BRITISH STANDARD

BS 6616:1986

Specification for

Paper and print for optical character recognition (OCR)

UDC 681.327.12:[676.22 + 655.244.07]

Committees responsible for this British Standard

This British Standard was entrusted by the Office and Information Standards Committee (OIS/-) to Technical Committee OIS/23, upon which the following bodies were represented:

Association for Payment Clearing Services
British Computer Society Ltd.
British Paper and Board Industry Federation (PIF)
British Printing Industries Federation
British Telecommunications plc
Business Equipment Trade Association
Electricity Supply Industry in England and Wales
Her Majesty's Stationery Office
HM Treasury (Central Computer and Telecommunications Agency)
Institute of Printing
National Girobank

This British Standard, having been prepared under the direction of the Office and Information Standards Committee, was published under the authority of the Board of BSI and comes into effect on
31 October 1986

The following BSI references relate to the work on this standard:
Committee reference OIS/23
Draft for comment 83/63637 DC

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Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

Foreword

BS 6616 was prepared under the direction of the Office and Information Standards Committee at the request of the clearing banks that arose as a result of the automation of the credit clearing system, involving the optical reading of bank giro credit vouchers. However, the standard is of general relevance to other optical reading applications.

This standard is based on ISO 1831:1980. The United Kingdom voted against ISO 1831 when it was circulated as a Draft International Standard (DIS), not for reasons of technical content but because it was considered that ISO 1831 was not sufficiently precise for use as a specification. BS 6616 differs principally from ISO 1831 in that the computer-aided method for determining character outline has been omitted and the visual method has been relegated to an appendix. The computer-aided method is primarily used for reading printed material of print quality tolerance range Z, which has also been omitted from this British Standard as it is not used in the United Kingdom. The visual method was considered to lack the precision required for a reference procedure but it has been retained in Appendix D as it may be a convenient method to use as a rough check on print quality for character sets OCR–A and OCR–B. ISO 1831 also includes a requirement and test method for the assessment of variation in paper reflectance. This was not considered to be sufficiently important for inclusion in this British Standard as a requirement but for guidance the test method has been included in Appendix A.

BS 6616 also covers the use of the character set E 13 B for OCR. Although E 13 B is designed to be magnetically read there is an increasing trend for it to be optically read in which case the requirements of this standard apply.

Fluorescence of paper can adversely affect the reading or sorting capabilities of some OCR systems and, as a consequence, this British Standard includes in Appendix A a recommendation for the maximum fluorescence to be exhibited by paper for OCR use. Currently there is no reference method for determining fluorescence, although the International Organization for Standardization (ISO) hopes to prepare one. When this method is available it is envisaged that the recommended fluorescence limit in Appendix A will become a requirement of this British Standard to be verified using the ISO method of test.

White paper is generally used where the technique of OCR is to be applied but the use of lightly tinted paper may be acceptable, provided the requirements of sections 2 and 3 are met.

Print quality is critical to the machine recognition of characters and it is necessary for OCR characters to be of higher print quality than characters to be read by the unaided human eye. Assessment of print quality includes the examination of the geometry of the character shape as well as the intensity of inking on the paper (print contrast). Ink of a high carbon black content is particularly suitable. The requirements of this standard apply to the printed image, not to the printing device (e.g. line printer) by which the printed image is produced.

The character positioning requirements ensure that each OCR character is read by the reader without interference from other OCR characters or from non-OCR elements.

Reference is made in this standard to the need for calibrated reference standards to be used for reflectance measurements. Within the United Kingdom ISO reference standards of level 3[1)], which are issued by authorized laboratories, can be obtained from the Research Association for Paper and Board, Printing and Packaging Industries (PIRA), Randalls Road, Leatherhead.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[1)] See measurement procedure described in BS 4432-1.

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Section 1. General

1 Scope

This British Standard specifies requirements for the optical properties of paper to be used for optical character recognition (OCR), for print quality, including character shape, quality, and positioning, and describes appropriate methods of test. The requirements are specifically for printed matter using one of the three character sets OCR–A[2], OCR–B[2] and E 13 B[3] (the latter where optically read), although the requirements for paper quality, character quality and character positioning may be applied irrespective of the character set or font, the printing system, or the end use of the printed material.

This specification does not include other dimensional requirements for the arrangement of characters. No specific dimensional measurements with respect to fields are given in this standard. No measurement of the distance between the average horizontal centreline on a line of OCR characters and a top or bottom reference edge is defined since this is dependent on varying systems requirements.

Colorimetric requirements are not specified, as they are considered unnecessary, other than by reference to the reflectance of the paper and the contrast between the paper and the print. The mechanical properties of the paper are not specified as the characteristics required will vary according to the reader being used; a list of appropriate standards is given in Sectional list SL 22.

NOTE The titles of the publications referred to in this British Standard are given on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1 Terms relating to paper quality

2.1.1
fluorescence F

the portion of the reflectance that can be directly attributed to the effect of a fluorescent whitening agent

2.1.2
gloss

the property of a surface responsible for a lustrous or mirror-like appearance

2.1.3
opacity[4]

the relationship, expressed as a percentage, between the reflectance factor R_0 and the intrinsic reflectance factor R_∞ of the same sheet of paper, obtained from the expression

$$100\,\frac{R_0}{R_\infty}$$

2.1.4 Terms relating to reflectance

2.1.4.1
intrinsic reflectance factor R_∞

the reflectance factor of a sheet or pad of paper thick enough to be opaque

2.1.4.2
reflectance factor R**[5]**

the relationship, expressed as a percentage, between the light reflected by a sheet of paper and that reflected by a perfect reflecting diffuser (i.e. having 100 % reflectance) under the same conditions

2.1.4.3
reflectance factor R_0

the reflectance factor R of a single sheet of paper with a black backing

2.1.5 Terms relating to sampling[6]

NOTE See Figure 1.

2.1.5.1
lot

the aggregate of paper or board of a single kind, of special characteristics comprising one or more nominally identical units

NOTE The unit may be in the form of a reel, a bale, a bundle, the contents of a packing case, a pallet load, etc. Where the material to be tested has already been incorporated into a manufactured article (for example a packing case), the lot is the aggregate of such articles of a single kind, of specified characteristics.

