

JIS

JAPANESE INDUSTRIAL STANDARD

Ergonomics — Office work with visual display terminals (VDTs) — Visual display requirements

JIS Z 8513—1994

Translated and Published

by

Japanese Standards Association

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

JAPANESE INDUSTRIAL STANDARD

J I S

**Ergonomics — Office work with
visual display terminals (VDTs)
— Visual display requirements**

Z 8513-1994

Foreword for Japanese Industrial Standard

This Japanese Industrial Standard is given birth by translating ISO 9241-3 [Ergonomic requirements for office work with visual display terminals (VDTs) — Part 3: Visual display requirements], first edition issued in 1992 into Japanese and changing a part of provisions in compliance with the actual condition in Japan.

The parts given the dotted under line in this Standard are the descriptions resulted from amending the provisions of original International Standard or not provided originally in it.

0. Introduction

Task performance as well as the comfort of people in office work systems is affected by the presentation of information on the visual display terminal (VDT) and by the visual conditions at the workplace.

The satisfaction of individual human requirements is highly application-dependent. The recommendations and requirements defined here are based on established ergonomics principles, as described in ISO 6385.

1. Scope

This Standard establishes image quality requirements for the design and evaluation of single- and multi-colour VDTs. The requirements are stated as performance specifications, and the evaluations provide test methods and conformance measurements. It should be noted that the requirements specified at present in this Standard on the basis of alphabetic characters and Arabic numerals are applicable to Chinese characters and KANA letters unless otherwise specified.

Note: In the original International Standard, the "alphabetic characters" are detailed as Latin, Cyrillic and Greek origin alphabetic characters.

Other factors that affect performance and comfort are coding, format, and the style of presentation of information according to luminance, blinking, colour, etc. With the exception of their visual aspects, they are not covered by this Standard.

This Standard applies to the ergonomic design of electronic displays for office tasks. Office tasks include such activities as data entry, text processing, and interactive inquiry, but do not include recommendations for other specific applications such as computer-aided design or process control.

It is planned to issue recommendations on such applications separately.

2
Z 8513-1994

2. Definitions

For the purposes of this Standard, the following definitions apply:

2.1 angle of view

The angle between the line-of-sight angle and the line orthogonal to the surface of the display at the point where the line-of-sight intersects the image surface of the display.

2.2 anti-aliased font

Alphanumeric characters in which such a technique as gradation has been utilized to smooth character edges.

2.3 between-character spacing

The distance between horizontally (vertically in vertical writing) adjacent characters at their nearest point.

2.4 between-line spacing

The distance between vertically (horizontally in vertical writing) adjacent characters at their nearest point.

2.5 between-word spacing

The horizontal distance between adjacent words at their nearest point.

2.6 blink coding

Information presented by temporal luminance variations in images.

2.7 character format

The number of horizontal and vertical elements in the matrix used to form a single character.

2.8 character height

The distance between the top and bottom edges of a non-accented capital letter (in the cases of Chinese characters and KANA letters, the outermost pixels out of the pixels forming a character).

Note: For the definition of edge, see Remarks in 6.6.1.

2.9 character size uniformity

The constancy in size of a particular character presented at different locations on the screen.

2.10 character width

The horizontal distance between the edges at the widest part of a capital letter (excluding serifs). In the cases of Chinese characters and KANA letters, the horizontal distance between the outermost pixels out of the pixels forming a character.

Note: Serifs are decorative short line stemming from an end of line forming a character as, for example, at both ends of vertical lines of H.

2.11 character width-to-height ratio

The ratio of character width to character height.

2.12 design viewing distance

The distance or range of distances (specified by the manufacturer or supplier) between the screen and the operator's eyes for which the images on the display meet the requirements of this Standard such as character size, raster modulation, fill factor, spatial instability (jitter) and temporal instability (flicker).

2.13 diacritic

A modifying mark near or through a character indicating a phonetic value different from that given the unmarked character.

Note: For example, cedilla given to c to make ç or tilde given to n to make ñ.
(see Table 4 in Annex 1 to JIS X 0212).

2.14 display luminance

The luminance of the radiation emitted and reflected from the screen corresponding to the luminance of character symbols for bright images on a darker background, and the luminance of the background for dark images on a brighter background.

