



Standard Practice for Formatting Cutting Data to Drive Numerically Controlled Fabric Cutting Machines¹

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1. Scope

1.1 This practice specifies a data format for numerically-controlled cutting machines for fabric. This standard uses the defined instruction set defined in ANSI/EIA-274-D in addition to the codes defined by this practice. Required instructions not defined in this standard are defined in ANSI/EIA-274-D.

1.2 In addition to specifying the format of cut files, this practice defines interrogation commands, to support bi-directional communication between a cut-file-generating system and a cutter for potential automatic configuration of the program that generates the cut file. This type of command results in format classification and format detail information which is further described in ANSI/EIA-274-D.

1.3 This practice defines functions which are necessary to the task of cutting fabric in addition to the ANSI/EIA-274-D functions. These functions are assigned commands from the collection of “permanently unassigned” codes in ANSI/EIA-274-D and from other codes which that standard allows to be redefined.

1.4 This practice provides two new types of communication between cut-file generating software and cutters. Both of the two new types of codes are defined within the confines specified by ANSI/EIA-274-D and are, therefore, completely compatible with that standard.

1.4.1 *Machine Specific*—Provides a means for expanding functionally on cutters without the need to depart from the industry standard.

1.4.2 *Format Classification Interrogation*—A process for exchanging data concerning cutter capabilities between cut file generators and cutters.

1.5 The intended application of this practice is limited to the class of cutters that is found in those industries cutting apparel, textiles, upholstery, and other soft goods.

2. Referenced Documents

2.1 ANSI/EIA Standard:

ANSI/EIA-274-D Interchangeable Variable Block Data Format For Positioning, Contouring, and Contouring/

Positioning Numerically Controlled Machines²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *block, n*—a sequence of commands within a cut file necessary to drive a numerically controlled fabric cutter.

3.1.2 *cut file, n*—numerically controlled fabric cutter instructions entered in blocks of ASCII characters.

3.1.3 *format classification interrogation, n*—procedure and associated commands that are used only when a cut-file-generating system is on-line with a numerically controlled fabric cutter to allow the cut-file-generating system to interrogate the cutter about its configuration before creating a cut file.

3.1.4 *function codes, n*—codes used within a cut file block to govern interpretation of subsequent commands and data.

4. Significance and Use

4.1 This standard allows cut files to be generated in CAD systems independent of the CAM system (fabric cutters) that uses the data.

4.2 Realizing that specific fabric cutters can operate far differently than others in specialized operations, such as in cutting plaid fabrics, custom cut data strings can be embedded within cut files.

5. Cut File

5.1 Instructions to the cutter are entered in blocks of ASCII characters. A block is a sequence of commands consisting of identification information, coordinate data, and tool instructions or functions. Each block contains one or more instruction “words.”

5.1.1 The following is an example of a block of cutter instructions:

*N30G00X500Y500F3T01D1**

where:

N30

= the sequence number; the sequence must precede each block of commands,

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² Available from Electronic Industries Association, Engineering Department, 2001 Eye Street N.W., Washington, DC 20008.

- G00* = a preparatory function. The preparatory function, if there is one, immediately follows the sequence number. Preparatory functions provide information for interpretation of system parameters,
- X500 and Y500* = coordinate values. Coordinates are expressed in absolute or incremental terms depending upon the format classification given for a particular cutter and upon the most recent “G” command regarding coordinate interpretation,
- F3* = feed rate. The feed function is used to specify the rate at which an operation is performed. The feed rate persists from one instruction block to another, that is, if no new feed rate is given, then the previous feed rate is assumed,
- T01* = selection of a particular tool,
- D1* = the selected tool’s orientation (down or up), and
- “*” = the end of block character. In actuality the end of block character is the ASCII newline character. Since the newline character is non-printing, it is symbolized in the document by an “*”.

5.1.2 Words may be omitted within a block when there is no change of state to the machine for that parameter. For example, the feed function may be omitted if no change in feed rate is desired. Also, coordinate information may be omitted if the position of the tool is not intended to change.

5.2 *Program Start and Identification*—The program start character “%”, indicates the starting point of information in the cut file which is relevant to the operation of the cutter. The cutter is expected to scan and ignore all characters in the cut file which precede the program start character, with the exception of format interrogation commands.