2.1.5.2
sample

the aggregate of all the specimens

2.1.5.3
specimen

a rectangle of paper or board cut to given dimensions, from the sheet (or manufactured articles) taken from the selected units which form the lot

[2] Described in BS 5464.

[3] Described in BS 4810.

[4] Definition based on **2.4** of BS 4432-3:1980.

[5] Definition based on **2.1** and **2.3** of BS 4432-1:1975.

[6] Definitions taken from BS 3430.

2.2 Terms relating to print quality

2.2.1
best fit

the position of a COL gauge over a character at which the character fills the minimum COL as much as possible and at the same time extends as little as possible beyond the maximum COL

NOTE See Figure 8 and Appendix C.

2.2.2
character outline limit (COL)

the outlines of a character. The minimum and maximum COL for a given character, in a specified font, character size and tolerance type, are the outlines of the printed image at the extremes of the tolerances for the strokewidth

2.2.3
character reflectance R_p

the reflectance factor of a point on a character

2.2.4
edge irregularity

that part of the stroke edge extending either inside the minimum COL or outside the maximum COL

2.2.5
local reflectance R_w

the reflectance of the paper within the area of interest around a character

NOTE See **C.1**.

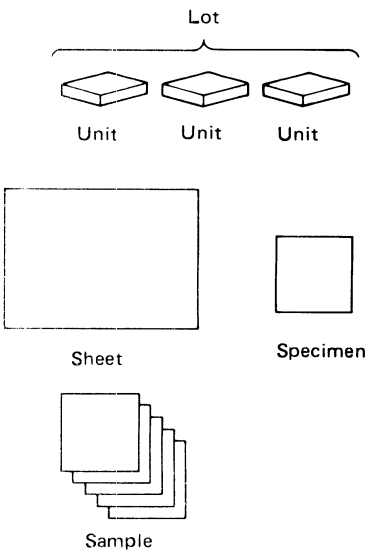


Figure 1 — Illustration of lot, sheet, specimen and sample

2.2.6
print contrast (PC), P

the arithmetic difference between the local reflectance R_w of the paper and the character reflectance R_p, i.e. $R_w - R_p$

2.2.7 print contrast signal (PCS), P_s

The print contrast divided by the reflectance factor R_o of the paper.

2.2.7.1
basic PCS values

a set of PCS values obtained with a COL gauge in the best fit

2.2.7.2
contrast variation ratio within a character (CVR), C

the relationship between the means of the highest three and lowest three basic P_s values for a character

2.2.7.3
P_{sa}

the arithmetic mean of the highest 80 % of the basic P_s values

2.2.7.4
P_{smax}

the highest mean value of any three consecutive basic PCS values for characters with a centreline 2 mm or more long or of five such consecutive values for characters with a centreline less than 2 mm long

2.2.7.5
P_{smin}

the lowest mean value of any three consecutive basic PCS values for characters with a centreline 2 mm or more long or of five such consecutive values for characters with a centreline less than 2 mm long

2.2.7.6
$P_{s80\ \%}$

the lowest value of the upper 80 % of the basic P_s values

2.2.7.7
print contrast signal within a character

the P_s value measured along the centreline of a character

2.2.8
spots

any extraneous ink outside the maximum COL

NOTE Spots could be connected to or adjacent to the printed image, or could be free-standing within the clear area.

2.2.9
stroke edge

the line joining the points at which the reflectance is approximately halfway between that of the local reflectance R_w and the character reflectance R_p

2.2.10
void

an area inside the minimum COL that is significantly lighter than the rest of the character

NOTE See **7.2.3**.

2.3 Terms relating to character positioning

2.3.1
character alignment within a line

the vertical displacement of the lower side of the character boundary, containing one character, relative to the lower side of the character boundary of another character within the same line boundary

NOTE 1 In the case of character sets OCR–A and OCR–B this displacement takes into account the intended position of the lowest edge, relative to the baseline, of certain characters, e.g. lower case with descenders or symbols, when in their nominal positions.
NOTE 2 See Figure 6.

2.3.2
character boundary

the smallest rectangle that has one side parallel to one of the document reference edges and which contains a character when aligned at the stroke edge

NOTE See Figure 2.

2.3.3
character separation within a line

the horizontal spacing between two adjacent vertical sides of the character boundaries of two characters within the same line boundary

NOTE See Figure 3.

2.3.4
character skew

the rotational deviation, expressed in degrees, of the vertical centreline of the character from the vertical document reference edge

NOTE See Figure 2.

2.3.5
character spacing within a line

the horizontal distance between the vertical centrelines of the character boundaries of two characters within the same line boundary

NOTE See Figure 3.

2.3.6
clear area

that region of a document reserved for one line of characters and the space around those characters

NOTE See Figure 5.

2.3.7
document reference edge

a specified horizontal and/or vertical edge of the document

NOTE See Figure 2.

2.3.8
external corner

a corner where the angle defined by the strokes of the centreline is greater than 180°

NOTE See Figure 12.

2.3.9
field

a specific portion of a line, comprising at least one character

NOTE A field may be treated as a unit of information. A line may comprise several fields.

2.3.10
internal corner

a corner where the angle defined by the strokes of the centreline is smaller than 180°

NOTE See Figure 12.

2.3.11
line boundary

the smallest rectangle parallel to the document reference edge which contains all the character boundaries of the characters in that line

NOTE See Figure 4.

2.3.12
line separation

the vertical distance between the upper side of the line boundary, and the lower side of the line boundary of the line of print immediately above

NOTE 1 See Figure 7.
NOTE 2 The parameters that influence line separation are the line pitch specification, line skew, character alignment, character height and strokewidth.

2.3.13
line spacing

the vertical distance between the average horizontal centreline position of all characters printed on one line and that of all characters printed on the next line

NOTE See Figure 7.

2.3.14
margin

the distance between any boundary of the printing area and the nearest parallel document reference edge

NOTE See Figure 5.

