INTERNATIONAL STANDARD ISO 1004

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Information processing — Magnetic ink character recognition — Print specifications

Traitement de l'information — Reconnaissance des caractères magnétiques imprimés — Spécifications d'impression

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 1004-1976, the second edition of this International Standard, has been drawn up by Technical Committee ISO/TC 97, *Computers and information processing*, and contains the modifications which were circulated, in the form of Amendment 1, to the ISO member bodies in October 1975.

This amendment has been approved by the member bodies of the following countries :

Australia	Hungary	Switzerland
Belgium	Italy	Turkey
Brazil	Japan	United Kingdom
Canada	Mexico	U.S.A.
France	Romania	Yugoslavia
Germany	South Africa, Rep. of	

No member body expressed disapproval of the document.

This second edition cancels and replaces the first edition (i.e. ISO 1004-1969), which had been approved by the member bodies of the following countries :

Argentina	Denmark	New Zealand
Australia	France	Portugal
Austria	Germany	Spain
Belgium	Ireland	Sweden
Brazil	Israel	Switzerland
Chile	Italy	United Kingdom
Czechoslovakia	Japan	U.S.S.R.
Egypt, Arab Rep. of	Netherlands	

No member body had expressed disapproval of the document.

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Information processing — Magnetic ink character recognition — Print specifications

SECTION ONE — FONT E 13 B

1 SCOPE AND FIELD OF APPLICATION

1.1 Scope

Section one of this International Standard specifies the shapes, dimensions and tolerances for the ten digits and four special symbols to be 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 Field of application

The characters specified in Section one of this International 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 CHARACTER CONFIGURATION

2.1 Designation

The series of standard magnetic ink characters consists of ten digits and four special symbols. They are 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

2.2 Dimensions

Detailed dimensions and the reference centre lines of the printed characters for Strokes 0 to 13 are shown in figures 1 to 14 inclusive. Figure 15 illustrates the character design matrix. Dimensions of the printed characters are as follows :

1)	character height	2,972 mm	(0.117 in)
2)	character widths	1,321 mm 1,651 mm 1,981 mm 2,311 mm	(0.052 in) (0.065 in) (0.078 in) (0.091 in)
3)	width of horizontal and vertical bars	0,330 mm	(0.013 in)
4)	minimum width of horizontal bars (this specification does not apply to vertical bars, see 5.5)	0,279 mm	(0.011 in)
5)	corner radii (except Stroke 0, see figure 1)	0,165 mm	(0.006 5 in)
6)	tolerance (average edge)	± 0,038 mm	(± 0.001 5 in)

3 CHARACTER SPACING AND ALIGNMENT

3.1 Spacing of characters

3.1.1 *Common fields (fixed format)*

3.1.1.1 The distance between the right average edge of adjacent characters shall be 3,175 ± 0,254 mm (0.125 ± 0.010 in) (see figure 16).

(Average edge is defined and discussed in clause 5.)

3.1.1.2 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.

1) As used in this International Standard, the term "magnetic ink" means ink capable of being magnetized and sensed.

3.1.2 *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 2,921 mm (0.115 in). This also applies to variable format fields. Maximum or other spacing requirements in variable fields shall be specified by the individual machine manufacturer involved.

3.2 Alignment of characters

3.2.1 *Definition*

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

3.2.2 *Tolerances*

Vertical alignment tolerance is that which is consistent with good printing practice and subject to the following interpretations :

a) 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 by more than 0,381 mm (0.015 in) (see figure 17);

b) on characters that do not come down to the "base" line (see figures 13, 14 and 16), the tolerance specified in a) applies to the horizontal centre line.

4 CHARACTER SKEW

The maximum allowable character skew is ± 1°30′ measured with respect to the bottom edge of the document. (See figure 18.)

5 CHARACTER TOLERANCES

5.1 Dimensions

See figures 1 to 14 for dimensions of printed characters.

5.2 Definition of "average edge"

average edge : An imaginary line that divides the irregularities along the edge of a printed character so 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 figure 19). (The typical edge of a printed character is not a straight line.)

5.3 Average edge tolerance

The average edge tolerance for all stroke edges shall be ± 0,038 mm (± 0.001 5 in) applied to the dimensions (measured from $\mathbb{C}$ and $\mathbb{C}_H$) that locate the edges. A typical illustration of this tolerance is shown in figure 20.

The average edge of the radii shall be tangential to the average edge of the stroke and shall fall within the ± 0,038 mm (± 0.001 5 in) tolerance specified for stroke edges. (See 2.2.)

5.4 Edge irregularity tolerance

5.4.1 Peaks and valleys about the average edge are permitted to extend to ± 0,089 mm (± 0.003 5 in) from the dimension locating the edge. An example is shown in figure 21. However, when these occur the sum of the edge present in the 0,038 to 0,089 mm (0.001 5 in to 0.003 5 in) zone shall not exceed 25 % of the total edge.

5.4.2 An occasional void can be present at the edge and cause a valley that exceeds the limits mentioned above. The maximum allowable size of such voids is specified in clause 6.

5.4.3 An occasional excursion (such as feathering or stringing out) can be present at the edge and extend beyond the 0,038 to 0,089 mm (0.001 5 to 0.003 5 in) 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 clause 8.

In measuring the size of such excursions, only that portion that extends beyond the 0,089 mm (0.003 5 in) limit mentioned in 5.4.1 should be considered since the portion of the excursion in the 0,038 to 0,089 mm (0.001 5 to 0.003 5 in) zone is controlled by character edge irregularity limits given in 5.4.1.

5.5 Minimum width of horizontal bars

The distance between the average edges of any horizontal bar shall be at least 0,279 mm (0.011 in). (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 the dimensions locating each edge.)

6 VOIDS

6.1 Definition

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

6.2 Maximum allowable single void

6.2.1 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 0,203 mm x 0,203 mm (0.008 in x 0.008 in) square, with the following exception :

If the portion of the character involving a single void is two or more zones wide [each zone is 0,330 mm (0.013 in) wide], then the maximum allowable single void must be completely surrounded by ink and contained entirely within the boundary of a 0,254 mm x 0,254 mm (0.010 in x 0.010 in) square.

In this case, voids at edges are not included and are, therefore, limited to a 0,203 mm x 0,203 mm (0.008 in x 0.008 in) square. (See figure 22.)

6.2.2 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 0,051 mm (0.002 in), average edge to average edge.

6.3 Maximum allowable combined voids

The combined area of all voids, in any vertical column or horizontal row nominally 0,330 mm (0.013 in) wide, shall not exceed 20 % of the area of the column or row. (See figure 23.)

7 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 0,038 mm (0.001 5 in) between its average edges. Such ridges are predominant in letterpress printing and some impact printing.

8 EXTRANEOUS INK (MAGNETIC)

8.1 Definition

extraneous ink : Magnetic ink, other than the printed character, located within the 15,875 mm (0.625 in) common language clear band. It is usually described as splatter, smear, tracking, feathering, stringing out, toning, back offset, background, etc.

8.2 Limitations

8.2.1 *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 within a 0,076 mm x 0,076 mm (0.003 in x 0.003 in) square are defined as "visible"; however, random occasional spots that are "visible" are acceptable provided that they can be contained within a 0,102 mm X 0,102 mm (0.004 in x 0.004 in) square and they are limited to one per 3,175 mm (0.125 in) character space and total not more than five per field. Spots that cannot be contained in a 0,102 mm x 0,102 mm (0.004 in x 0.004 in) 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".

8.2.2 *Extraneous ink back*

Extraneous magnetic ink on the reserve side of the clear band 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 within a 0,152 mm x 0,152 mm (0.006 in x 0.006 in) square, or an equivalent area, are not acceptable.

9 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 0,025 mm (0.001 in) in depth on the front of the document.

10 SIGNAL LEVEL

10.1 Definitions

10.1.1 signal level : The amplitude of the voltage wave form produced when a d.c. 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 figure 24.

10.1.2 nominal signal level : The signal obtained from a reference standard printing sample (designated as the "November 30, 1967, Reference Document"; see 10.1.4) when suitable test equipment is used (see 10.2 and annex A, figure 28).

This reference standard, maintained in a vault, consists of a set of 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.

10.1.3 relative signal level : 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 %.

The signal level of the character being measured is obtained using suitable procedures and testing equipment. (See 10.2, 10.3 and 10.4).

10.1.4 secondary reference documents : Paper documents printed in magnetic ink with the characters of the E 13 B 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 % of the nominal signal level. One or more characters on a secondary reference document are marked to indicate the actual relative signal level of that character.[1)]

10.2 Test equipment and parameters

Test equipment described below, or its equivalent, is suitable for measuring signal level.

10.2.1 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 d.c. 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.

The transport shall move the document at the rate of 3,81 m (150 in) per second within 2 %. Combined character skew from all causes shall not exceed 1°30′ relative to the centre line of the reading head gap.

10.2.2 A d.c. 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. The leading pole relative to the printed character is to be the north pole.

10.2.3 A single-gap, magnetic reading head mounted with the long axis of the gap perpendicular to the bottom reference edge and parallel to 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.

The reading head shall have a 0,076 mm (0.003 in) gap and a minimum resonant frequency of 40 kHz. The height of the reading head gap shall be sufficient to scan the 5,875 mm (0.625 in) clear band (see 12.2). 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 % reference material.[2)]

10.2.4 A linear amplifier to amplify the output of the magnetic reading head for presentation on an oscilloscope. The amplifier has the following characteristics :

10.2.4.1 Gain

The amplifier gain shall be such that an input sine wave of 10 ± 0,2 mV peak to peak, at 1 kHz, produces a sine wave output of 2,4 ± 0,4 V peak to peak.

10.2.4.2 Frequency response

a) The amplifier gain must not vary by more than ± 0,5 dB from 1 kHz gain over a frequency range of 200 Hz to 3 kHz.

b) The amplifier gain between the frequencies 200 Hz and 75 Hz must not drop more than 3 dB below the 1 kHz gain.

c) The amplifier gain below 75 Hz must not exceed the 1 kHz gain.

d) The amplifier gain above 3 kHz must drop on a smooth curve such that at 5,1 ± 0,6 kHz the gain is 3 dB below the 1 kHz gain, and at 11,2 ± 1,2 kHz the gain is 12 dB below the 1 kHz gain.

NOTE – A gain 3 dB below a reference value is 0,707 of the reference value; a gain 12 dB below a reference value is 0,25 of the reference value.

10.2.4.3 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 dB per octave per stage or 24 dB per octave for the four stages.

1) Secondary reference documents may be obtained from the custodian of the "November 30, 1967, Reference Document" at the following address : Bank Administration Institute, P.O. Box 500, Park Ridge, Illinois 60068, U.S.A.

1) The Brush Clevite reading head No. BK 3806/S 7165, or its equivalent, is suitable.

10.2.4.4 LINEARITY

At any frequency within the range from 75 Hz to 11,2 ± 1,2 kHz, the amplifier gain must be linear within ± 0,5 dB for an input voltage range of 3 to 25 mV peak to peak.

10.2.4.5 NOISE

With the input connection to ground, the noise output shall not exceed a voltage of 0,1 mV peak to peak, which is equivalent to 1 % of the nominal signal level.

A circuit diagram of a suitable amplifier is given in annex A (figure 26).

10.2.5 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. The oscilloscope may be of any commercially available type intended for laboratory measurement, equipped with a reticle bearing horizontal rulings.[1)]

10.3 Testing procedure

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

10.3.2 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 below) from which the average amplitude may be measured. If it is desired to measure other characters, the peaks as shown in annex A, figure 27, should be used. The vertical gain of the oscilloscope is then adjusted so that the deflection to the uppermost division of the reticle corresponds to the base line to positive peak amplitude of 200 % relative signal level. This may be done as follows :

10.3.2.1 Determine the number of major divisions on the reticle in the vertical direction.

10.3.2.2 Divide this number by two.

10.3.2.3 Multiply this result by the relative signal level percentage on 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 is 104 %.

$$\text{Number of divisions} = \frac{8}{2} \times \frac{104}{100} = 4{,}16.$$

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 % relative signal level for the character which was used to make the calibration.

NOTE – On secondary reference documents (see 10.1.4), the two positive peaks resulting from two identical bars will not differ in amplitude by more than 10 %.

10.3.3 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 10.3.2, dividing this by the number of divisions corresponding to 100 %, and multiplying by 100 %.

Example :

Calibration as in 10.3.2.

Deflection of unknown sample is 4,4 divisions.

$$\text{Relative signal level of unknown sample} = \frac{4{,}4}{4{,}0} \times 100\,\% = 110\,\%.$$

10.3.4 Another optional method for calibration is as follows :

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

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

Then place the vertical position of the free-running trace, whith no document in transport, at the 0 % line.

Place the secondary reference standard in transport and adjust the vertical gain of the oscilloscope so that the highest single positive peak, or the average of similar positive peaks, reads a value on the oscilloscope graduations that is identical to the value designated on the reference document.

1) The Tektronix oscilloscope Type 560 or 561, with Type 50 and 51 Plug-in Modules, or the equivalent, is suitable.

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.

10.4 Relative signal level tolerance

The relative signal level from any printed character may vary from 50 to 200 % of its nominal signal level.

10.5 Residual signal level

residual signal level : The signal delivered by a character which has been voided.

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

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

11 PAPER

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

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

12 FORMAT

12.1 Reference edges

12.1.1 *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 7,925 ± 1,575 mm (0.312 ± 0.062 in) from the right-hand reference edge. (See figure 25.)

12.1.2 *Vertical dimensions*

All vertical format dimensions are measured from the bottom edge of the document.

12.2 Clear band

clear band : A band 15,875 mm (0.625 in) wide that must be free of any magnetic ink, other than prints of the E 13 B font, and whose vertical location on a document is determined by the application involved. The encoding strip must be located within the clear band. Fonts E 13 B and CMC 7 shall not be permitted in the same clear band or adjacent clear bands on any document.

