*

4.1.1.1 The distance between the right average edge of adjacent characters shall be 0.125 ± 0.010 inch. (See Fig. 16.) (Average edge is defined and discussed in Section 5.)

4.1.1.2 The accumulation of spacing tolerances in any common (fixed format) field is limited to the extent that the accumulation does not infringe upon the boundaries defining this field.

4.1.2 *Minimum Space — Any Field.* The minimum space between the right average edge of adjacent characters, whether they are in the same field or adjoining fields, can never be less than 0.115 inch.

This also applies to variable format fields. Maximum or other spacing requirements in variable fields shall be specified by the individual machine manufacturer involved.

4.2 Alignment. Alignment is the relative vertical location of a character with respect to adjacent characters within a given field. The horizontal center line of each character is indicated on drawings of the printed character by the symbol $\mathbb{C}_H$. These center lines serve to establish vertical alignment of all characters, since all characters are designed about the same horizontal center line.

Vertical alignment tolerance is that which is consistent with good printing practice and subject to the interpretations in 4.2.1.

NOTES to Figs. 1 through 14:
(1) All radii are 0.0065 inch except in character zero.
(2) All radii shall be blended with adjacent edges.
(3) Tolerance ± 0.0015 inch.
(4) Minimum width horizontal bars 0.011 inch. This specification does not apply to vertical bars.

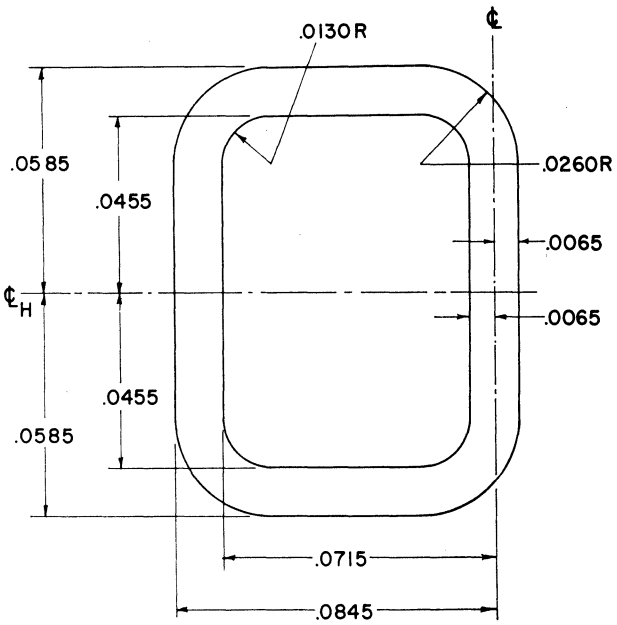


Fig. 1
Stroke 0 (Zero)

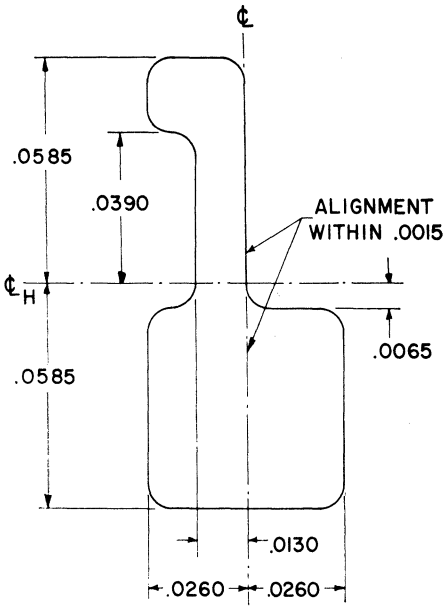


Fig. 2
Stroke 1 (One)

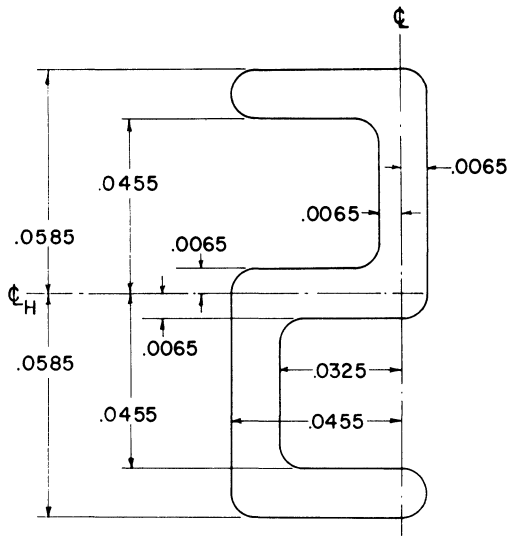


Fig. 3
Stroke 2 (Two)

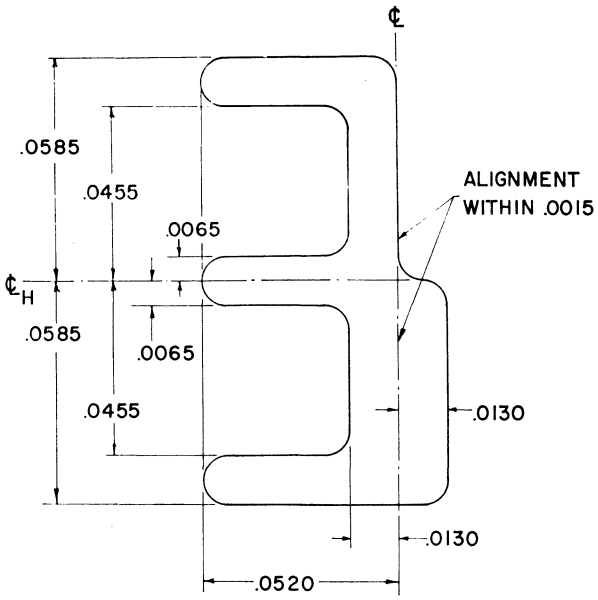


Fig. 4
Stroke 3 (Three)

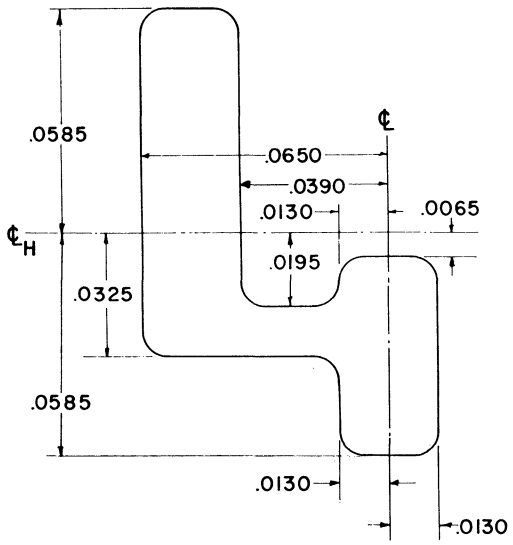


Fig. 5
Stroke 4 (Four)

