ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA - 3

for the

CMC7 Printed Image Specification

2nd Edition - September 1966

CONTENTS

BRIEF HISTORY

ECMA Technical Working Committee on Character Recognition set up in 1962 a Task Group on MICR, which presented a preliminary report on the MICR situation in September 1962. In view of the decisions made by different Bankers Organizations in Europe, it appeared that further work was still needed in order to have good working specifications for the CMC7 font.

A Technical Working Committee TC 7 was set up for this specific task and the representatives of following Companies participated in the work of the committee :

Compagnie des Machines BULL

Lamson Paragon Ltd

IBM-WTEC

ICT International Computers and Tabulators Ltd

ITT Europe Inc.

N.C.R. The National Cash Register Company Ltd

Ing. C. Olivetti & Co. S.p.A.

Sperry Rand International Corp.

Telefunken Aktiengesellschaft

The work has led to the production of the Standard ECMA-3 for the CMC7 printed image specification dated April 1964. In addition this Technical Committee has cooperated with following organizations :

Association Française de Normalisation (AFNOR)

Business Equipment Manufacturers Association of America (BEMA)

International Organization for Standardization (ISO)

Réunion Européenne d'Automatisme (REA) and Club CMC7.

The present revised 2nd Edition of the Standard is in full conformity with the ISO Recommendation for MICR. It supersedes the first edition dated April 1964.

CMC7 PRINTED IMAGE SPECIFICATION

Since this Standard defines the nominal printed images, the type should not be cut to the dimensions given. The type dimensions should be deduced from the nominal printed image dimensions after due correction for the systematic effects in the printing process.

1. Character Set

There are 41 characters in the set :

10 numerals 0 to 9
5 symbols
26 letters

NOTE : In some applications it may be necessary to insert spaces between characters. Rules governing their usage are given in the document "Comments and Notes on the Standard ECMA-3 for the Printed Image of the CMC7 Font" 2nd Edition, Sept. 1966.

2. Character Configuration

2.1 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 15 possible ways (C_2^6) - a total which is available for the 10 numerals and 5 symbols.

The alphabetic code comprises one or three long intervals $C_1^6 + C_3^6 = 26$ combinations which are thus available for 26 letters.

The following tables show the correspondence between the codes and the characters. The intervals are numbered 1 to 6 from left to right on the printed character. Their value is epresented by the digit 0 for shc intervals anc by the digit 1 for long inter .ls.

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	SI
0	1	0	0	0	1	SII
0	0	1	0	0	1	SIII
0	0	0	1	0	1	SIV
0	0	0	0	1	1	SV

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

1	2	3	4	5	6	
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

2.2 Configuration

There are four font heights (see 8.5) : 2,70; 2,85; 3,00 and 3,20 mm. Full details of the alpha-numeric character set and symbols are given on pages 19 through 38.

3. Means of Automatic Sensing

Automatic character recognition is based on the identification of interval lengths between adjacent strokes. Stroke sensing takes place magnetically.

4. Reference edges of documents

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

5. Print Location

5.1 Horizontal location : the right-most mean edge of the printed line should be located at least 6,0 mm from the right reference edge of the document. The distance between the left-hand edge of the document, and the left-most mean

edge in the printed line should be at least 4 mm. In some cases, by agreement between the parties concerned, this latter distance may be reduced to 2 mm. System considerations may dictate a 6,0 mm minimum margin on both sides, if the document is to be readable in both directions.

5.2 Vertical location : the characters must be printed entirely within a printing band 6,4 mm high. The bottom edge of this printing band is located 4,8 mm above and parallel to the bottom reference edge of the document.

NOTE : Item 5.2 does not apply to punched cards.

6. Clear Band

Over the whole length and on both sides of the document a clear band, 16 mm high, measured from the bottom edge of the document, must be free from any magnetic ink other than CMC7 characters. CMC7 and E13B fonts shall not be permitted in the same clear band on any document. Under no circumstances may CMC7 characters be printed within the clear band using non-magnetic ink.

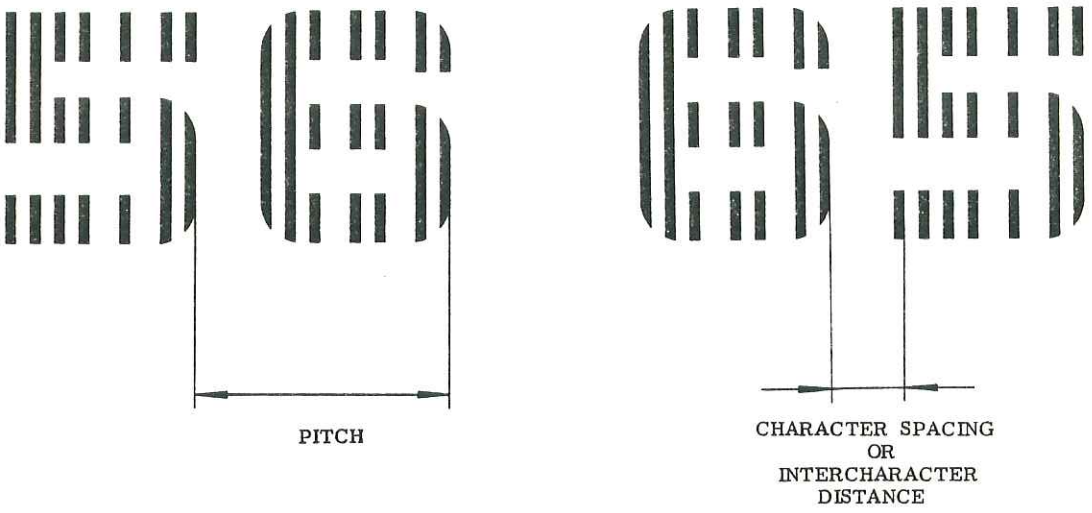
7. Character Spacing and Alignment

7.1 Horizontal Character Spacing

The character pitch B is the distance between the orthogonal projections upon the bottom reference edge of the right-most mean edges (see 8.6) at mid-character height of adjacent characters. The nominal character pitch B may be as small as 3,17 mm (which means at most 8 characters/25,4 mm). The horizontal spacing between adjacent characters must be such that a minimum intercharacter distance D_m is maintained.

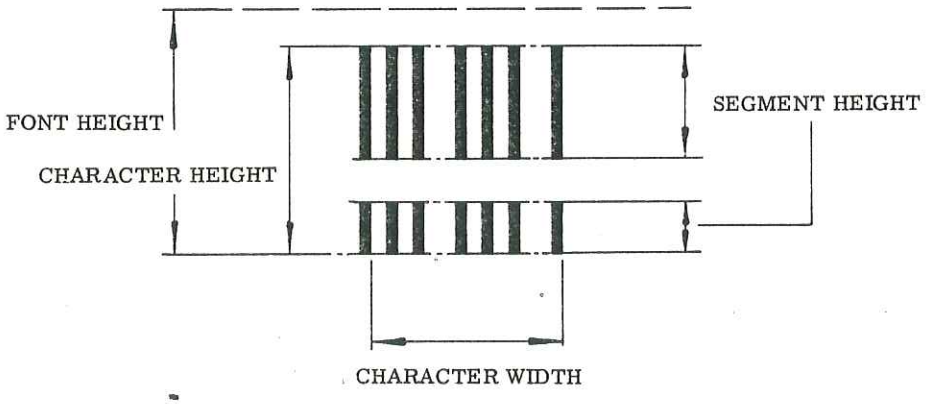
The intercharacter distance D between two adjacent characters is the distance between the orthogonal projections upon the bottom reference edge of the right mean edges (see 8.6) at mid-character height of the left hand stroke of the right hand character and the right hand stroke of the left hand character.

The minimum intercharacter distance : D_{m1} = 0,67 mm if the right hand character has 1 or 2 long intervals, and D_{m2} = 0,50 mm if the right hand character has 3 long intervals.



The character width A is the distance between the right mean edge of the outmost strokes of a character. The nominal values for characters with 1,2 and 3 long intervals respectively, are :

A_1 = 2,0 mm A_2 = 2,2 mm A_3 = 2,4 mm



7.2 Vertical misalignment

Definition :

The vertical misalignment is defined as the deviation of the printed character from the nominal vertical position on the document.

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 5.2) of the document.

8. Character Definitions and Tolerances

8.1 A stroke consists of one or more segments.

8.2 The segment height h is the distance between the top and the bottom of that segment.

8.3 The stroke height M is the sum of the heights of the segments contained in that stroke.

8.4 The character height H_c is the distance between the top and the bottom of that character.

8.5 The font height H_f is the nominal height of the highest character of the font.

8.6 Stroke edge zones and mean edges

8.6.1 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. There are fourteen printed edge zones in a character. The value of b is 0,06 mm.

Each printed edge zone extends over the full height of the stroke, intersegment interruptions and segment end zones excluded.

8.6.2 Mean edge

The mean edge is the centreline of the printed edge zone and divides 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.

8.6.3 Theoretical mean edge

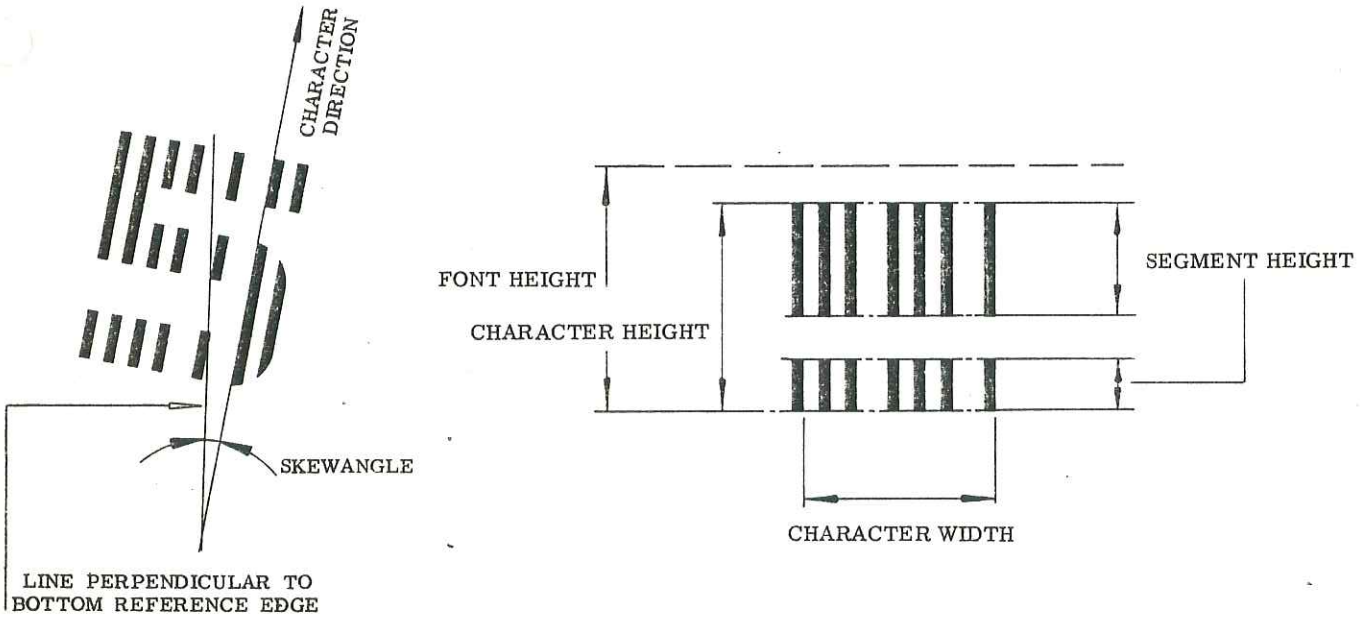
When the above mentioned sums remain equal and are minimized the mean edge is then called theoretical mean edge. The fourteen theoretical mean edges of a character need not be parallel to each other.