Dimensions in millimetres

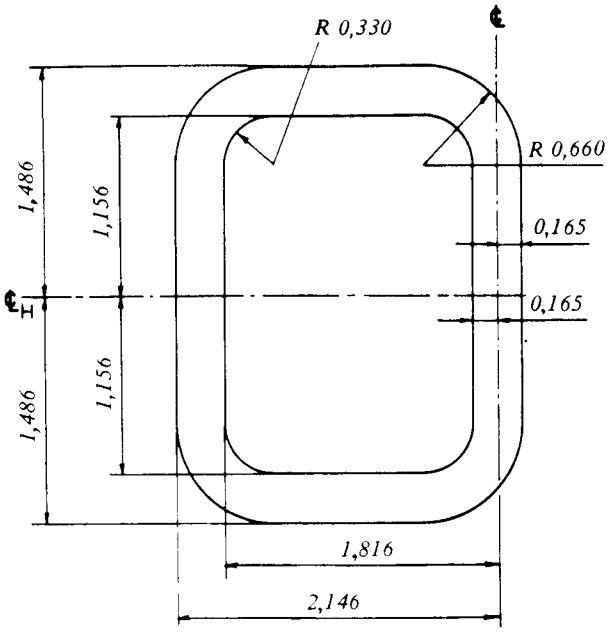


FIGURE 1 — **Stroke 0 (Zero)**

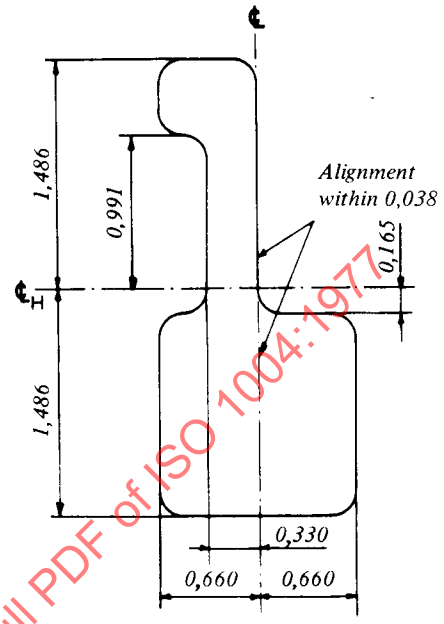


FIGURE 2 — **Stroke 1 (One)**

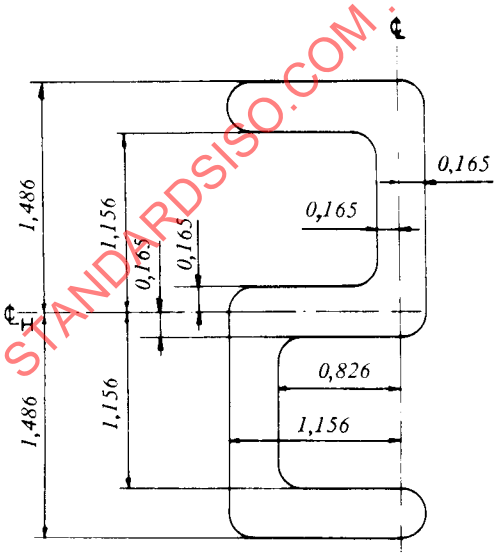


FIGURE 3 — **Stroke 2 (Two)**

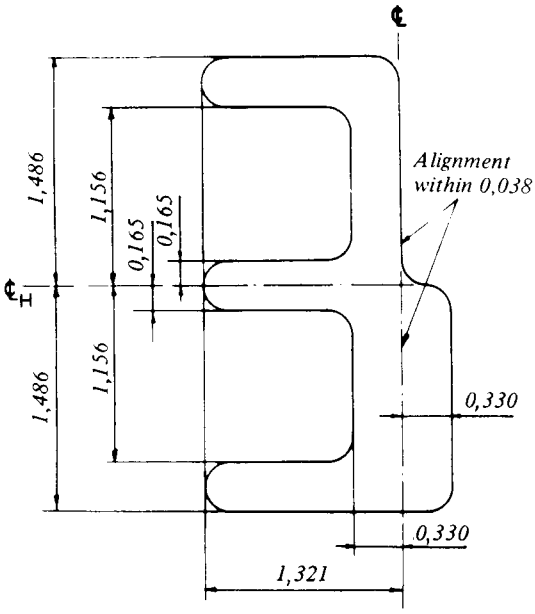


FIGURE 4 — **Stroke 3 (Three)**

Dimensions in millimetres

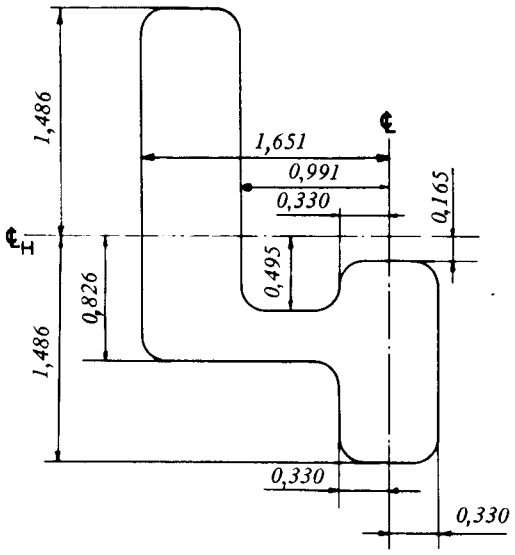


FIGURE 5 – **Stroke 4 (Four)**

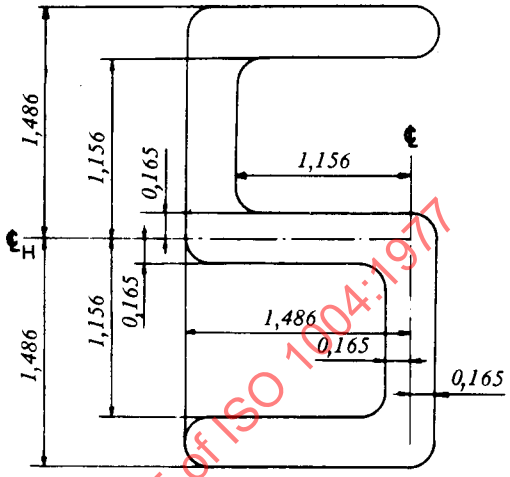


FIGURE 6 – **Stroke 5 (Five)**

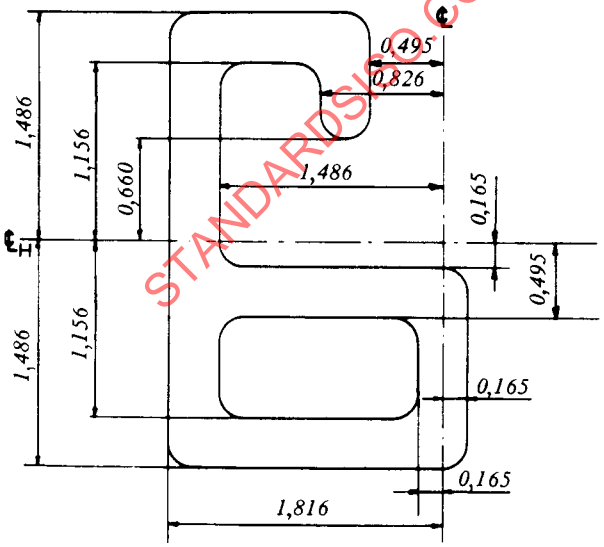


FIGURE 7 – **Stroke 6 (Six)**

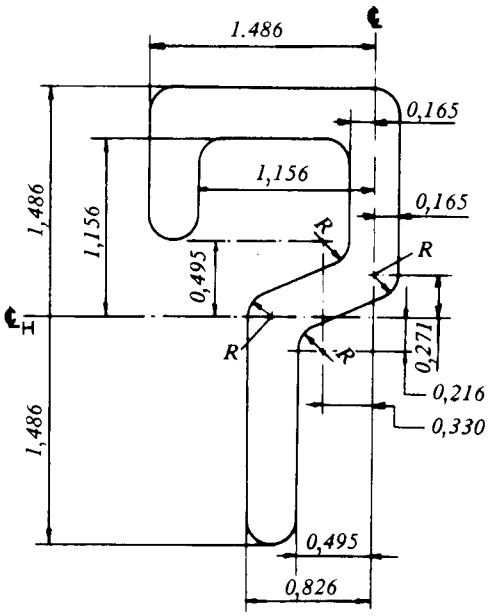


FIGURE 8 – **Stroke 7 (Seven)**

Dimensions in millimetres

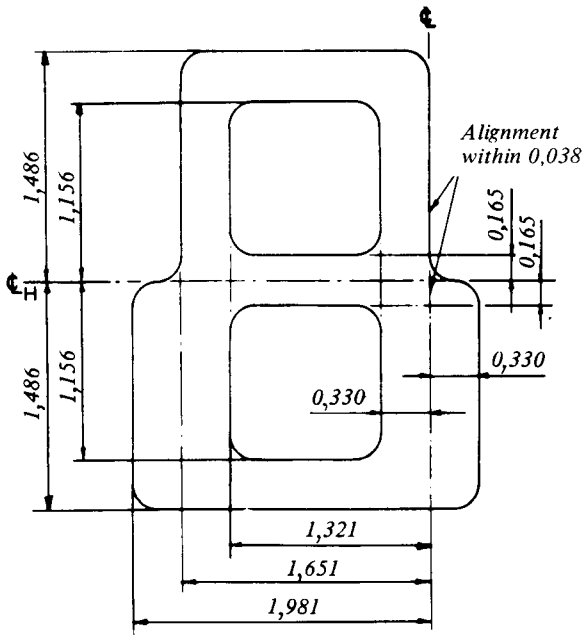


FIGURE 9 — **Stroke 8 (Eight)**

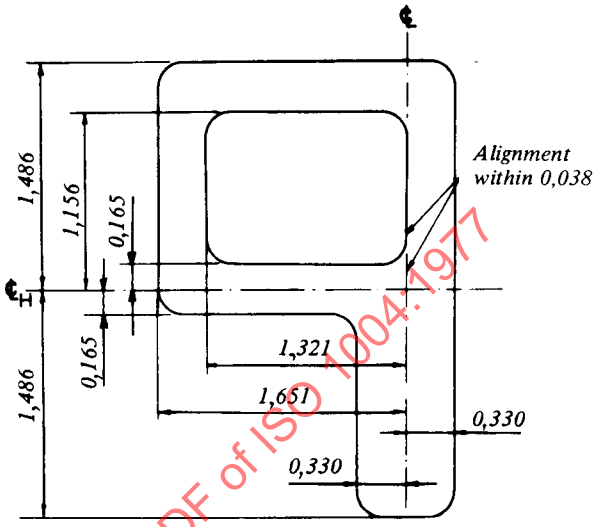


FIGURE 10 — **Stroke 9 (Nine)**

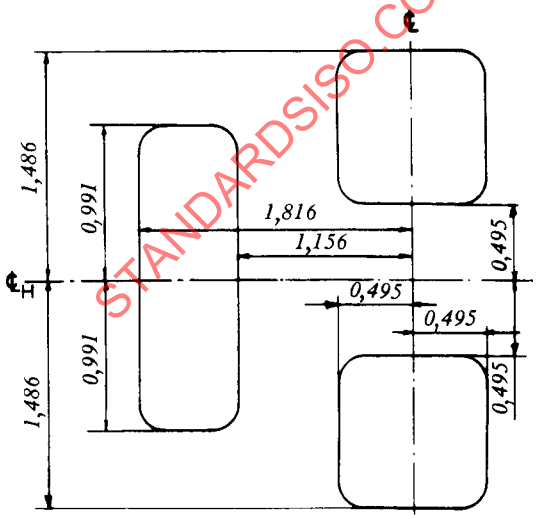


FIGURE 11 — **Stroke 10 (Symbol 1)**

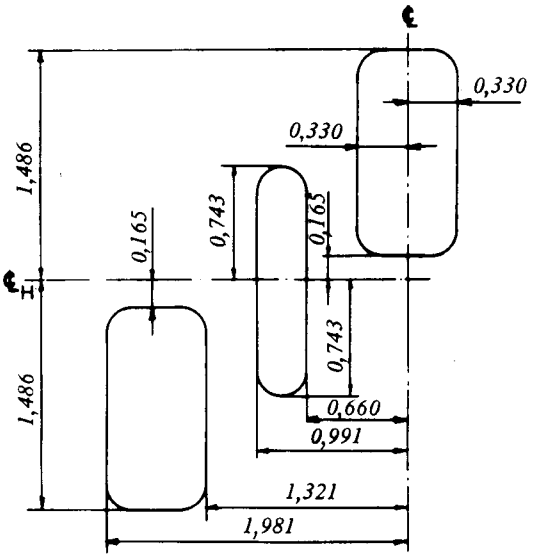


FIGURE 12 — **Stroke 11 (Symbol 2)**

Dimensions in millimetres

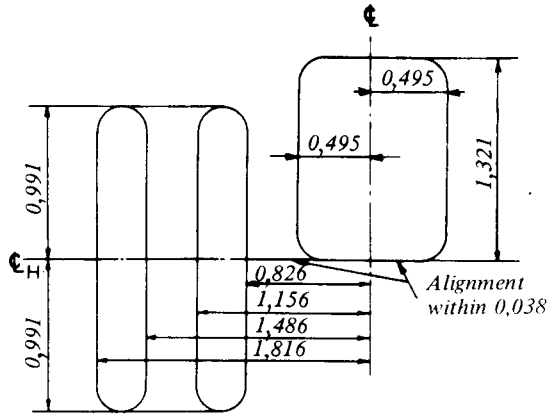


FIGURE 13 – **Stroke 12 (Symbol 3)**

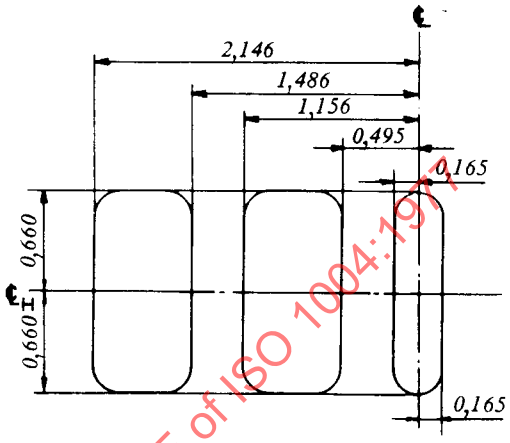


FIGURE 14 – **Stroke 13 (Symbol 4)**

NOTES CONCERNING FIGURES 1 TO 14

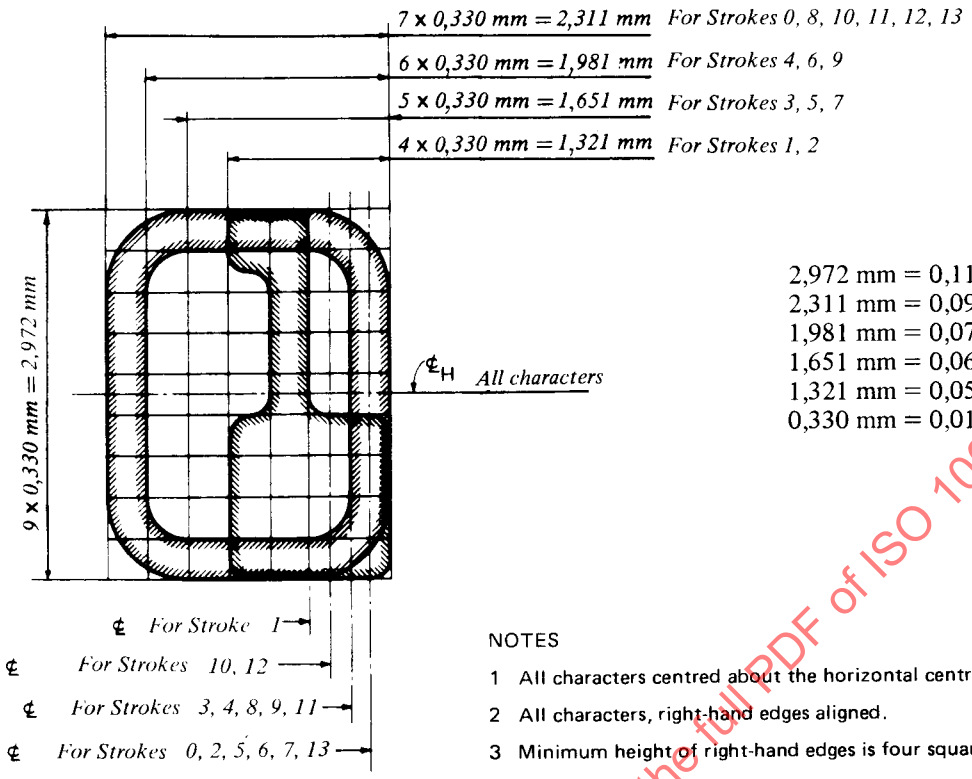
1 All radii are 0,165 mm (0.006 5 in), except for Stroke 0 (Zero).

