



BSI Standards Publication

Automation systems and integration — Numerical control of machines — Program format and definitions of address words

Part 1: Data format for positioning, line motion and contouring control systems

National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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**Automation systems and integration —
Numerical control of machines —
Program format and definitions of
address words —**

**Part 1:
Data format for positioning, line motion
and contouring control systems**

*Systèmes d'automatisation industrielle et intégration — Commande
numérique des machines — Format de programme et définitions des
mots adresses —*

*Partie 1: Format des données pour les systèmes de positionnement, de
commande paraxiale de mouvement et de contourage*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 6983-1 was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 1, *Physical device control*.

This second edition cancels and replaces the first edition (ISO 6983-1:1982), which has been technically revised.

The following changes have been made to the first edition:

- the content has been restructured in a more logical order;
- the commonly used preparatory (G) and miscellaneous (M) function codes have been grouped in one standard (see Annex E);
- address indexing has been introduced (see 6.2);
- the equal (=) sign has been added to allow for axis indexing (see 6.2.1);
- new data formats have been specified to existing programming methods: helical interpolation (see 7.3); dwell time (see Clause 13); thread cutting (see Clause 11).

ISO 6983 consists of the following parts, under the general title *Automation systems and integration — Numerical control of machines — Program format and definitions of address words*:

- *Part 1: Data format for positioning, line motion and contouring control systems*

The following parts are under preparation:

- *Part 2: Coding of miscellaneous functions M (class 1 to 8)* [Technical Report]

Introduction

ISO 6983 describes a word address program format for machine control programs on different data storages, e.g. perforated tape, magnetic media, universal serial bus (USB) stick, hard disk, floppy disk, random-access memory (RAM), etc., or provided from a remote data source. ISO 6983 covers variable block format only and is not intended to specify machine design.

ISO 6983 is intended to specify the program format for the control program to be used for numerical controls (NC) on machines/machine tools. However, ISO 6983 can also be used for all kinds of geometric specifications and interactions with machines.

The program format specified by ISO 6983 is commonly referred to as “G code programming” or “ISO programming”.

Compliance with ISO 6983 does not guarantee interchangeability of machine control programs between different machines/machine tools. Annex D details some of the additional considerations necessary to ensure this interchangeability.

Automation systems and integration — Numerical control of machines — Program format and definitions of address words —

Part 1: Data format for positioning, line motion and contouring control systems

1 Scope

This part of ISO 6983 specifies requirements and makes recommendations for a data format for positioning, line motion and contouring control systems used in the numerical control of machines. This part of ISO 6983 helps the co-ordination of system design in order to minimize the variety of program manuscripts required, to promote uniformity of programming techniques, and to foster interchangeability of input programs between numerically controlled machines of the same classification by type, process, function, size and accuracy. It is intended that simple numerically controlled machines be programmed using a simple format, which is systematically extensible for more complex machines.

This part of ISO 6983 is not intended for use in the specialized cases of numerically controlled flame cutting machines and drafting machines used specifically and exclusively in the shipbuilding industry. In this application, a related format ("the ESSI Format") is specified in ISO 6582.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2806, *Industrial automation systems — Numerical control of machines — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2806 apply.

4 Program format

The machine program shall be structured in blocks of data, which contain sets of commands to the control system. A block shall consist of a number of words each of which is a specific instruction to the control system.

A character designated "end of block" shall terminate every block of data and in addition shall precede the first block of data.

A "program start" character shall precede all control data including "end of block". It is recommended that it should be used as an "absolute rewind stop" character.

All alphabetic, numeric and special characters shall conform to Annex A. Those characters required for reproducing a hard copy of the machine program, listed in Annex A as “non printing characters”, shall be ignored by the control equipment, with the exception of the LF/NL (end of block) character.

If there is any group of characters that is not to be processed in accordance with this part of ISO 6983, this group shall be within parenthesis characters (control out – control in). Any such group shall not contain either “.” or “%” characters. This group may be processed for display purposes, e.g. as instructions to an operator.