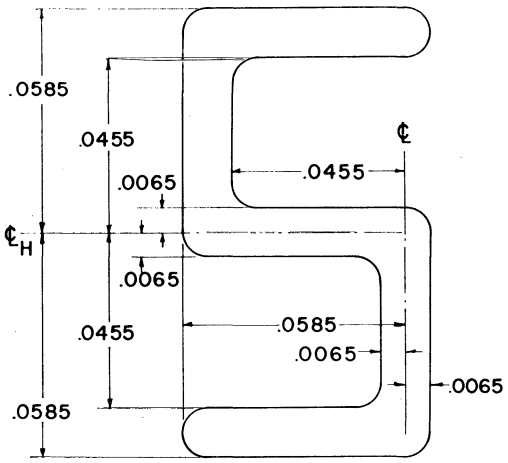


Fig. 6
Stroke 5 (Five)

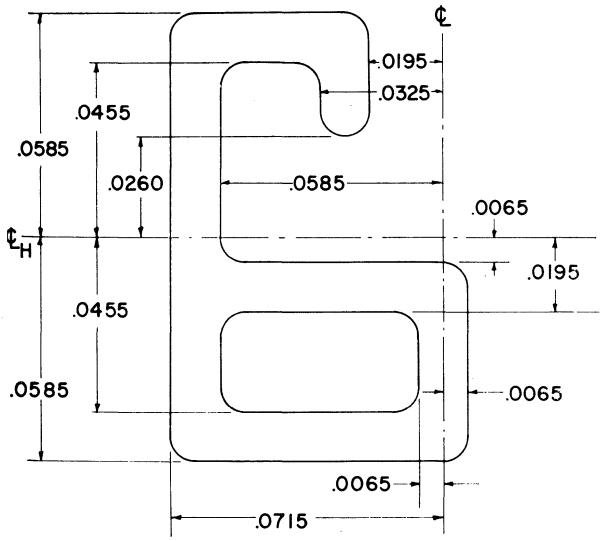


Fig. 7
Stroke 6 (Six)

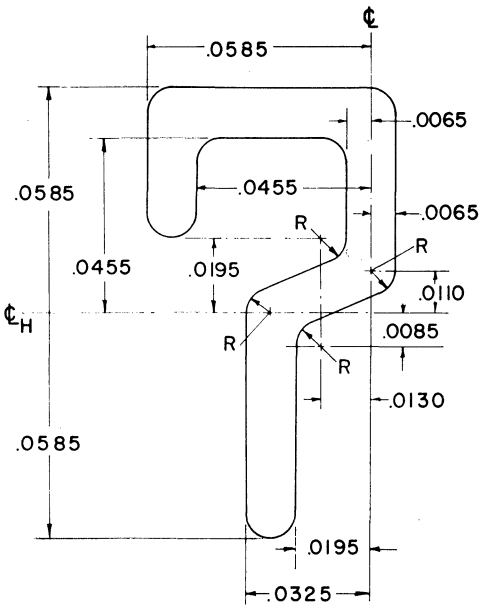


Fig. 8
Stroke 7 (Seven)

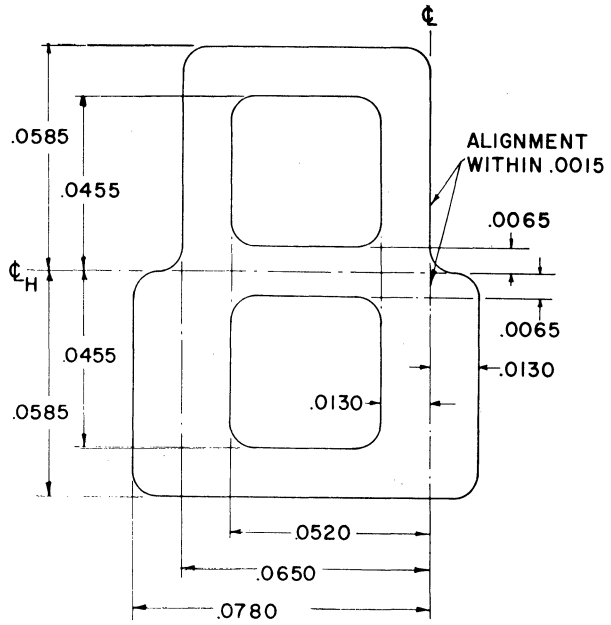


Fig. 9
Stroke 8 (Eight)

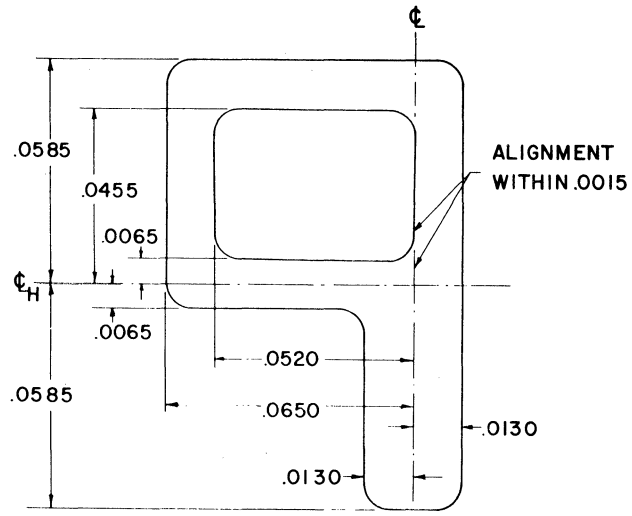


Fig. 10
Stroke 9 (Nine)