2 All radii shall be blended with adjacent edges.

3 Tolerance : ± 0,038 mm (± 0.001 5 in).

4 Minimum width of horizontal bars is 0,279 mm (0.011 in). This specification does not apply to vertical bars.

5 Dimensions are in millimetres. (For values in inches, see annex B.)



NOTES

1 All characters centred about the horizontal centre line.

2 All characters, right-hand edges aligned.

3 Minimum height of right-hand edges is four squares.

FIGURE 15 – **Character design matrix.**
This is a 7 × 9 matrix of 0,330 mm (0.013 in) squares

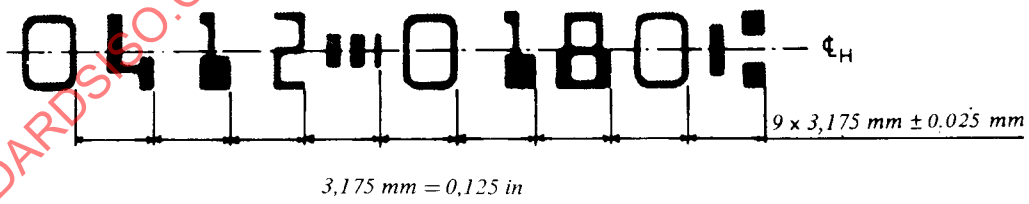


FIGURE 16 – **Distance between characters**

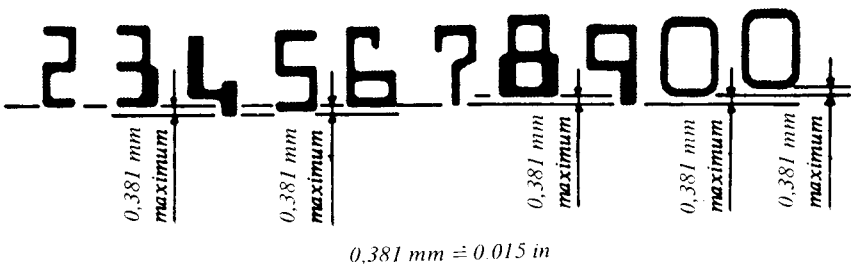


FIGURE 17 – **Allowable variation in vertical alignment**

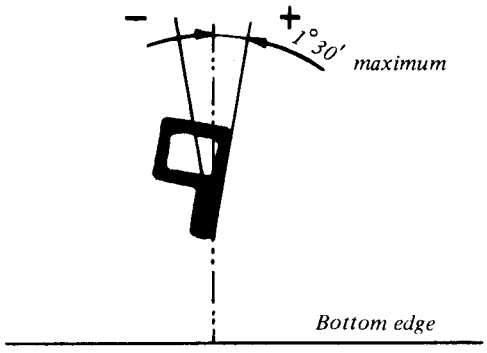


FIGURE 18 — **Allowable character skew**

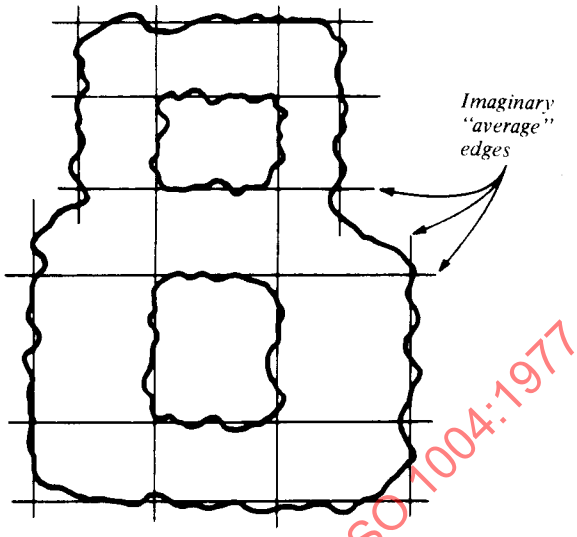


FIGURE 19 — **Average edge**

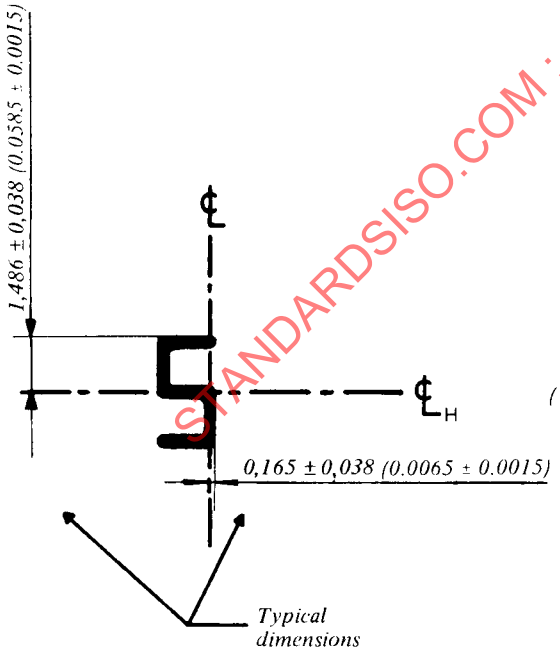


FIGURE 20 — **Average edge tolerance**

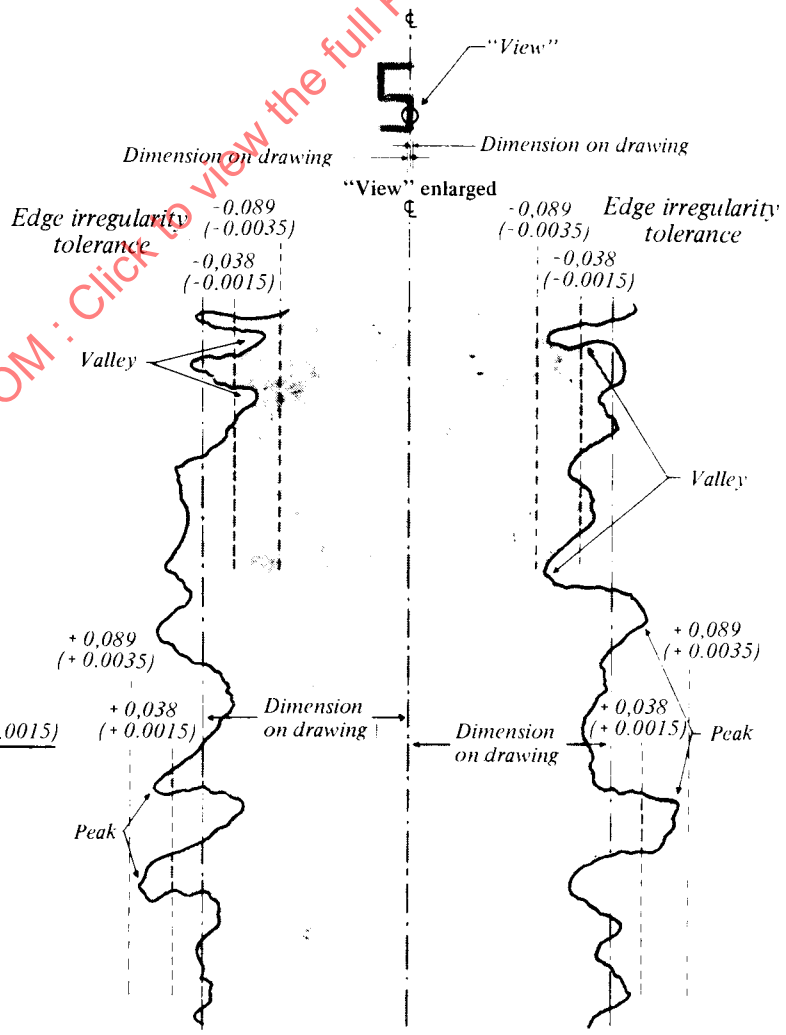


FIGURE 21 — **Edge irregularity**

NOTE — Figures 20 and 21 : Dimensions in millimetres with inch values in parentheses.

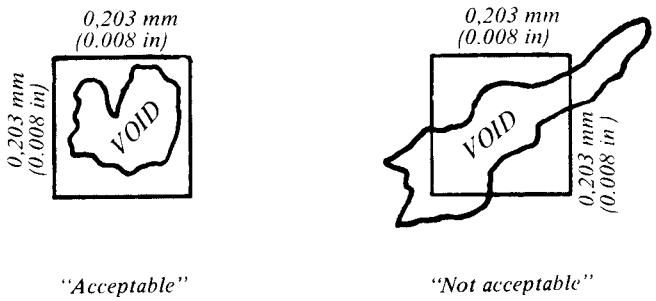


FIGURE 22 — **Examples of single voids**

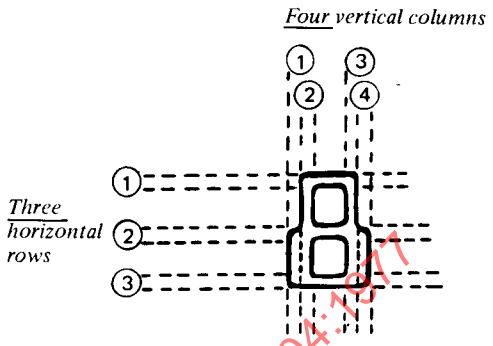


FIGURE 23 — **Example of rows and columns**

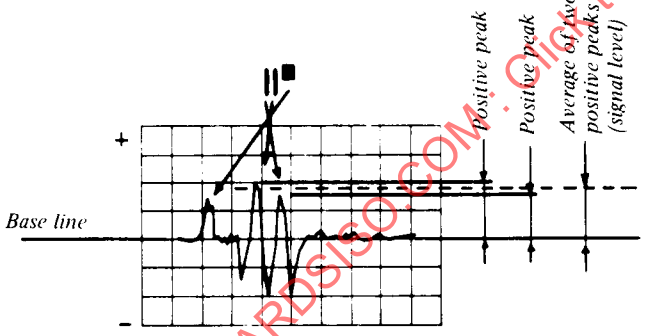


FIGURE 24 — **Wave form as it appears on face of oscilloscope**

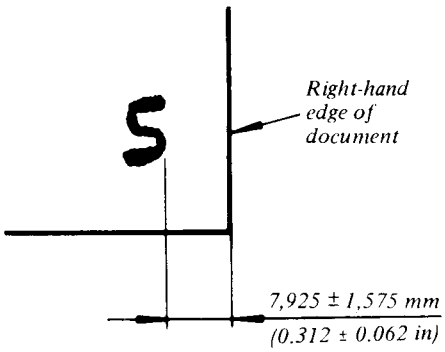


FIGURE 25 — **Distance of right-hand character from right-hand reference edge**

ANNEX A

LINEAR AMPLIFIER, PEAKS FOR CALIBRATING CHARACTERS, AND SIGNAL LEVEL REFERENCE

A circuit diagram of a suitable linear amplifier for determining the output of the magnetic reading heads as described in 10.2.4 is given below.

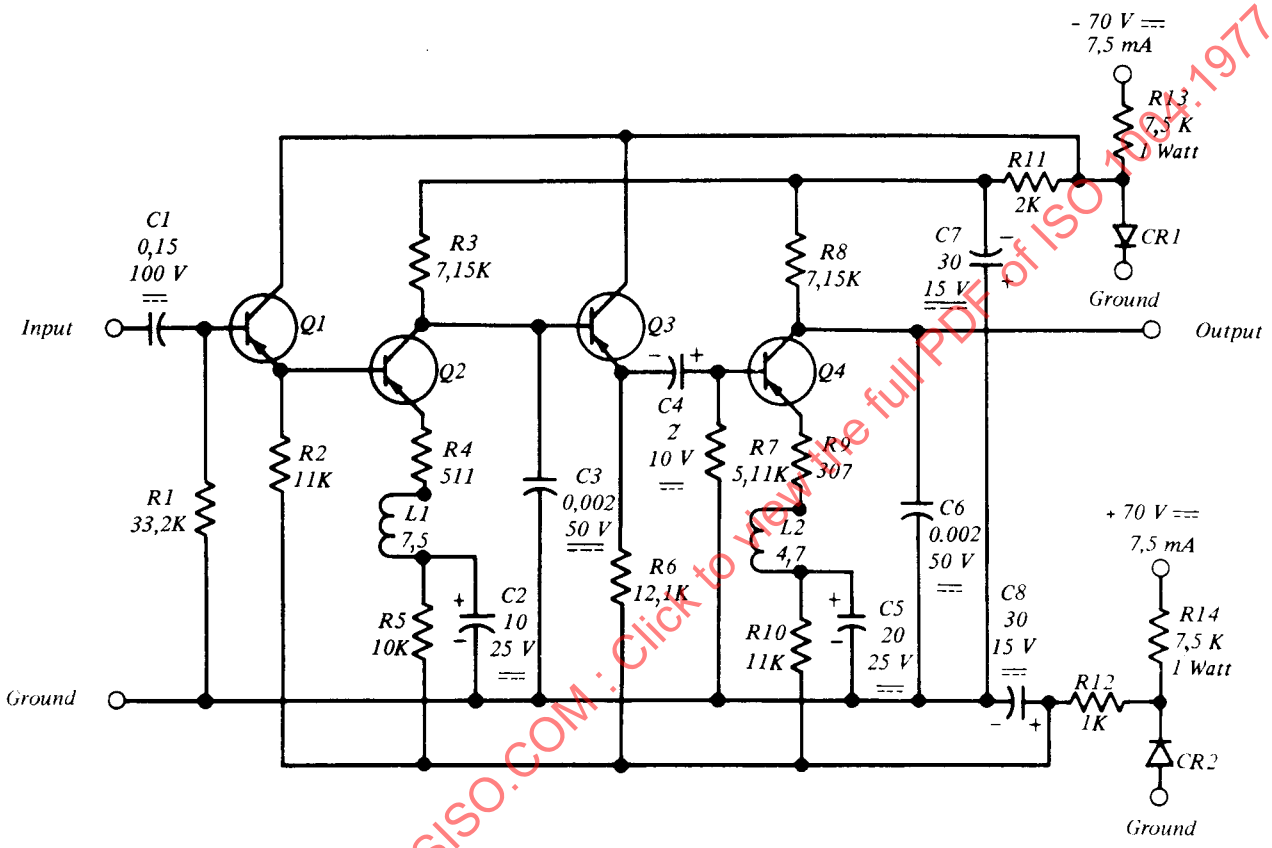


FIGURE 26 – **Circuit diagram of a linear amplifier**

NOTES

1 L1 and L2 are powdered iron core inductors, in millihenries (mH).

2 C1 to C8 inclusive are capacitors, in microfarads (μf).

3 R1 to R14 inclusive are resistors, in ohms; K = 1 000; 1/4 watt unless otherwise specified.

4 Q1, Q2, Q3 and Q4 are transistors, Type 2N 527.

5 CR1 and CR2 are diodes, Type 1N 766.

Peaks for calibrating all characters

Character	Peak [1]	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 and 5 (average)	67
▪ ▪	3	105
▪ ▪	1 and 5 (average)	70
▪▪	3 and 5 (average)	100

1) Counting vertical edges right to left on the printed character; counting peaks left to right on the displayed wave forms and including positive and negative peaks.

