

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 Machine Tools, many people, including control systems builders, Machine Tool builders and users, have realized the importance of a standardized input medium. This is particularly true for the large majority of Numerically Controlled Machine Tools using perforated tape input.

Based on this need, the Aerospace Industries Association, Aerospace Manufacturing Engineering Committee/Numerical Panel had had close liaison with Electronics Industries Association Subcommittee TR-27.2.1, Numerical Machine Tool Control Systems - Contouring and Positioning, to obtain unanimity of thinking. This subcommittee is made up of representatives of Control Systems Builders, Machine Tool Builders and Users.

The interchangeable tape described in these standards is a combination of word address and tab sequential format and includes both tab and address characters. A system designed to accept interchangeable tape may use either tab or address characters but not necessarily both. For systems so designed, the user may make tape using only tab or address characters, foregoing interchangeability. For systems using the tab character, letter characters may be omitted and command words, except for the tab character, may be omitted where not required. For systems using the address character, tab characters may be omitted and command words may be omitted where not required.

The interchangeable tape described in these Standards for positioning and straight cut controls must include all leading and trailing zeros in the dimension words. A system designed to accept interchangeable tape may permit elimination of leading zeros or trailing zeros. For systems so designed the user may make tapes without the zeros, which may be eliminated, thereby foregoing interchangeability.

These standards cover Interchangeable Perforated Tape Variable Block Format only, and are not intended to specify machine tool design. In certain cases provisions must be included by the control system builder and Machine Tool Builder in order to gain full use of Interchangeable Perforated Tape. Some of these provisions are:

- A. Feed & Speed Coding - When the part programmer calls for feeds or speeds as outlined in paragraph 3.3.1.4.7, all such coded feeds and speeds within the range from at least 10% below the available minimum to at least 10% 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. Tape Interchangeability at the Machine - Users desiring tape interchangeability between machines must make sure that these machines use tape with the same Format Classification (see Appendix A). In addition, the user must make sure that the machines 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.

Certain words and terms used in this standard are in accordance with definitions for "Numerically Controlled Machine Tools," Automation Bulletin No. 3A, published by Electronics Industries Association. Definitions applying to this standard are as follows:

BLOCK

A word or group of words considered as a unit and separated from other such units by an end of block character.

FEED FUNCTION

The relative motion between the cutting tool and the work other than the motion that provides the main power for removing material from the work. The units, such as inches per minute or inches per revolution, will depend upon the particular machine.

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LIST OF CURRENT SHEETS

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CUSTODIAN: MANUFACTURING COMMITTEE

PROCUREMENT
SPECIFICATION

TITLE

INTERCHANGEABLE PERFORATED TAPE STANDARDS VARIABLE
BLOCK FORMAT FOR POSITIONING AND STRAIGHT CUT
NUMERICALLY CONTROLLED EQUIPMENT

CLASSIFICATION
STANDARD PRACTICE

NAS943 Documents

SHEET 1 OF 17

FIXED SEQUENTIAL FORMAT

Means of identifying a word by its location in the block. Words must be presented in a specific order and all possible words preceding the last desired word must be present in the block.

FORMAT, INPUT MEDIA

The physical arrangement of possible location of holes or magnetized areas. Also, the general order in which information appears on the input medium.

MISCELLANEOUS FUNCTION

An On-Off function of a machine such as Spindle Stop, Coolant On, Clamp, etc.

PREPARATORY FUNCTION

A command changing the mode of operation of the control.

SEQUENCE NUMBER

A number identifying the relative location of blocks or groups of blocks on a tape.

SPINDLE SPEED

The rate of rotation of the machine spindle. The units, such as revolutions/minute or revolutions/second, will depend upon the particular machine.

TAB SEQUENTIAL FORMAT

Means of identifying a word by the number of tab characters preceding the word in the block. The first character in each word is a tab character. Words must be presented in a specific order but all characters in a word, except the tab character, may be omitted when the command represented by that word is not desired.

WORD

An ordered set of characters which is the normal unit in which information may be stored, transmitted, or operated upon.

Example: The set of characters 10692 is a word which may give a command for a machine element to move to a point 10.692 inches from a specified zero.

WORD ADDRESS FORMAT

Addressing each word in a block by one or more characters which identify the meaning of the word.