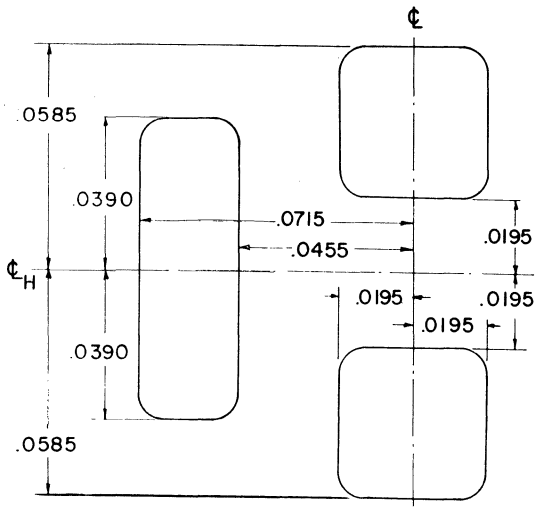


Fig. 11
Stroke 10 (Ten) — Symbol 1

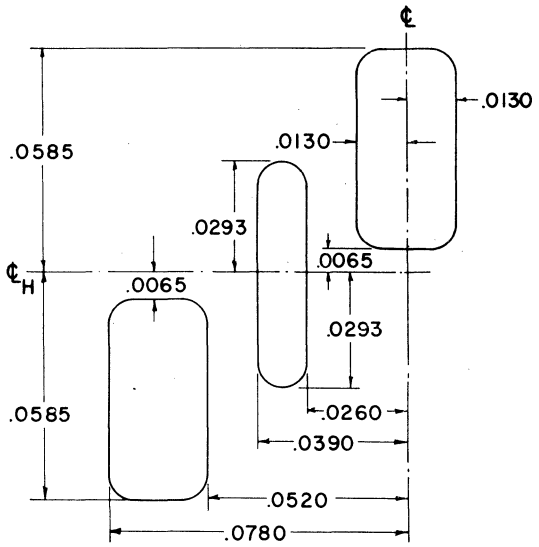


Fig. 12
Stroke 11 (Eleven) — Symbol 2

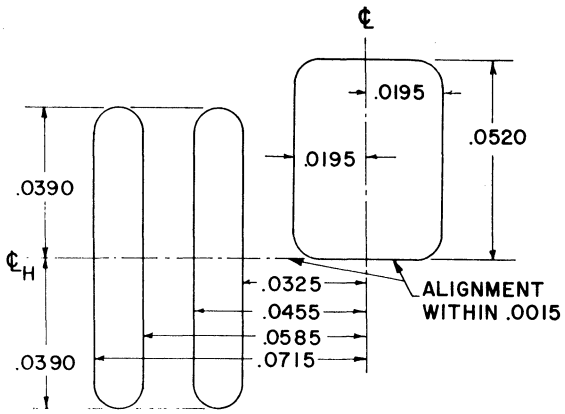


Fig. 13
Stroke 12 (Twelve) — Symbol 3

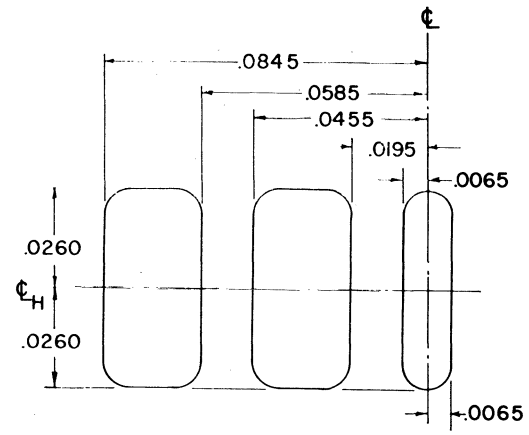
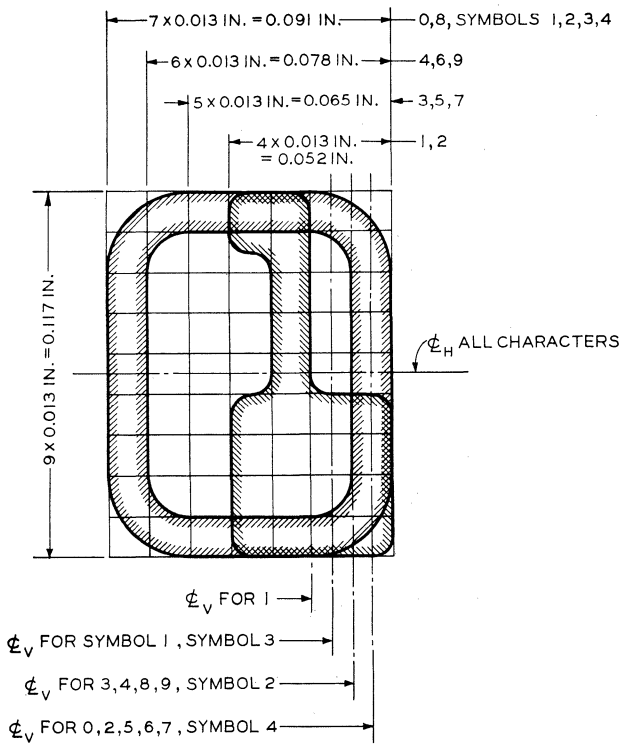


Fig. 14
Stroke 13 (Thirteen) — Symbol 4

4.2.1 *Tolerance.* Alignment of a line of characters printed in *any* field should be such that the bottom edges of adjacent characters *within* each field do not vary vertically more than 0.015 inch. (See Fig. 17.)

On characters that do not come down to the "base" line (see Figs. 13, 14, and 16), the same tolerance will apply to the horizontal center line.



This is a 7 × 9 matrix of 0.013-inch squares.

NOTES to Fig. 15:
(1) All characters centered about the horizontal center line.
(2) All characters — right-hand edges aligned.
(3) Minimum height of right-hand edge is four squares.

Fig. 15
Character Design Matrix

5. Character Skew

The maximum allowable character skew is ± 1.5 degrees measured with respect to the bottom edge of the document. (See Fig. 18.)

6. Character Tolerances

6.1 Dimensions. See Figs. 1 through 14 for dimensions of printed characters.

6.2 Definition of Average Edge. The typical edge of a printed character is not a straight line. The term "average edge" will be used and is defined as an imaginary line that divides the irregularities. The result is that the summation of the white areas on one side of the line is equal to the summation of the black areas on the other side. (See Fig. 19.)

6.3 Average Edge Tolerance. The average edge tolerance for all stroke edges shall be ± 0.0015 inch applied to the dimensions (measured from ℄ and ℄H) that locate the edges. A typical illustration of this tolerance is shown in Fig. 20. The average edge of the radii shall be tangent to the average edge of the stroke and shall fall within the ± 0.0015-inch tolerance band also allowed for radii.

6.4 Edge Irregularity Tolerance

6.4.1 Peaks and valleys about the average edge are permitted to extend to ± 0.0035 inch from the dimension locating the edge. An example is shown in Fig. 21. However, when these occur the summation of the edge present in the 0.0015 to 0.0035-inch zone shall not exceed 25 percent of the total edge.

6.4.2 An occasional void can be present at the edge and cause a valley that exceeds the limits mentioned in the foregoing. The maximum allowable size of such voids is specified in Section 7.

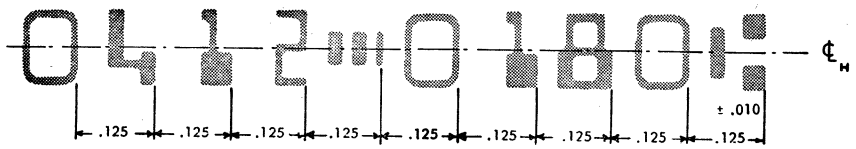


Fig. 16
Distance Between Characters

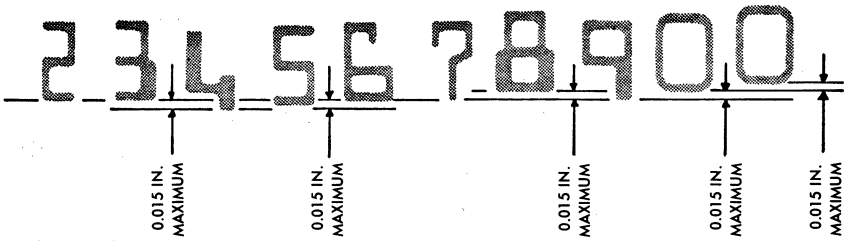


Fig. 17
Allowable Variation in Vertical Alignment

6.4.3 An occasional excursion (such as feathering or stringing out) can be present at the edge and extend beyond the 0.0015 to 0.0035-inch zone. Such occasional excursions are not considered to be edge irregularities, and are defined as extraneous ink that is "attached" to the character. The maximum allowable size and quantity of such excursions is given in Section 9.