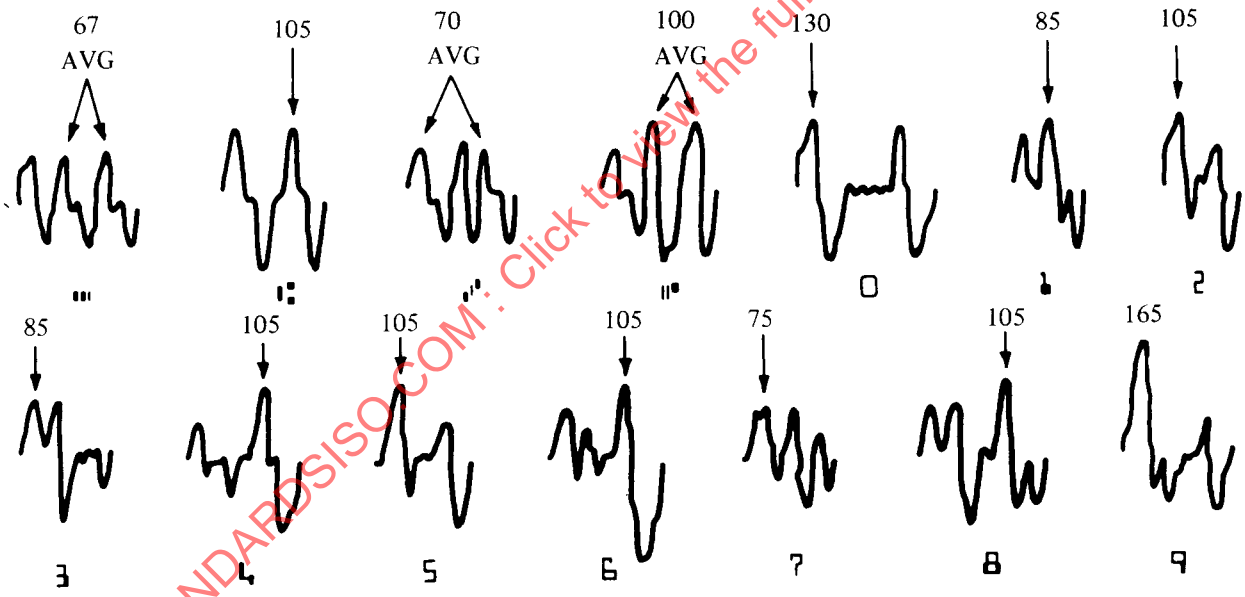


FIGURE 27 — **Wave form peaks for signal level measurement**

E 13 B SECONDARY SIGNAL LEVEL REFERENCE C 0000

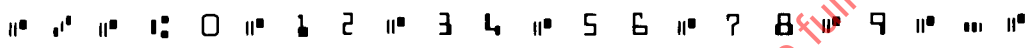
References :

[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] Information processing — Magnetic ink character recognition — Print specifications, International Standard ISO 1004-1976. Geneva : International Organization for Standardization, March 1976, 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.
Reference [2] is available from American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

FIGURE 28 — **Illustration of secondary signal level reference document**

ANNEX B

EQUIVALENT METRIC-INCH DIMENSIONS USED IN FONT E 13 B

millimetres	inches	millimetres	inches
0,025	0.001 0	0,826	0.032 5
0,038	0.001 5	0,991	0.039 0
0,051	0.002 0	1,156	0.045 5
0,076	0.003 0	1,321	0.052 0
0,089	0.003 5	1,486	0.058 5
0,102	0.004 0	1,575	0.062 0
0,152	0.006 0	1,651	0.065 0
0,165	0.006 5	1,816	0.071 5
0,178	0.007 0	1,981	0.078 0
0,203	0.008 0	2,146	0.084 5
0,216	0.008 5	2,311	0.091 0
0,254	0.010 0	2,921	0.115 0
0,279	0.011 0	2,972	0.117 0
0,330	0.013 0	3,175	0.125 0
0,495	0.019 5	7,925	0.312 0
0,660	0.026 0	15,875	0.625 0
0,744	0.029 3		

SECTION TWO – FONT CMC 7

13 SCOPE AND FIELD OF APPLICATION

13.1 Scope

Section two of this International Standard specifies the shapes, dimensions and tolerances for the ten digits 0 to 9, five symbols, and twenty-six letters, to be printed with magnetic ink[1] 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.

13.2 Field of application

The characters specified in Section two of this International 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.

14 CHARACTER CONFIGURATION

14.1 Code description

The coded character is composed of six intervals contained within seven strokes cut to the shape of a conventional character.

Two interval widths are used : "long" and "short". It is the combination of these "long" and "short" intervals that determines the character code.

Two long and four short intervals may be combined in fifteen possible ways (C_2^6) – a total which is available for the ten digits and five symbols.

The alphabetic code uses one or three long intervals, allowing a total of $C_1^6 + C_3^6 = 26$ combinations which are thus available for twenty-six letters.

The adjacent table shows the correspondence between the codes and the characters. The intervals are numbered 1 to 6 from left to right on the printed character. Their values are represented by the digit 0 for short intervals and by the digit 1 for long intervals.

1	*2*	*3*	*4*	*5*	*6*	
1	0	0	0	1	0	**1**
0	1	1	0	0	0	**2**
1	0	1	0	0	0	**3**
1	0	0	1	0	0	**4**
0	0	0	1	1	0	**5**
0	0	1	0	1	0	**6**
1	1	0	0	0	0	**7**
0	1	0	0	1	0	**8**
0	1	0	1	0	0	**9**
0	0	1	1	0	0	**0**
1	0	0	0	0	1	**S I**
0	1	0	0	0	1	**S II**
0	0	1	0	0	1	**S III**
0	0	0	1	0	1	**S IV**
0	0	0	0	1	1	**S V**

1	*2*	*3*	*4*	*5*	*6*	
0	1	0	0	0	0	**A**
1	0	1	0	1	0	**B**
0	0	0	1	1	1	**C**
1	0	0	1	1	0	**D**
0	0	0	1	0	0	**E**
0	0	1	0	1	1	**F**
1	0	0	0	1	1	**G**
1	0	1	1	0	0	**H**
0	0	0	0	0	1	**I**
1	0	1	0	0	1	**J**
0	1	1	0	1	0	**K**
0	1	0	0	1	1	**L**
0	0	1	1	1	0	**M**
0	0	1	0	0	0	**N**
1	0	0	0	0	0	**O**
0	1	0	1	1	0	**P**
1	1	1	0	0	0	**Q**
0	1	1	1	0	0	**R**
0	1	0	1	0	1	**S**
0	0	0	0	1	0	**T**
1	1	0	1	0	0	**U**
1	1	0	0	0	1	**V**
1	0	0	1	0	1	**W**
1	1	0	0	1	0	**X**
0	1	1	0	0	1	**Y**
0	0	1	1	0	1	**Z**

14.2 Configuration

There are four font heights (see 20.5) : 3,20 mm (0.1260 in), 3,00 mm (0.1181 in), 2,85 mm (0.1122 in) and 2,70 mm (0.1063 in). Figures 31 to 51 give full details of the alphanumeric character set and symbols.

15 MEANS OF AUTOMATIC SENSING

The automatic character recognition takes place by means of identification of the interval lengths between adjacent strokes. Stroke sensing takes place magnetically.

1) As used in this International Standard, the term "magnetic ink" means ink capable of being magnetized and sensed.

16 REFERENCE EDGES OF DOCUMENTS

For the purpose of measuring the printed image, the right-hand and bottom edges are the reference edges of the document.

17 PRINT LOCATION

17.1 Horizontal location

The extreme right mean edge of the printed line should be located at least 6,0 mm (0.236 in) from the right reference edge of the document. The distance between the left-hand edge of the document and the extreme left mean edge in the printed line should be at least 4,0 mm (0.157 in). In some cases, by agreement between the parties concerned, this latter distance may be reduced to 2,0 mm (0.079 in). System consideration may dictate a 6,0 mm (0.236 in) minimum margin on both sides, if the document is to be readable in both directions.

17.2 Vertical location

The characters must be printed entirely within a printing band 6,4 mm (0.252 in) high. The bottom edge of this printing band is located 4,8 mm (0.189 in) above and parallel to the bottom reference edge of the document.

This sub-clause (17.2) does not apply to punched cards.

18 CLEAR BAND

Over the whole length and on both sides of the document a clear band, 16 mm (0.625 in) measured from the bottom edge of the document, must be free from any magnetic ink other than CMC 7 characters. Under no circumstances may CMC 7 characters be printed within the clear band using non-magnetic ink.

CMC 7 and E 13 B fonts shall not be permitted in the same clear band on any document.

19 CHARACTER SPACING AND ALIGNMENT

19.1 Horizontal character spacing

19.1.1 *Character pitch B*

The distance between the orthogonal projections upon the bottom reference edge of the extreme right mean edges (see 20.6) at mid-character height of adjacent characters. The *nominal character pitch B* may be as small as 3,17 mm (0.125 in) (which means at most eight characters per inch). The *horizontal spacing* between adjacent characters must be such that a *minimum intercharacter distance* D_m is maintained.

19.1.2 *Intercharacter distance D between two adjacent characters*

The distance between the orthogonal projections upon the bottom reference edge of the right mean edges (see 20.6) at mid-character height of the left-hand stroke of the right-hand character and the right-hand stroke of the left-hand character.

19.1.3 *Minimum intercharacter distance*

$D_{m1} = 0{,}67$ mm (0.0264 in) if the right-hand character has one or two long intervals, and $D_{m2} = 0{,}50$ mm (0.0197 in) if the right-hand character has three long intervals.

19.1.4 *Character width A*

The distance between the right mean edges of the outermost strokes of a character. The nominal values for characters with one, two and three long intervals respectively, are as follows :

$A_1 = 2{,}0$ mm (0.079 in)
$A_2 = 2{,}2$ mm (0.087 in)
$A_3 = 2{,}4$ mm (0.094 in)

19.2 Vertical misalignment

19.2.1 *Definition*

vertical misalignment : The deviation of the printed character from the nominal vertical position on the document.

19.2.2 *Limitation*

Vertical misalignment should be consistent with good printing practice and can be tolerated as far as the characters are completely contained in the printing band (see 17.2) of the document.

20 CHARACTER DEFINITIONS AND TOLERANCES

20.1 stroke : One or more *segments.*

20.2 segment height h : The distance between the top and bottom of that segment.

20.3 stroke height M : The sum of the heights of the segments contained in that stroke.

20.4 character height H_c : The distance between the top and the bottom of that character.

20.5 font height H_f : The nominal height of the highest character of the font.

20.6 stroke edge zones and mean edges

20.6.1 printed edge zone : Printed edge zones are located at both edges of all strokes, each one being defined by two parallel lines having a fixed distance – the printed edge zone width b – from each other. The value of b is 0,06 mm (0.0024 in).

There are fourteen printed edge zones in a character. Each printed edge zone extends over the full height of the stroke, excluding intersegment interruptions and segment end zones.

20.6.2 mean edge : The centre line of the printed edge zone dividing the irregularities of the printed edge, contained in the printed edge zone, in such a way that the sum of the non-inked areas on the stroke side is equal to the sum of the inked areas on the space side. If this sum is minimized, the centre line is then called *theoretical mean edge.*

20.6.3 theoretical mean edge : The fourteen theoretical mean edges of a character are used to determine the skew angle of the character (see 20.7); in this case the fourteen mean edges of a character need not be parallel to each other.

20.6.4 practical mean edge : For practical measurements, parallel mean edges are used, placed so that their direction is the average direction of the fourteen theoretical mean edges. Such parallel mean edges are called *practical mean edges.*

20.7 skew angle α : The angle between any practical mean edge and a line perpendicular to the bottom reference edge. The absolute value of the skew angle of a character must not exceed $1^\circ 30'$.

20.8 stroke width L : The distance between the right and left mean edges of a stroke. Its value must lie within the range 0,10 to 0,19 mm (0.0039 to 0.0075 in).

20.9 stroke interval P : The distance between the right mean edges of adjacent strokes *or* the distance between left mean edges of adjacent strokes. The value of the tolerances depends on the value of α as specified in 20.9.1 and 20.9.2.

20.9.1 *Right mean edges* P_{R1} *and* P_{R2}

$P_{R1} = 0{,}30 \pm 0{,}04$ mm (0.0118 ± 0.0016 in) for $0^\circ < \alpha < 45'$

$P_{R1} = 0{,}30 \pm 0{,}03$ mm (0.0118 ± 0.0012 in) for $45' < \alpha < 1^\circ 30'$

$P_{R2} = 0{,}50 \pm 0{,}04$ mm (0.0197 ± 0.0016 in) for $0^\circ < \alpha < 45'$

$P_{R2} = 0{,}50 \pm 0{,}03$ mm (0.0197 ± 0.0012 in) for $45' < \alpha < 1^\circ 30'$

20.9.2 *Left mean edges* P_{L1} *and* P_{L2}

$P_{L1} = 0{,}30 \pm 0{,}06$ mm (0.0118 ± 0,0024 in) for $0^\circ < \alpha < 1^\circ 30'$

$P_{L2} = 0{,}50 \pm 0{,}06$ mm (0.0197 ± 0,0024 in) for $0^\circ < \alpha < 1^\circ 30'$

21 EXTRANEOUS INK (SPOTS)

21.1 extraneous ink front : Magnetic ink located outside the printed edge zone and outside segment end zone and within the clear band in the area that should be ink free.

The integrated height of the extraneous ink front along any line parallel to the skew angle of the character must not exceed 0,2 mm (0.008 in).

21.2 extraneous ink back : Magnetic ink present in the clear band on the reverse side of the document.

The spots on the reverse side of the document are not acceptable if they are detectable by the unaided eye.

22 VOIDS

void : An absence of magnetic ink outside the printed edge zone and outside the segment end zones in an area that should be inked.

The integrated height of voids along any line parallel to the skew angle of the character must not exceed 0,4 mm (0.016 in).

The absence of ink in an area extending over the full width of a stroke including its printed edge zones is allowable over a height greater than 0,4 mm (0.016 in) provided the signal level specification is satisfied. However, voids are limited by the requirement that the character must be readable visually without confusion.

23 SEGMENT END ZONES

segment end zone : A zone of maximum height of 0,20 mm (0.0079 in), that can be located at both ends of strokes and stroke segments.

The width is equal to that of the stroke together with its printed edge zones.

The following rules apply :

a) any shape of stroke ends within the segment end zone is acceptable;

b) the segment end zones may be located at stroke ends at the most convenient vertical position to minimize the voids and extraneous ink;

c) the height of the segment end zone should be chosen such as to ease the fulfilment of the specification on voids. The sum of the heights of all segment end zones along any stroke must be smaller than

0,6 mm (0.024 in) for two or three segment strokes;

0,4 mm (0.016 in) for one segment stroke.

Where a stroke (segment) is interrupted, the new stroke ends may not be covered with segment end zones.