2.15 fill factor

The fraction of the total area geometrically available to a pixel that can be altered to display information.

Note: This does not apply to cathode-ray screen (hereafter referred to as "CRT")
(see 5.7).

2.16 image polarity

The relationship between background brightness and image brightness. The presentation of brighter images on a darker background is designated negative polarity, and darker images on a brighter background is designated positive polarity.

2.17 legibility

The visual properties of a character or symbol that determine the ease with which it can be recognized.

2.18 line-of-sight

The line connecting the point of fixation and the centre of the pupil.

2.19 linearity

The uniformity of the raster such that rows or columns appear straight and continuous.

Note: Barrel distortion and pin-cushion distortion in JIS C 7102 (Glossary of terms for electron tubes) indicate the phenomenon in which the linearity is damaged in the case of CRT.

2.20 luminance balance

The ratio between the luminances of the displayed image and its adjacent surround, or the image, manuscript, key board, etc. the worker sequentially views.

2.21 luminance coding

Information presented by temporally independent differences (not depending on blinking) in image luminances.

2.22 luminance contrast

The relationship between the higher (L_H) and lower (L_L) luminances that define the feature to be detected, expressed as either contrast modulation (C_m) defined as:

$$C_m = \frac{(L_H - L_L)}{(L_H + L_L)}$$

or contrast ratio (CR), defined as:

$$CR = \frac{L_H}{L_L}$$

2.23 luminance uniformity

The constancy in luminance between areas on the display that are intended to have the same luminance.

2.24 orthogonality

The appearance of geometric alignment or perpendicularity of rows and columns to each other.

Note: Parallelogram distortion and keystone distortion in JIS C 7102 indicate the phenomenon that the orthogonality is damaged in the case of CRT.

2.25 pixel

The smallest addressable element of a display. In a multicolour display, the smallest addressable element capable of producing the full colour range.

2.26 raster modulation

The relative spatial variation in maximum (on raster) to minimum (between rasters) luminance when all pixels are switched on.

2.27 readability

The characteristics of text which allow groups of characters to be easily discriminated, recognized, and interpreted.

2.28 spatial instability; jitter

The perception of unintended spatial variations in images.

2.29 stroke width

The edge-to-edge distance of a character stroke; for a multiple-pixel stroke, the exterior edge-to-edge width of the character stroke.

Note: Stroke is the line forming a character.

2.30 temporal instability; flicker

The perception of unintended temporal variations in luminance.

3. Guiding principles

The office work system is an integrated whole, which includes the visual display work station, environment, task structure, organisational concerns, and sociological factors. The characteristics of a visual display terminal have to be considered in relation to the other elements of the work system and not as a collection of isolated visual requirements.

Design elements often interact such that optimising one degrades another. For example, for CRT displays there is a trade-off between character brightness and sharpness. Trade-offs should be made to achieve an acceptable balance.

Note: Trade-off is to come to a compromise in order to achieve the optimal solution.

A good work system should meet the needs of the individual. In a specific situation, this can be accomplished by custom design or by providing appropriate adjustability.

For viewing efficiency and comfort in office environments, the image quality should be significantly above the threshold values for the individual stimuli. The recommendations of this Standard take this into account.

4. Performance requirements

The objective of this Standard is to specify requirements for VDTs, compliance with which ensures that the VDTs are legible, readable and comfortable in use (see clause 7 for compliance with this Standard and clause 2 for definitions).

5. Design requirements and recommendations

5.1 Design viewing distance

For usual office tasks, the design viewing distance shall be no less than 400 mm.