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THIS DRAWING SUPERSEDES ALL ANTECEDENT STANDARD DRAWINGS FOR THE SAME PRODUCT AND SHALL BECOME EFFECTIVE NO LATER THAN SIX MONTHS FROM THE LAST DATE OF APPROVAL SHOWN HEREON

APPROVAL DATE Jan. 1960 REVISION ① 30 Sept. 1961 ② 28 Feb. 1963 ③ 30 Aug. 1974

1.0 SCOPE

- 1.1 **Purpose:** This specification is intended to serve as a guide in the coordination of system design, to minimize the variety of program manuscripts required and the number of word and block format systems used, to promote uniformity of programming techniques, and to foster interchangeability of input tapes between numerically controlled machine tools of the same classification by type, process function, size, and accuracy. It is intended that simple numerically controlled machine tools be programmed using a simple format which is systematically extensible for more complex machine tools.
- 1.2 **Classification:** This standard applies wherever variable block format is used on perforated tape to control a Class III Positioning and Straight Cut Numerically Controlled Machine Tool. (Note: This format will usually be used with tape read row-by-row.)
- 1.3 **Intended Uses:** Perforated tape with variable block format as described in the following sections shall be usable, interchangeably, among numerically controlled machine tools which conform to the same format classification as shown in Appendix A. (Note: The degree of interchangeability will depend upon 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 **Revisions and Amendments:** Revisions to these standards will be proposed as technical progress warrants, or as future standards are adopted which conflict with these standards.

2.0 **APPLICABLE SPECIFICATIONS** All existing NAS 900 series machine specifications adaptable to numerical control and using perforated tape, as the input control, or any other machine not now covered by NAS which utilizes perforated tape control. E. I. A. Standards R. S. 227 and R. S. 244, shall apply.

- 2.1 Definitions of terms used in this standard are in accordance with E. I. A. Automation Bulletin No. 3A "Definitions for Numerically Controlled Machine Tools."
- 2.2 Axis and motion nomenclature, used in this standard, is in accordance with NAS938 Axis and Motion Nomenclature for Numerically Controlled Machine Tools.

3.0 REQUIREMENTS

- 3.1 **Physical Characteristics - Class III**
- 3.1.1 All perforated tape used shall be one inch wide, 8 track with physical dimensions in accordance with Figure #1.
- 3.1.2 The measurement of all dimensions of the perforated tape shall be made with the perforated tape conditioned to the same environmental condition under which it was perforated.
- 3.1.3 Material - Tape shall be of a material suitable for the particular use. Where other than paper tape is used, thickness may be less but not greater than .0043 inch.

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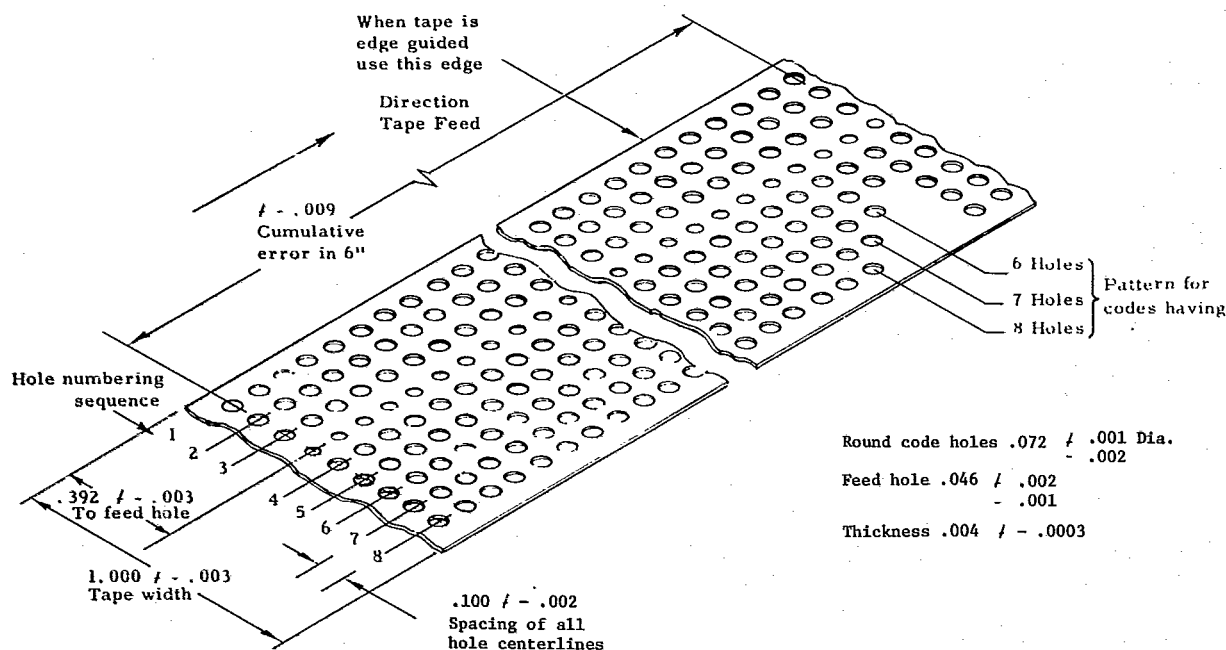


Figure 1. Standard One Inch Perforated Paper Tape

3.2 Code - Class III

3.2.1 The standard code shall be one character per row punched perpendicular to the longitudinal axis of the tape.

3.2.2 Code Table - The arrangement of code shall be in rows of holes across the tape with each row of holes signifying an alphabetic or numeric character. Individual characters are defined in the following table. Presence of a level number indicates a hole.