24 UNIFORMITY OF INK

The ink deposited must be uniformly distributed within the outlines of each stroke. Conditions to be avoided include excessive squeeze out, halo and other uneven deposits which might result in a ridge of ink that outlines a stroke, and that appears dense in relation to the ink deposited within the stroke. Such ridges are predominant in letterpress printing and some impact printing.

25 EMBOSSMENT

The embossment is, at any point on the front of the document, the distance between the average paper surface and the ink surface. Embossment can vary over the character and even within a stroke. It has an influence on the signal wave form. This influence is accounted for in the signal level specification. Nonetheless, embossment must not exceed that which a skilled person could barely detect by eye or by touch.

26 SIGNAL LEVEL

26.1 Description of the signal

When a suitably magnetized CMC 7 character is scanned by a reading head, the passage of each stroke edge results in a voltage pulse.

The signal that corresponds to a character is thus a succession of fourteen pulses, the signs of which alternate. Pulses associated with right-hand stroke edges are conventionally called positive pulses; pulses associated with left-hand edges are negative.

The amplitude of each of the two pulses that are associated with a stroke is approximately proportional to the height of that stroke.

26.2 Definitions

26.2.1 standard stroke : A unique and well-defined stroke, specially created to remain stable with time.

26.2.2 relative signal level : A quantity n, associated with every stroke edge and defined by the following equation :

$$n\ \% = 100\ \frac{U}{U_0}$$

where

U is the absolute value of the pulse amplitude delivered by the edge under consideration and measured by means of suitable equipment;

U_0 is the pulse amplitude delivered by the right edge of the standard stroke and measured by means of the same equipment.

26.3 Allowable signal level range

The maximum relative signal level in any character must not exceed 300 %. The minimum relative signal level in any character must not be less than 25 %. The ratio between highest and lowest relative signal levels within any one character must not exceed 5.

26.4 Nominal signal level

In practice the signal level is proportional to the stroke height M. Signal level is said to be nominal if

$$\text{actual signal level} = \frac{M}{1{,}9} \times 100\ \%$$

26.5 Residual signal level

residual signal level : The maximum signal level delivered by a character which has been voided.

Whenever misencoded information is voided, the residual signal level shall not exceed 5 % (with respect to U_0 according to the definition in 26.2.2).

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

27 PAPER

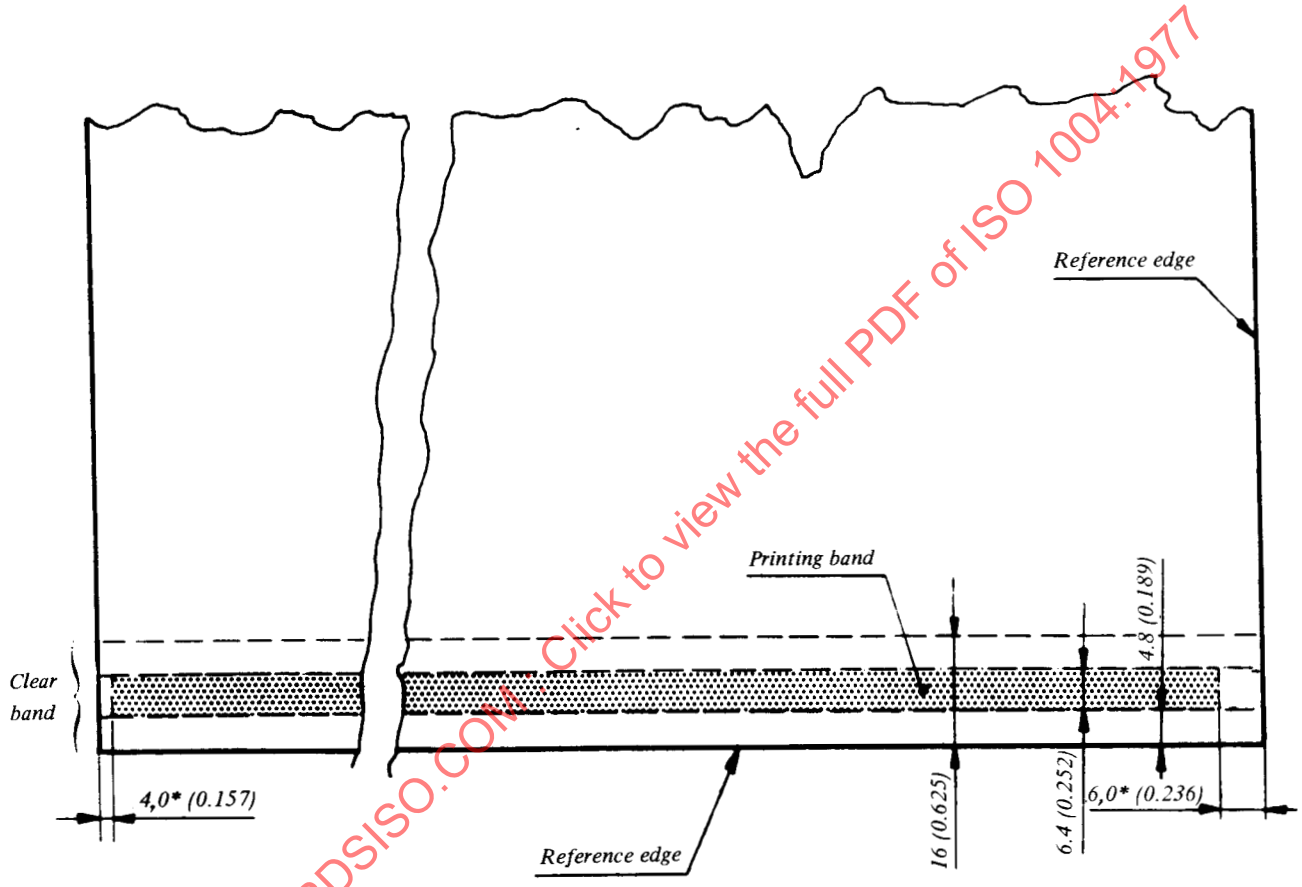
It is recognized that certain particles embedded in paper can be a cause for machine reading rejects.

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

SYMBOLS AND ABBREVIATIONS

Symbol or Abbreviation	Corresponding clause or sub-clause	Characteristic
A	19.1.4	Character width
A_1	19.1.4	Character width of a character with one long interval
A_2	19.1.4	Character width of a character with two long intervals
A_3	19.1.4	Character width of a character with three long intervals
AL	19.1	Alignment
b	20.6.1	Printed edge zone width
B	19.1.1	Character pitch
CB	18	Clear band
D	19.1.2	Intercharacter distance
D_m	19.1.3	Minimum intercharacter distance
D_{m1}	19.1.3	Minimum intercharacter distance for character with one or two long intervals
D_{m2}	19.1.3	Minimum intercharacter distance for character with three long intervals
EM	25	Embossment
ExB	21.2	Extraneous ink back
ExF	21.1	Extraneous ink front
FT	17	Format
h	20.2	Segment height
H_c	20.4	Character height
H_f	20.5	Font height
L	20.8	Stroke width
M	20.3	Stroke height
P	20.9	Stroke interval
P_{L1}	20.9.2	Short stroke interval between left mean edges
P_{L2}	20.9.2	Long stroke interval between left mean edges
P_{R1}	20.9.1	Short stroke interval between right mean edges
P_{R2}	20.9.1	Long stroke interval between right mean edges
SP	19	Character spacing
UI	24	Uniformity of ink
V	22	Voids
VM	19.2	Vertical misalignment
α	20.7	Character skew angle

Dimensions in millimetres with inch conversions in parentheses

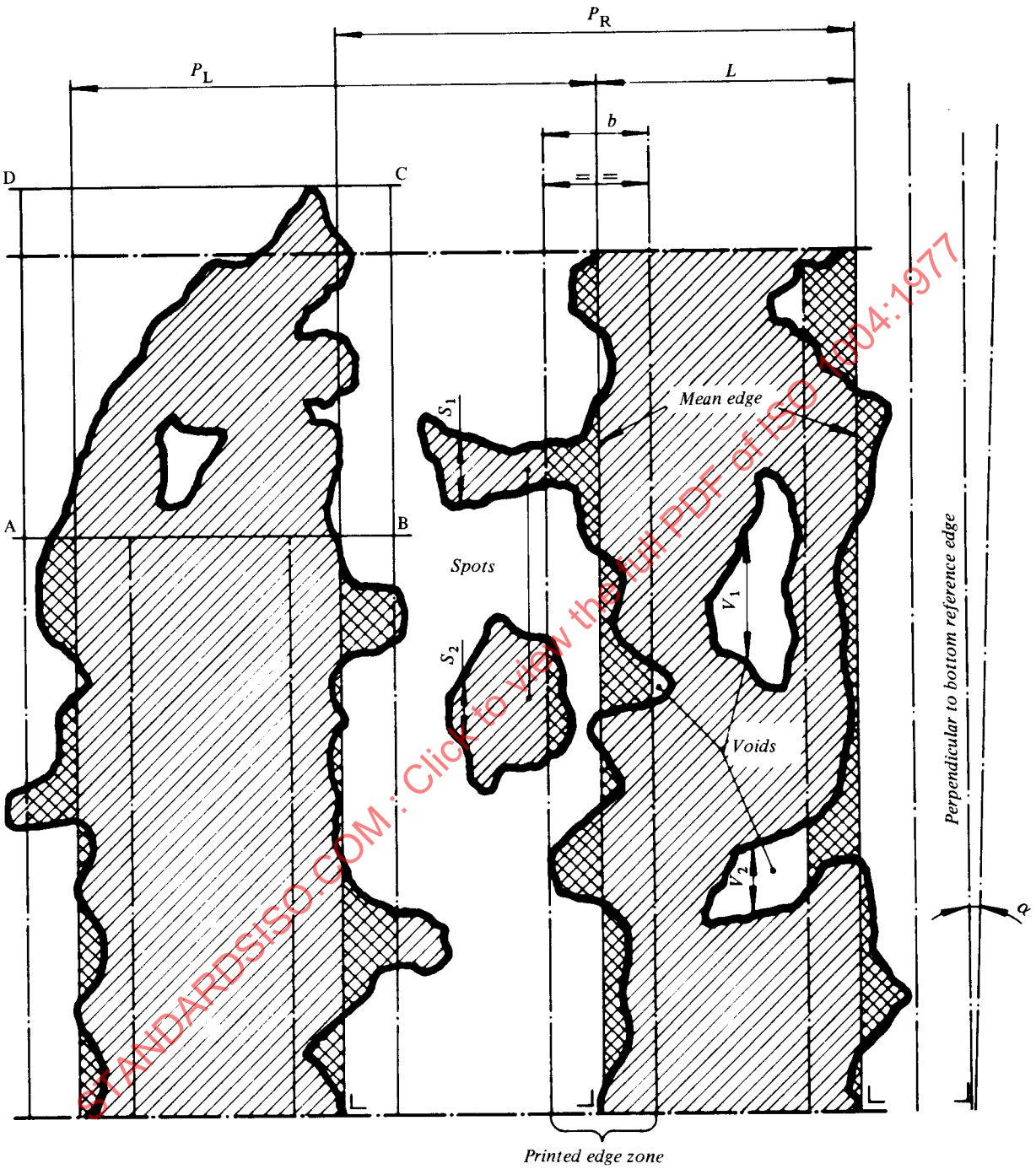


* Minimum values (see 17.1)

FIGURE 29 – **Format of documents**

A B C D *is segment end zone*

Scale 300 : 1



P_L = Stroke interval left
P_R = Stroke interval right
L = Stroke width

S = Spots
V = Voids
α = Character skew angle

Requirements :

Sum of voids : $V_1 + V_2 + \ldots\ldots V_n = V \leqslant 0{,}4$ mm (0.016 in)
Sum of spots : $S_1 + S_2 + \ldots\ldots S_n = S \leqslant 0{,}2$ mm (0.008 in)

FIGURE 30 – **Magnified view of part of a character**

INTRODUCTION TO THE DRAWINGS OF THE PRINTED CHARACTERS OF FONT CMC 7

The nominal shapes and dimensions of the printed digits, symbols and letters are shown on the following pages, for each of the four font heights 3,20 mm (0.1260 in), 3,00 mm (0.1181 in), 2,85 mm (0.1122 in) and 2,70 mm (0.1063 in). The scale is 10 : 1.

All dimensions are quoted in millimetres. A table of conversions to inches is given in annex C.

The radius of rounded character corners is 0,5 mm (0.020 in). The corresponding circles are always tangential to the character outlines.

Segment ends may be straight or rounded. If the ends differ from the drawings, the nominal segment height should correspond to the drawings when measured along the vertical axis of the stroke.

Horizontal dimensions (stroke width and intervals) and their tolerances are not included on the drawings and are specified in 20.8 and 20.9.

Vertical dimensions are less critical, and therefore no tolerances are given.

a) **Stroke width**

The value of stroke width chosen for use throughout the drawings is 0,15 mm (0.0059 in).

b) **Stroke intervals**

Stroke intervals throughout the drawings are equal to the nominal values given in 20.9.