6. Preparatory Function Codes

6.1 Function codes are used primarily to govern interpretation of subsequent commands and data. See Appendix X1 for more information. The following list shows the function code followed by its meaning:

- 6.1.1 *G00*—Point to point positioning,
- 6.1.2 *G01*—Linear interpolation,
- 6.1.3 *G02*—Circular interpolation arc CW,
- 6.1.4 *G03*—Circular interpolation arc CCW,
- 6.1.5 *G04*—Dwell,
- 6.1.6 *G06*—Parabolic interpolation,
- 6.1.7 *G08*—Acceleration,
- 6.1.8 *G09*—Deceleration,
- 6.1.9 *G25*—Inhibit next overcut,
- 6.1.10 *G26*—Ignore overcut and advance,
- 6.1.11 *G27*—Enable automatic sharpen,
- 6.1.12 *G28*—Disable automatic sharpen,
- 6.1.13 *G29*—Sharpen,
- 6.1.14 *G36*—Turn off knife intelligence,
- 6.1.15 *G37*—Turn on knife intelligence,
- 6.1.16 *G38*—Null knife intelligence,
- 6.1.17 *G70*—Inch programming,

- 6.1.18 *G71*—Metric programming,
 - 6.1.19 *G90*—Absolute dimension input, and
 - 6.1.20 *G91*—Incremental dimension input.
- 6.2 Table 1 compares these codes with those of ANSI/EIA-274-D.

7. Miscellaneous Function Codes

7.1 Individual cutters may implement any subset of the codes given in this practice without losing compatibility with the practice. The subset chosen for a given cutter would appear in the format specification for that cutter. See Appendix X1 for more information. The miscellaneous function codes and their meanings are:

- 7.1.1 *M00*—Program stop,
- 7.1.2 *M01*—Optional stop,
- 7.1.3 *M20*—Message stop,
- 7.1.4 *M21*—Lift and plunge corner,
- 7.1.5 *M22*—Set origin,
- 7.1.6 *M23*—Edge clip
- 7.1.7 *M30*—End of file, and
- 7.1.8 *M47*—Rewind data file.

7.2 Table 2 compares these codes with those of ANSI/EIA-274-D.

8. Other Function Codes

8.1 The F, T, and S codes are defined for a range of tools on a cutter. Feed, or F, function codes refer to linear movement of the cutter arm, while the secondary feed function code, E, refers to the conveyor. Spindle speed, or S, function codes apply to the drill revolutions per min or knife oscillation speed, depending upon which tool is selected. The tool down and tool up commands, D1 and D2, also apply to whatever tool is currently selected. A tool position command which cannot be implemented shall be ignored.

8.2 *T Codes, Designates Current Selected Tool:*

- 8.2.1 The following T codes and their assigned devices are:
- 8.2.1.1 *T01*—Knife,
- 8.2.1.2 *T02*—Light,
- 8.2.1.3 *T03*—Marker,

TABLE 1 Preparatory Function Codes

Code	D 6672	ANSI/EIA-274-D
G00	Point to point positioning	Point to point positioning
G01	Linear interpolation	Linear interpolation
G02	Circular interpolation arc CW	Circular interpolation arc CW
G03	Circular interpolation arc CCW	Circular interpolation arc CCW
G04	Dwell	Dwell
G06	Parabolic interpolation	Parabolic interpolation
G08	Acceleration	Acceleration
G09	Deceleration	Deceleration
G25	Inhibit next overcut	Permanently unassigned
G26	Ignore overcut and advance	Permanently unassigned
G27	Enable automatic sharpen	Permanently unassigned
G28	Disable automatic sharpen	Permanently unassigned
G29	Sharpen	Permanently unassigned
G36	Turn off knife intelligence	Permanently unassigned
G37	Turn on knife intelligence	Permanently unassigned
G38	Null knife intelligence	Permanently unassigned
G70	Inch programming	Inch programming
G71	Metric programming	Metric programming
G90	Absolute dimension input	Absolute dimension input
G91	Incremental dimension input	Incremental dimension input

TABLE 2 Miscellaneous Function Codes

Code	D 6672	ANSI/EIA-274-D
M00	Program stop	Program stop
M01	Optional stop	Optional stop
M20	Message stop	Permanently unassigned
M21	Lift and plunge corner	Permanently unassigned
M22	Set origin	Permanently unassigned
M23	Edge clip	Permanently unassigned
M30	End of file	End of file
M47	Rewind data file	Rewind data file

8.2.1.4 *T04*—Labeler,

8.2.1.5 *T05*—Drill,

8.2.1.6 *T06*—Auxiliary Drill, and

8.2.1.7 *T07*—Conveyor.

8.2.2 *Usage Notes*—The following block would move the conveyor: *T07X50**. Note that selection of a tool indicates that all subsequent data refers to that tool. This eliminates the need for M or G commands which instruct the cutter to perform special interpretations of data. A tool remains selected until a different tool is selected. A selected tool may be rendered inactive through the D2 command, which is the tool up command given in 8.3, provided the tool may be disengaged from the working surface by so doing. The conveyor may ignore tool up and tool down commands.