Where it is necessary to identify a machine program, this identification should be placed immediately after the program start character and before the first “end of block” character. If the identification contains alpha characters, the entire identification should be enclosed with parentheses. Where it is desired to identify a machine program number word, the program number word should be placed immediately after the first “end of block” for this identification. If the program number is greater than the system can store or display, the least significant digits shall be displayed.

It is recommended that the alignment code should be used at all positions in the program at which it is permissible to start the machine sequence. When used, this code shall be as defined in 6.3. The alignment function character “.” may be used as an intermediate rewind stop character.

The “/” (slash) character shall be used to provide an “optional block skip” function validated at the option of the operator. When used, this character shall immediately precede the “sequence number” word.

A general classification of the format shall be used to detail the capabilities of a system and machine configuration. This is called the general format classification and is defined in Annex B.

A classification of the data in a block shall be used to specify the programming detail for a system and machine configuration. This is called the detailed format classification and is described in Annex C.

For position values or length values, either metric or inch units of length shall be used.

When a system has the ability to use machine programs which have been prepared in either system of measurement, preparatory codes shall be used to signify whether the coded data is in metric or inch values. The mode of control shall be selected by one of the following G codes (preparatory function codes):

- G70 inch data input;
- G71 metric data input.

5 Format make-up

5.1 Data block

A block of data shall consist of the following:

- a) the sequence number word;
- b) the data word;

Tab characters, which are optional for the tabulation of a printed copy of the data, may be inserted between words but shall be ignored by the control system.

5.2 Data words

The data words shall be presented in the following sequence and shall be not repeated within one block. However, existing control systems may permit the repetition of non dimensional words, but it is recommended for maximum machine program interchangeability that this facility should not be used.

The sequence is as follows:

- a) the preparatory words “G”;
- b) the “dimension” words, which shall be arranged in the following sequence: X, Y, Z, U, V, W, P, Q, R, A, B, C;
- c) the “interpolation or thread cutting lead words” I, J and K, which apply only to a specific group of axes and shall immediately follow that group; the words shall conform in detail to Clauses 7 or 11;
- d) the “feed function” word (or words), which applies to one or more of several axes and shall follow the last dimension word to which it applies and immediately follow the applicable interpolation parameter words; the word shall conform in detail to 6.3;
- e) the “spindle speed function” word (or words);
- f) the “tool function” word (or words);
- g) the “miscellaneous function” word (or words).

5.3 Omitted words

Words may be omitted in a specific block of data. This should be understood as meaning that there is no change in the condition of the machine with respect to the function denoted by the omitted word. Therefore, the “end of block” character may be used after any complete word. Instructions that are inherently executed in a single block shall be repeated whenever necessary.

6 Words

6.1 All words

The address character shall be the first in the word and it shall be followed by an algebraic sign, if required, and then by digital data. The address character shall be in accordance with Annex A.

The implicit position of the decimal sign shall be defined by the detailed format classification (see Annex C). All control systems shall accept implicit decimal sign programming. Optionally, the decimal sign character may be recognized.

Implicit decimal sign and explicit decimal sign format shall not be mixed in any machine program.

In the explicit decimal sign format mode, words from which the decimal sign is missing shall be interpreted as whole numbers. The procedure for recognition of explicit decimal sign format shall be defined in the detailed format classification (see Annex C).

In order to reduce the amount of data with the implicit decimal sign format, either leading zeros only, or trailing zeros only, shall be omitted. It is recommended that leading zeros should be omitted.

Zero omission shall be specified in the detailed format classification (see Annex C).

With explicit decimal sign format, both leading zeros before the decimal sign and trailing zeros after the decimal sign may be omitted.

EXAMPLE 1 X1030 represents a dimension of 1 030 mm in the X-axis.

EXAMPLE 2 X.03 represents a dimension of 0,03 mm in the X-axis.

In either decimal format, a dimension containing only zeros shall be expressed by at least one zero.