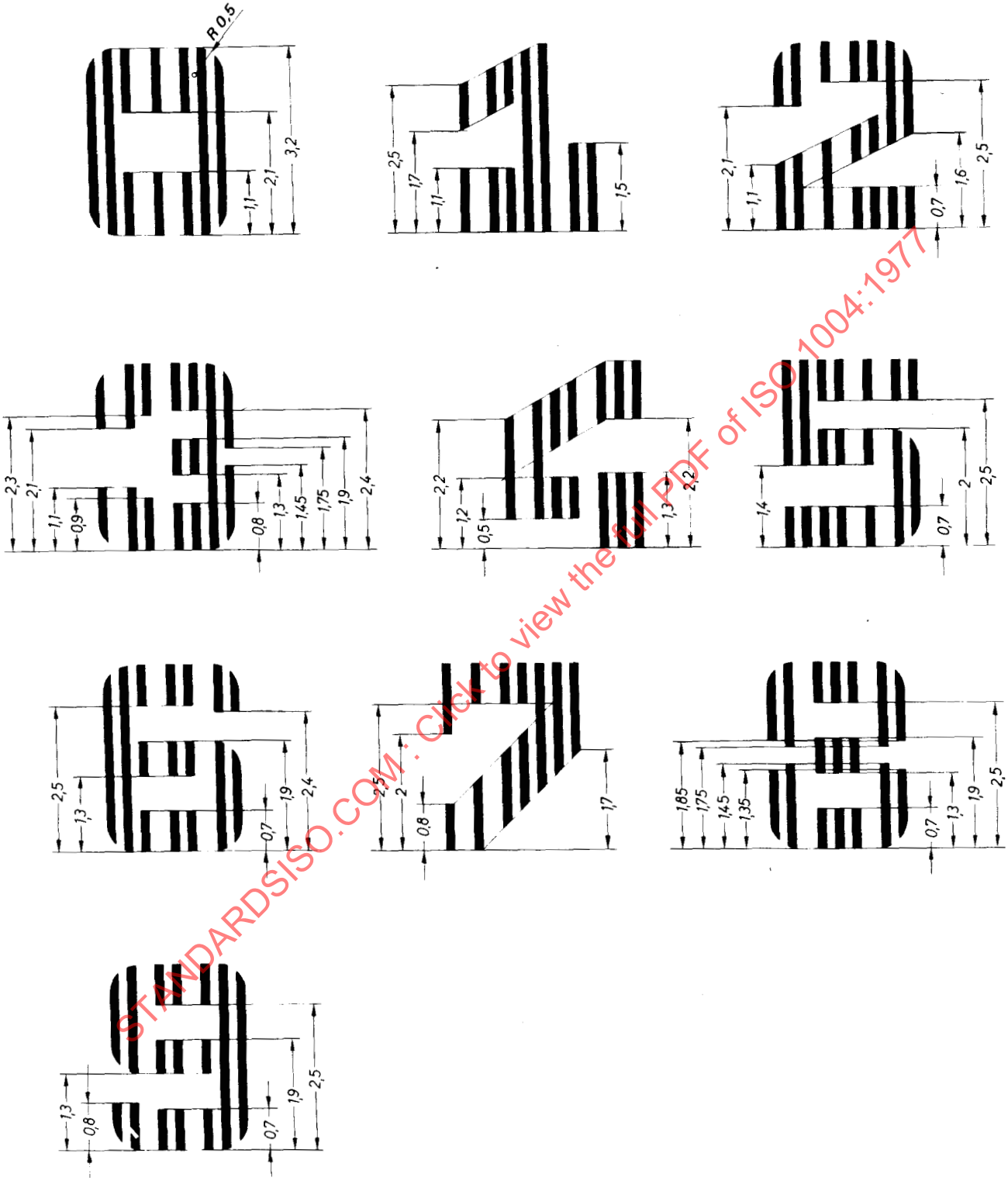


FIGURE 31 – **Digits : Font height 3,20 mm (H_{f1})**

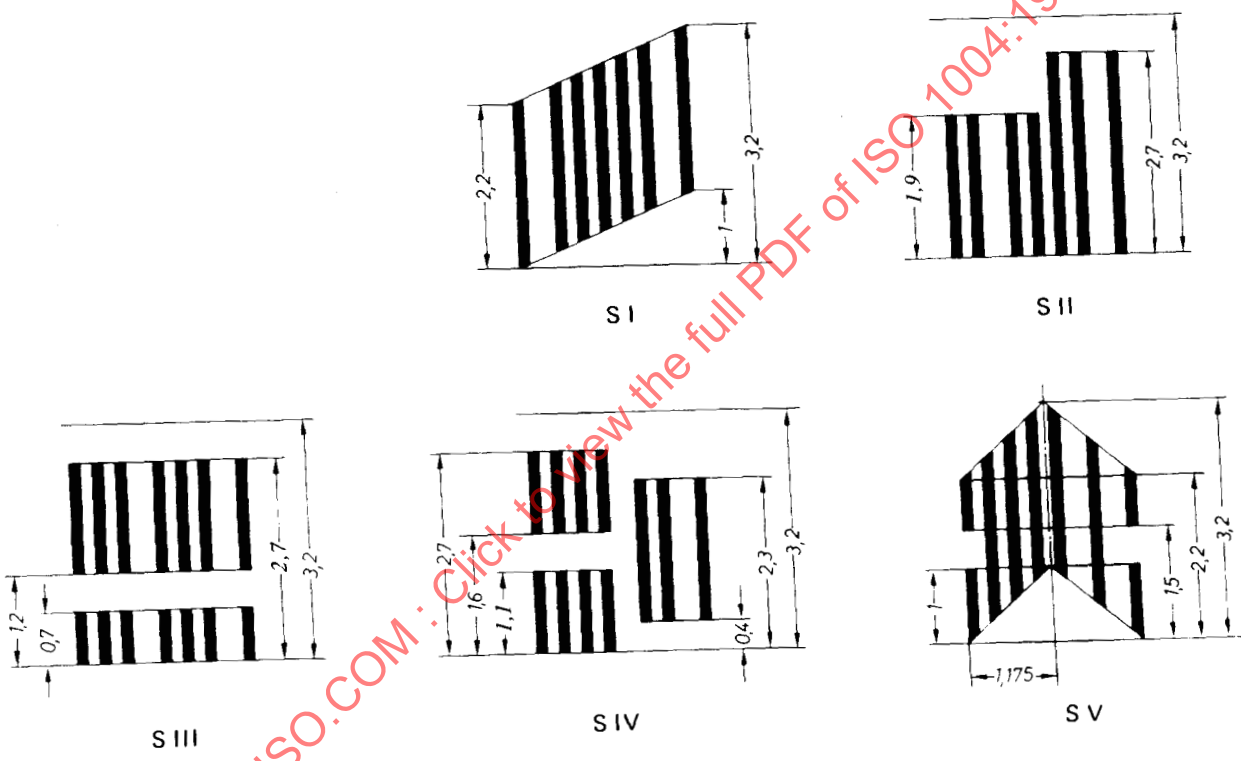


FIGURE 32 – **Symbols : Font height 3,20 mm (H_{f1})**

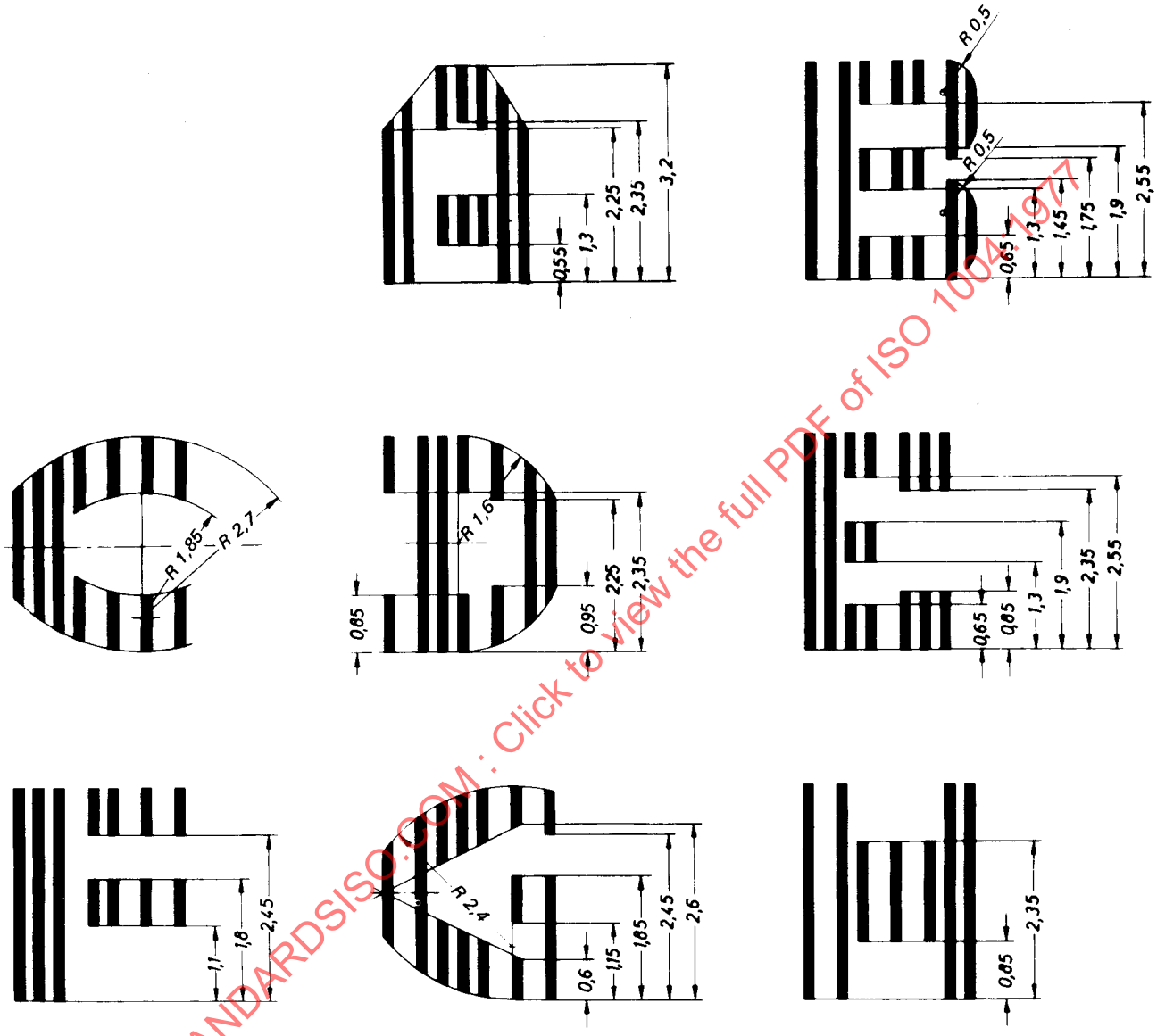


FIGURE 33 – **Letters A to H : Font height 3,20 mm (H_{f1})**

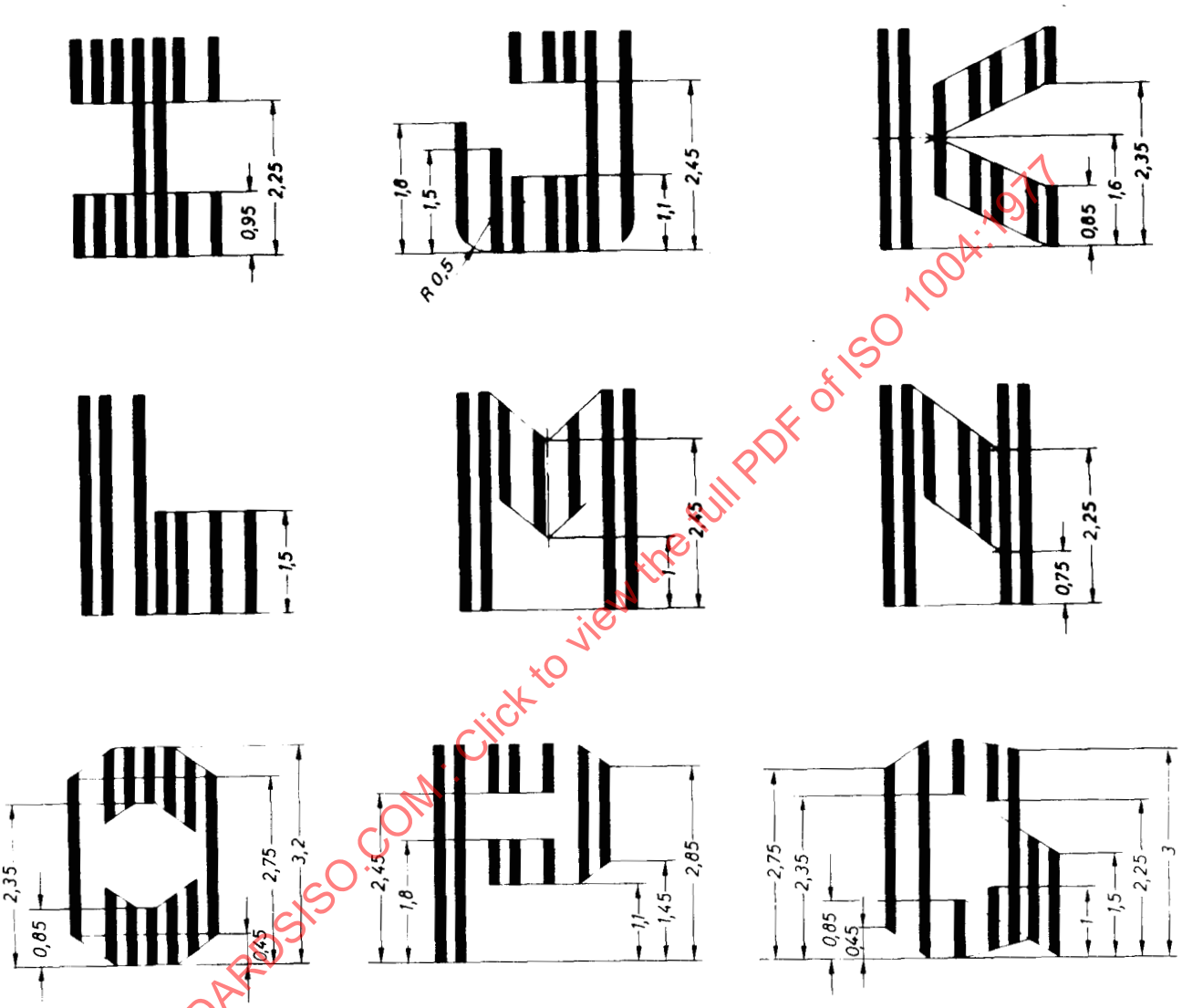


FIGURE 34 — **Letters I to Q : Font height 3,20 mm (H_{11})**

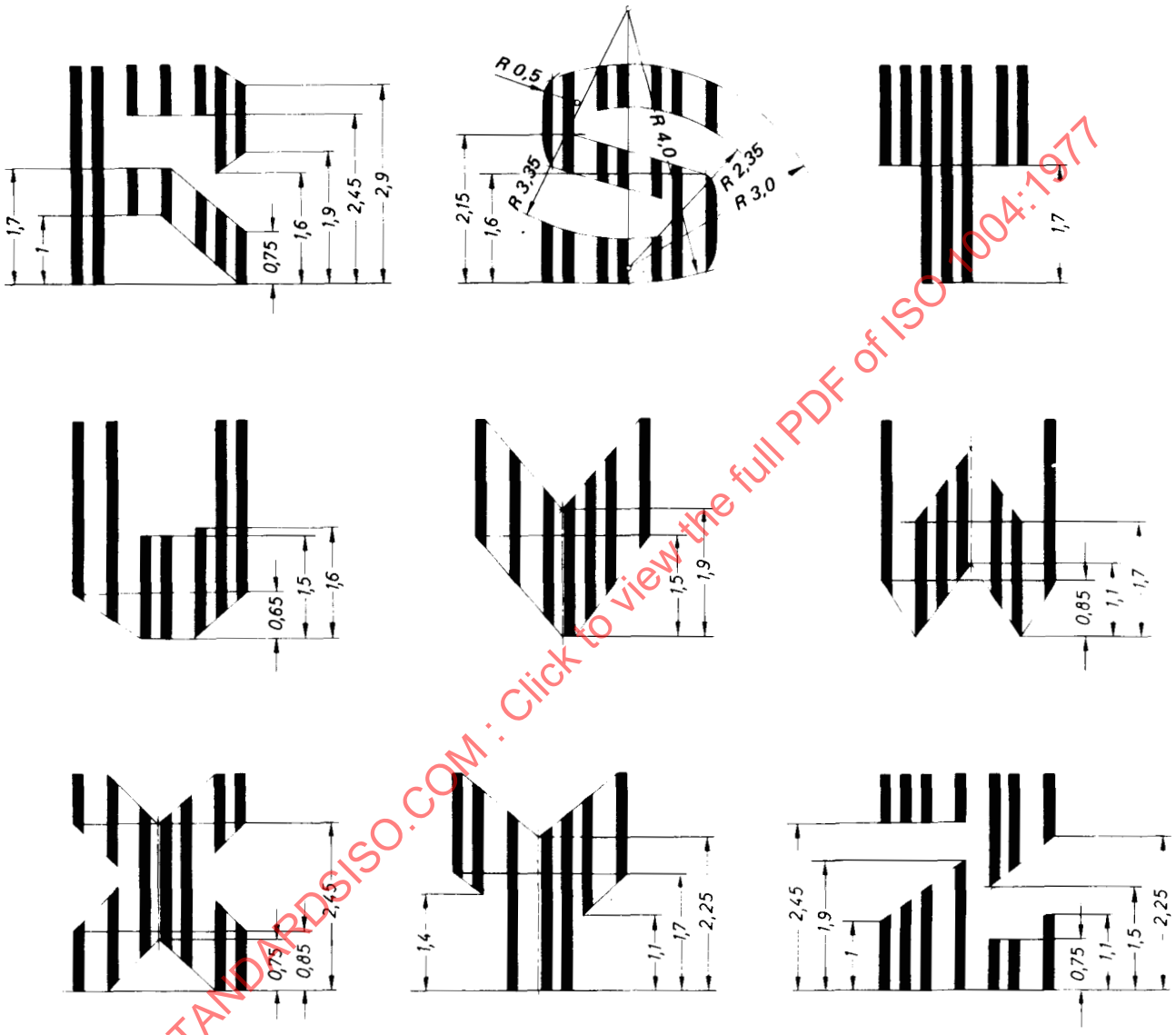