8.6.4 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 (referred to as "mean edge" in the following sections).

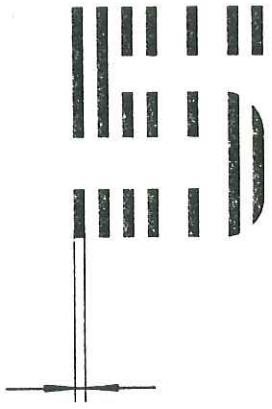
8.7 Skew angle

The skew angle α of a character is 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 $1^{\circ}30'$.



8.8 The strokewidth L is the distance between the right and left mean edge of a stroke.

L = 0,10 to 0,19 mm



STROKEWIDTH

8.9 The stroke interval P is 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 follows :

8.9.1 Right Mean Edges P_{R1} and P_{R2}

$P_{R1} = 0,30 \pm 0,04$ mm for $0^{\circ} < \alpha < 45'$

$P_{R1} = 0,30 \pm 0,03$ mm for $45' < \alpha < 1^{\circ}\ 30'$

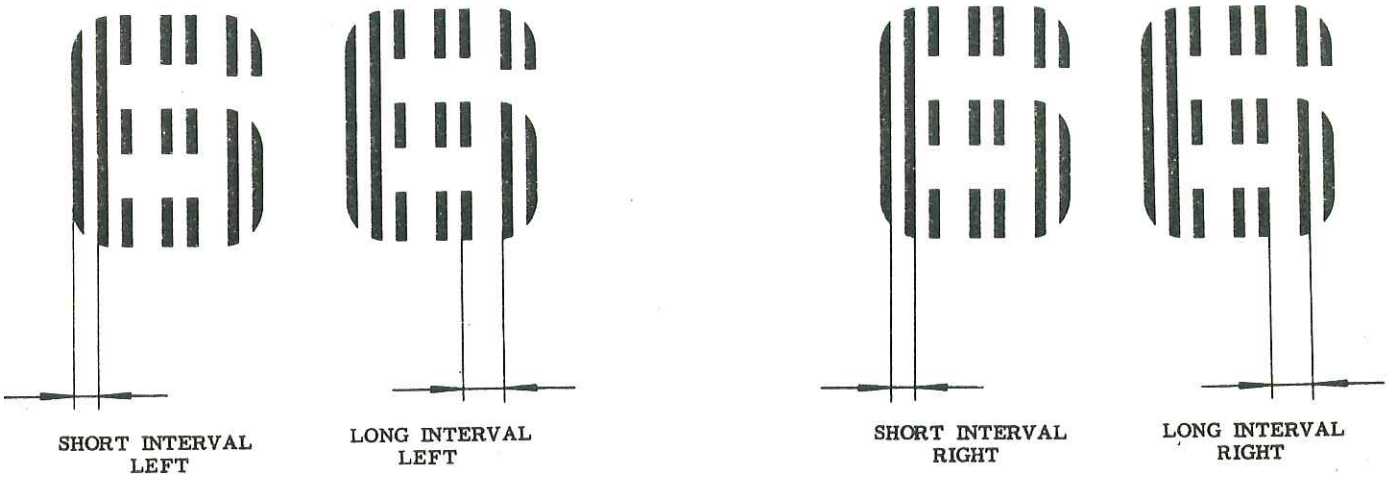
$P_{R2} = 0,50 \pm 0,04$ mm for $0^{\circ} < \alpha < 45'$

$P_{R2} = 0,50 \pm 0,03$ mm for $45' < \alpha < 1^{\circ}\ 30'$

8.9.2 Left Mean Edges P_{L1} and P_{L2}

$P_{L1} = 0,30 \pm 0,06$ mm for $0^{\circ} < \alpha < 1^{\circ}\ 30'$

$P_{L2} = 0,50 \pm 0,06$ mm for $0^{\circ} < \alpha < 1^{\circ}\ 30'$



9. Extraneous ink (spots)

9.1 Extraneous ink front is magnetic ink present outside the printed edge zones, outside the segment end zones 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 character direction must not exceed 0,2 mm.

9.2 Extraneous ink back is 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.

10. Voids

A void is an absence of magnetic ink outside the printed edge zones and outside the segment end zones, in an area that should be inked.

The integrated height of voids along any line parallel to the character direction must not exceed 0,4 mm. 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 provided the signal level specification is satisfied. However,

voids are limited by the requirements that the character must be human readable without confusion.

11. Segment End Zones

Segment end zone is a zone of maximum height of 0,20 mm, 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 must be chosen such as to ease the fulfillment 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 for 2 or 3 segment strokes
0,4 mm for 1 segment strokes

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

12. 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.

13. 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 waveform. This influence is accounted for in the signal level specification. Nevertheless, embossment must be kept down to the extent that a skilled

person can barely detect it by eye or by touch.

14. Signal level

14.1 Description of the signal

When a suitably magnetized CMC7 character is scanned by a read-head, the passage of each stroke edge results into a voltage pulse.

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

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

14.2 Definitions

14.2.1 Standard stroke

The standard stroke is a unique and well defined stroke, specially created to remain stable with time.

14.2.2 Definition of relative signal level

A quantity n, called relative signal level, is associated to every stroke edge, and defined by :

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

U is the absolute value of the pulse amplitude, delivered by the edge under consideration and measured by means of an equipment (see 14.3).

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

14.3 Equipment for measuring the relative signal level

The apparatus to be used for measuring signal level is described in Appendix B to this Standard.

NOTE : Pending the realisation of the standard CMC7 stroke and the designation of the custodian, the amplitude U_o will be that one, which corresponds to the average of the two amplitudes produced by the right edges of the two left strokes of the E13B ON US reference symbol, kept by the NABAC Research Institute (205, West Touhy Ave P.O. Box 500 - Park Ridge, Illinois, USA). Temporarily, calibration documents issued by NABAC will be used accordingly.

14.4 Allowable Signal Level Range

The maximum signal level in any character must not exceed 300 %.

The minimum signal level in any character must not be less than 25 %.

The ratio between highest and lowest signal levels within any one character must not exceed 5.

14.5 Nominal Signal Level

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

$$\text{Actual signal level} = \frac{M}{1,9} \cdot 100\ \%$$

A table of nominal signal levels is given in "Comments and Notes on the Standard ECMA-3 for the Printed Image of the CMC7 Font, 2nd Edition dated Sept. 1966."

14.6 Residual Signal Level

Residual signal level is the maximum signal level delivered by a character which has been erased.

Whenever misencoded information is erased the residual signal level shall not exceed 5 % (with respect to U_o according to the definition in 14.2.2).

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

15. 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. (For recommended paper characteristics, see document Comments and Notes on the Standard ECMA-3 for the Printed Image of the CMC7 Font, 2nd Edition dated Sept. 1966).

Abbreviations

A	7.1	Character width
A_1	7.1	Character width of a character with 1 long interval
A_2	7.1	Character width of a character with 2 long intervals
A_3	7.1	Character width of a character with 3 long intervals
b	8.6.1	Printed edge zone width
B	7.1	Character pitch
D	7.1	Intercharacter distance
D_m	7.1	Minimum intercharacter distance
D_{m1}	7.1	Minimum intercharacter distance for character with 1 or 2 long intervals
D_{m2}	7.1	Minimum intercharacter distance for character with 3 long intervals
h	8.2	Segment height
H_c	8.4	Character height
H_f	8.5	Font height
L	8.8	Strokewidth
M	8.3	Stroke height
n	14.2.2	(Relative) signal level
P	8.9	Stroke interval
P_{L1}	8.9.2	Short stroke interval between left mean edges
P_{L2}	8.9.2	Long stroke interval between left mean edges
P_{R1}	8.9.1	Short stroke interval between right mean edges
P_{R2}	8.9.1	Long stroke interval between right mean edges
U	14.2.2	Absolute amplitude
U_o	14.2.2	Standard amplitude
α	8.7	Skew angle

INTRODUCTION TO THE PRINTED IMAGE DRAWINGS

The nominal shapes and dimensions of the printed numerals, symbols and letters, are shown on the following pages, for each of the 4 font sizes (2,70; 2,85; 3,00; 3,20 mm). The scale is 10 : 1. All dimensions are quoted in millimetres.

The value of strokewidth chosen for use throughout the drawings is 0,15 mm. Stroke intervals throughout the drawings are equal to the nominal values given in section 8.9. The radius of rounded character corners is 0,5 mm. The corresponding circles are always tangential to the character outlines.

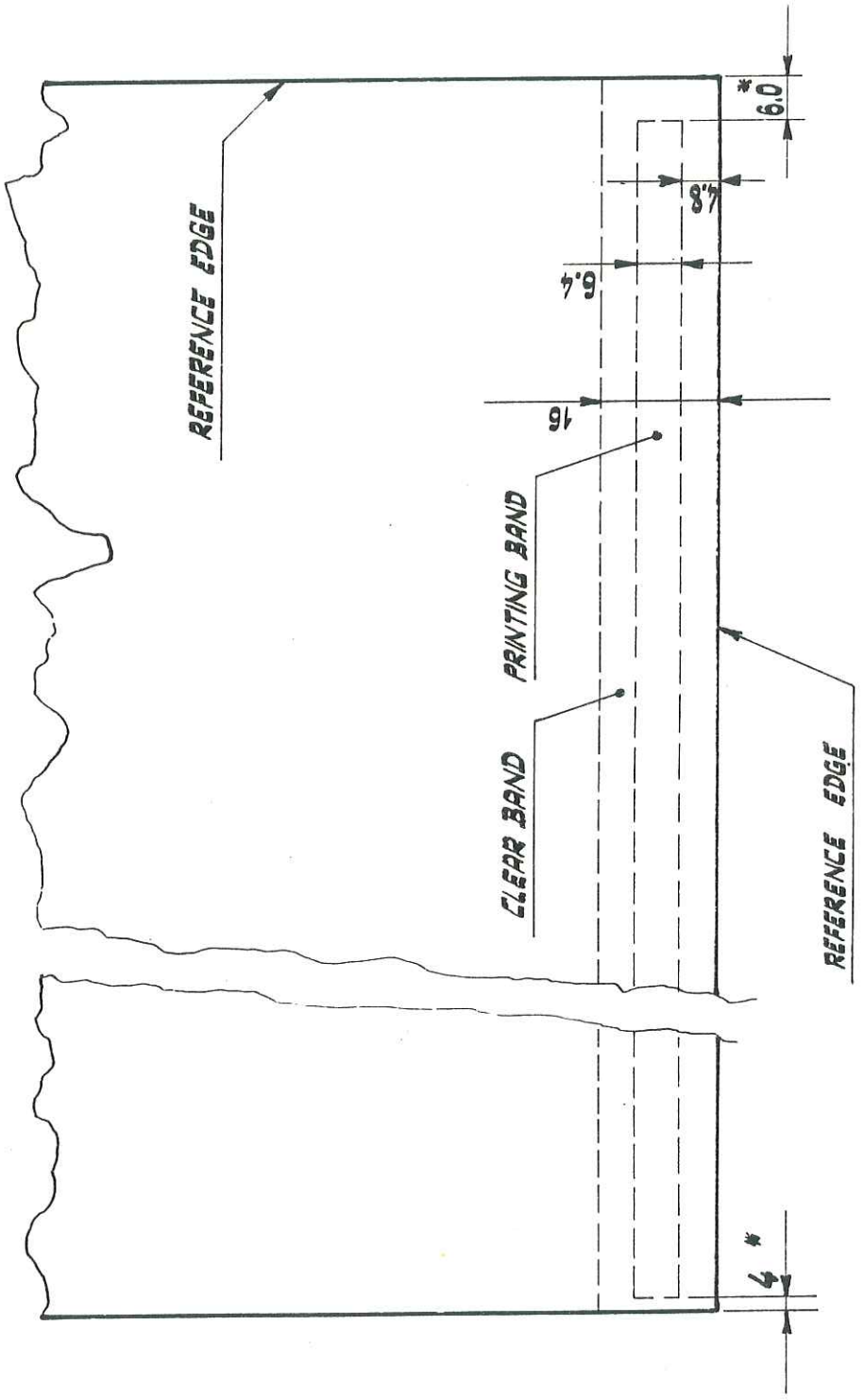
Segment ends may be straight or rounded. If the ends differ from the drawings, the nominal segment height should correspond to the drawings when measured along the vertical axis of the stroke.