2.3.15
printing area

a rectangle that has one side parallel to the document reference edge and is intended to contain only machine readable characters of one line

NOTE See Figure 5.

3 Classification

Paper shall be classified as either high or medium opacity paper, in accordance with clause **4**. Print shall be classified, in accordance with **7.1**, as either print quality tolerance range X or Y.

Section 2. Paper quality

NOTE In addition to the requirements specified in clauses **4** to **6**, the following qualities are desirable but are not specified in this British Standard as they cannot be precisely measured. However, information on them is given in Appendix A:

a) low gloss;
b) freedom from watermarks in the print area;
c) evenness of paper formation;
d) variations in reflectance;
e) freedom from fluorescent additives.

4 Paper opacity

When tested in accordance with BS 4432-3, paper opacity shall be in accordance with the following values:

high opacity $\geqslant$ 85 %;

medium opacity $\geqslant$ 70 %.

5 Reflectance factor R_o

5.1 Paper for optical readers operating in the blue/green spectral region

When tested in accordance with Appendix B, the mean value of the reflectance factor R_o shall be as follows.

	High opacity paper	*Medium opacity paper*
	%	%
Blue filter	> 60	> 50
Green filter	> 70	> 60

5.2 Paper for optical readers operating in the infra-red spectral region

When tested in accordance with Appendix B, the mean value of the reflectance factor R_o shall be as follows:

high opacity paper $\geqslant$ 70 %;

medium opacity paper $\geqslant$ 60 %.

6 Freedom from dirt

When tested in accordance with BS 5477, the number of squares of paper per 6 m^2 containing dirt shall not exceed 200.

Section 3. Print quality

7 Print quality characteristics

7.1 General

The character set used shall be either

a) OCR–A or OCR–B complying with BS 5464 and of print quality tolerance range X or Y in accordance with Table 1 and **7.2** of this British Standard; or

b) E 13 B complying with BS 4810 and with **7.2.5.2**.

NOTE Tolerances for character set E 13 B are specified in BS 4810.

Table 1 — Tolerances on dimensions for character sets OCR–A and OCR–B

Size	Tolerances	
	Print quality tolerance range X	Print quality tolerance range Y
	mm	mm
I	± 0.08	± 0.15
III	± 0.08	± 0.18
IV	± 0.13	± 0.25

7.2 Character sets OCR–A and OCR–B

NOTE **7.2.1** to **7.2.5** specify limits for print quality for machine readable material. Characters that do not comply with these requirements may still be legible to the unaided human eye (see also foreword).

7.2.1 $P_{s80\ \%}$. When measured in accordance with **C.1**, the value of $P_{s80\ \%}$ shall be as follows:

print quality tolerance range X, $\geqslant 0.60$;

print quality tolerance range Y, $\geqslant 0.50$.

7.2.2 *Contrast variation ratio (CVR).* When determined in accordance with **C.1**, the value of C shall be as follows:

print quality tolerance range X, < 1.50;

print quality tolerance range Y, < 1.75.

7.2.3 *Voids*. When printed characters are tested for voids in accordance with **C.2**, the results shall be in accordance with the limiting conditions on PCS values specified in either **7.2.3.1** or **7.2.3.2**, depending on the centreline length.

NOTE Voids occur in printed characters as an almost inevitable consequence of conventional printing processes. However, OCR readers are capable of ignoring such blemishes provided that they fall within certain limits.

7.2.3.1 *Limiting conditions for characters having a centreline length of 2 mm or more*. Characters having a centreline length of 2 mm or more shall be deemed to comply with this British Standard if;

a) when two adjacent points have $P_s < d$, the distance to the next similar pair of points is not less than 11 steps;

b) no set of three consecutive points with $P_s < d$ exists.

NOTE No restriction exists on the occurrence of isolated points where $P_s < d$ and where the adjacent points have $P_s > d$.

7.2.3.2 *Limiting conditions for characters having a centreline length of less than* 2 mm. Characters having a centreline length of less than 2 mm shall be deemed to comply with this British Standard if:

a) when three or four consecutive points have $P_s < d$, the distance to the first point of the next similar group of three or four points is at least 21 steps;

b) no set of five consecutive points with $P_s < d$ exists.

NOTE No restriction exists on isolated single points or pairs of points having $P_s < d$.

7.2.4 *Edge irregularities*. When measured in accordance with **C.3**, the stroke edges of the character under consideration shall be deemed to comply with this British Standard provided that all measurements of P_s along the maximum COL are greater than 0.5 P_{sa}, and along the minimum COL are less than 0.5 P_{sa}, except if the minimum COL value of 0.5 P_{sa} is less than 0.3 in which case the measured P_s values shall be compared with the fixed value of 0.3.

If there are edge irregularities where the stroke edges exceed one or both COL, each such stroke edge shall be deemed to comply with this British Standard provided that it is no closer than 1 mm, measured centre-to-centre, from another edge irregularity.

7.2.5 ***Spots***

NOTE This standard does not set limits on spots outside the printing area and the clear area.

7.2.5.1 *Spots in the printing area.* Printing areas shall be deemed to comply with this British Standard when any spots, measured in accordance with **C.4**, have

a) one point having a $P_s > e$;

b) two points having a $P_s > e$, if the distance to the nearest such point and to the maximum COL is greater than 1 mm.

Printing areas with three or more points having a $P_s > e$ shall be deemed not to comply with this British Standard.

7.2.5.2 *Spots in the clear area.* Spots in the clear area shall be not greater than 0.2 mm in diameter.

Section 4. Character positioning

8 All character sets

8.1 Character skew

The character skew shall not exceed 3° (see Figure 2).

8.2 Character separation within a line

The character separation within a line shall not be less than the nominal strokewidth for each size of character (see **7.1** and Figure 3).

8.3 Line boundary

The line boundary of a line of printed characters shall be completely inside the printing area (see Figure 4).

8.4 Clear area

The clear area shall surround the printing area symmetrically (see Figure 5).

NOTE 1 The location and dimensions of clear areas are determined by the nature of the individual applications but normally the distances between the corresponding boundaries of the printing area and the clear area (*a*, *b*, *c* and *d* in Figure 5) should be not less than 2.5 mm.

