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INTERCHANGEABLE VARIABLE BLOCK DATA FORMAT FOR POSITIONING, CONTOURING, AND CONTOURING/POSITIONING, NUMERICALLY CONTROLLED MACHINES		

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EIA RS-274-D

EIA STANDARD

INTERCHANGEABLE VARIABLE BLOCK DATA FORMAT
FOR POSITIONING, CONTOURING, AND
CONTOURING/POSITIONING
NUMERICALLY CONTROLLED MACHINES

RS-274-D

(Revision of RS-274-C)

FEBRUARY 1979



Engineering Department

ELECTRONIC INDUSTRIES ASSOCIATION

EIA RS-274-D

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**INTERCHANGEABLE VARIABLE BLOCK DATA FORMAT FOR POSITIONING,
CONTOURING, AND CONTOURING/POSITIONING
NUMERICALLY CONTROLLED MACHINES**

(From EIA Standards RS-274-C and RS-358-A, and Standards Proposals 1276A and 1277, formulated under the cognizance of EIA Committee IE-31 on Numerical Control Systems and Equipment.)

FOREWORD

The information and comments contained in this foreword should not be considered part of the standard. They have been included for clarification and guidance.

With the advent of numerical control and the continually increasing use of numerically controlled machines, many people, including control system builders, programmers, and users, have realized the importance of a standardized data format. This is particularly true for the large majority of numerically controlled machines using perforated tape input.

Based upon this need, the Electronic Industries Association has sponsored the standardization work done by Committee IE-31 on Numerical Control Systems and Equipment. This committee, made up of representatives of control systems builders, machine builders, and users, has prepared these standards for use by people building and using numerical machine control.

The preparation of these standards has been quite involved and time-consuming, particularly because of the complexity and variety of machines and systems. In certain cases, it may not be technically or economically desirable to conform to these standards in complete detail. Nevertheless, it is felt that these standards will prove of benefit to those interested in numerical control.

A word address data format is described in this standard and does not include tab characters. If a columnized listing is desired, tab characters may be included between words but will be ignored by the control system.

If the carriage return character (or characters) is required, for example for hard copy printout, the RT (return) character will be used. The RT character will be ignored by the control system.

This revised standard replaces EIA Standard RS-274-C (Interchangeable Perforated Tape Variable Block Format for Positioning, Contouring, and Contouring/Positioning Numerically Controlled Machines).

This revision of RS-274 includes the following:

1. Recognition of the character code set of EIA Standard RS-358 as the designated code set for Numerical Control.
2. Definition of formats using the decimal point.
3. Addition of 3 dimensional circular interpolation.
4. Addition of the programming of parabolic interpolation in two blocks.
5. Definition of format for dwells expressed in revolutions.
6. Addition of Application notes for programming machines with two sets of contouring axes, for example four axis lathes.
7. Addition of Application notes for programming Constant Surface Speed.

To promote international standardization and because of its limited character set, EIA Standard RS-244 "Character Code for Numerical Machine Control Perforated Tape" is no longer referenced. It is recognized that some systems are able to accept either RS-358 or RS-244 code, however, some capabilities may be restricted to the use of the RS-358 code.

This standard covers variable block data format only, and is not intended to specify machine design.

If interchangeability is desired, certain provisions must be considered. Some of these provisions are:

- A. Feed and Speed Coding — The programmer can call for feeds and speeds as outlined in Paragraph 2.4.3 and 2.4.6. All coded feeds and speeds within the range from at least 10 percent below the available minimum to at least 10 percent above the available maximum shall produce the most appropriate feeds and speeds available. Feed or speed codes outside the acceptable range shall stop operation.
- B. Data Interchangeability at the Machine — Users desiring data interchangeability between machines must make sure that these machines use compatible input media with the same Data Format Classification. (See Appendix A.) In addition, the user must make sure that the machines and controls have the same capability.
- C. Non-Programmed Functions — Certain functions are normally controlled by the operator. These include mirror image, axis interchange, amount of cutter compensation, floating zero or zero offset, and similar functions.
- D. If interchangeability is desired, leading and trailing zeros must be included in all words, or the decimal format must be used.
- E. Machine axis dynamics, such as maximum step velocity capability and cornering capability.
- F. Auxiliary code sequencing required by the machine, such as in tool changers, pallet shuttles, spindles, etc.