Horizontal dimensions and tolerances (strokewidth and intervals) are not indicated on the drawings and are specified in the standard (Section 8).

Vertical dimensions are less critical, and although no tolerances are given, some comments will be offered in the document "Comments and Notes on the Standard ECMA-3 for the Printed Image of the CMC7 Font".

NOTE

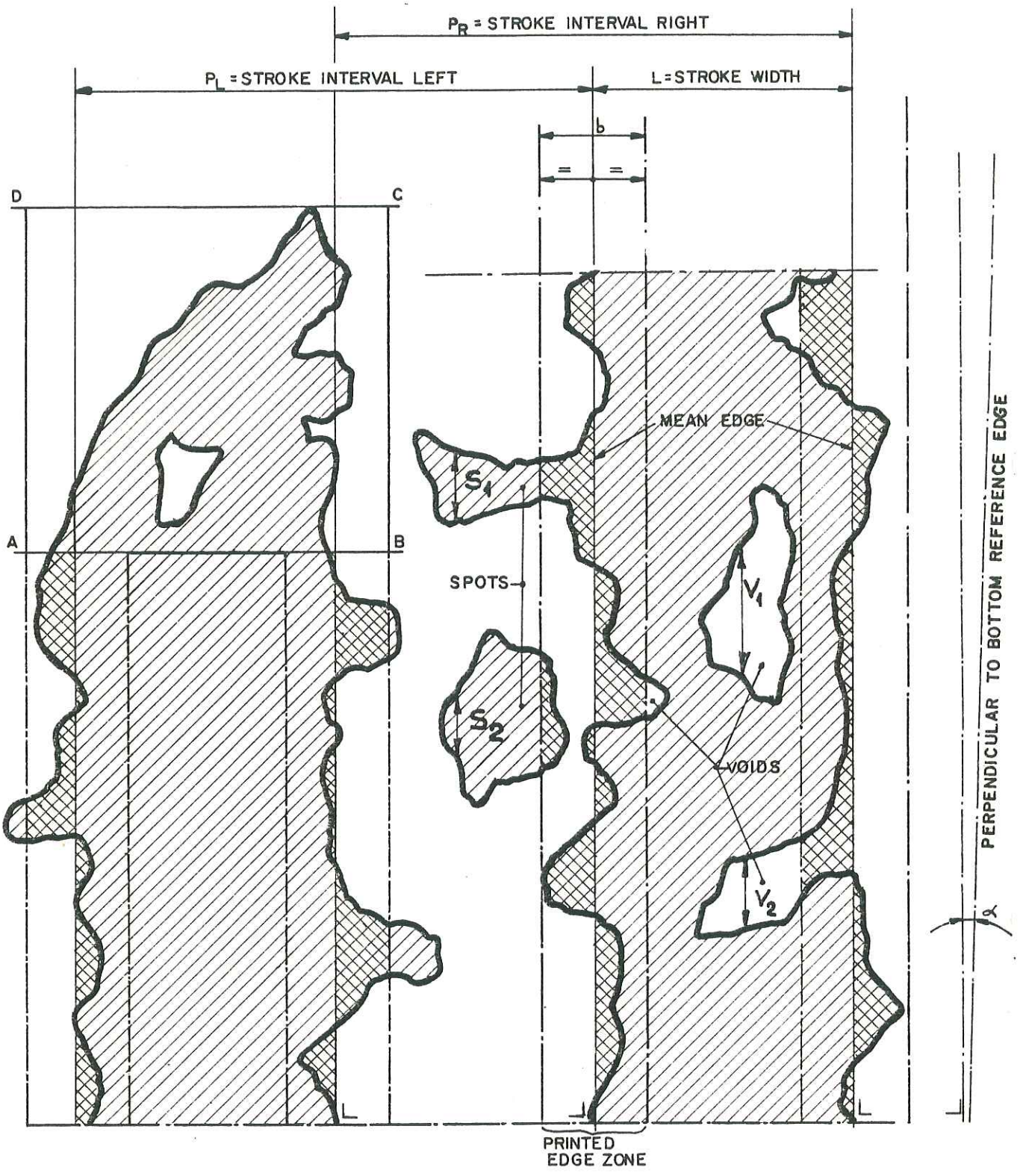
As already stated on page 4, since this Standard defines the nominal printed images, the type should not be cut to the dimensions given. The type dimensions should be deduced from the nominal printed image dimensions after due correction for the systematic effects in the printing process.



* MINIMUM VALUE
SEE 5.1

- PRINT LOCATION AND CLEAR BAND -

A B C D IS SEGMENT END ZONE

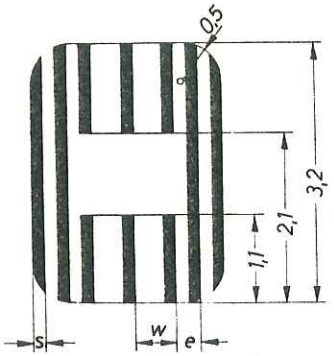


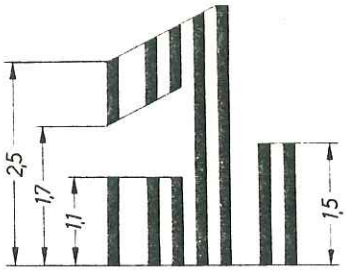
P_{R1} = 0,30 mm $\pm$ 0,04 for α = 0°-45'
P_{R1} = 0,30 mm $\pm$ 0,03 for α = 45'-1°30'
P_{R2} = 0,50 mm $\pm$ 0,04 for α = 0°-45'
P_{R2} = 0,50 mm $\pm$ 0,03 for α = 45'-1°30'

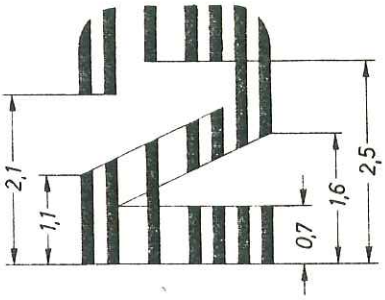
P_{L1} = 0,30 mm $\pm$ 0,06 for α = 0°-1°30'
P_{L2} = 0,50 mm $\pm$ 0,06 for α = 0°-1°30'
L = 0,10 mm to 0,19 mm
b = 0,06 mm

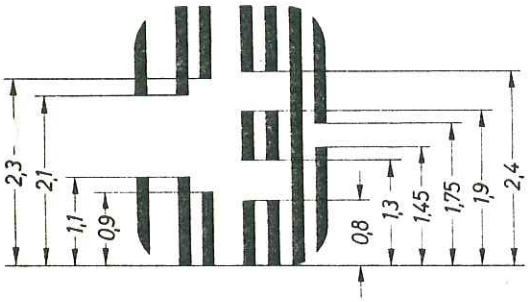
Sum of voids : $V_1 + V_2 + \ldots V_n = V \leqslant 0,4$ mm
Sum of spots : $S_1 + S_2 + \ldots S_n = S \leqslant 0,2$ mm

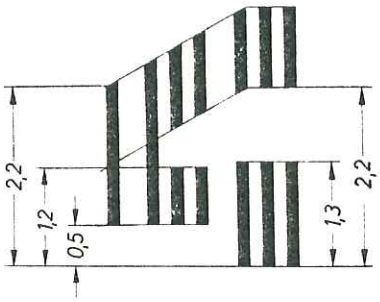
α = character skew angle

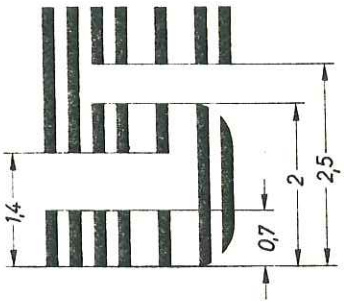

0,5
3,2
2,1
1,1
s
w
e

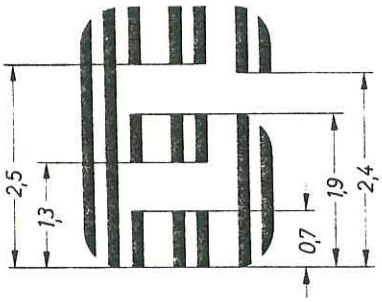

2,5
1,7
1,1
1,5

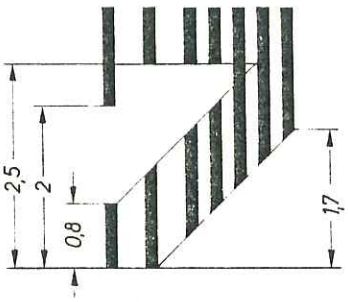

2,1
1,1
0,7
1,6
2,5

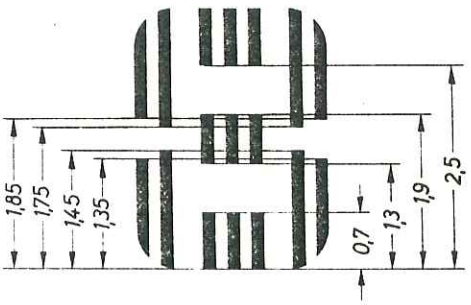

2,3
2,1
1,1
0,9
0,8
1,3
1,45
1,75
1,9
2,4


2,2
1,2
0,5
1,3
2,2


1,4
0,7
2
2,5


2,5
1,3
0,7
1,9
2,4


2,5
2
0,8
1,7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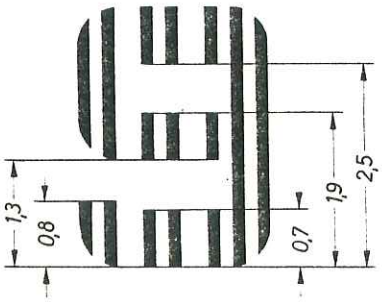
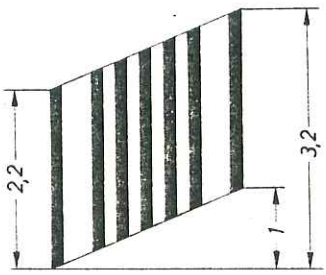
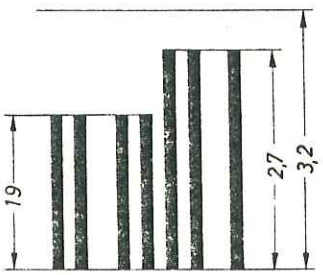
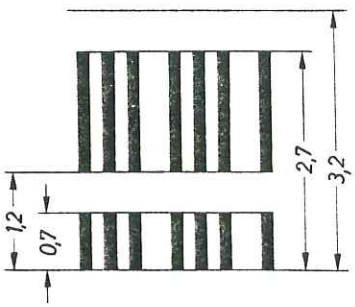
1,75
1,45
1,35
0,7
1,3
1,9
2,5