NOTE 2 For readers able to read several lines on the same document simultaneously, a number of clear areas and print areas will be defined on the document. For two succeeding lines the clear areas of the two lines may overlap, with the clear space between the lines being shared.

8.5 Margin

The margin shall be at least 6.35 mm wide (see Figure 5).

NOTE If manually operated serial entry devices (for example typewriters) are used, the top and bottom margins should be at least 25.4 mm wide.

8.6 Long vertical mark alignment

The character "LONG VERTICAL MARK" shall extend beyond the top and the bottom boundaries of any adjacent character, except for lower case characters with descenders, within the same line.

9 Character sets OCR–A and OCR–B

9.1 Character spacing within a line

Character spacing within a line (see Figure 3) shall be not less than the following (but see note):

sizes I and III	2.30 mm;
size IV	3.30 mm.

NOTE Some printing methods and devices such as letterpress, variable pitch typewriters and some journal tape printers produce printing that does not meet the character spacing requirements for all combinations of characters within the repertoire of the printer. Some readers are not affected by this as long as the character alignment requirement of **9.2** are satisfied.

9.2 Character alignment

9.2.1 *Adjacent character alignment.* Adjacent character displacement shall not exceed the following (see Figure 6):

size I	0.65 mm;
size III	0.90 mm;
size IV	1.10 mm.

NOTE For the purpose of OCR two characters are considered adjacent if their spacing within the line is less than the following:

sizes I and III	4.60 mm;
size IV	6.60 mm.

9.2.2 *Character alignment within a line.* Character displacement within a line shall not exceed the following (see Figure 6):

size I	1.30 mm;
size III	1.80 mm;
size IV	2.20 mm.

9.3 Text for readers able to read several lines on the same document simultaneously

9.3.1 *Line separation.* The line separation shall be not less than the following (see Figure 7):

size I	0.65 mm;
size III	1.50 mm;
size IV	2.00 mm.

If character sizes are intermixed, the line separation limitation for any pair of lines shall be that applicable to the largest character in the two lines.

9.3.2 *Line spacing.* The line spacing shall be not less than the following (see Figure 7):

size I	4.20 mm;
size III	4.80 mm;
size IV	5.30 mm.

If character sizes are intermixed, the limitation applying to the largest size shall apply.