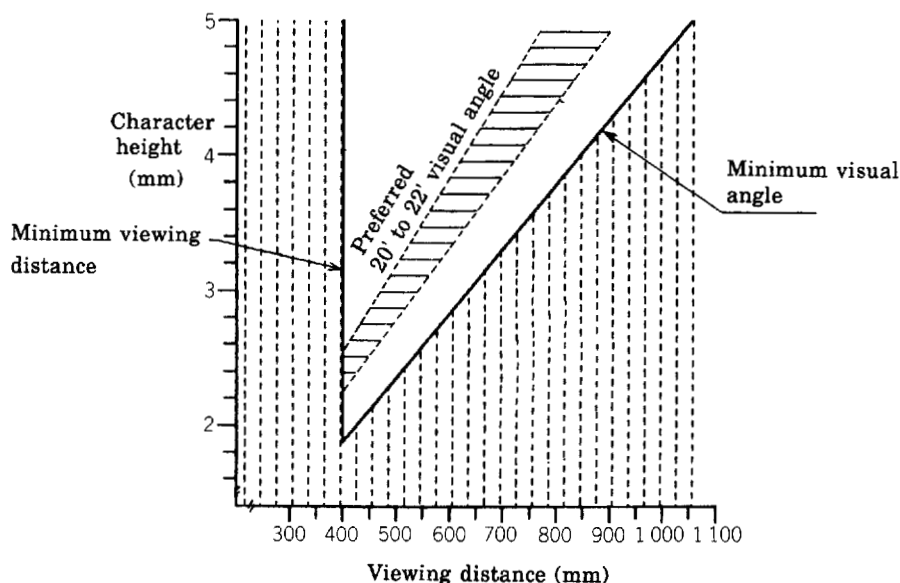
For certain applications (e.g. soft key labels on touch screens) the minimum design viewing distance may be reduced to 300 mm.

Workstation parameters are the subject of ISO 9241-5. However, the workstation design should allow the display to be used within the design viewing distance. Preferably, if the task requires a significant amount of reading for context, the workstation design should permit the display to be used at a distance where the heights of alphabetic character and Arabic numeral subtend approximately 20' to 22'. Fig. 1 gives a guide to the relationship between character height and viewing distance for character heights between approximately 2.0 mm and 5.0 mm.

The same design viewing distance as in the alphabetic character and Arabic numeral should be also taken for Chinese character displays.

Note: The requirements for design viewing distance (and other requirements in this Standard) are based on the alphabetic characters and Arabic numerals. Even for the Chinese characters, the requirements are specified on the basis of those for alphabetic characters and Arabic numerals.

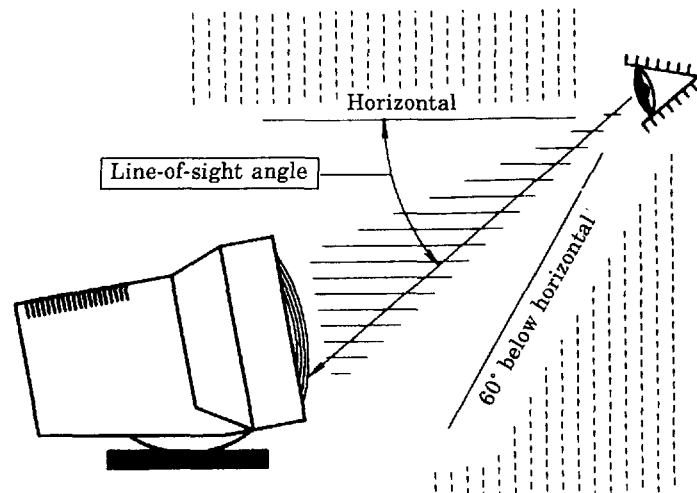
Fig. 1. Relationship between design viewing distance and character height



5.2 Line-of-sight angle

It shall be possible to position the display so that those areas of it to be viewed continuously can be viewed with a line-of-sight angle between horizontal and 60° below the horizontal (see Fig. 2). This requirement applies to the entire workstation.

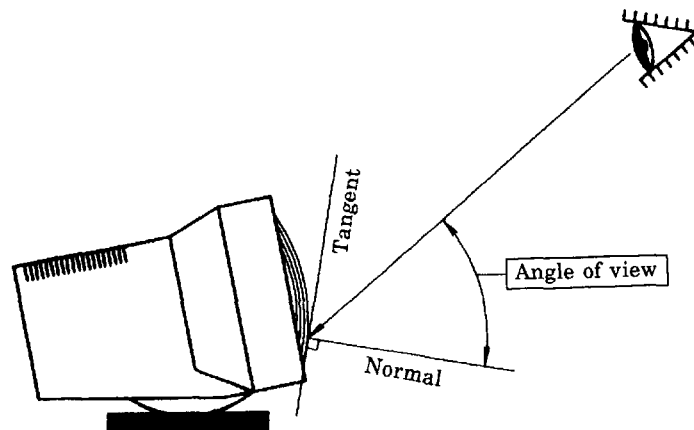
Fig. 2. Line-of-sight angle



5.3 Angle of view

A display should be legible from any angle of view up to at least 40° from the normal to the surface of the display, measured in any plane. If this is not the case, the manufacturer shall specify the restricted angle of view, and the display shall be easy to reposition to an orientation in which it is legible (see Fig. 3).