1,3
0,8
0,7
1,9
2,5


2,2
1
3,2


1,9
2,7
3,2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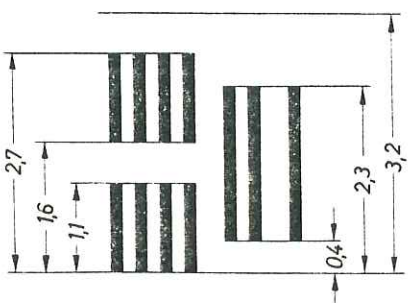
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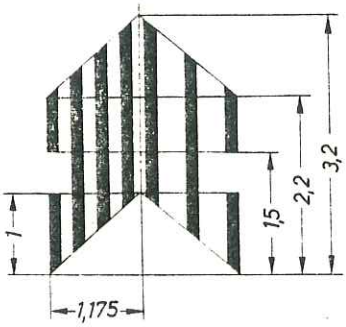
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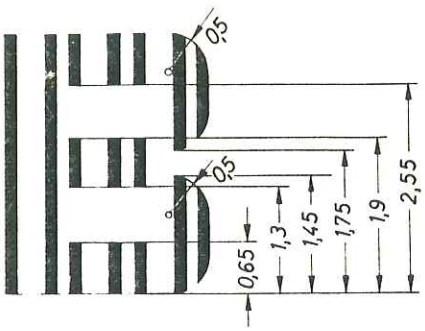
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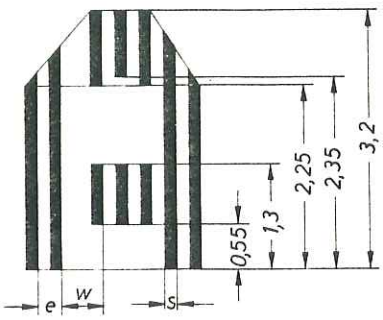
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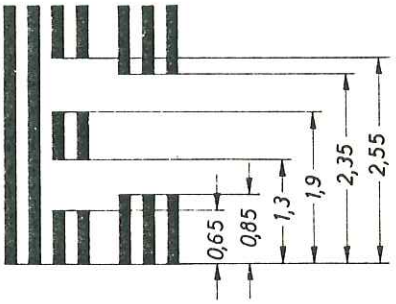
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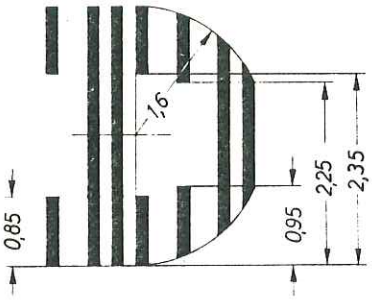
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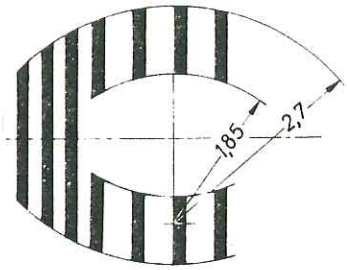
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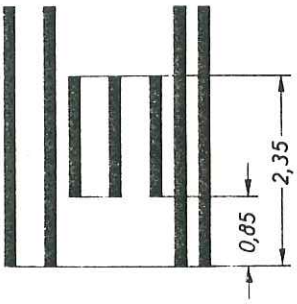
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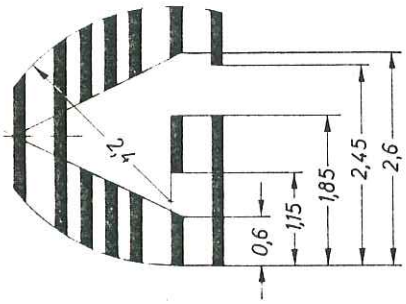
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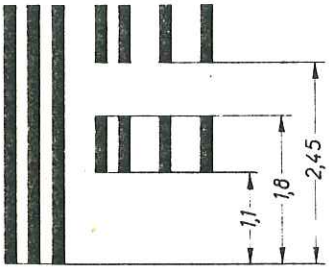
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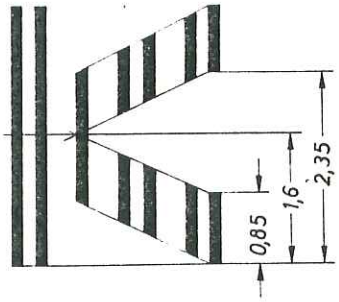
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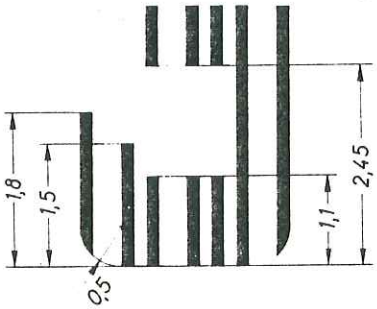
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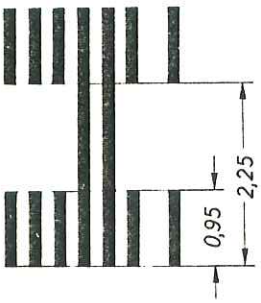
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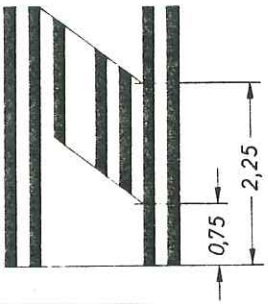
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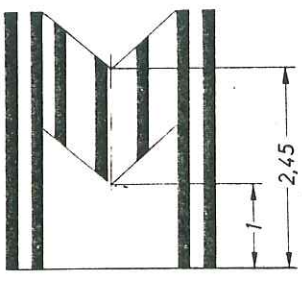
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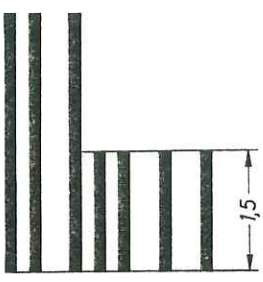
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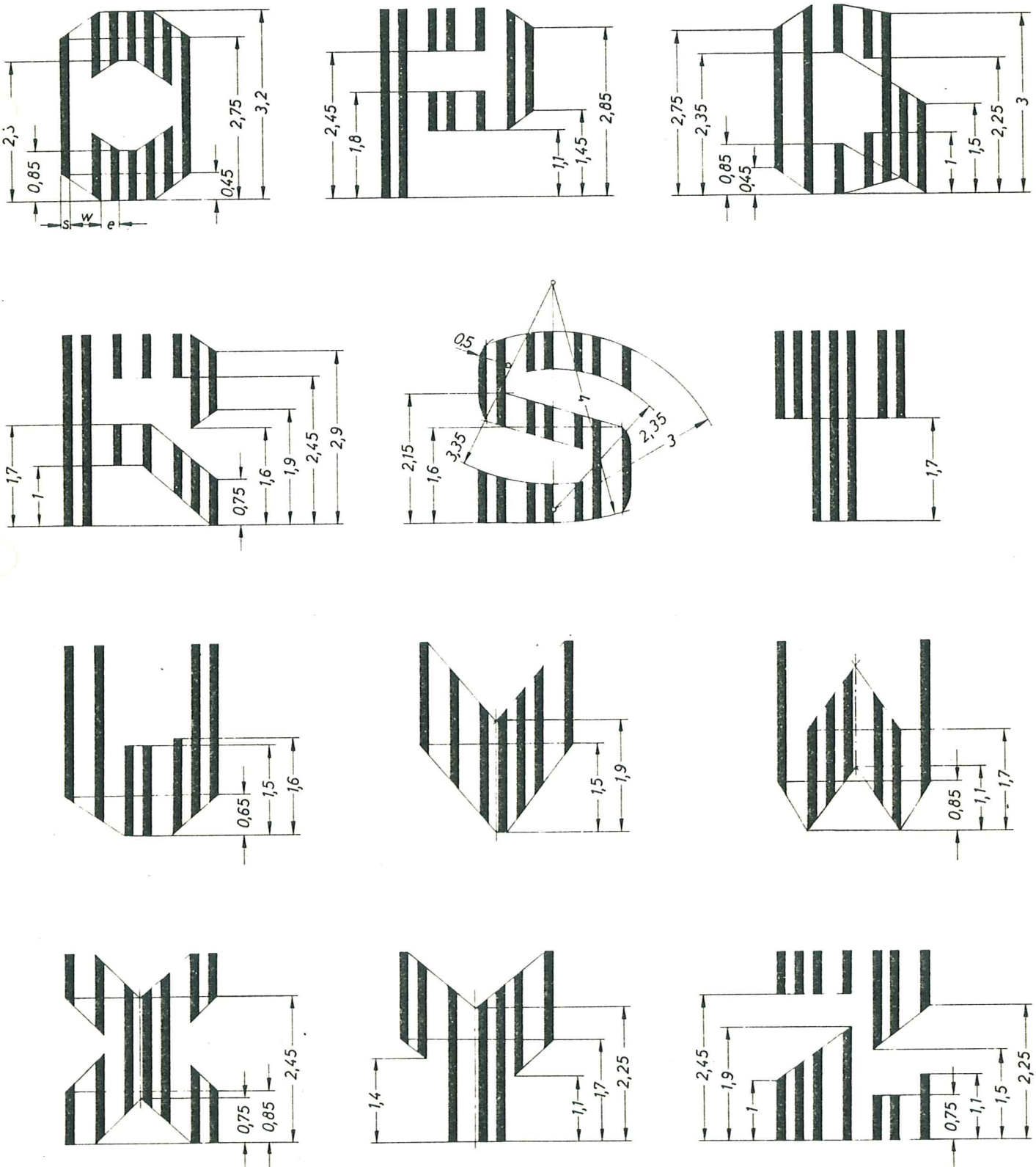
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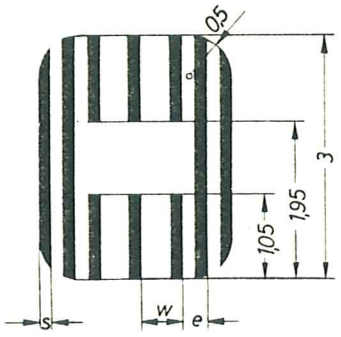
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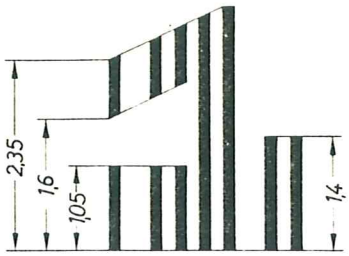
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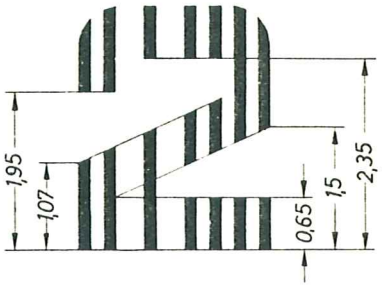
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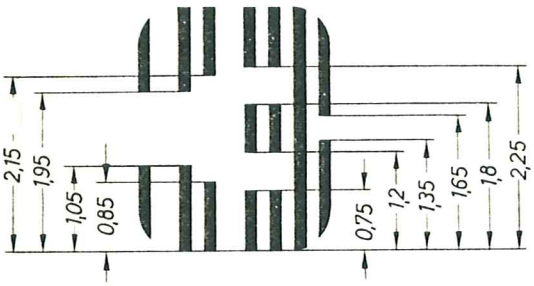
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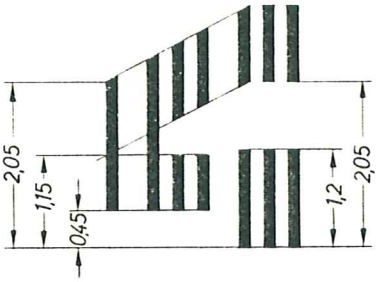
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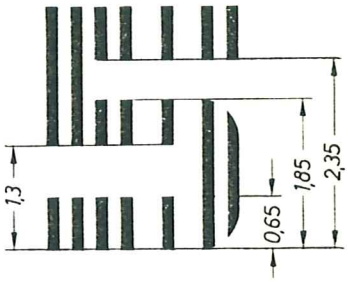
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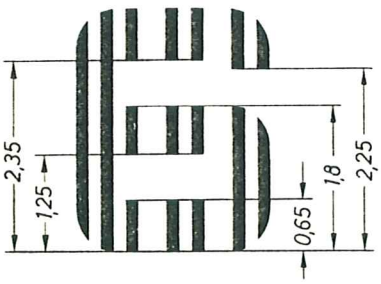
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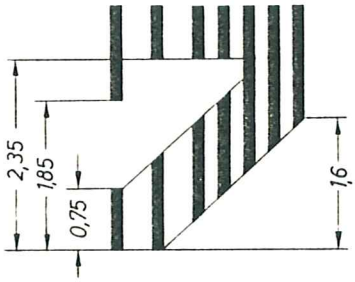
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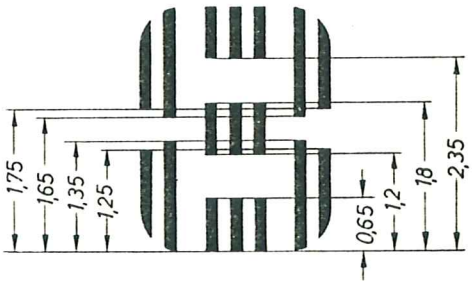
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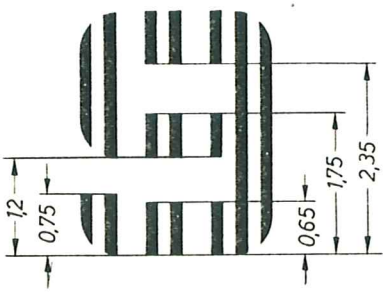
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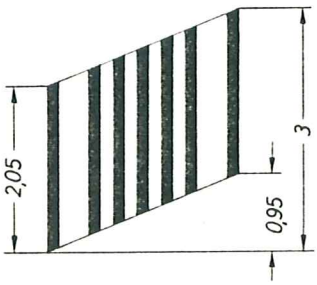
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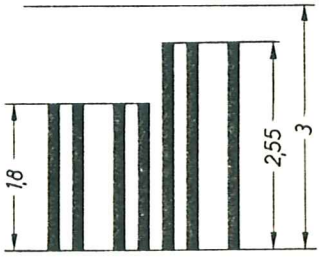
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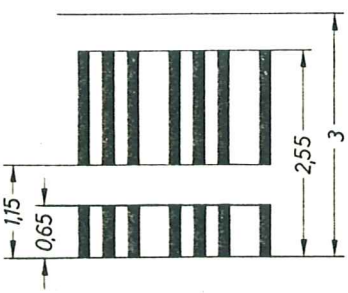
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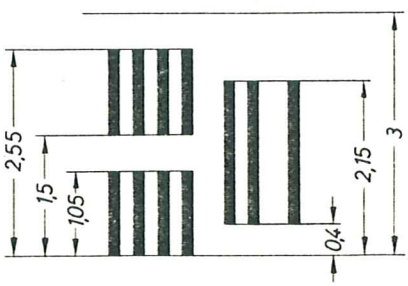
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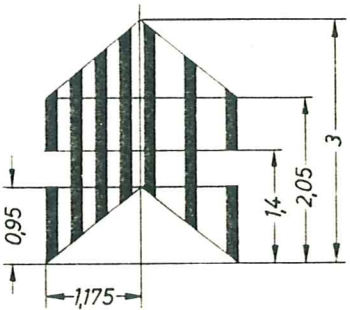