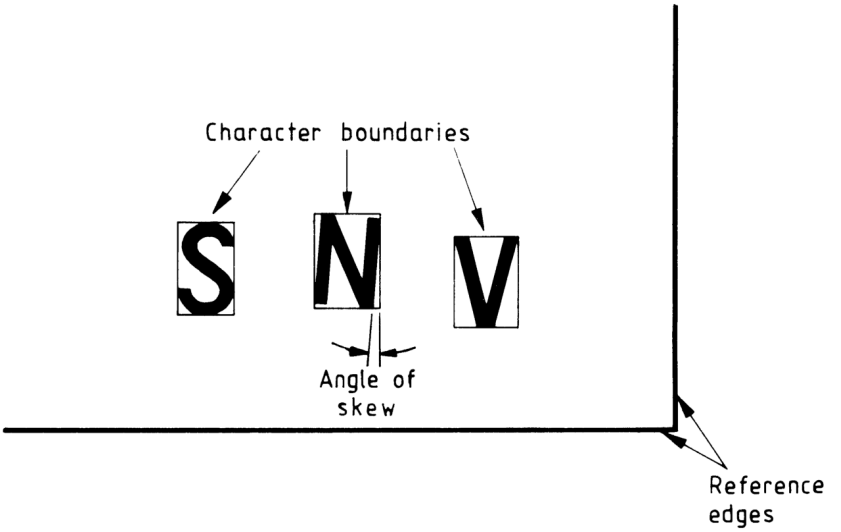


Figure 2 — Character skew

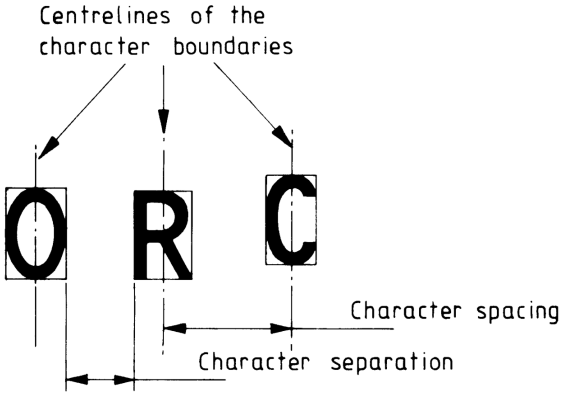


Figure 3 — Character separation and character spacing within a line

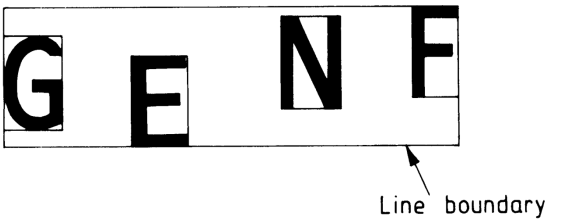


Figure 4 — Line boundary

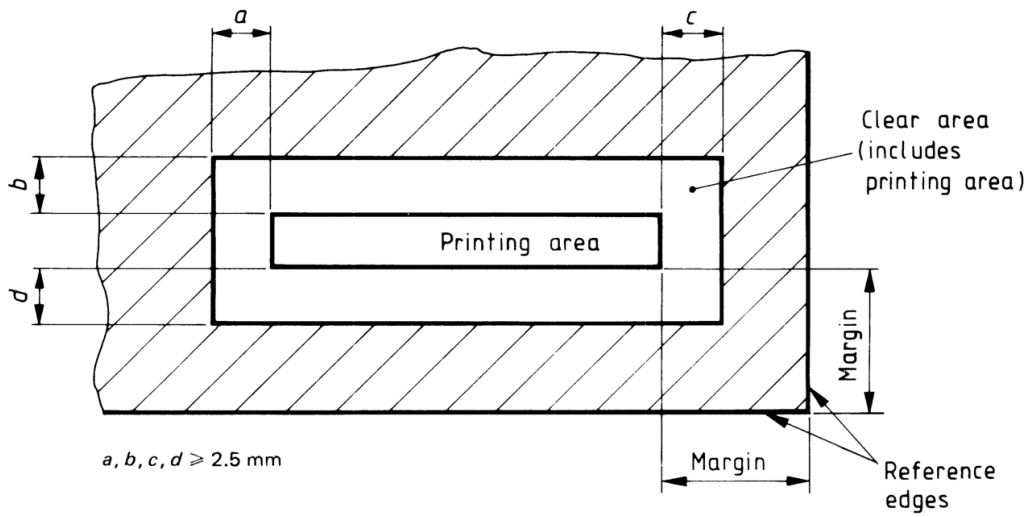
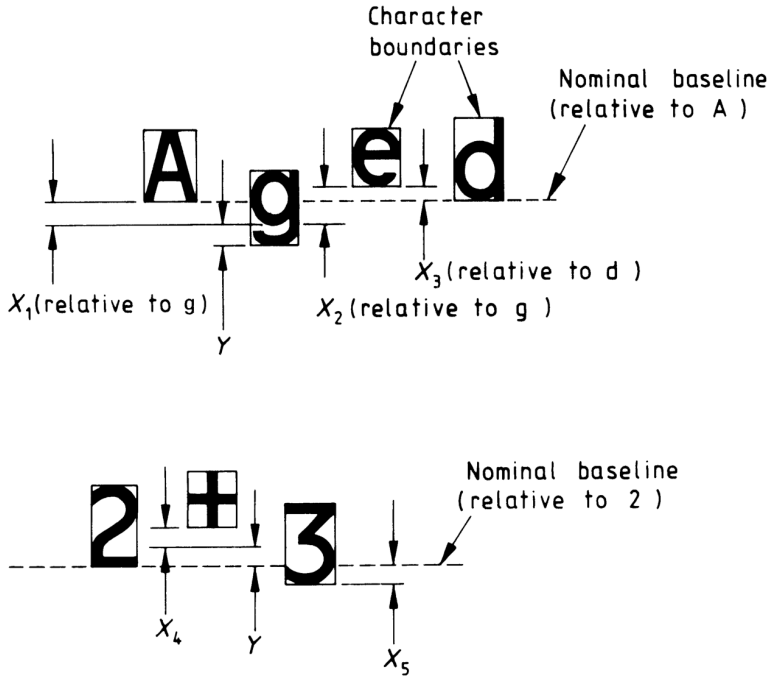


Figure 5 — Printing area, clear area and margin



NOTE X_n is the displacement value used when determining character alignment in accordance with **9.2**, e.g. X_6 (displacement of + relative to 3) = $X_4 + X_5$. Y is the nominal value, i.e. the relative displacement that would always occur were the two adjacent characters positioned exactly in the correct positions relative to a nominal baseline. (The value of Y can be determined from the reference figures for OCR–A or OCR–B described in BS 5464).

Figure 6 — Character alignment within a line

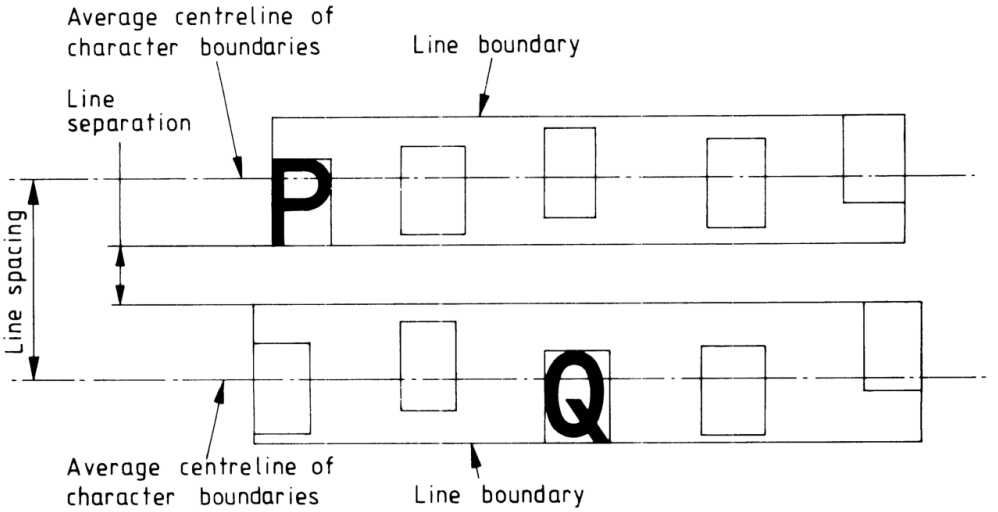


Figure 7 — Line separation and line spacing

Appendix A Guidance on paper properties

A.1 Gloss

Gloss is a particularly difficult property to measure and no standardized test method exists. Gloss should be low, in the order of 10 % to 15 % reflectance of incident light. High gloss, i.e. in the order of 50 % to 60 % reflectance, will interfere with the effective functioning of the reader. The general degree of gloss will be readily apparent from visual examination of the paper. Low gloss can be achieved by the use of non-coated or non-calendered papers.

A.2 Freedom from watermarks in the print area

There should be no watermarks in the area to be printed with OCR characters.

A.3 Evenness of paper formation

The paper should be as even as possible. Excessively uneven or wired formation can affect the optical properties.

A.4 Variations in reflectance

Reflectance measurements obtained with a microscopic aperture R_f at a variety of positions at the paper surface are subject to variation of the measurements obtained.

The average variation in reflectance is defined by the variation coefficient R_a of R_f.

The maximum variation in reflectance, f, is defined as the ratio of the highest to the lowest value of R_f.

The variations in reflectance should be established with a single sample against a black background (the reflectance of this background should not exceed 3 %). The average variation from the measured mean value should not result in a variation coefficient greater than 3.5 %. In addition, assuming a normal distribution, no more than 1 % of all measured values should lie beyond the range R_M (1.00 ± 0.10), where R_M is the mean of the R_f values. This corresponds to a limit of 1.20 for f.

