



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS B 6310 : 2003

(ISO 841 : 2001)

(JMTBA/JSA)

**Industrial automation systems and
integration—Numerical control of
machines—Coordinate system and
motion nomenclature**

ICS 25.040.20

Reference number : JIS B 6310 : 2003 (E)

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Machine Tool Builders' Association (JMTBA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS B 6310 : 1998** is replaced with this Standard.

This revision has been made based on **ISO 841 : 2001** *Industrial automation systems and integration—Numerical control of machines—Coordinate system and motion nomenclature* for the purposes of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 1971-06-01

Date of Revision: 2003-12-20

Date of Public Notice in Official Gazette: 2003-12-22

Investigated by: Japanese Industrial Standards Committee
Standards Board

Technical Committee on Industrial Automation

JIS B 6310:2003, First English edition published in 2005-02

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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Printed in Japan

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Industrial automation systems and integration—Numerical control of machines—Coordinate system and motion nomenclature

Introduction This Japanese Industrial Standard has been prepared based on the second edition of **ISO 841 : 2001** *Industrial automation systems and integration—Numerical control of machines—Coordinate system and motion nomenclature* published in 2001 without modifying the technical contents.

Portions underlined with dots are the matters not stated in the original International Standard.

1 Scope This Standard describes numerically controlled machines, similar machine coordinate systems, and motion nomenclature in industrial automation system.

NOTES 1 Individual numerically controlled machines mean that all axes are mounted on one base or frame and all motions are related to one standard coordinate system.

2 For the sake of simplicity the majority of the text of this Standard is written in terms accorded to machine tools but nevertheless accorded to numerically controlled machines in general. Coordinate systems and axis motion nomenclature for industrial robots is defined in **JIS B 8437**.

3 The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are **IDT** (identical), **MOD** (modified), and **NEQ** (not equivalent) according to **ISO/IEC Guide 21**.

ISO 841 : 2001 *Industrial automation systems and integration—Numerical control of machines—Coordinate system and motion nomenclature* (**IDT**)

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0181 *Industrial automation systems—Numerical control of machines—Vocabulary*

NOTE : **ISO 2806 : 1994** *Industrial automation systems—Numerical control of machines—Vocabulary* is equivalent to the said standard.

JIS B 6315-1 *Numerical control of machines—Program format and definition of address words—Part 1 : Data format for positioning, line motion and contouring control systems*

NOTE : **ISO 6983-1** : 1982 *Numerical control of machines—Program format and definition of address words—Part 1 : Data format for positioning, line motion and contouring control systems* is equivalent to the said standard.

JIS B 8437 *Manipulating industrial robots—Coordinate systems and motion nomenclatures*

NOTE : **ISO 9787** : 1999 *Manipulating industrial robots—Coordinate systems and motion nomenclatures* is equivalent to the said standard.

3 Terms and definitions For the purposes of this Standard, the terms and definitions given in **JIS B 0181** apply.

4 Machine coordinate system

4.1 Designation The machine coordinate system is a right-hand rectangular system with the three principal axes labelled *X*, *Y* and *Z*, with rotary axes about each of these axes labelled *A*, *B* and *C*, respectively (see figure A.1).

4.2 Origin The location of the origin of the machine coordinate system shall be defined by the manufacturer.

4.3 Z axis

4.3.1 General The *Z* axis is parallel to the principal spindle of the machine. For the case where the machine has no spindle, see **4.3.4** and **4.3.5**.

NOTES 1 On machines used for milling, grinding, boring, drilling and tapping, the spindle rotates the tool.

2 On machines such as lathes, cylindrical grinders and others which generate a surface of revolution, the spindle rotates the work piece.

4.3.2 More than one spindle Where there are several spindles, one shall be selected as the principal spindle, preferably perpendicular to the workholding surface.

4.3.3 Swivelling or gimbaling spindle Where the principal spindle can be swivelled or gimbaled, the *Z* axis should be parallel to spindle axis when the spindle is in the zero position. The preferred zero position is with the spindle perpendicular to the work-holding surface.

Where the principal spindle axis can be swivelled and if the extent of its motion allows it to lie in only one position parallel to one of the axes of the standard three-axis system, this standard axis is the *Z* axis.

Where the extent of the swivelling motion is such that the principal spindle can lie parallel to two of the three axes of the standard three-axis system, the *Z* axis is the standard axis which is perpendicular to the work holding surface of the work table of the machine, ignoring such auxiliary devices as mounting brackets or angle plates.