FIGURE 35 — **Letters R to Z : Font height 3,20 mm (H_{f1})**

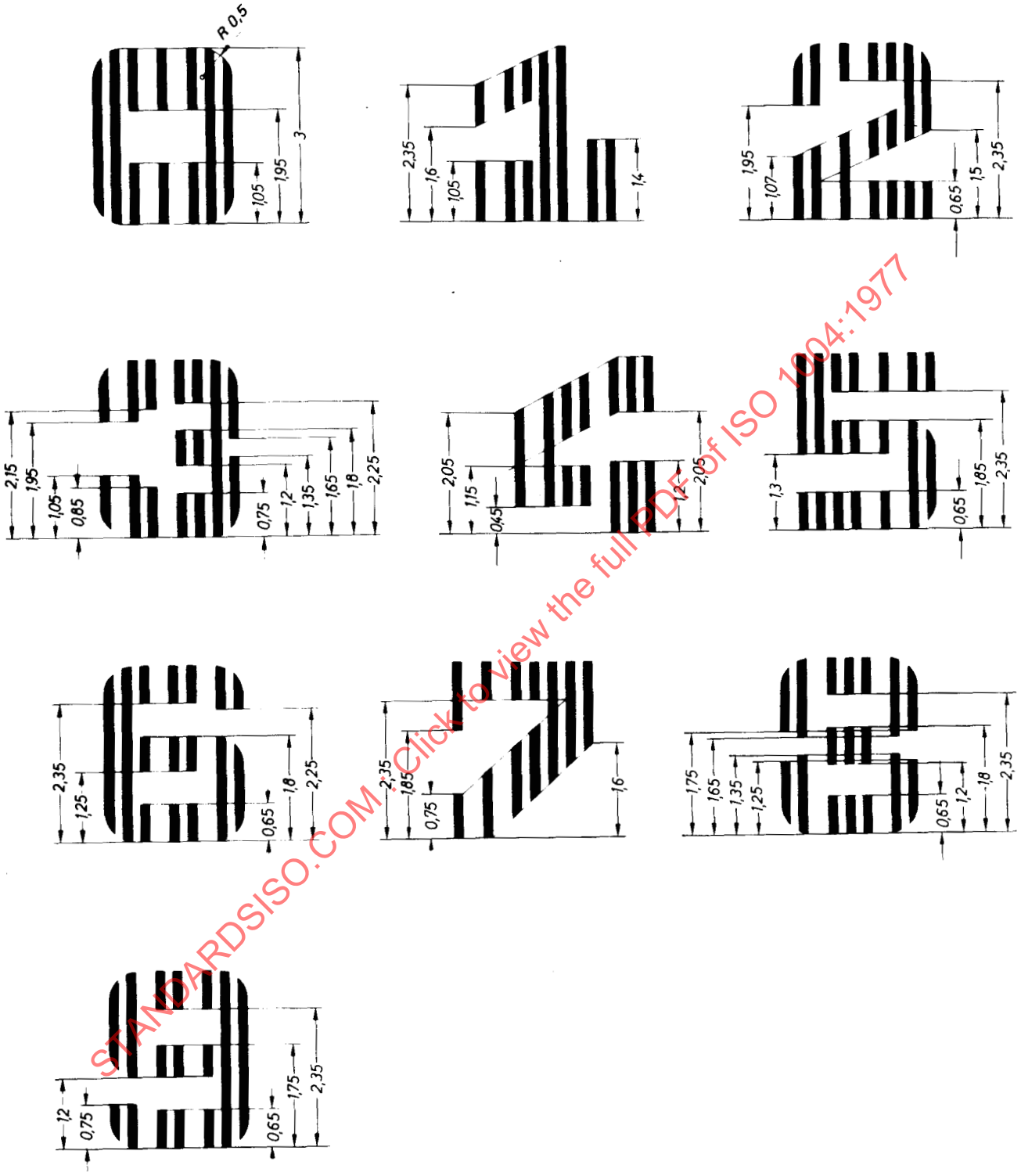


FIGURE 36 — **Digits : Font height 3,00 mm (H_{12})**

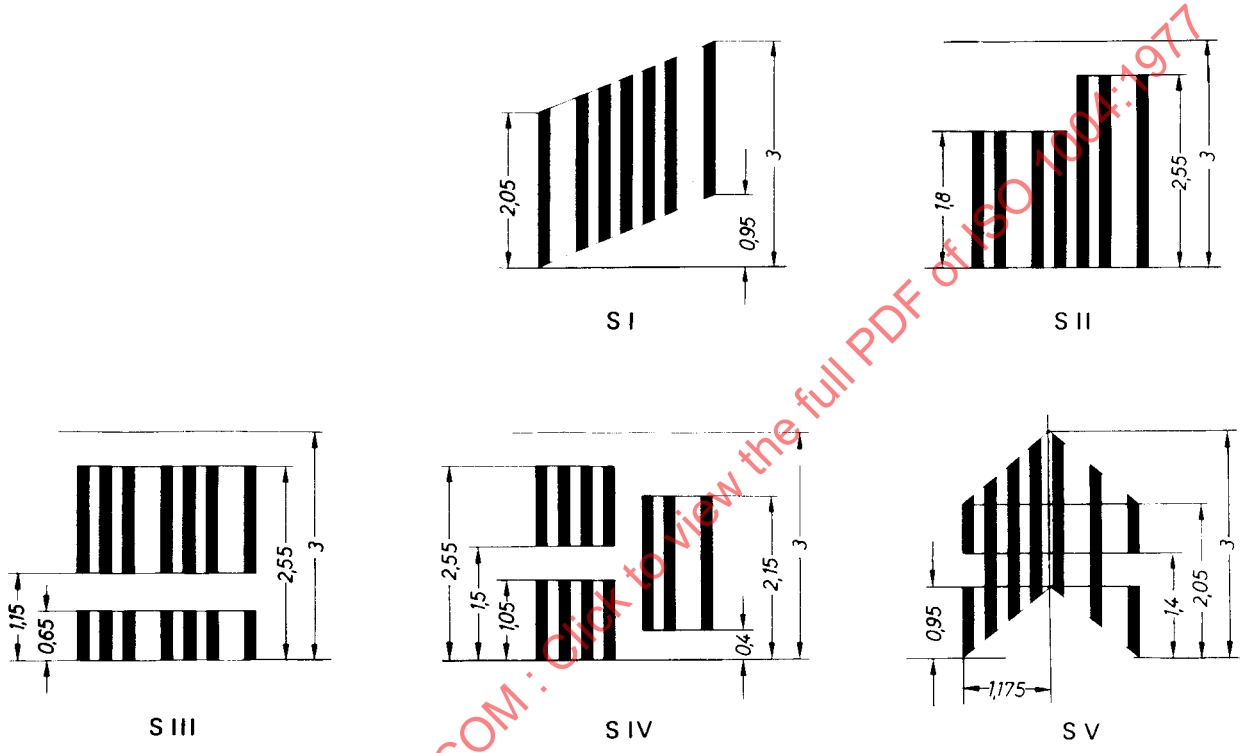


FIGURE 37 – **Symbols : Font height 3,00 mm (H_{12})**

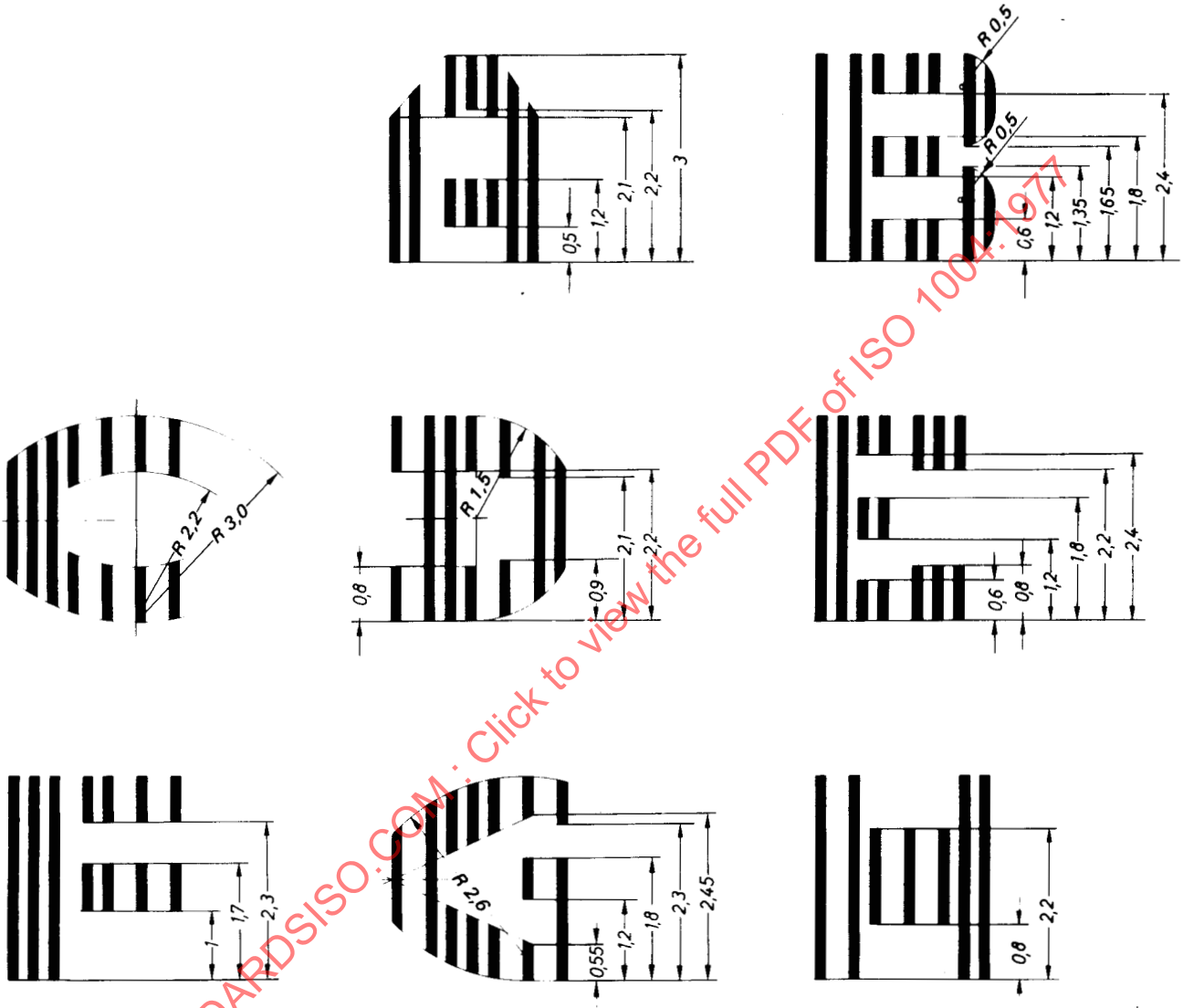


FIGURE 38 – **Letters A to H : Font height 3,00 mm (H_{f2})**

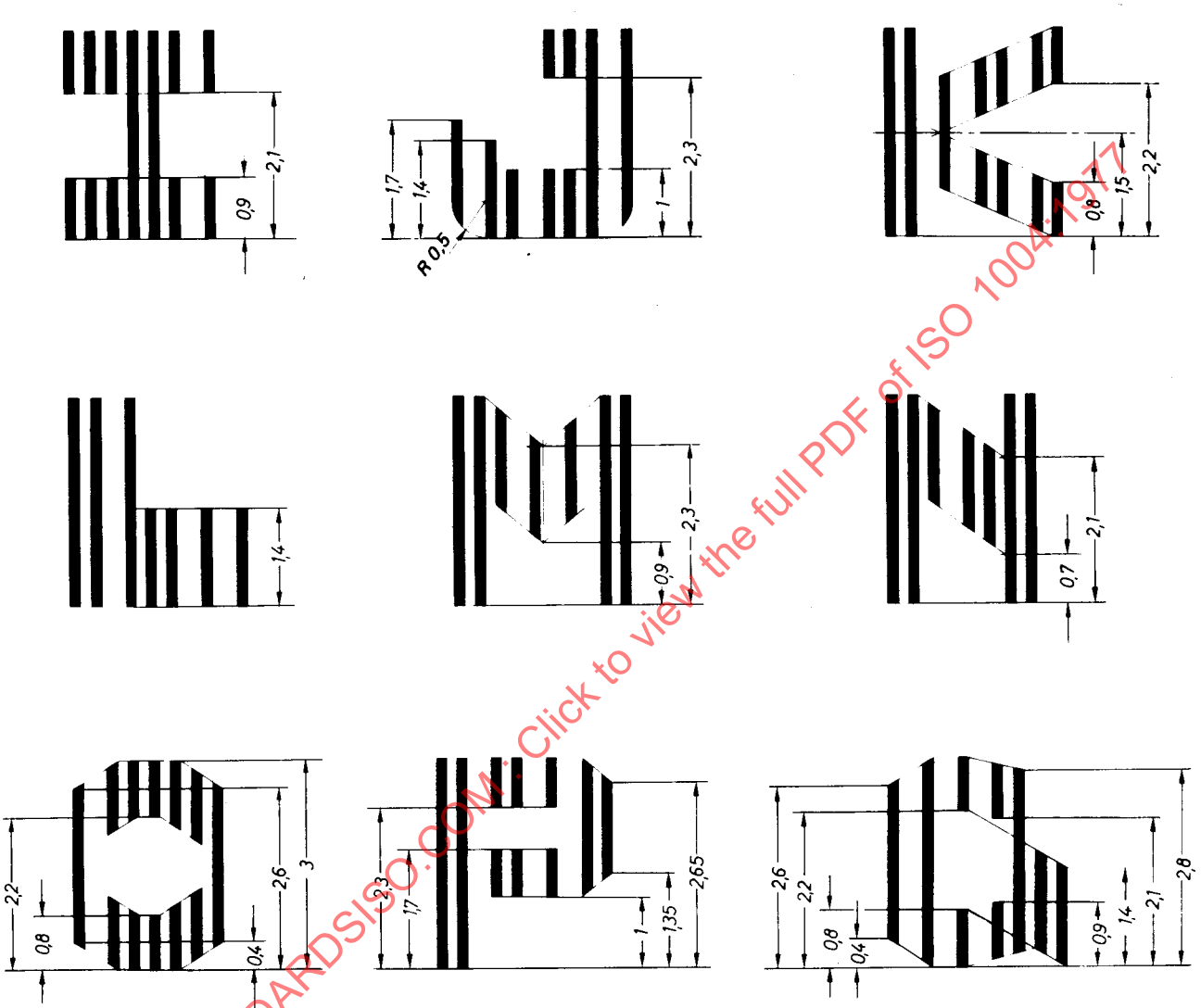