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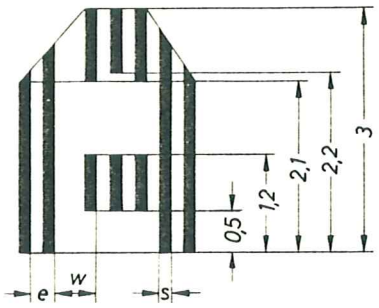
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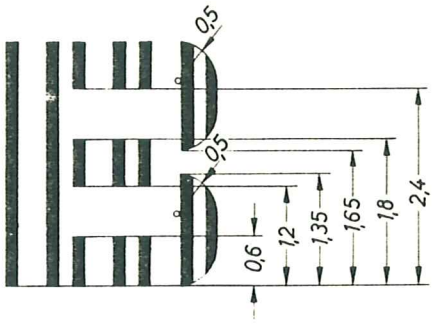
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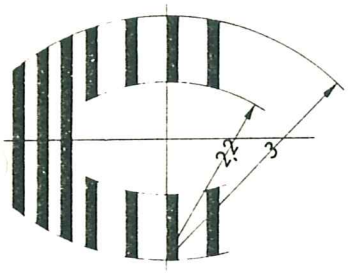
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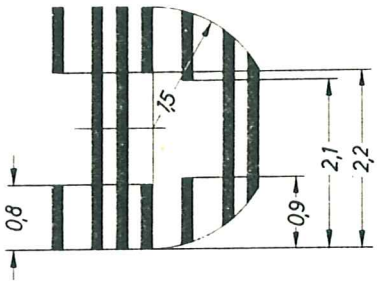
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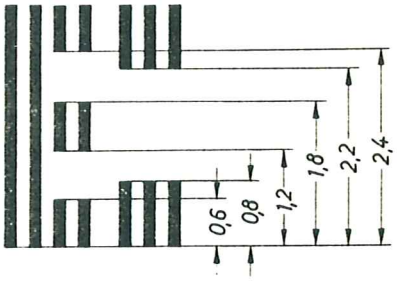
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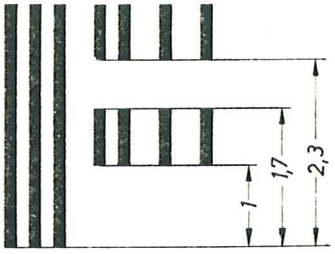
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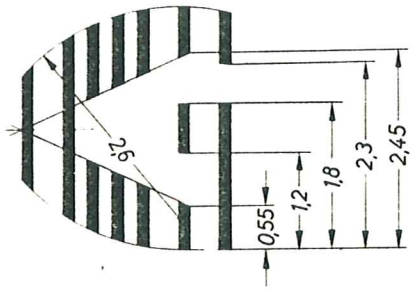
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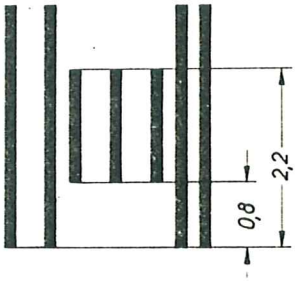
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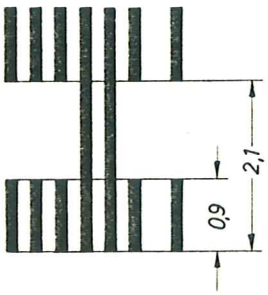
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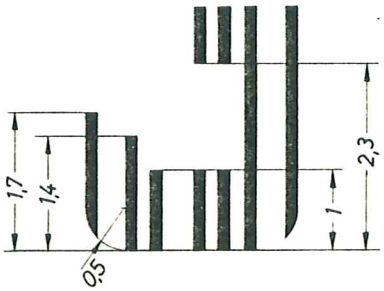
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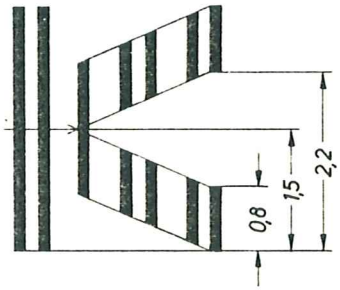
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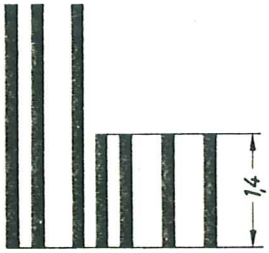
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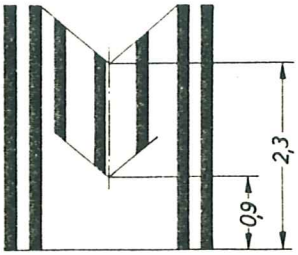
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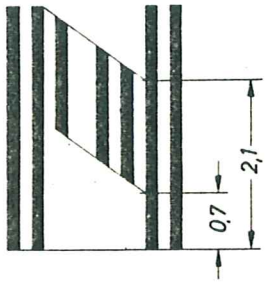
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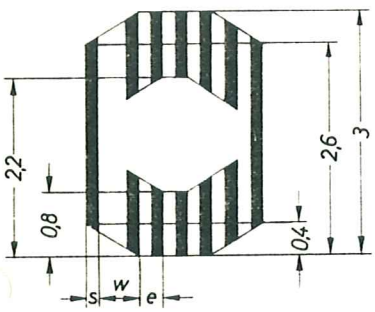
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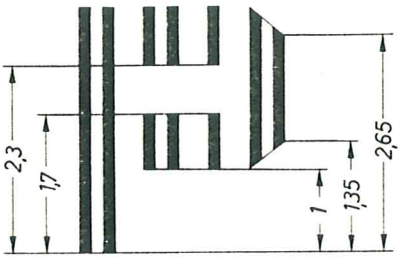
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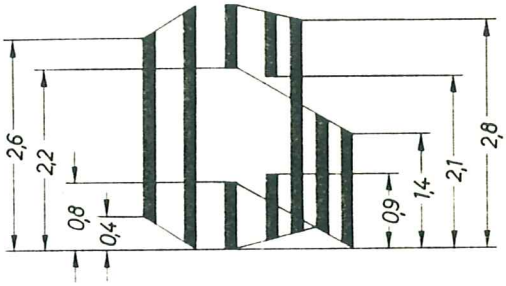
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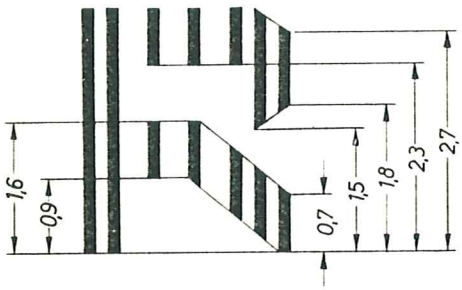
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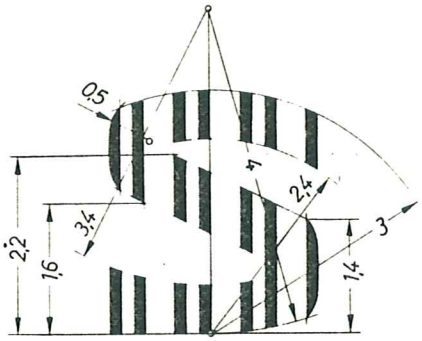
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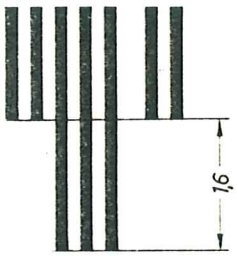
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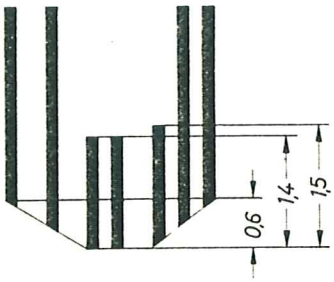
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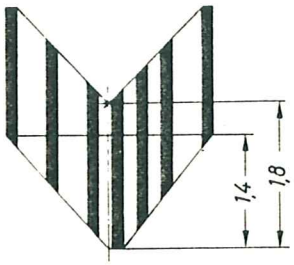
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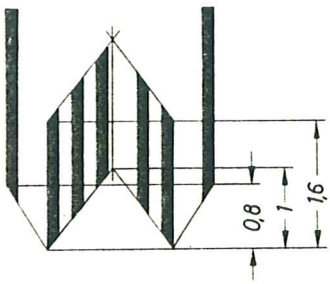
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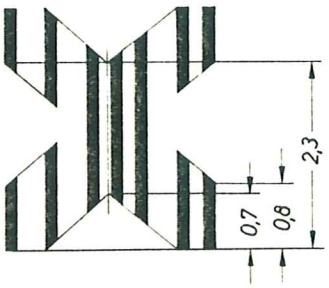
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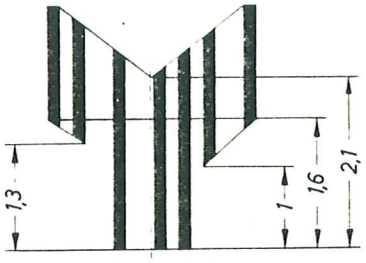
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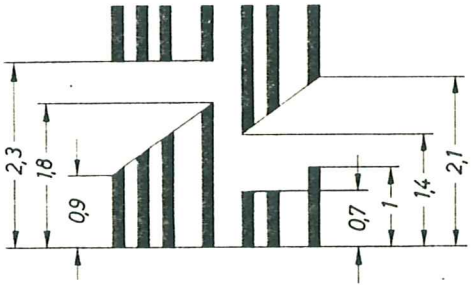
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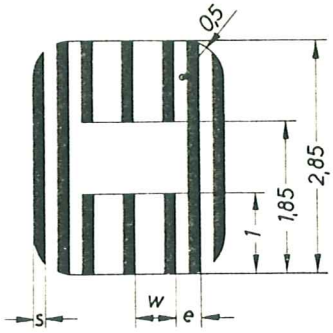
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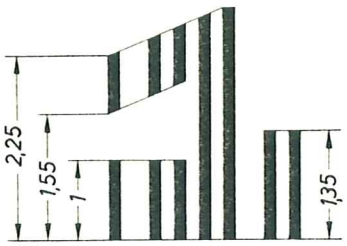
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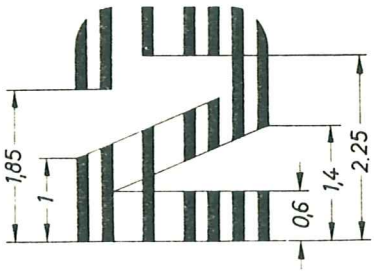
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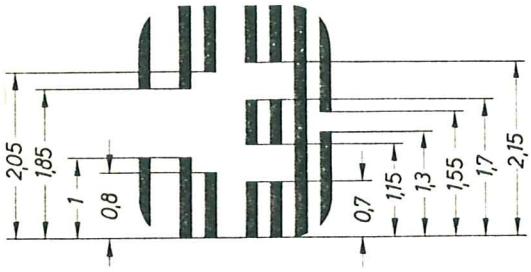
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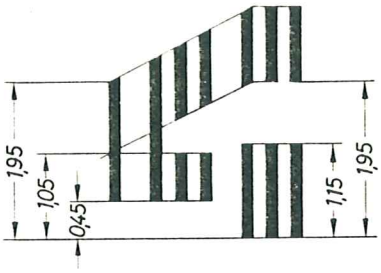
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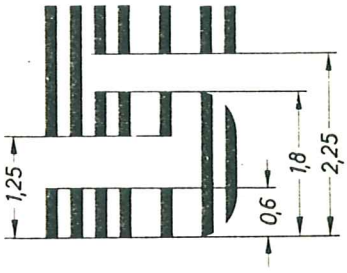
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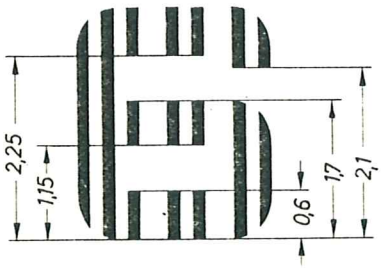