1. SCOPE

- 1.1 This standard is intended to serve as a guide in the coordination of system design, to minimize the variety of program manuscripts required, to promote uniformity of programming techniques, and to foster interchangeability of input data 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 expandable for more complex machines.
- 1.2 This standard applies wherever a variable block data format is used with numerically controlled machines.
- 1.3 The variable block data format, as described in the following sections, may be used interchangeably among numerically controlled machines with compatible input media and which conform to the same Format Classification as shown in Appendix A. (NOTE: The degree of interchangeability will depend on the conformity of the machines with respect to function, capacity, range, horsepower, geometric relationship of axes, preparatory, miscellaneous, and tooling functions, and use of absolute or incremental dimensions.)
- 1.4 If perforated tape is used as the input medium, it shall be in accordance with EIA Automation Bulletin 3C "Glossary of Terms for Numerically Controlled Machines"
- 1.5 The definitions of terms used in this standard are in accordance with EIA Automation Bulletin 3C "Glossary of Terms for Numerically Controlled Machines."
- 1.6 Axis and motion nomenclature used in this standard is in accordance with EIA Standard RS-267-A "Axis and Motion Nomenclature for Numerically Controlled Machines."
- 1.7 Revisions to these standards will be proposed as technical progress warrants or as future standards are adopted which conflict with these standards.

2. WORDS

- 2.1 The length of each specific word is defined by the Format Detail. When it is desirable to reduce data, positive signs and either leading or trailing zeros may be omitted. In decimal point format, all extraneous zeros may be omitted.
- 2.2 The address character shall be the first character of the word.
- 2.3 Dimension words shall be either coordinate (absolute dimensions) or incremental (as specified by the Format Classification) and shall contain digital data as follows:
- 2.3.1 The most significant digit of the dimension word shall be first.
- 2.3.2 In leading and/or trailing zero formats, the implicit position of the decimal point shall be defined by the Format Specification. In decimal point only format, when the decimal point is omitted, it shall indicate that the number is a whole number. See format classification.
- 2.3.3 *Coordinate Dimension Words*
- 2.3.3.1 All linear coordinates shall be absolute and expressed in decimal inches (millimeters).
- 2.3.3.2 All angular coordinates shall be absolute and expressed in decimal degrees or decimal parts of a revolution. Decimal degrees is recommended practice.
- 2.3.3.3 Where positive and negative coordinates are used, the + or - character is considered part of the coordinate and shall immediately precede the first digit of the corresponding coordinate. If the sign is omitted, + will be assumed.
- 2.3.4 *Incremental Dimension Words*
- 2.3.4.1 All linear increments shall be expressed in decimal inches (millimeters) preceded by an algebraic sign to indicate direction.
- 2.3.4.2 All angular increments shall be expressed in decimal degrees or decimal parts of a revolution preceded by an algebraic sign to indicate direction. Decimal degrees is recommended practice.
- 2.3.4.3 The + and - character is considered part of the coordinate and shall immediately precede the first digit of the corresponding coordinate. If the sign is omitted, + will be assumed.
- 2.4 Non-dimension words shall contain digital data as follows:
- 2.4.1 The "Sequence Number" shall be as designated by the Format Detail.
- 2.4.2 The "Preparatory Function" shall consist of a maximum of two (2) digits. For designations, see Appendix B.
- 2.4.3 It is recommended that the "Feed Function" for linear, circular, and parabolic motions be programmed in vectorial inches (millimeters) per minute whenever applicable. The length and range shall be designated by the Format Detail and Classification Sheet (see Appendix A).
- 2.4.4 Alternative to 2.4.3 the "Feed Function" for rates of vectorial motion (linear and/or rotary) independent of spindle speed and which are programmed in linear interpolation may be expressed by a "Feed Command." This "Feed Command" is the reciprocal of time in minutes to execute the block and is equivalent to the vector velocity (expressed in inches/millimeters per minute or degrees per minute) divided by the corresponding programmed vector distance (expressed in inches/millimeters or degrees). The length and range of the "Feed Command" shall be designated by the Format Detail and Format Classification Sheet (see Appendix A).