In measuring the size of such excursions, only that portion that extends beyond the 0.0035-inch limit mentioned in 6.4.1 should be considered since the portion of the excursion in the 0.0015 to 0.0035-inch zone is controlled by character edge irregularity limits given in 6.4.1.

6.5 Minimum Width of Horizontal Bars. The distance between the average edges of any horizontal bar shall be at least 0.011 inch. (This specification is an adjunct to the dimension specification locating each edge. This specification does not apply to vertical bars, since vertical bars are controlled entirely by dimensions locating each edge.)

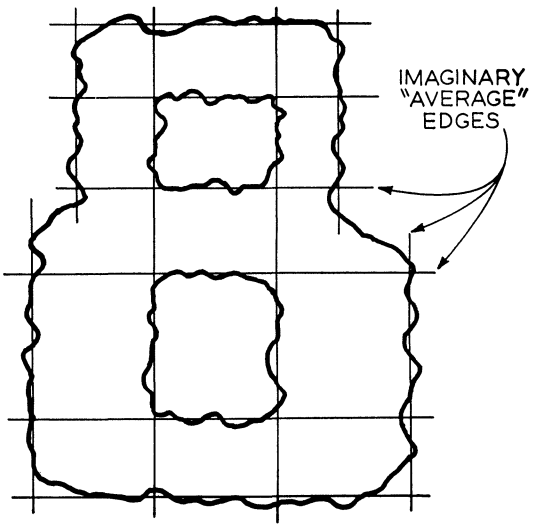


Fig. 19
Average Edge

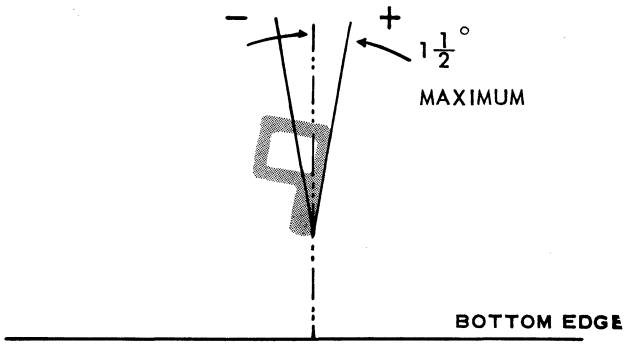


Fig. 18
Allowable Character Skew

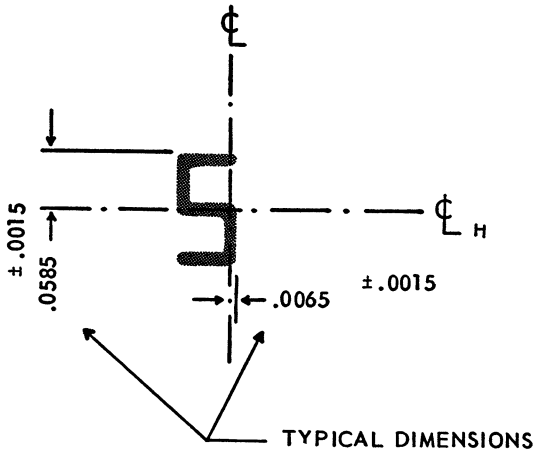


Fig. 20
Average Edge Tolerance

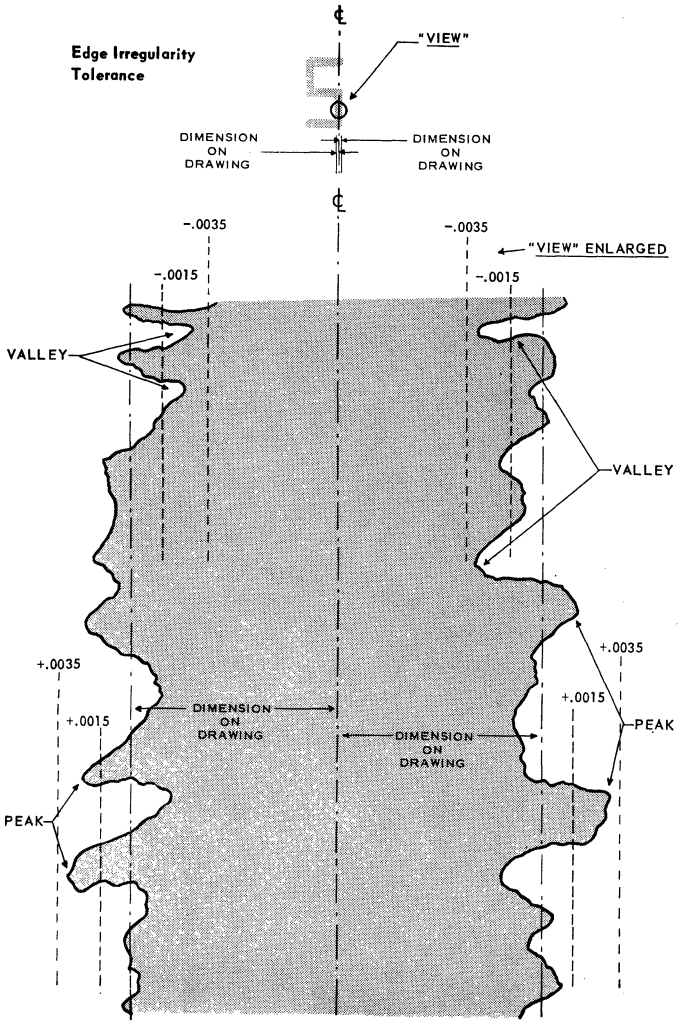


Fig. 21
Edge Irregularity

7. Voids

7.1 Definition. Voids are the absence of ink within the specified outline of the printed character.

7.2 Maximum Allowable Single Void

7.2.1 The maximum allowable single void anywhere in the character, including at an edge, shall be of a size that can be contained entirely within the boundary of a 0.008 × 0.008-inch square, with the following exception:

If the portion of the character involving a single void is two or more zones wide (each zone is 0.013 inch wide), then the maximum allowable single void must be completely surrounded by ink and contained entirely within the boundary of a 0.010 × 0.010-inch square. In this case, voids at edges are not included and are, therefore, limited to a 0.008 × 0.008-inch square. (See Fig. 22.)

7.2.2 Single voids that are long and narrow are called "needle" type voids. They are allowable in any length anywhere on the character provided that they are no wider than 0.002 inch average edge to average edge.

7.3 Maximum Allowable Combined Voids. The combined area of all voids, in any vertical column or horizontal row nominally 0.013 inch wide, shall not exceed 20 percent of the column or row. (See Fig. 23.)

8. Uniformity of Ink Film

The ink deposited shall be uniformly distributed within the outlines of each character. Conditions to be avoided include excessive squeeze-out, halo, and other uneven deposits.