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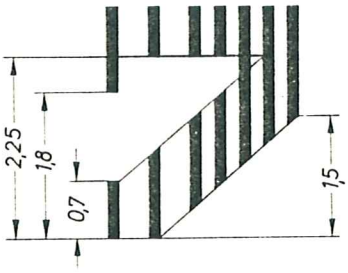
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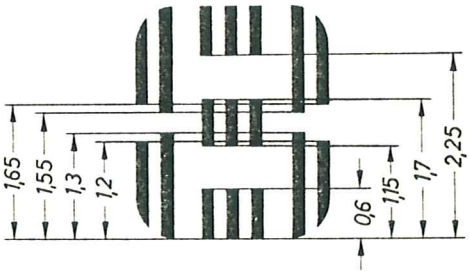
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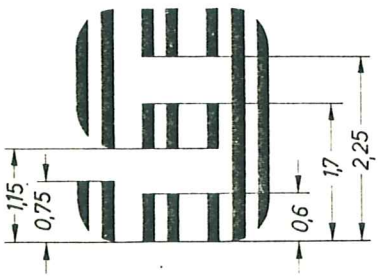
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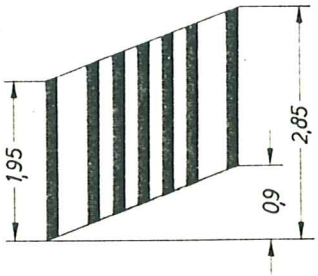
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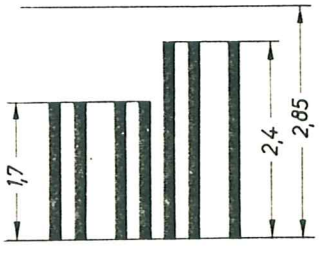
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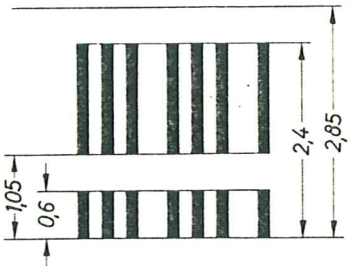
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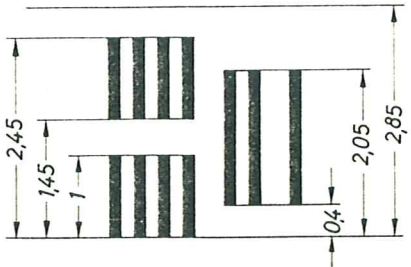
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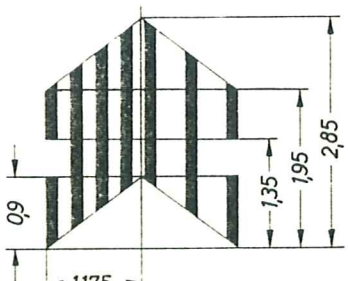
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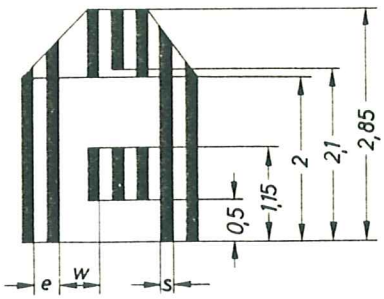
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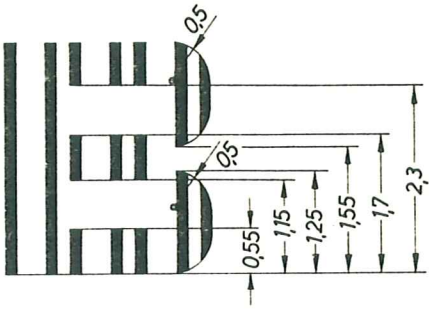
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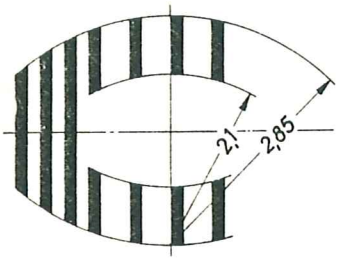
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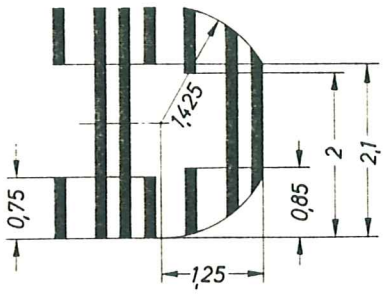
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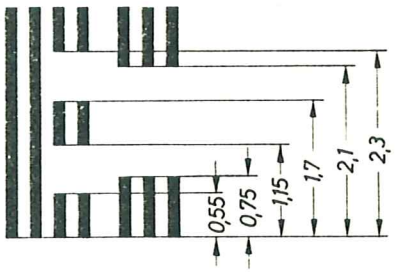
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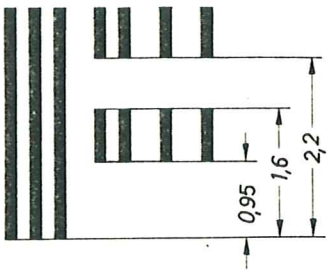
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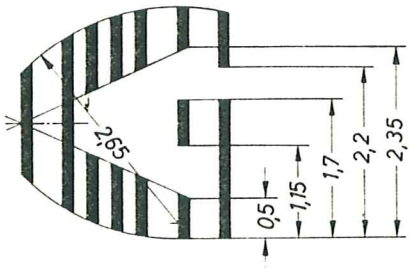
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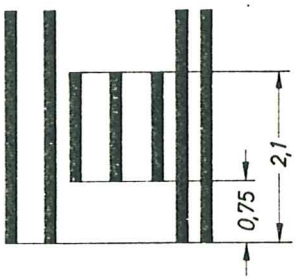
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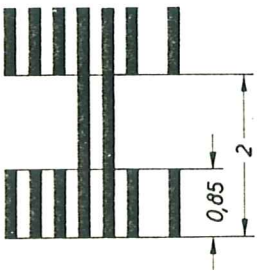
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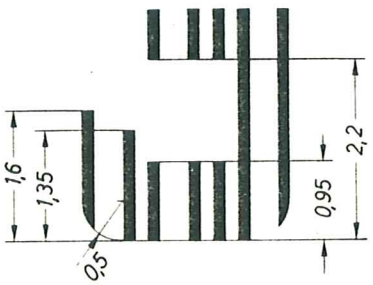
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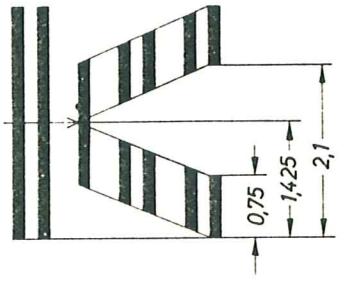
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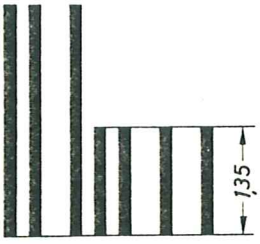
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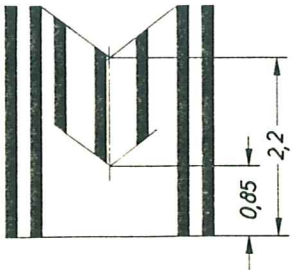
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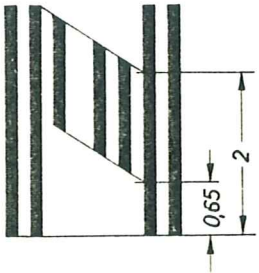
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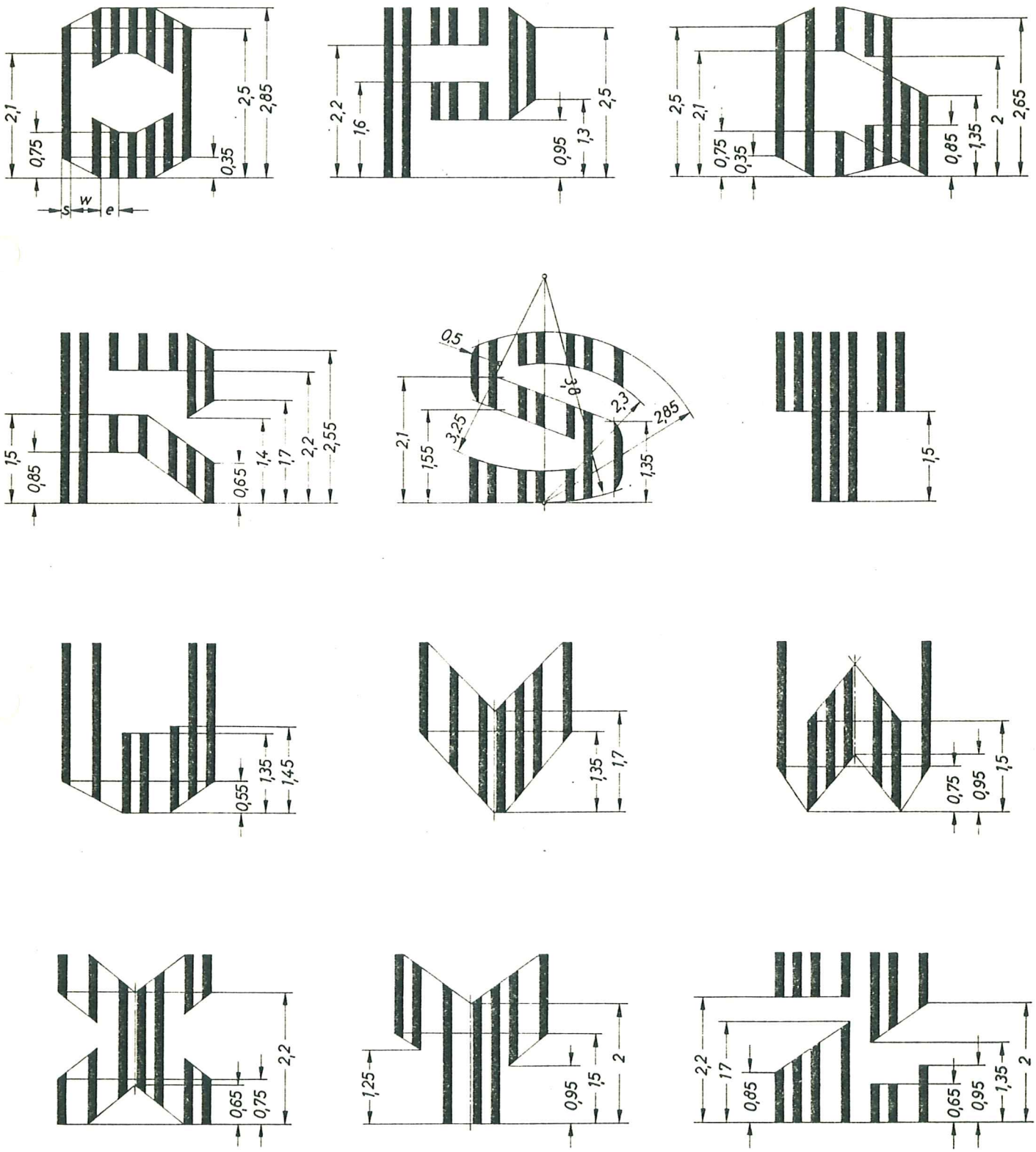
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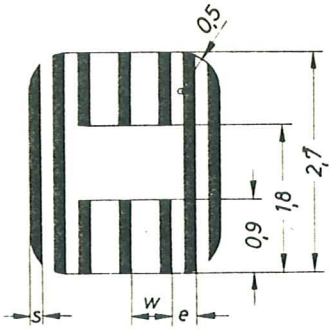
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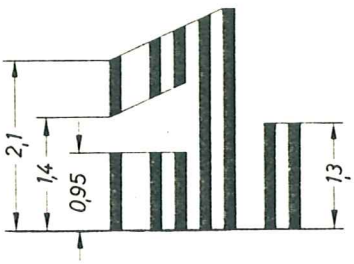
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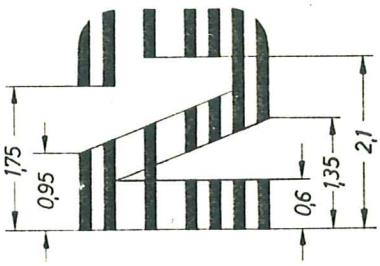
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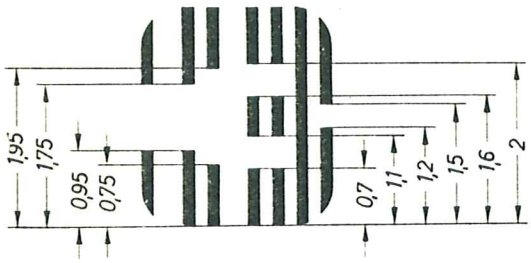
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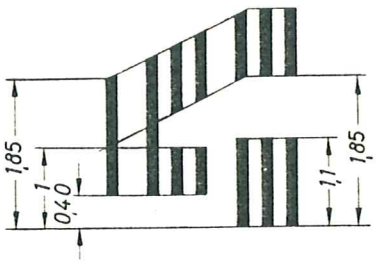
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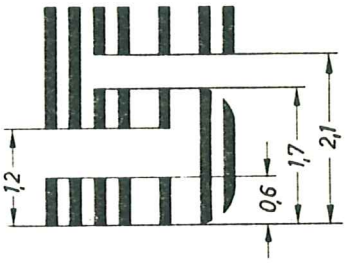
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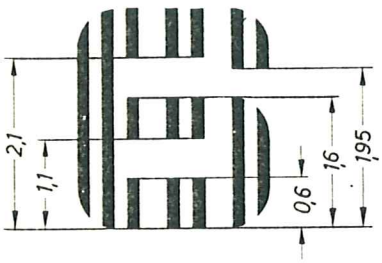
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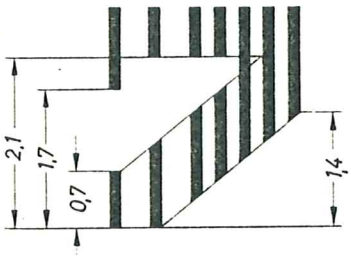
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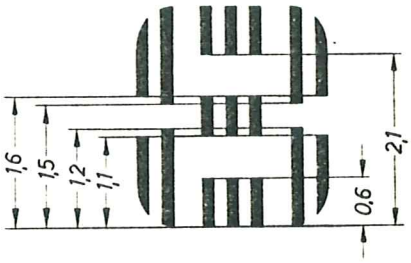
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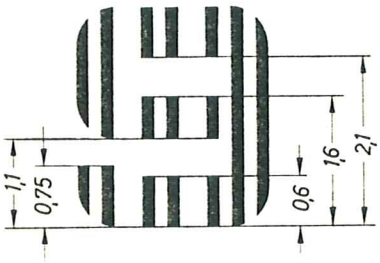