Fig. 3. Angle of view



5.4 Character height

Character heights subtending from 20' to 22' are preferred for most tasks. The minimum character height shall be 16' in the alphabetic characters and Arabic numerals, and 25' in the Chinese characters.

For applications where readability is incidental to the task, smaller characters may be used (e.g. for footnotes, superscripts, subscripts).

5.5 Stroke width

The stroke width of alphabetic characters and Arabic numerals shall be within the range of $\frac{1}{6}$ to $\frac{1}{12}$ of character height.

Remarks: In general, the wider stroke widths are preferred for a positive image polarity, and the narrower stroke widths for a negative image polarity.

5.6 Character width-to-height ratio

A width-to-height ratio between 0.7 : 1 and 0.9 : 1 is recommended for optimum legibility and readability. However, for other considerations (e.g. line length, proportional spacing of alphabetic characters and alignment of Chinese characters) the ratio shall be between 0.5 : 1 and 1 : 1.

The width-to-height ratio of Chinese characters and KANA letters should be between 0.8 : 1 and 1.2 : 1.

5.7 Raster modulation and fill factor

5.7.1 Raster modulation

For a CRT having a pixel density of less than 30 pixels per degree (perpendicular to the raster, at the design viewing distance), the luminance modulation in the direction perpendicular to adjacent raster lines shall not exceed $C_m = 0.4$ for monochrome displays, and $C_m = 0.7$ for multi-colour displays when all pixels are in their "on" state.

Remarks: For better legibility it is recommended that C_m should not exceed 0.2 for either type of display.

5.7.2 Fill factor

For non-CRT matrix displays having a pixel density of less than 30 pixels per degree at the design viewing distance, the fill factor shall be at least 0.3.

5.8 Character format

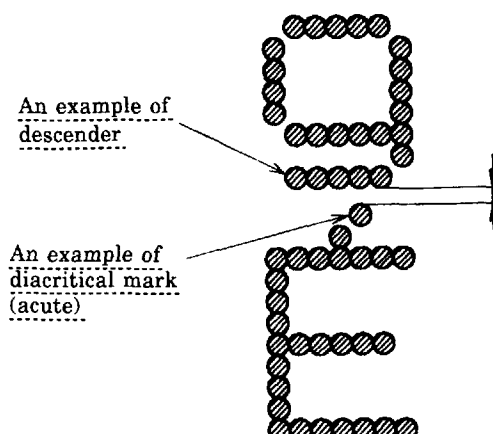
A 5 pixels by 7 pixels (width × height) character matrix shall be the minimum used for numeric and upper-case-only presentations. The character matrix used for Chinese characters shall be at least 15 pixels by 16 pixels (width by height). For the reproducibility of complex characters, the larger number of pixels are preferable.

A 7 pixels by 9 pixels (width × height) character matrix shall be the minimum used for tasks that require continuous reading for context, or where individual alphabetic character and Arabic numeral legibility is important for the task, such as proofreading.

The character matrix shall be increased upward by at least two pixels if diacritics are used. If lower case is used, the character matrix shall be increased downward by at least two pixels, to accommodate the descenders of the lower case letters (see Fig. 4).

Note: A part of lower case letter of alphabet extruding downward from the base line as in "g" is called descender.

Fig. 4. Between-line spacing



For higher density character matrices, the number of pixels used for diacritics should follow conventional designs for printed text.

A 4 pixels for 5 pixels (width × height) character matrix shall be the minimum used for subscripts and superscripts, and for numerators and denominators of fractions that are displayed in a single character position. It may also be used for alphanumeric information not related to the operator's task, such as copyright information.

For non-dot-matrix techniques, equivalent character shapes should be achieved.

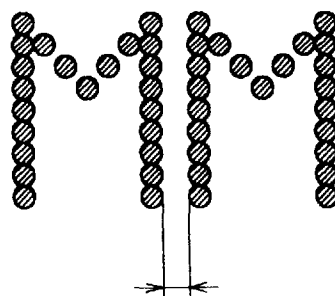
5.9 Character size uniformity

The height and width of a specific character of a specific character font shall not vary by more than $\pm 5\%$ of the character height (see 6.6.1) of that character set, regardless of where it is presented on the display surface.