The mean value of the variation should be not less than 5 % below the minimum specified for the reflectance factor R_o in clause **5**.

A.5 Freedom from fluorescent additives

It is not always possible to avoid residual fluorescence, for example as a result of the recycling of paper. However, for the best performance of OCR readers, fluorescence should be kept as low as possible and it is strongly recommended that the value for fluorescence of the paper F should not exceed 2 %. Fluorescent additives should not be deliberately introduced.

NOTE A method of test to determine fluorescence is in preparation (see foreword).

Appendix B Method for measurement of reflectance factor R_o

B.1 Test sample size and treatment of results

Test five specimens of paper and calculate the mean value. If one result deviates from the mean by more than 10 % discard that result and take one further specimen. Calculate a new mean for the resulting sample of five specimens and use this value to check compliance.

B.2 Apparatus

B.2.1 *Reflectometer,* as specified in BS 4432-1.

B.2.2 *Filters,* having the following characteristics.

a) *Blue filter*, that in conjunction with the optical characteristics of the instrument gives an overall response equivalent to the CIE tristimulus value Z (CIE 45-16-060)[7] of the CIE 1931 standard colorimetric system (CIE 45-15-040)[7] of the test piece evaluated for the CIE standard illuminant C (CIE 45-15-145).

b) *Green filter*, that in conjunction with the optical characteristics of the instrument gives an overall response equivalent to the CIE tristimulus value Y (CIE 45-16-060)[7] of the CIE 1931 standard colorimetric system (CIE 45-15-040)[7] of the test piece evaluated for the CIE standard illuminant C (CIE 45-15-145).

c) *Infra-red filter*, that in conjunction with the optical characteristics of the instrument provides a source of illumination with the following spectral response;

peak height: 900 ± 50 nm;

bandwidth: 400 nm max. at 50 % level.

[7] CIE (Commission Internationale de l'Eclairage). *International Lighting Vocabulary,* 3rd Edition, for CIE definitions. Available from Hon. Librarian (National Illumination Committee), c/o Thorn Lighting Limited, Great Cambridge Road, Enfield, Middlesex EN1 1UL.

B.3 Procedure

Determine the reflectance factor R_o using the procedure specified in BS 4432-3 with the appropriate filters.

For readers operating in the blue/green spectral region, use blue and green filters, taking separate measurements for each filter. For readers operating in the infra-red spectral region, use the infra-red filter.

Appendix C Methods for determining the quality of print for optical character recognition

NOTE For a method for visual checking of print quality see Appendix D.

C.1 Method for the determination of print contrast signal (PCS) and contrast variation ratio within a character (CVR)

C.1.1 *Apparatus*

C.1.1.1 *Optical reader*, of the type with which the text will be used and having an aperture capable of adjustment.

C.1.1.2 *Incandescent lamp and filter combination*, that together emit light with a spectral content corresponding to the spectral response of the optical reader.

C.1.1.3 *COL gauges* (see Appendix E)

C.1.1.4 *White reference*, e.g. barium sulphate, calibrated in accordance with BS 4432-1.

NOTE Although normally reflectance values are related to a white reference (see BS 4432-3) this is not necessary in the determination of PCS and CVR as these values are dependent only on the relationship between R_w and R_p.

C.1.2 *Procedure*

Arrange the lamp/filter combination so that the paper and characters are completely and evenly illuminated at an angle of 45° to the paper surface. Arrange the optical reader at 90° to the paper surface and adjust the aperture of the reader so that the viewing area at the paper surface has a diameter of 0.2 mm.

For each character to be measured, designate the area of interest as being a rectangle, centred on the character, of approximately twice the nominal character length by twice the nominal character width. Within this area of interest measure the local reflectance, R_w, of the paper at five points clear of the character.

Place the appropriate COL gauge over the character in the best fit position. Move the optical reader along the centreline of the character and measure the character reflectance, R_p, at intervals of 0.05 mm if the centreline is less than 2 mm long or 1.0 mm if the centreline is 2 mm or longer.

C.1.3 *Calculations*

Calculate the mean value of the five values of R_w and use this as the value for calculation of P_s.

Calculate the basic PCS values from the measured values of R_p using the equation:

$$P_s = \frac{R_w - R_p}{R_w}$$

From these basic PCS values determine $P_{s80\ \%}$, P_{sa}, P_{smin} and $P_{s\ max}$.

Calculate C using the expression:

$$\frac{P_{s\ max}}{P_{s\ min}}$$

C.2 Method for the assessment of voids

C.2.1 *Apparatus*

Use the apparatus described in **C.1.1**.

C.2.2 *Procedure*

Arrange the appropriate COL gauge over the characters in the best fit position. Visually inspect the character for any voids inside the minimum COL.

Compare all basic PCS values lower than $P_{s80\ \%}$ with the reference values d as follows:

print quality tolerance range X, 0.40;

print quality tolerance range Y, 0.35.

Measure the character reflectance R_p of all voids as described in **C.1.2** and calculate the individual values of PCS as described in **C.1.3**.

C.3 Method for the assessment of edge irregularities

C.3.1 *Apparatus*

Use the apparatus described in **C.1.1**.

C.3.2 *Procedure*

Arrange the appropriate COL gauge over the character in the best fit position. Measure the reflectance character, R_p, as described in **C.1.2** along the maximum COL and minimum COL in steps of 0.2 mm and calculate the individual values of PCS as described in **C.1.3**.

C.4 Method for the assessment of spots

C.4.1 *Apparatus*

Use the apparatus described in **C.1.1**.

C.4.2 *Procedure*

Compare spots against the reference values e of $P_{s\ min}$ as follows:

print quality tolerance range X, 0.65;

print quality tolerance range Y, 0.70.

Disregard any spots having their centre within the maximum COL of the character.