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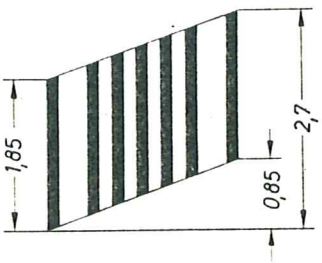
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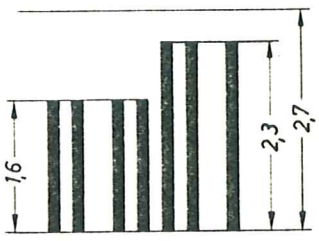
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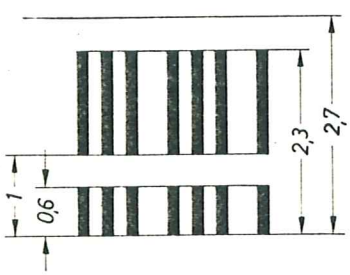
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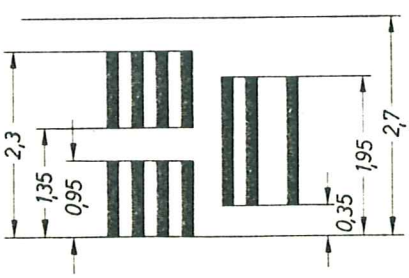
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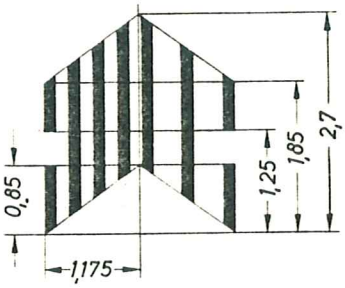
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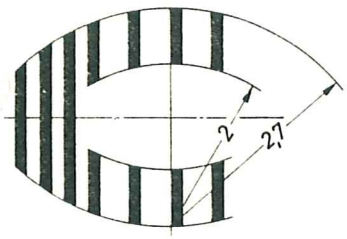
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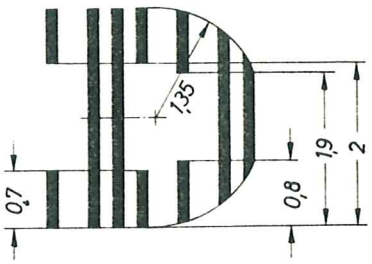
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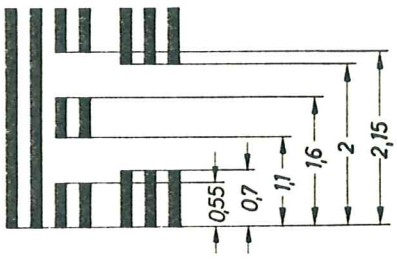
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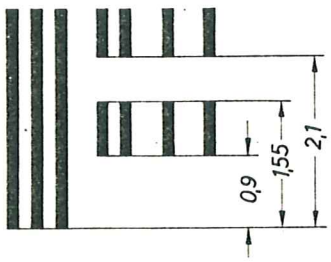
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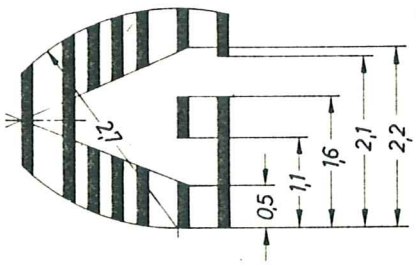
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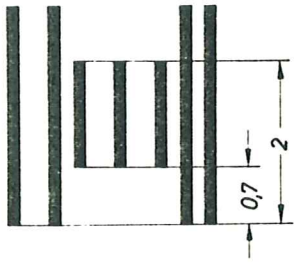
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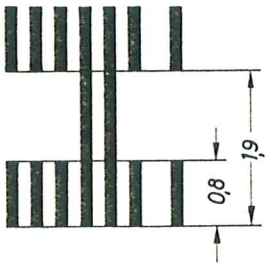
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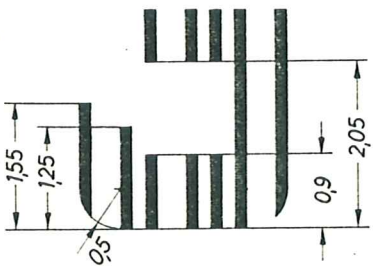
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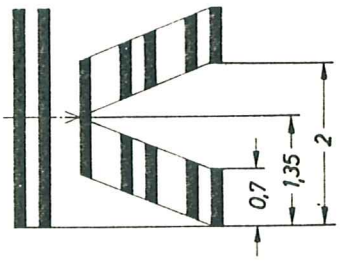
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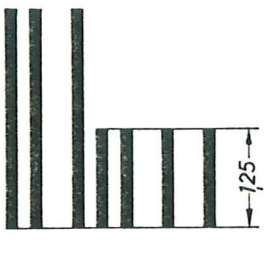
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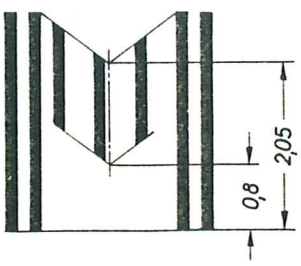
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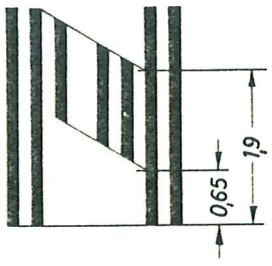
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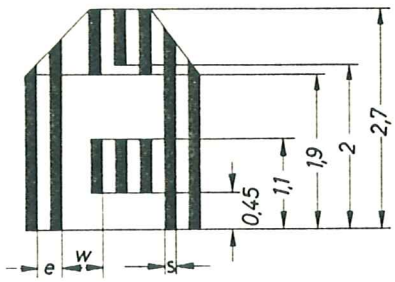
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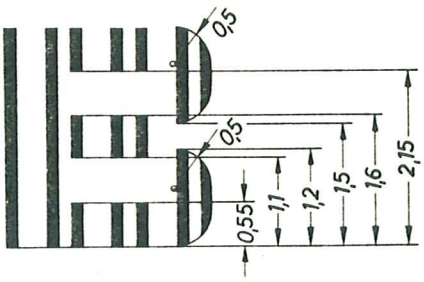
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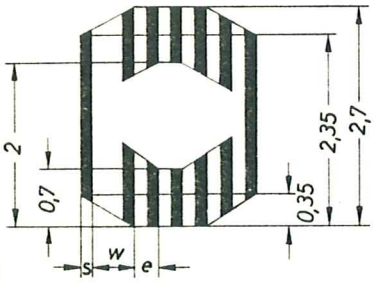
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w
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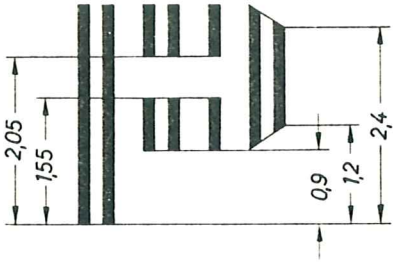
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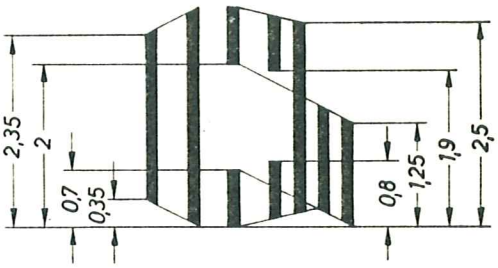
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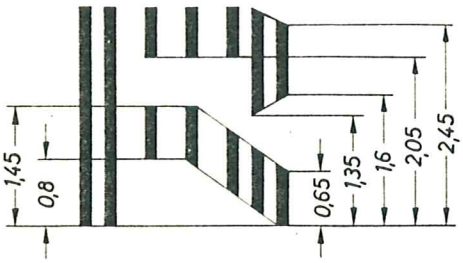
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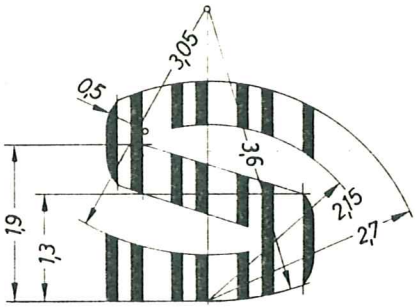
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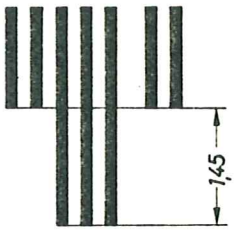
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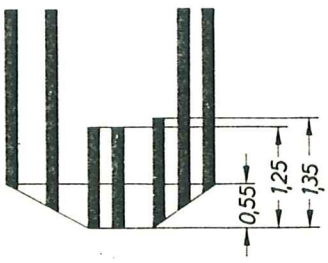
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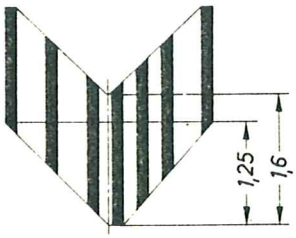
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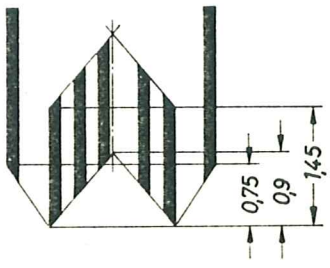
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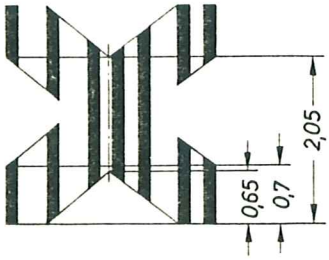
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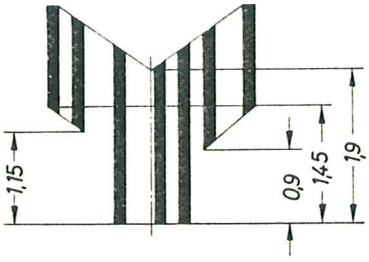
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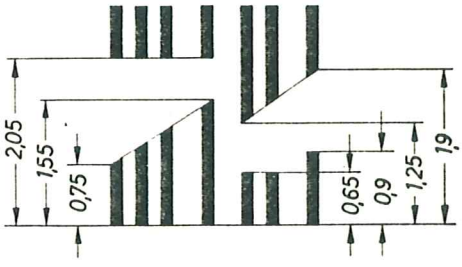
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APPENDIX A