A ridge of ink that outlines a character and that appears dense in relation to the ink deposited within the character is acceptable provided that it does not exceed 0.0015 inch between its average edges. Such ridges are predominant in letterpress printing and some impact printing.

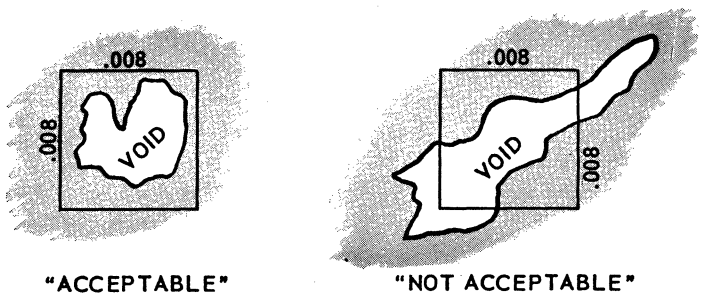


Fig. 22
Example of Single Voids

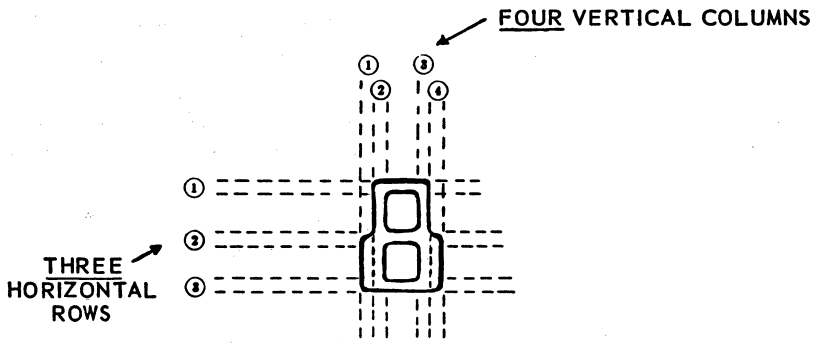


Fig. 23
Example of Rows and Columns

9. Extraneous Ink (Magnetic)

9.1 Definition. Extraneous ink is defined as magnetic ink, other than the printed character, located within the 0.625-inch common language clear band. It is usually described as splatter, smear, tracking, feathering, stringing out, toning, back offset, background, etc.

9.2 Limitations

9.2.1 ***Extraneous Ink Front.*** Extraneous magnetic ink on the front of the document is not acceptable if it is "visible" to the experienced eye without the aid of a magnifying device. This statement is subject to the following interpretation:

Spots that cannot be contained in a 0.003 × 0.003-inch square are defined as "visible"; however, random occasional spots that are "visible" are acceptable provided that they can be contained in a 0.004 × 0.004-inch square and are limited to one per 0.125-inch character space and total not more than five per field. Spots that cannot be contained in a 0.004 × 0.004-inch square are not acceptable.

Spots that are found to be located within the outermost limits established by the character edge irregularity tolerance are to be considered under the character edge irregularity specifications.

The printer should make every reasonable effort to eliminate extraneous ink on the front of the document, since its presence can be a cause for "machine reading rejects."

9.2.2 ***Extraneous Ink Back.*** Extraneous magnetic ink on the back of the document is not acceptable if it is more than barely visible to the unaided eye. This statement is subject to the following interpretation:

Spots that cannot be contained in a 0.006 × 0.006-inch square, or an equivalent area, are not acceptable.

10. Embossment (Impression)

Embossment of the printed character shall not exceed that which is barely detectable to the experienced touch or eye. Barely detectable embossment is defined as that which does not exceed 0.001 inch in depth on the front of the document.

11. Signal Level

11.1 Definition of Signal Level. Signal level is defined as the amplitude of the voltage wave form produced when a dc magnetized printed character is scanned by a suitable magnetic reading head. A typical wave form as it appears on the face of the oscilloscope is given in Fig. 24.

11.2 Nominal Signal Level. Nominal signal level is the signal obtained from a reference standard printing sample (designated as the Primary Signal Level Reference Documents accepted on November 30, 1967 as being equivalent to and replacing the May 27, 1958 document) when suitable test equipment is used. (See 11.4 and 11.5.) This reference printing, maintained in a vault, consists of a set of

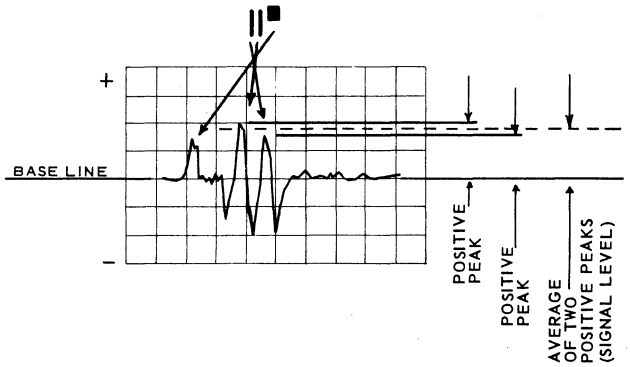


Fig. 24
Wave Form as It Appears on Face of Oscilloscope

paper documents each of which has each character of the E-13B font printed under very precise conditions. The signal level of each character has been adjusted by relating its reading to the signal level of the flanking Stroke 12 symbols. The average of a set of these adjusted readings has been used to establish the nominal signal level of that character.

11.3 Relative Signal Level. Relative signal level is the ratio stated as a percentage that the signal level of a character being measured bears to the nominal signal level for that character on the reference standard taken as 100 percent.

The signal level of the character being measured is obtained using suitable procedures and testing equipment. (See 11.5, 11.6, and 11.7.)

11.4 Secondary Reference Document. Secondary reference documents are paper documents printed in magnetic ink with the characters of the E-13B font. These documents are of known relative signal level and are made available for use in calibration of equipment used to measure relative signal level. Secondary reference documents are selected such that the relative signal level of the printing thereon is as close as practicable to 100 percent of the nominal. One or more characters on a secondary reference document are marked to indicate the actual relative signal level of that character. (See Appendix Fig. A2.) Secondary reference documents may be obtained from the custodian of the Primary Signal Level Reference Documents at the following address: BAI (Bank Administration Institute), P.O. Box 500, Park Ridge, Illinois 60068.

11.5 Test Equipment and Equipment Parameters

11.5.1 ***Test Equipment.*** Test equipment suitable for measuring relative signal level consists of the following:

11.5.1.1 Means for moving a document bearing the dry magnetic ink printing from left to right (the characters are scanned from right to left), in a direction parallel to the bottom reference edge, past a dc magnetizing head and a magnetic reading head, and including means for holding the document in intimate contact with the face of the magnetizing head and reading head.

11.5.1.2 A dc magnetizing head capable of magnetizing the characters to saturation in a direction parallel to the bottom reference edge and in the plane of the printed characters.