5.10 Between-character spacing

For character fonts without serifs, (see Note in 2.10), the between-character spacing shall be a minimum of one stroke width or one pixel (see Fig. 5). If characters have serifs, the between-character spacing shall be a minimum of one pixel between the serifs of adjacent characters.

Fig. 5. Between-character spacing



5.11 Between-word spacing

A minimum of one character width (capital "N" for proportional spacing) shall be used between words in the case of European writing.

5.12 Between-line spacing

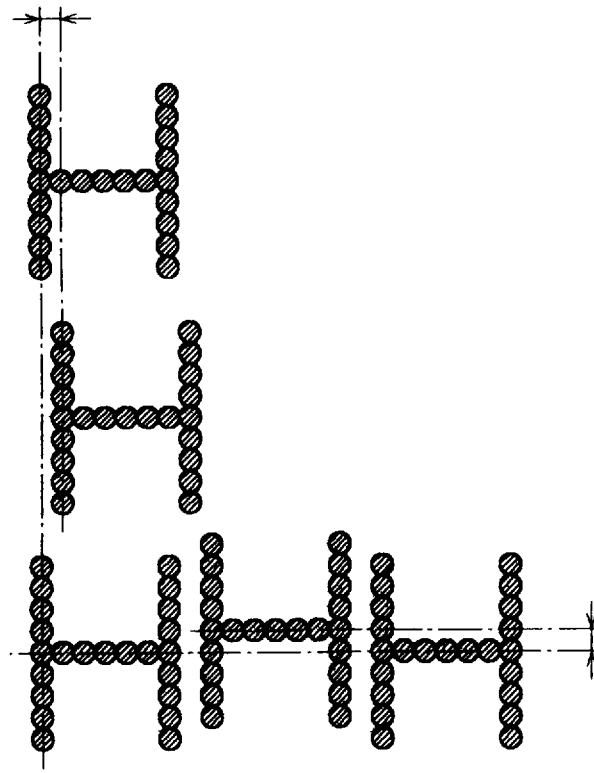
A minimum of one pixel shall be used for spacing between lines of text. This area may not contain parts of characters or diacritics, but may contain underscores (see Fig. 4).

5.13 Linearity

The following two conditions shall be fulfilled.

- (a) For different rows or columns, the difference of length shall not exceed 2 % of the length of that row or column.
- (b) The horizontal displacement of a symbol position relative to the symbol positions directly above and below it shall not vary by more than 5 % of the character width. The vertical displacement of a symbol position, relative to the symbol positions to the right and left of it, shall not vary by more than 5 % of the character height (see Fig. 6).

Fig. 6. Linearity



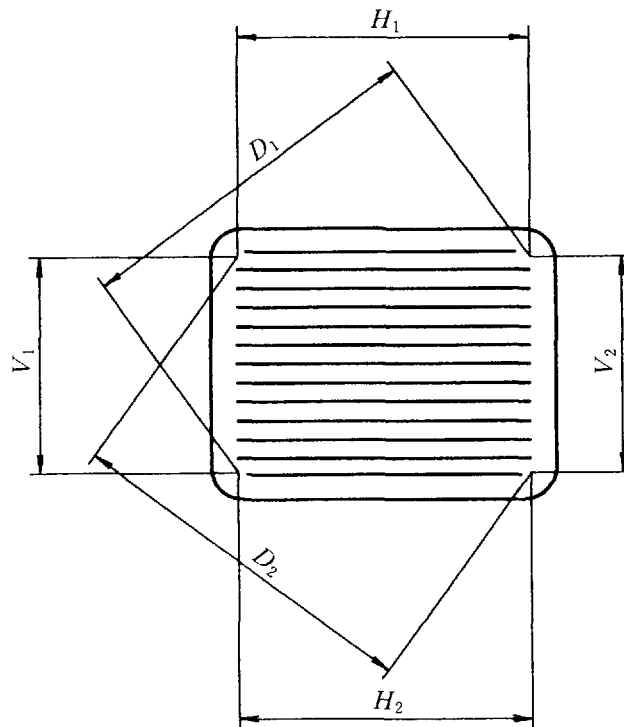
5.14 Orthogonality

The addressable area of the display shall be rectangular, and the following conditions shall be fulfilled (see Fig. 7).