USE OF SYMBOLS

1. A code line contains various groups of characters called fields (or zones) of information.

2. These fields may contain numerical or alphabetical characters or both.

3. 1. In applications, in which all fields contain numerical characters only, there is no restriction on the use of any symbol.

3. 2. In applications, in which no field contains numerical characters only, there is no restriction on the use of any symbol.

4. In applications, in which the fields may contain numerical as well as alphabetical characters, one can desire in fields with numerical characters only, to check systematically the presence of two long intervals in each such character. In this case following rules shall apply :

4. 1. fields which may contain at least one alphabetic character shall be preceded by S IV,

4. 2. fields containing numerical characters only shall be preceded by S I, S II, S III or S V.

APPENDIX B

EQUIPMENT FOR MEASURING THE RELATIVE SIGNAL LEVEL

1. Apparatus

An apparatus suitable for measuring signal level shall comprise means for

1.1. magnetizing into saturation the magnetic characters on the document, parallel to the bottom reference edge. The leading pole relative to the printed character must be the northpole.

1.2. moving the document in contact with the read head.

1.3. amplifying the output of the read head for presentation on an oscilloscope.

1.4 presentation of the complete wave-form of one or more characters to be measured on an oscilloscope.

2. Parameters for the measuring equipment

2.1. The document velocity relative to the read head must be constant within ± 1 %. The velocity must under no circumstances be lower than 1 m/s. The frequency values mentioned below are valid for a velocity of 4 m/s and must be modified proportionally if a different velocity is used.

2.2. The angle of the read head gap with the line perpendicular to the bottom reference edge of the document must be smaller than $1/2^{o}$ in absolute value.

2.3. The apparatus must have a magnetic read head, the gap of which has a width of 30 microns (tolerance + 0, - 5 μ). The height of the head must be sufficient to scan the clear band.

2.4.

2.4.1 The passband of the head-plus-amplifier combination must be flat, within ± 1 db, for frequencies in the range of 200 c/s to 30 kc/s, and must drop above 30 kc/s on a smooth curve with at least 6 db per octave. For frequencies below 200 c/s the amplifier gain must not exceed the gain specified for the range of 200 c/s to 30 kc/s. In achieving this performance the designer should keep in mind the inherent resonance effects of the read head.

2.4.2 The gain must be constant to ± 5% over the range of the inputs corresponding to signal levels between 10% and 400%. It should be possible, by means of a switched gain control, to study residual signal levels of the order of 5%.

2.4.3 With the output connection to ground, the noise output shall not exceed a voltage equivalent to 1% of the nominal signal level (i.e., U_o, according to the definition of 14.2.2).

2.5. The oscilloscope may be of any commercially available type having a reticle bearing horizontal rulings, provided it has characteristics adapted to the amplifier, mentioned above.

3. Calibration

A method for calibration follows :

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

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

Place the calibration document in transport and adjust simultaneously :

3.1 the level, corresponding to the non-printed areas between characters, (commonly referred to as baseline) onto the 0 percent line,

3.2 the vertical gain of oscilloscope so that the two right most positive pulses read an average value on the scope graduations which is identical to the value designated on the calibration document. The test equipment is then calibrated.

4. Signal level measuring method

After the test equipment has been calibrated, as outlined above, the character to be measured is placed in the transport device, and the location on the oscilloscope of the baseline is adjusted so as to coincide with the 0 percent line.
The signal level of each edge of each stroke of that character is then read as the value which each pulse attains.