11.5.1.3 A single gap magnetic reading head mounted with the long axis of the gap perpendicular to the bottom reference edge and parallel with the plane of the printed characters. Considering the reading head gap as a plane of negligible thickness, the plane of the gap must be perpendicular to the plane of the document and to the bottom reference edge of the document.

11.5.1.4 A linear amplifier to amplify the output of the magnetic reading head for presentation on an oscilloscope.

11.5.1.5 An oscilloscope for display of the voltage wave form(s) of the character(s) to be measured and the voltage wave form(s) of the corresponding character(s) on a secondary reference document.

11.5.2 ***Equipment Parameters***

11.5.2.1 The transport shall move the document at the rate of 150 inches per second within 2 percent. Combined character skew from all causes shall not exceed 1.5 degrees relative to the center line of the reading head gap.

11.5.2.2 The magnetizing head shall be such as to produce dc magnetic saturation in printed characters in the direction specified in 11.5.1.2. The leading pole relative to the printed character is to be the north pole.

11.5.2.3 The reading head shall have an 0.003-inch (0.076-millimeter) gap and a minimum resonant frequency of 40 kilohertz. The height of the reading head gap shall be sufficient to scan the 0.625-inch clear band along the bottom edge of the document. The head shall be shielded on all sides, except the reading face and the back, such that any induced noise shall not cause a signal-to-noise ratio less than 40:1 when reading 100 percent reference material (Brush Clevite reading head No. BK3806/S7165, or equivalent).

11.5.2.4 The amplifier shall have the following characteristics:

(1) Gain. The amplifier gain shall be such that an input sine wave of 10 ± 0.2 millivolts peak to peak, at 1 kilohertz, produces a sine wave output of 2.4 ± 0.4 volts peak to peak.

(2) Frequency Response

(a) The amplifier gain must not vary by more than ± 0.5 decibels from the 1-kilohertz gain over a frequency range of 200 hertz to 3 kilohertz.

(b) The amplifier gain between the frequencies 200 hertz and 75 hertz must not drop more than 3 decibels below the 1-kilohertz gain.

(c) The amplifier gain below 75 hertz must not exceed the 1-kilohertz gain.

(d) The amplifier gain above 3 kilohertz must drop on a smooth curve such that: At 5.1 kilohertz ± 600 hertz the gain is 3 decibels below the 1-kilohertz gain; and at 11.2 kilohertz ± 1.2 kilohertz the gain is 12 decibels below the 1-kilohertz gain.

NOTE: A gain 3 decibels below a reference value is 0.707 of the reference value; a gain 12 decibels below a reference value is 0.25 of the reference value.

(3) Roll-Off. The high-frequency roll-off characteristics of the amplifier must be equivalent to those of a four-section resistance-capacitance filter with buffering between stages, that is, nonpeaking, and having an attenuation of 6 decibels per octave per stage or 24 decibels per octave for the four stages.

(4) Linearity. At any frequency within the range from 75 hertz to 11.2 kilohertz ± 1.2 kilohertz, the amplifier gain must be linear within ± 0.5 decibels for an input voltage range of 3 millivolts to 25 millivolts peak to peak.

(5) Noise

(a) With the input connection to ground, the noise output shall not exceed a voltage of 0.1 millivolts peak to peak, which is equivalent to 1 percent of the nominal signal level.

(b) A circuit diagram of a suitable amplifier is given in Fig. A1 of the Appendix.

11.5.2.5 The oscilloscope may be of any commercially available type intended for laboratory measurements and equipped with a reticle bearing horizontal rulings.

11.6 Testing Procedure

11.6.1 The horizontal trace which appears on the face of the oscilloscope when the output of the amplifier is connected to the ac input of the oscilloscope, but with no document being scanned, is adjusted to coincide with the lowest ruling on the oscilloscope reticle.

11.6.2 A secondary reference document is placed in the transport and scanned. It is preferable that Symbol 2 (⑈), Symbol 3 (⑈), or Symbol 4 (⑈) be used, since each of these characters has two identical bars (see note, p 19) from which the average amplitude may be measured. If it is desired to measure other characters, the peaks as shown in Appendix Figs. A3 and A4 should be used. The vertical gain of the oscilloscope is then adjusted so that the deflection to the uppermost division of the recticle corresponds to the base line to positive peak amplitude of 200 percent relative signal level. This may be done as follows:

(1) Determine the number of major divisions on the reticle in the vertical direction.

(2) Divide this number by two.

(3) Multiply this by the relative signal level percentage of the secondary reference document character being used divided by 100. Adjust the vertical gain so that the vertical deflection of the character being observed is equal to this calculated deflection.

Example:

Eight major divisions on the face of the oscilloscope.

Secondary reference document relative signal level equals 104 percent.

Number of divisions equals $\frac{8}{2}$ times $\frac{104}{100}$, which equals 4.16.

Adjust the vertical gain so that the average amplitude of the two identical positive peaks equals 4.16 divisions on the reticle.

Four divisions then correspond to 100 percent relative signal level for the character which was used to make the calibration.

NOTE: On secondary reference documents (see 11.4), the two positive peaks resulting from the two identical bars will not differ in amplitude by more than 10 percent.

11.6.3 With the test equipment so calibrated, the relative signal level of any character may be determined by observing the vertical deflection of the positive peaks of the character corresponding to the character on the secondary reference document, as described in 11.6.2, dividing this by the number of divisions corresponding to 100 percent, and multiplying by 100 percent.

Example:

Calibration as in 11.6.2.

Deflection of unknown sample equals 4.4 divisions.

Relative signal level of unknown sample equals $\frac{4.4}{4.0}$ times 100 percent equals 110 percent.

11.6.4 Another optional method for calibration is as follows:

Assign specific linear values to each major division on the reticle, such as:

bottom line equals	0 percent
2nd line equals	50 percent
3rd line equals	100 percent
4th line equals	150 percent
5th line equals	200 percent
6th line equals	250 percent

Then place vertical position of the free-running trace, with no document in transport, at the zero-percent line. Place the secondary reference standard in transport and adjust vertical gain of oscilloscope so that a highest single positive peak or the average of similar positive peaks, reads a value on the scope graduations that is identical to the value designated on the reference document. The test equipment is then calibrated.

If it is desired to measure other character(s), it is necessary that the test equipment be recalibrated with a reference standard for the character(s) to be measured.

11.7 Relative Signal Level Tolerance. The relative signal level from any printed character may vary from 50 percent to 200 percent of its nominal signal level.

11.8 Residual Signal Level. The residual signal level is the signal delivered by a character which has been voided.

Whenever misencoded information is voided, the residual signal level shall not exceed 5 percent of the nominal signal level for Symbol 3 (Stroke 12).

The method employed should permit re-encoding of the document.

12. Paper

It is recognized that certain particles embedded in paper can be a cause for machine reading reject.

Paper should be used from which magnetic particles, such as iron and other ferromagnetic materials, have been eliminated or reduced to a minimum.