Centre the aperture of the optical reader over the area of the spot having the lowest character reflectance R_p, measured as described in **C.1.2**. Note the value of R_p and take the centre of the area as the reference point for the further reading. Moving the measuring aperture in steps of 0.1 mm, measure R_p at two positions vertically above and vertically below the reference point and two positions horizontally at either side of the reference point, i.e. eight measurements. Calculate P_s for each position (a total of nine values in all), as described in **C.1.3**.

If two positions have a $P_s > e$, centre the aperture on the position with the smaller P_s value and measure the seven remaining positions in steps of 0.1 mm, horizontally and vertically.

Appendix D Method for visual checking of print quality of character sets OCR–A and OCR–B

NOTE This appendix describes a method for obtaining a quick but not necessarily accurate check on print quality. Print quality requirements are specified in section 3 of this standard and are the only means by which formal compliance with this standard may be determined.

D.1 General

For a rapid check on print quality, obtain the best fit for the appropriate COL gauge (see Figure 8) and visually inspect the character using a magnifying glass of magnification between × 5 and × 8, and apply the criteria given in **D.2** to **D.4**.

D.2 Voids

Check that voids are contained entirely in an inspection circle of 0.2 mm diameter and occupy less than one-third of the surface area of the inspection circle (see Figure 9).

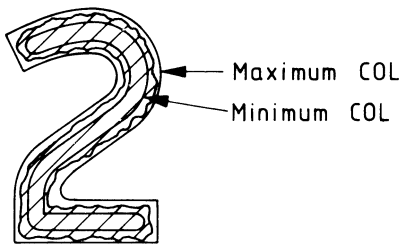


Figure 8 — COL gauge in its "best fit" position

If the total surface area of the void exceeds one-third of that of the inspection circle but is contained entirely within the inspection circle, the distance between the centre of the inspection circle and that of the nearest such void should be greater than 1 mm.

D.3 Edge irregularities

Check that the projecting parts of edge irregularities measured along the maximum COL and/or the missing part measured along the minimum COL, do not exceed 0.3 mm (see Figure 10).

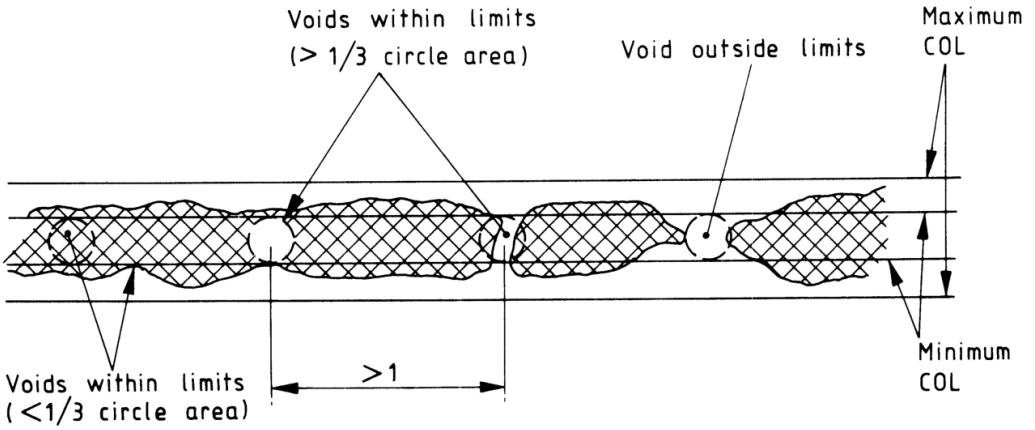
Check that the distance between edge irregularities is greater than 1 mm, measured from centre to centre.

D.4 Spots

Check all extraneous ink that is nearly as dark or darker than the lightest printing within the minimum COL.

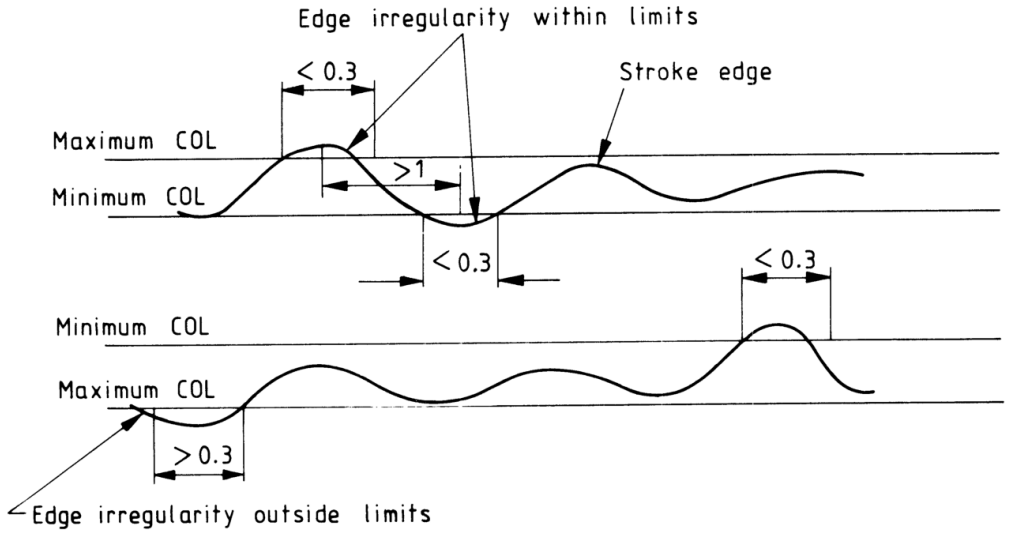
Check that spots are contained entirely in an inspection circle of 0.2 mm diameter and occupy less than one-third of the surface of the inspection circle.

If the total surface area of the spot exceeds one-third of that of the inspection circle but is contained entirely within the inspection circle, the distance between the centre of the inspection circle and that of the nearest such spot should be greater than 1 mm (see Figure 11).



All dimensions are in millimetres.

Figure 9 — Voids



All dimensions are in millimetres.