- (a) The ratio of the difference in length between the horizontal edges, $|H_1 - H_2|$, and their mean length, $0.5 (H_1 + H_2)$ shall not exceed 0.02.
- (b) The ratio of the difference in length between the vertical edges, $|V_1 - V_2|$, and their mean length, $0.5 (V_1 + V_2)$ shall not exceed 0.02.

- (c) The ratio of the difference in length between the diagonals, $|D_1 - D_2|$, and their mean length, $0.5 (D_1 + D_2)$ shall not exceed 0.04 times the ratio of the mean length of the shorter edges (i.e. vertical or horizontal depending on orientation) to the mean length of the longer edges (i.e. horizontal or vertical).

Fig. 7. Orthogonality



$$\text{Horizontal} : \frac{|H_1 - H_2|}{0.5 (H_1 + H_2)} \leq 0.02$$

$$\text{Vertical} : \frac{|V_1 - V_2|}{0.5 (V_1 + V_2)} \leq 0.02$$

$$\text{Diagonal} : \frac{|D_1 - D_2|}{0.5 (D_1 + D_2)} \leq 0.04 \times \frac{0.5 (V_1 + V_2)}{0.5 (H_1 + H_2)}$$

5.15 Display luminance

From a perspective of the limits of visual acuity, the display shall be capable of a display luminance of at least 35 cd/m² or display luminance multiplying diffuse reflection luminance $L_D (E_0)$ under the condition of Informative reference 1.1 by $1 + 10^{0.82} \times L_D^{-0.39} (E_0)$. For displays to which the provisions of 5.7.2 (Fill factor) apply, this shall be achievable with the peak luminance of the display. If luminance coding is used, this requirement shall also be achievable even with the luminance of lower coding.

Remarks: Operators often prefer substantially higher display luminance levels (e.g. 100 cd/m²), particularly in conditions of high ambient illuminance.

Note: The displays to which the provisions of 5.7.2 apply are the matrix displays other than CRT having the density less than 30 pixels per 1° at the design viewing distance.

5.16 Luminance contrast

The minimum luminance contrast of character details, within or between characters, that are relevant for legibility, shall be

$$C_m = 0.5 \text{ (contrast modulation), namely,}$$

$$CR = 3 : 1 \text{ (contrast ratio),}$$

or $CR = 1 + 10^{0.82 \times LD^{-0.39} (E_0)} : 1 \text{ (contrast ratio)}$

5.17 Luminance balance

The ratio of wide area average luminances (see Informative reference 2) of task areas that are frequently viewed in sequence (e.g. screen, document, etc.) should be lower than 10 : 1. For a stationary visual field at the time when a task area is frequently viewed, a significantly higher ratio of space average luminances between the task area and its surrounds (e.g. display housing, room walls, etc.) should not have any adverse effect. However, a luminance ratio of 100 : 1 between those two areas would be expected to produce a small but significant drop in performance.

5.18 Glare

Glare should be avoided. Additional glare reduction or contrast enhancement techniques, if used, shall not cause the display to violate the requirements of 5.15 (Display luminance) and 5.16 (Luminance contrast). ISO 9241-7 will give further requirements for glare.

5.19 Image polarity

Either dark characters on a brighter background (positive image polarity), or bright characters on a darker background (negative image polarity) are acceptable provided the requirements of this Standard are met.

Users vary in their preferences for image polarity. If a display provides switchable image polarity, it shall meet the requirements of this Standard for each image polarity.

There are advantages for each image polarity. For example,

- (a) with positive polarity, specular reflections are less perceptible, edges appear sharper, and luminance balance is easier to obtain;
- (b) with negative polarity, flicker is less perceptible, legibility is superior or individuals with anomalous low acuity vision, and characters are possibly perceived to be larger than they actually are.

5.20 Luminance uniformity

For an intended uniform luminance, the variation in area average display luminance from the centre of the display to the edge of any portion thereof shall not exceed a ratio of 1.7 : 1.

The variation of the peak luminance of character elements (dots or strokes) shall not exceed a ratio of 1.5 : 1 within a character.