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TABLE I

Character Digit or Code	Description or Address For	Standard Level Number (5 is Parity Channel)							
		1	2	3	4	5	6	7	8
0	Digit 0						6		
1	Digit 1	1							
2	Digit 2		2						
3	Digit 3	1	2			5			
4	Digit 4			3					
5	Digit 5	1		3		5			
6	Digit 6		2	3		5			
7	Digit 7	1	2	3					
8	Digit 8				4				
9	Digit 9	1			4	5			
a	Angular dimension around x axis	1					6	7	
b	Angular dimension around y axis		2				6	7	
c	Angular dimension around z axis	1	2			5	6	7	
d	Angular dimension around special axis or third feed function*			3			6	7	
e	Angular dimension around special axis or second feed function*	1		3		5	6	7	
f	Feed Function		2	3		5	6	7	
g	Preparatory Function	1	2	3			6	7	
h	Unassigned				4		6	7	
i	Do Not Use	1			4	5	6	7	
j	Unassigned	1				5		7	
k	Unassigned		2			5		7	
l	Do Not Use	1	2					7	
m	Miscellaneous Function			3		5		7	
n	Sequence Number	1		3				7	
o	Do Not Use		2	3				7	
p	Third rapid traverse dimension or tertiary motion dimension parallel to x*	1	2	3		5		7	
q	Second rapid traverse dimension or tertiary motion dimension parallel to y*				4	5		7	
r	First rapid traverse dimension or tertiary motion dimension parallel to z*	1			4			7	
s	Spindle Speed		2			5	6		
t	Tool Function	1	2				6		
u	Secondary motion dimension parallel to x*			3		5	6		
v	Secondary motion dimension parallel to y*	1		3			6		
w	Secondary motion dimension parallel to z*		2	3			6		
x	Primary x motion dimension	1	2	3		5	6		
y	Primary y motion dimension				4	5	6		
z	Primary z motion dimension	1			4		6		
.	Decimal Point	1	2		4		6	7	
,	(Comma)	1	2		4	5	6		
()	(Check)								
+	Plus Sign					5	6	7	
-	Minus Sign							7	
Space	Unassigned					5			
Delete	Error Delete	1	2	3	4	5	6	7	
Carriage Return	End of Block (Execute)								8
Back Space	Unassigned		2		4		6		
Tab	Tab		2	3	4	5	6		
Tape Stop	End of Record	1	2		4				
Tape Feed Hole	Leader								
No Feed Hole	Blank Tape								
Upper Case	Unassigned			3	4	5	6	7	
Lower Case	Unassigned		2		4	5	6	7	

*Where d, e, p, q, r, u, v and w are not used as indicated, they may be used elsewhere.

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- 3.3 Format - Class III Positioning and Straight Cut Numerical Control Systems.
- 3.3.1 Words
- 3.3.1.1 The length of each specific word as assigned by the format classification shall remain constant.
- 3.3.1.2 Tab and address characters shall be the first characters of the word. The address character shall follow the tab character.
- 3.3.1.2.1 The "tab character" shall be omitted from the "Sequence Number" word. (See Paragraph 3.4.2.1.)
- 3.3.1.3 Dimension words shall be either coordinate (absolute dimension) or incremental (as specified by Format Classification) and shall contain digital data as follows:
- 3.3.1.3.1 The most significant digit of the dimension word shall be read first.
- 3.3.1.3.2 Decimal points shall not be used.
- 3.3.1.3.3 Coordinate dimension words.
- 3.3.1.3.3.1 All linear coordinates shall be absolute and expressed in decimal inches.
- 3.3.1.3.3.2 All angular coordinates shall be absolute and expressed in decimal parts of a revolution.
- 3.3.1.3.3.3 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.
- 3.3.1.3.4 Incremental dimension words.
- 3.3.1.3.4.1 All linear increments shall be expressed in decimal inches preceded by an algebraic sign (+ or -) to indicate direction.
- 3.3.1.3.4.2 All angular increments shall be expressed in decimal parts of a revolution preceded by an algebraic sign (+ or -) to indicate direction.
- 3.3.1.4 Non-dimension words shall contain digital data as follows:
- 3.3.1.4.1 The "Sequence Number" shall consist of three (3) digits.
- 3.3.1.4.2 The "Preparatory Function" shall consist of two (2) digits. For designations, see Appendix B
- 3.3.1.4.3 The "Feed Function" for a linear motion whose rate of motion is independent of spindle speed shall be in inches per minute. (See Paragraph 3.3.1.4.7.)
- 3.3.1.4.4 The "Feed Function" for a linear motion whose rate of motion is a function of spindle speed shall be in inches per revolution. (See Paragraph 3.3.1.4.7.)
- 3.3.1.4.5 The "Feed Function" for a rotary motion shall be in revolutions per minute. (See Paragraph 3.3.1.4.7.)
- 3.3.1.4.6 The "Spindle Speed" shall be in revolutions per minute. (See Paragraph 3.3.1.4.7.)

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