Figure 10 — Edge irregularities

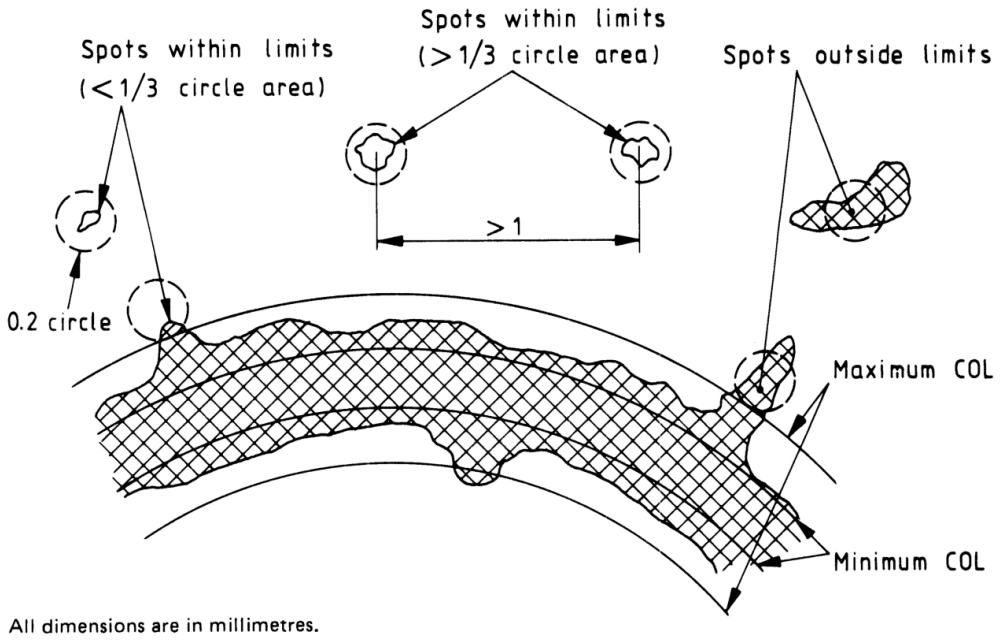


Figure 11 — Spots

Appendix E Method for construction of a COL gauge for character sets OCR–A and OCR–B

E.1 General

For a given character size and tolerance range, the minimum COL is generally the geometric envelope of a circle of diameter equal to the minimum strokewidth centred on, and moved along, the character centreline. Likewise, the maximum COL is generally the geometric envelope of a circle with a diameter equal to the maximum strokewidth centred on, and moved along, the character centreline.

However, at free ends of strokes and corners of the stroke centreline, the fairing radii given in Table 2 should be used.

Table 2 — Fairing radii

Size	Fairing radius, minimum COL (R_1)	Fairing radius, maximum COL (R_2)
	mm	mm
I	0.10	0.10
III	0.10	0.13
IV	0.13	0.20

E.2 Minimum COL

If the minimum COL presents an internal corner with a radius equal to or less than R_1, draw it with a sharp corner defined by the tangents to the envelope at the point where the radius changes from greater to either equal to or less than R_1 (see Figure 12).

E.3 Maximum COL

E.3.1 *Internal corner*

If the maximum COL presents an internal corner (see **2.3.10**) with a radius equal to or less than R_2, use a fairing radius equal to R_2 (see Figure 12).

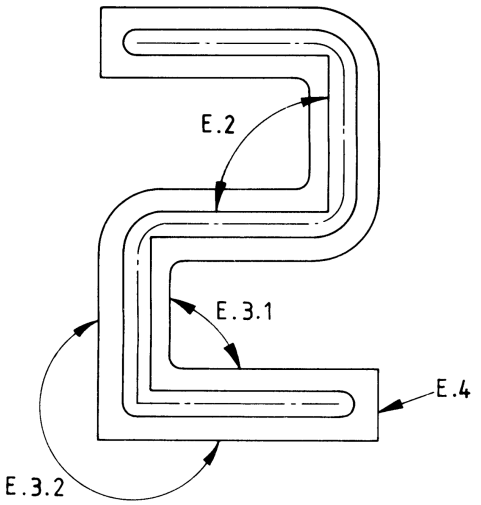


Figure 12 — Special situations at minimum and maximum COL

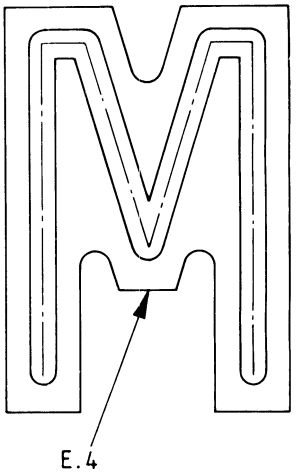


Figure 13 — Special corner at maximum COL

E.3.2 ***External corner***

If the centreline has a sharp corner, i.e. less than 305°, draw the external corner (see **2.3.8**) of the maximum COL as a sharp corner also (see Figure 12). If the stroke centreline has a corner with an angle of more than 305°, draw the external corner of the maximum COL as a tangent to the envelope perpendicular to the bisector of the corner defined by the stroke centreline (see Figure 13).

E.4 Free stroke ends

At free stroke ends, square off the maximum COL by drawing the tangent to the envelope parallel and perpendicular to the corresponding free end of the character stroke centreline.

Publications referred to

BS 3430, *Method for sampling for testing paper and board.*
BS 4432, *Methods for determining optical properties of pulp, paper and board.*
BS 4432-1, *Measurement of diffuse reflectance factor of paper, board and pulps.*
BS 4432-3, *Determination of opacity (paper backing) of paper and board by the diffuse reflectance method.*
BS 4810, *Print for magnetic ink character recognition.*
BS 5464, *Specification for optical character recognition.*
BS 5464-1, *Character set OCR–A. Shapes and dimensions of the printed image.*
BS 5464-2, *Character set OCR–B. Shapes and dimensions of the printed image.*
BS 5477, *Method for visual assessment, by grid assay, of dirt in paper for character recognition.*
SL 22, *Printing and stationery, paper and board.*
ISO 1831, *Printing specifications for optical character recognition.*
CIE, (Commission Internationale de l'Eclairage) International Lighting Vocabulary, 3rd Edition.

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