FIGURE 39 — **Letters I to Q : Font height 3,00 mm (H_{f2})**

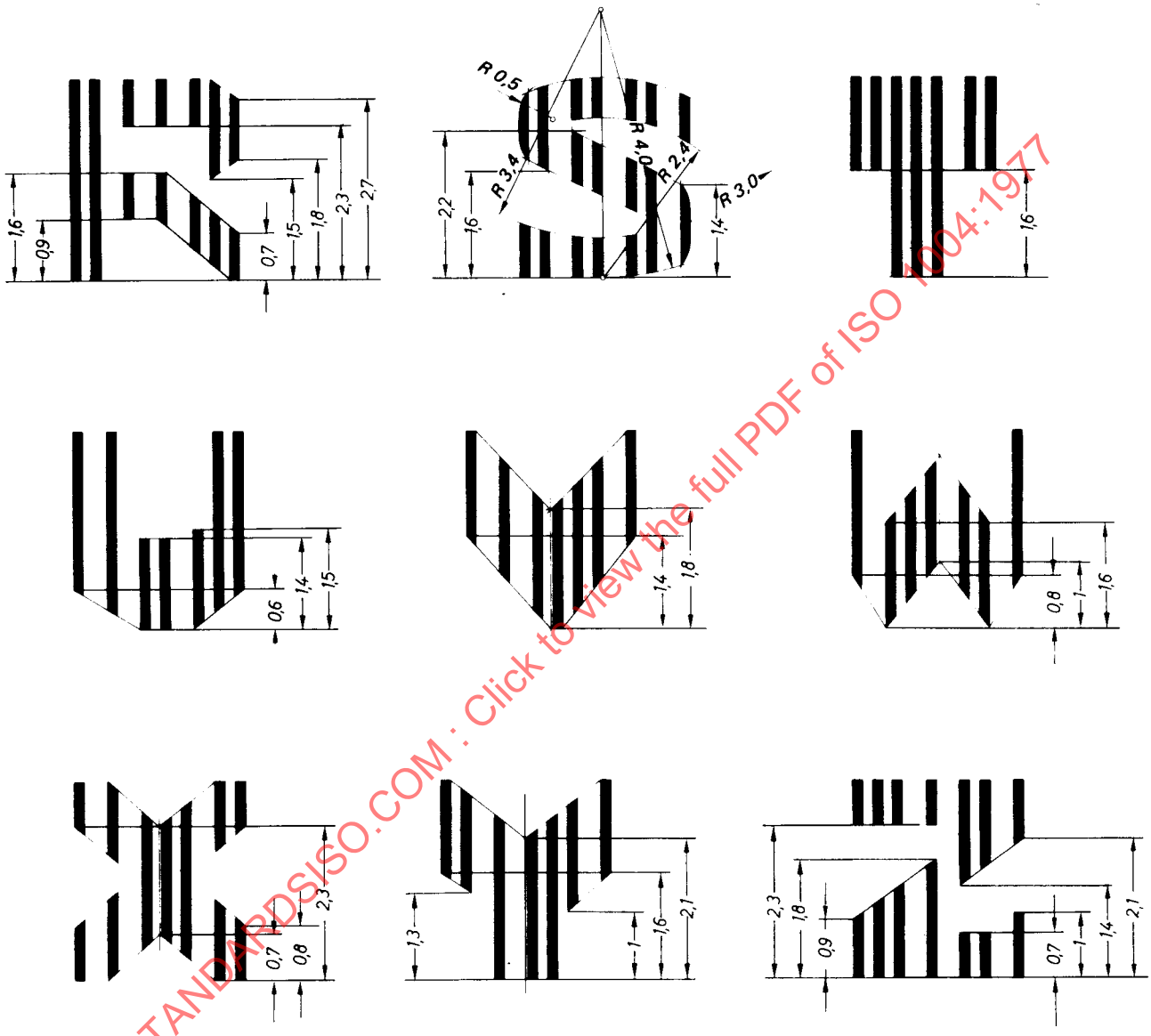


FIGURE 40 — **Letters R to Z : Font height 3,00 mm (H_{f2})**

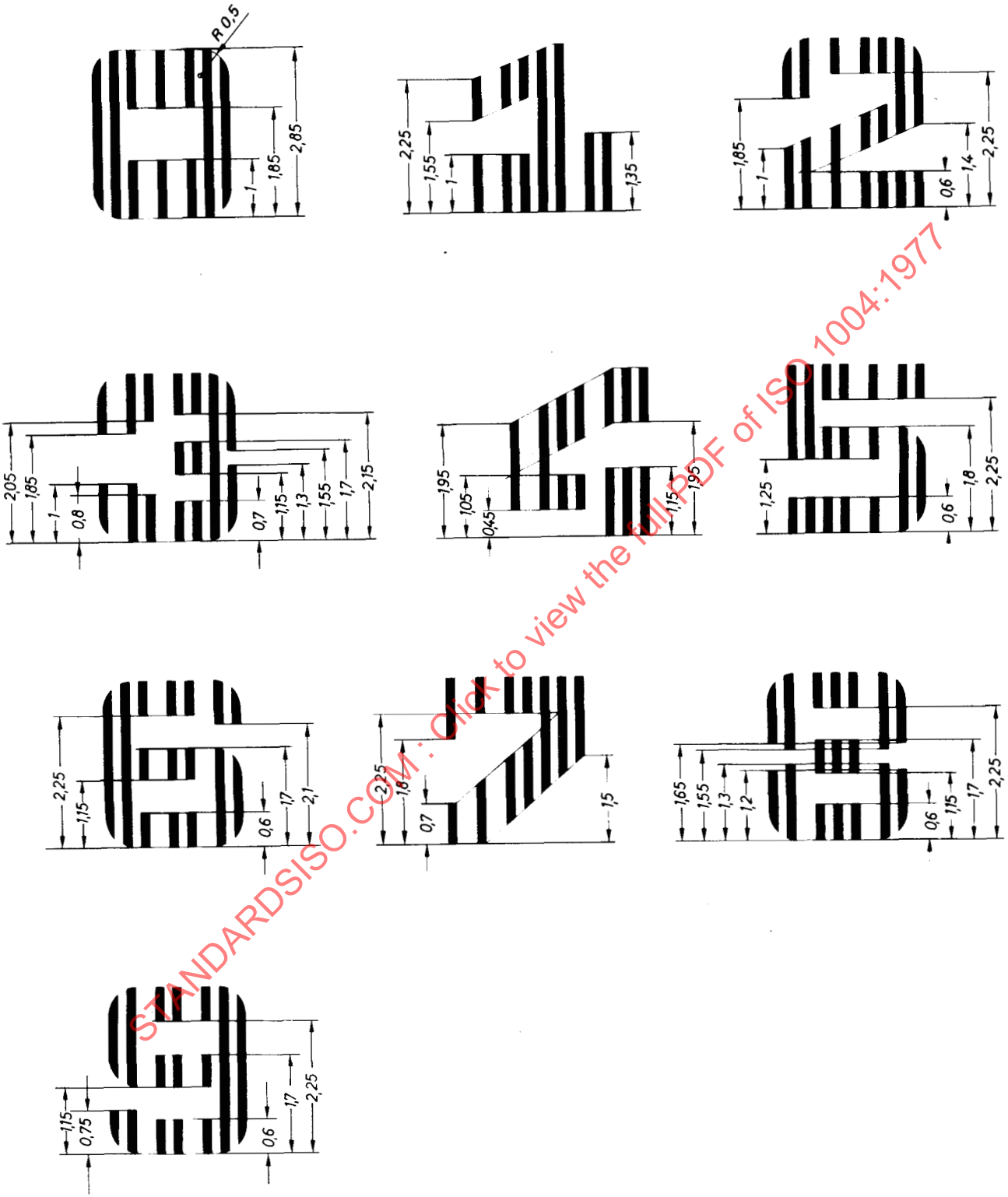


FIGURE 41 — **Digits : Font height 2,85 mm (H_{f3})**

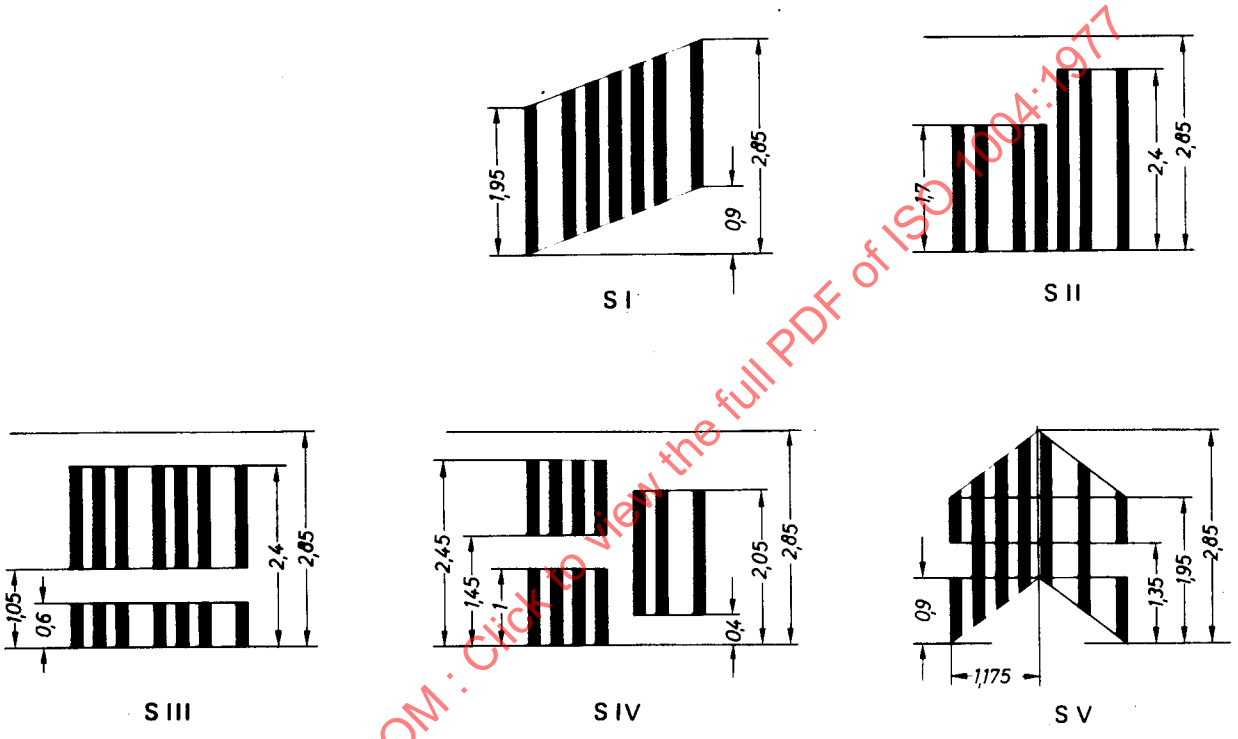


FIGURE 42 – **Symbols : Font height 2,85 mm (H_{f3})**

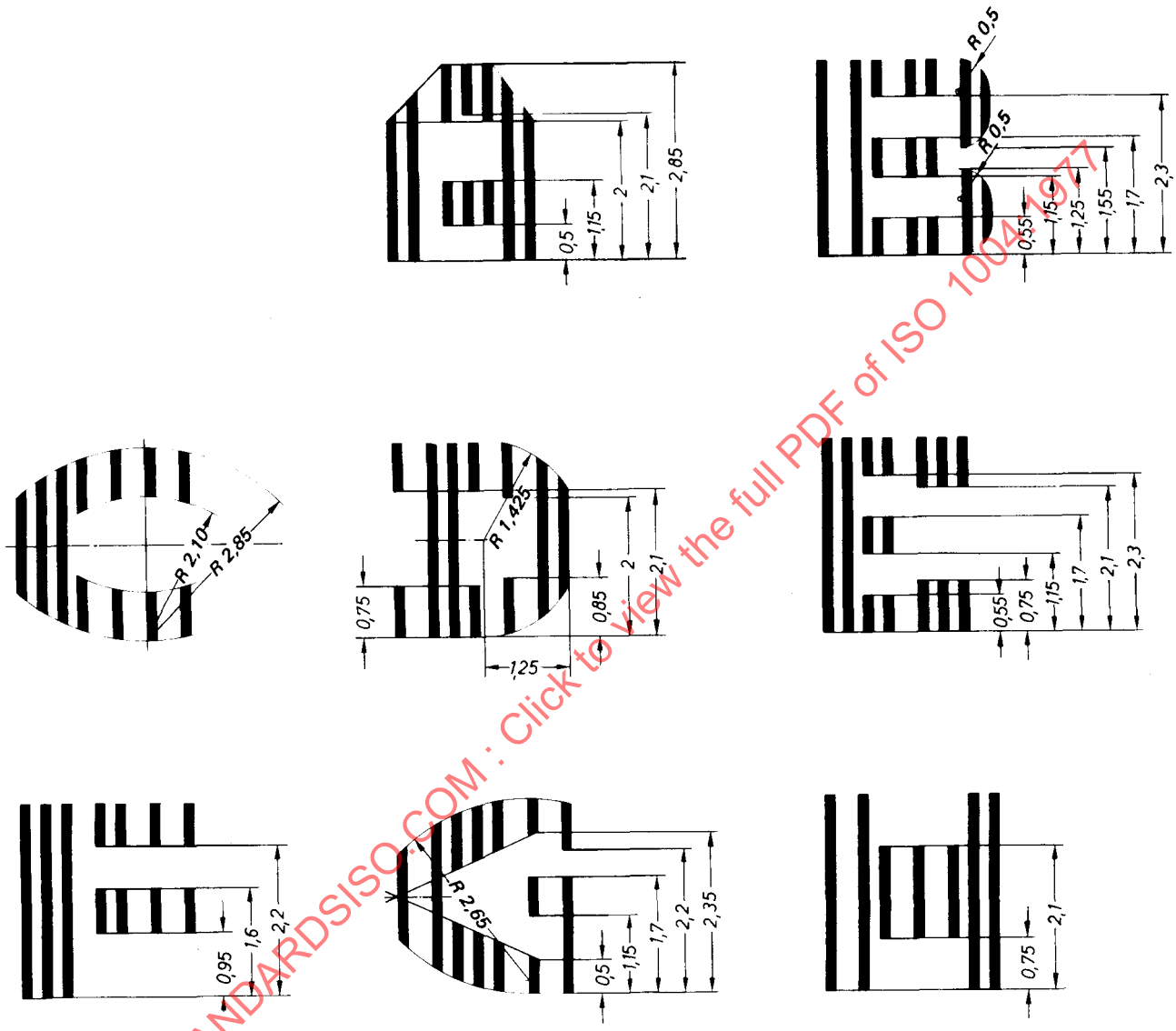


FIGURE 43 — **Letters A to H : Font height 2,85 mm (H_{f3})**