4.3.4 No spindle For cutting and forming machines, the Z axis should be perpendicular to the work-holding surface.

For coordinate measuring machines, the Z axis should be collinear with the acceleration of gravity vector (i.e. perpendicular to the surface of the earth).

4.3.5 Direction For cutting and forming machines, the $+Z$ axis direction is defined from the workpiece to the tool holder.

NOTE : For lathes, the tail stock is considered as the tool holder.

For coordinate measuring machines, the $+Z$ direction is defined as in the opposite sense as the acceleration of gravity vector (i.e. pointing away from the surface of the earth).

4.4 X axis

4.4.1 General Where possible, the X axis shall be horizontal.

4.4.2 Machines with rotating tools

Horizontal Z axis: Positive X shall be to the right when viewed in the negative Z direction.

Vertical Z axis, single column: Positive X shall be to the right when viewed from the front of the machine into the column.

Vertical Z axis, gantry type: Positive X shall be to the right when viewed from the principal spindle to the left-hand gantry support (see also note 1 in 4.3.1).

4.4.3 Machines with rotating workpieces The X axis shall be radial and parallel to the cross slide. The positive direction shall be away from the axis of rotation (see also note 2 in 4.3.1).

4.4.4 Machines with no spindle For cutting machines, positive X shall be parallel to and in the principal direction of cutting.

For coordinate measuring machines, positive X shall be defined by the manufacturer.

4.5 Y axis Positive Y shall be in the direction to make a right-hand set of coordinates (see figure A.1).

4.6 Rotary axes A, B and C

4.6.1 Designation A , B and C define rotary axes about linear axes X , Y and Z respectively.

4.6.2 Direction Positive A , B and C are in the direction to advance right-hand screws in the positive X , Y and Z directions respectively (see figure A.1).

5 Principal machine motions

5.1 Designation The principal linear motions of the machine which are parallel to the axes of the machine coordinate system shall be designated *X*, *Y* and *Z* respectively. The principle machine rotary motions which are around one or more of the principal coordinate system axes shall be designated *A*, *B* and *C* respectively.

5.2 Direction

5.2.1 General Motion in the positive direction of the linear or rotary axes increases the positive position values and decreases the negative position values.

Letter designations shall be used to denote movement of either the tool or the workpiece.

5.2.2 Moving the tool When moving the tool, the direction of movement and the axes directions are equal. Positive movements are designated with $+X$, $+Y$, $+Z$, $+A$, $+B$, ...

5.2.3 Moving the workpiece When moving the workpiece, the direction of movement and the axis direction are opposite. To indicate the opposite direction, positive movements are designated with $+X'$, $+Y'$, $+Z'$, $+A'$, $+B'$, ... (i.e. the axis direction $-X = +X'$ of the workpiece movement).

6 Additional motions

6.1 Linear motions When, in addition to the primary linear motions *X*, *Y* and *Z*, there exists secondary linear motions parallel to the primary motions, these shall be designated *U*, *V* and *W* respectively. Similarly, for tertiary motions, they shall be designated *P*, *Q* and *R* respectively. When linear motions exist which are not (or may not be) parallel to *X*, *Y* and *Z*, they may be designated *U*, *V*, *W*, *P*, *Q*, or *R* as is most convenient.

The primary linear motions should be those nearest the principal spindle, the secondary the next nearest, and the tertiary are the farthest.

For milling machines, the cutting-bit with respect to a facing slide should be designated *U* or *P* if these letters are available.

For machines with multiple units or many parallel movements, the designation of these motions may be indexed by using a letter and a number or letter (e.g. X_1 , X_2 , ...). The index shall be a positive integer greater than zero. The primary motion(s) may or may not have an index. Thus it is possible on one machine to have motions with and without indices.

6.2 Rotary motion When, in addition to the primary rotary motions, there exists secondary rotary motions, either parallel to *A*, *B*, or *C* or compounded or gimbaled to *A*, *B*, or *C*, they shall be designated *D* or *E* (if these letters are available). As with linear motions, rotary motions may be indexed (see 6.1).

6.3 Letter restrictions Certain letters (e.g. *G*, *M*, *F*) shall not be used for motion (see JIS B 6315-1).

6.4 Direction The rules given in **5.2** for determining the direction of principal machine motions shall apply to additional motions.

7 Schematic drawings of machines

7.1 Examples of machine drawings The schematic drawings of machines in annex A are the official interpretation for those machines. Where a conflict exists between the text of this Standard and a given schematic, the schematic drawing shall take precedence.

7.2 Designation The schematic drawing shows the machine coordinate system as appropriate to that machine together with the machine motions. Letters indicate axes and machine motions, arrows indicate positive directions.