13. Format

13.1 Reference Edges

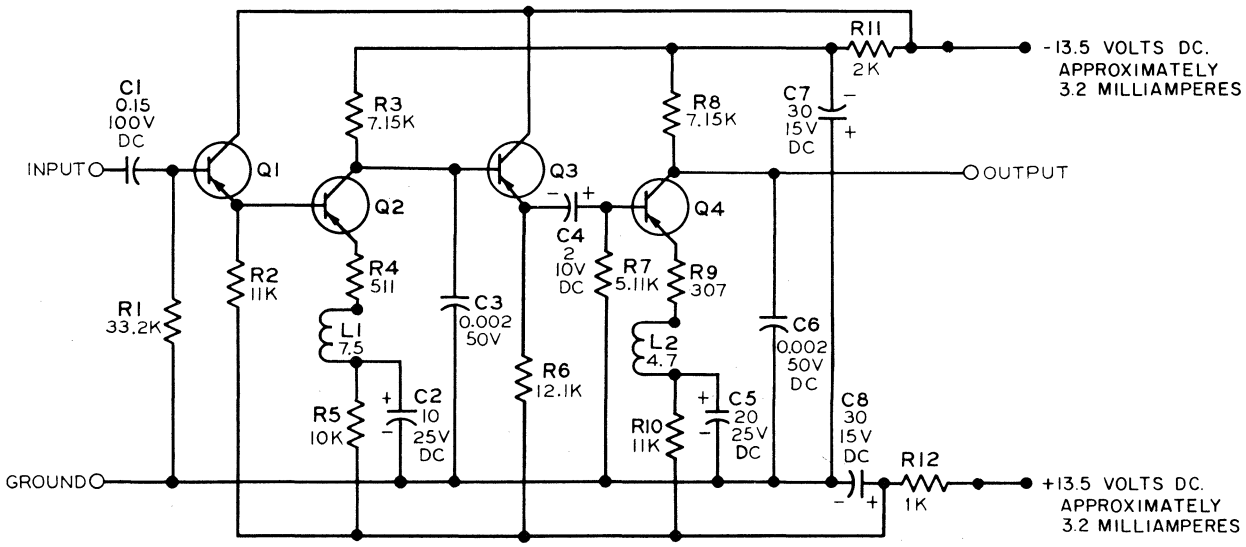
13.1.1 ***Horizontal Dimensions.*** All horizontal format dimensions are measured from the right-hand edge of the document. The right-hand edge of the first or right-hand character shall be located not less than 0.250 inch from the right-hand reference edge.

13.1.2 ***Vertical Dimensions.*** All vertical format dimensions are measured from the bottom edge of the document.

13.2 Clear Band. The clear band is a horizontal band 0.625 inch wide that must be free of any magnetic ink, other than prints of the E-13B font, and whose vertical location on a document is determined by the application involved. The encoding strip must be located within the clear band.

Appendix

(This Appendix is not a part of American National Standard Print Specifications for Magnetic Ink Character Recognition, X3.2-1970, but is included for information purposes only.)



NOTES:
(1) L1 and L2 are powdered iron core inductors, in millihenries (mH).
(2) C1 through C8 are capacitors, in microfarads (μF).
(3) R1 through R12 are resistors, in ohms; K = 1000; ¼ watt unless otherwise specified.
(4) Q1, Q2, Q3, Q4 are transistors, Type 2N527.

Fig. A1
Circuit Diagram of a Linear Amplifier
(suitable for determining the output of magnetic reading heads as described in 11.5.2.4)

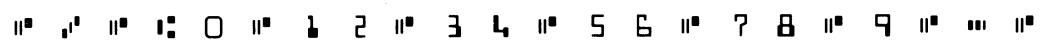
E-13B SECONDARY SIGNAL LEVEL REFERENCE C 0000

References: (1) The Common Machine Language for Mechanized Check Handling, ABA Publication 147. New York: American Bankers Association, April 1959, revised.

(2) American National Standard Print Specifications for Magnetic Ink Character Recognition, X3.2-1970. New York: American National Standards Institute, 1970.

(3) Print Specifications for Magnetic Ink Character Recognition, ISO Recommendation R 1004-1969. Geneva: International Organization for Standardization, March 1969, 1st edition.

100	70	100	105	130	100	85	105	100	85	105	100	105	105	100	75	105	100	165	100	67	100	Nominal Signal Level
																		97	99	97		% Of Nominal
																		160	99	65		Signal Level Reading



NOTE: Reference (1) is available from American Bankers Association, 1120 Connecticut Ave, N.W., Washington, D.C. 20036. References (2) and (3) are available from American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

Fig. A2
Illustration of Secondary Signal Level Reference Document

Character	*Peak**	*Nominal Signal Level*
0	1	130
1	2	85
2	1	105
3	1	85
4	3	105
5	1	105
6	5	105
7	1	75
8	4	105
9	1	165
▪▪▪	3 & 5 (average)	67
▪ ▪	3	105
▪ ▪	1 & 5 (average)	70
▪▪	3 & 5 (average)	100

*Counting vertical edges right to left on the printed character; counting peaks left to right on the displayed waveforms and including positive and negative peaks.