- 2.4.5 It is recommended that the "Feed Function" for rates of vectorial linear motion dependent upon spindle speed be programmed directly in inches (millimeters) per revolution. The length and range of the Feed Command shall be designated by the Format Detail and Format Classification Sheet (see Appendix A).
- 2.4.6 If a specific "F" code is used for traverse, it shall be specified in the Format Classification Sheet and shall be defined as modal or non-modal.
- 2.4.7 It is recommended that the "Spindle Speed Function" be programmed directly in revolutions per minute. The length and range of the Speed Command shall be designated by the Format Detail and Format Classification Sheet (see Appendix A).
- 2.4.8 Alternative to the recommended practice per Paragraph 2.4.7, the "Spindle Speed Function" may be programmed directly in surface feet (meters) per minute through the G96 Preparatory Function. The length and range of the Speed Command shall be designated by the Format Detail and Format Classification Sheet (see Appendix A). See Appendix C for Application Notes.
- 2.4.9 Alternative to the recommended practice per Paragraph 2.4.7, the "Spindle Speed Function" may be coded also using a three (3) digit coded number in which the most significant digit indicates the range desired, and the least two significant digits represent the coded spindle speed within the selected range.
- 2.4.10 Alternative to the recommended practice per Paragraphs 2.4.5 and 2.4.6, the "Feed Function" and/or the "Spindle Speed Function" may consist of a two (2) digit code and may be given as follows:
 - 2.4.10.1 The feedrate (or spindle speed) shall be designated by a two (2) digit code with increasing arbitrary values of feedrate (or spindle speed) represented by increasing code numbers.
- 2.4.11 Start, stop, and direction signals of feeds and speeds shall be "Miscellaneous Functions" where required or part of "Preparatory Functions," such as "Fixed Cycles." (See Appendix B.)
- 2.4.12 The "Tool Function" shall consist of a number of digits defined by the Format Classification. If the tool identification and the tool compensation are separately designated in the "T" word, then the tool compensation digits shall follow the associated tool identification digits.
 - 2.4.12.1 When tool compensation is selected by a different word, the "D" address is recommended. It is recommended that the "D" word follow immediately the "T" word within a block.
- 2.4.13 The "Miscellaneous Function" shall consist of a maximum of two (2) digits. (For designations, see Appendix B.)

3. BLOCKS

- 3.1 The maximum number of characters per block for any particular system may be derived from the Format and Format Classification Sheet found in Appendix A.
- 3.2 The "end of block" character shall be used to indicate the end of each block. In addition, the first block of information shall be preceded by this character.
- 3.3 The "Sequence Number" word shall be first in the block.
- 3.4 The "Preparatory Function" word (or words) shall follow immediately the "Sequence Number" word.

- 3.5 "Dimension" words shall follow the "Preparatory Function" word. In systems containing multiple axes, dimensions in block shall be in the order X, Y, Z, U, V, W, P, Q, R, A, B, C, D, E. (See Sections 2 and 4).
- 3.6 The "Interpolation Parameter" words shall follow immediately in respective order the group of dimension words to which they apply.
- 3.7 The "Feed Function" word applying only to a specific axis shall follow immediately the "Dimension" word for that axis. (See Paragraph 4.1.)
- 3.8 The "Feed Function" word applying to one or more of several axes shall follow the last "Dimension" word to which it applies. (See Paragraph 4.1.1.)
- 3.9 The "Spindle Speed Function" word shall follow immediately the last "Feed Function" or "Dimension" word.
- 3.10 The "Tool Function" word shall follow immediately the "Spindle Speed Function" word. If the "D" word is used for tool compensation selection, it should follow the "T" word in the block.
- 3.11 The "Miscellaneous Function" word (or words) shall follow the "Tool Function" words and immediately precede the "end of block" character.
- 3.12 The above words shall appear only in the order specified. For interchangeability words shall not be repeated in any one block.

4. ADDRESSES

- 4.1 The address character shall be in accordance with Table 1. The coding for these characters shall be in accordance with Electronics Industries Assoc. Standard RS-358-B "Subset of USA Standard Code for Information Interchange for Numerical Machine Control Perforated Tape."
 - 4.1.1 Where one "Feed Function" word is used, the address shall be "F." Where additional "Feed Function" words are used, their addresses shall be in accordance with Table 1.
 - 4.1.2 Where one "Rapid Traverse Dimension" word is used, the address shall be "R." Where additional "Rapid Traverse Dimension" words are used, their addresses shall be in accordance with Table 1.

5. FORMAT

- 5.1 Formats must conform in at least the following areas to be considered in the same classification.
 - 5.1.1 Number of axes and their nomenclature.
 - 5.1.2 Number of words in the format block.
 - 5.1.3 Number of digits in each word.
 - 5.1.4 Position of the decimal point.
 - 5.1.5 Presence or absence of algebraic signs.
 - 5.1.6 Meaning of each character and word.
 - 5.1.7 Use of coordinate or incremental dimension words.
 - 5.1.8 Use of leading or trailing zero suppression, full field or decimal point format.