Fig. A3
Peaks for Calibrating All Characters

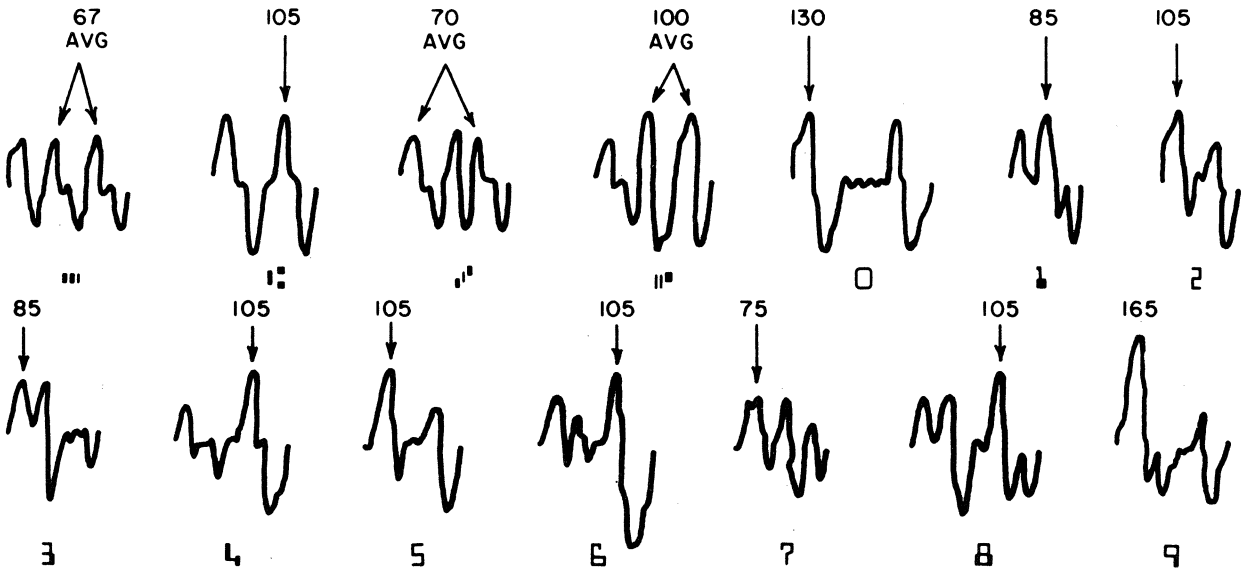


Fig. A4
Waveform Peaks for Signal Level Measurement

American National Standards for Information Processing

X3.1-1976 Synchronous Signaling Rates for Data Transmission
X3.2-1970 (R1976) Print Specifications for Magnetic Ink Character Recognition
X3.3-1970 (R1976) Bank Check Specifications for Magnetic Ink Character Recognition
X3.4-1977 Code for Information Interchange
X3.5-1970 Flowchart Symbols and Their Usage in Information Processing
X3.6-1965 (R1973) Perforated Tape Code for Information Interchange
X3.9-1978 Programming Language FORTRAN
X3.11-1969 Specification for General Purpose Paper Cards for Information Processing
X3.14-1973 Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI)
X3.15-1976 Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission
X3.16-1976 Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange
X3.17-1981 Character Set for Optical Character Recognition (OCR-A)
X3.18-1974 One-Inch Perforated Paper Tape for Information Interchange
X3.19-1974 Eleven-Sixteenths-Inch Perforated Paper Tape for Information Interchange
X3.20-1967 (R1974) Take-Up Reels for One-Inch Perforated Tape for Information Interchange
X3.21-1967 Rectangular Holes in Twelve-Row Punched Cards
X3.22-1973 Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI)
X3.23-1974 Programming Language COBOL
X3.24-1968 Signal Quality at Interface between Data Processing Terminal Equipment and Synchronous Data Communication Equipment for Serial Data Transmission
X3.25-1976 Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the American National Standard Code for Information Interchange
X3.26-1980 Hollerith Punched Card Code
X3.27-1978 Magnetic Tape Labels and File Structure for Information Interchange
X3.28-1976 Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links
X3.29-1971 Specifications for Properties of Unpunched Oiled Paper Perforator Tape
X3.30-1971 Representation for Calendar Date and Ordinal Date for Information Interchange
X3.31-1973 Structure for the Identification of the Counties of the United States for Information Interchange
X3.32-1973 Graphic Representation of the Control Characters of American National Standard Code for Information Interchange
X3.34-1972 Interchange Rolls of Perforated Tape for Information Interchange
X3.36-1975 Synchronous High-Speed Data Signaling Rates between Data Terminal Equipment and Data Communication Equipment
X3.37-1980 Programming Language APT
X3.38-1972 (R1977) Identification of States of the United States (Including the District of Columbia) for Information Interchange
X3.39-1973 Recorded Magnetic Tape for Information Interchange (1600 CPI, PE)
X3.40-1976 Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE)
X3.41-1974 Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange
X3.42-1975 Representation of Numeric Values in Character Strings for Information Interchange
X3.43-1977 Representations of Local Time of the Day for Information Interchange
X3.44-1974 Determination of the Performance of Data Communication Systems
X3.45-1974 Character Set for Handprinting
X3.46-1974 Unrecorded Magnetic Six-Disk Pack (General, Physical, and Magnetic Characteristics)
X3.47-1977 Structure for the Identification of Named Populated Places and Related Entities of the States of the United States for Information Interchange
X3.48-1977 Magnetic Tape Cassettes for Information Interchange (3.810-mm [0.150-Inch] Tape at 32 bpmm [800 bpi], PE)
X3.49-1975 Character Set for Optical Character Recognition (OCR-B)
X3.50-1976 Representations for U.S. Customary, SI, and Other Units to Be Used in Systems with Limited Character Sets
X3.51-1975 Representations of Universal Time, Local Time Differentials, and United States Time Zone References for Information Interchange
X3.52-1976 Unrecorded Single-Disk Cartridge (Front Loading, 2200 BPI) (General, Physical, and Magnetic Requirements)
X3.53-1976 Programming Language PL/I
X3.54-1976 Recorded Magnetic Tape for Information Interchange (6250 CPI, Group Coded Recording)
X3.55-1977 Unrecorded Magnetic Tape Cartridge for Information Interchange, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded
X3.56-1977 Recorded Magnetic Tape Cartridge for Information Interchange, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded
X3.57-1977 Structure for Formatting Message Headings for Information Interchange Using the American National Standard Code for Information Interchange for Data Communication Systems Control
X3.58-1977 Unrecorded Eleven-Disk Pack (General, Physical, and Magnetic Requirements)
X3.59-1981 Magnetic Tape Cassettes for Information Interchange, Dual Track Complementary Return-to-Bias (CRB) Four-States Recording on 3.81-mm (0.150-Inch) Tape
X3.60-1978 Programming Language Minimal BASIC
X3.61-1978 Representation of Geographic Point Locations for Information Interchange
X3.62-1979 Paper Used in Optical Character Recognition (OCR) Systems
X3.63-1981 Unrecorded Twelve-Disk Pack (100 Megabytes) (General, Physical, and Magnetic Requirements)
X3.64-1979 Additional Controls for Use with American National Standard Code for Information Interchange
X3.66-1979 Advanced Data Communication Control Procedures (ADCCP)
X3.72-1981 Parallel Recorded Magnetic Tape Cartridge for Information Interchange, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded
X3.73-1980 Single-Sided Unformatted Flexible Disk Cartridge (for 6631-BPR Use)
X3.74-1981 Programming Language PL/I, General-Purpose Subset
X3.76-1981 Unformatted Single-Disk Cartridge (Top Loading, 200 tpi 4400 bpi) (General, Physical, and Magnetic Requirements)
X3.77-1980 Representation of Pocket Select Characters in Information Interchange
X3.79-1981 Determination of Performance of Data Communications Systems That Use Bit-Oriented Communication Procedures
X3.80-1981 Interfaces between Flexible Disk Cartridge Drives and Their Host Controllers
X3.82-1980 One-Sided Single-Density Unformatted 5.25-Inch Flexible Disk Cartridge (for 3979-BPR Use)
X3.83-1980 ANSI Sponsorship Procedures for ISO Registration According to ISO 2375
X3.84-1981 Unformatted Twelve-Disk Pack (200 Megabytes) (General, Physical, and Magnetic Requirements
X3.85-1981 1/2-Inch Magnetic Tape Interchange Using a Self Loading Cartridge
X3.86-1980 Optical Character Recognition (OCR) Inks
X3.88-1981 Computer Program Abstracts
X3.89-1981 Unrecorded Single-Disk, Double-Density Cartridge (Front Loading, 2200 bpi, 200 tpi) (General, Physical, and Magnetic Requirements)
X3.92-1981 Data Encryption Algorithm
X3.93M-1981 OCR Character Positioning

X3/TR1-77 Dictionary for Information Processing (Technical Report)

American National Standards Institute, Inc
1430 Broadway
New York, N.Y. 10018