8.3 *Other Codes*:

8.3.1 Other function codes and their meanings include:

8.3.1.1 *C*—Angular dimension in degrees around Z axis,

8.3.1.2 *D1*—Tool down,

8.3.1.3 *D2*—Tool up,

8.3.1.4 *E*—Set conveyor feedrate,

8.3.1.5 *F*—Set cutter arm feedrate,

8.3.1.6 *N*—Sequence number,

8.3.1.7 *R*—Piece number,

8.3.1.8 *S*—Spindle speed,

8.3.1.9 *T*—Tool function,

8.3.1.10 *U*—Decimal format,

8.3.1.11 *X*—Primary X motion dimension,

8.3.1.12 *Y*—Primary Y motion dimension,

8.3.1.13 *Z*—Primary Z motion dimension,

8.3.1.14 *'*, *The ASCII Decimal Character 96*—Designates start labeler character string, and

8.3.1.15 *'*, *The ASCII Decimal Character 39*—Designates end labeler character string.

8.3.2 Table 3 compares the codes from 8.1-8.3 with those of ANSI/EIA-274-D.

8.3.3 *Usage Notes*—Most of the address codes in 8.3 take a numeric argument. The exceptions are D1, D2 and Q. E and F are each followed by a feedrate within the range of that system. S is followed by a spindle speed rate. Where more than one tool may be affected by a speed change, the currently selected tool is the only one affected.

8.3.3.1 *N Usage*—N is followed by the block number and must precede each command block.

8.3.3.2 *T Usage*—T is followed by the tool number, selecting the tool to which subsequent commands apply.

8.3.3.3 *P Usage*—P is used within the same block as an acceleration or deceleration command, G08 or G09 respectively, to indicate the percentage of change of speed. This change only applies to the currently selected tool. In cases of

TABLE 3 Other Function Codes

Code	D 6672	ANSI/EIA-274-D
C	Angular dimension in degrees around Z axis	Angular dimension around Z axis
D1	Stylus (tool) down	Stylus down
E	Set conveyor feedrate	Second feed function or special axis dimension
F	Set (cutter arm) feedrate	Feed function
N	Sequence number	Sequence number
P	Percent of velocity ^A	Third rapid traverse dimension
T	Tool function	Tool function
X	Primary X motion dimension	Primary X motion dimension
Y	Primary Y motion dimension	Primary Y motion dimension
'	Start labeler character string ^B	Not used
'	End labeler character string ^C	Not used

^A ANSI/EIA-274-D footnote * of Table 1 allows that D, E, P, Q, R, U, V and W can be used elsewhere if not used as indicated by Table 1.

^B This is the ASCII decimal character code 96.

^C This is the ASCII decimal character code 39.

ambiguity, it is advisable to give the tool number within the block. If no tool number is given, the change of speed is taken to apply to the feed function of the currently selected tool, that can be either the conveyor or the cutter arm. If, for example, the knife tool number is given in the deceleration block command, then the deceleration refers to the knife oscillation speed. Note that the latter is a spindle speed.

8.3.3.4 *U Usage*—The U code may be used within any block to change interpretation of the decimal point format of all motion dimension words which follow the U format block. It is recommended, however, that the U command be used only in conjunction with one of the G70, G71, G90 or G91 preparatory function codes, even if the specification of that code is redundant.

8.3.3.5 *C Usage*—The C address code is used to turn the knife blade to coincide with the path of the cutter arm by specifying an angular dimension. Linear movement along the Z axis, however, is generally performed with the D commands, making a Z specification unnecessary.

8.3.3.6 *Labeler*—The labeler may be oriented in the same manner as described in 8.3.3.5. The position of the labeler may be specified by using the C address character. The string of characters to be printed on the label is enclosed by the open quote symbol, *'*, ASCII decimal character 96 on the leading side and ended with the apostrophe symbol, *'*, ASCII decimal character 39. The entire command block is terminated with a newline. Newlines within the parentheses are taken as labeler string data. The open quote and apostrophe may be printed by preceding each occurrence with the escape character, *""*. The escape character may also be printed by preceding it with the escape character (for example, *""*).

8.4 *Machine Specific Code Format*:

8.4.1 In order to address a need by the industry for specialized functionality required by individual cutters, the machine specific code Q is utilized. This code allows specialized commands to be submitted to a cutter which possesses capabilities not common to all cutters.

8.4.2 The format for machine specific codes is:

*QMidCidDdate**

where:

Q = the address code as specified in Table 3,

- Mid* = the manufacturer identifier character address code followed by a unique manufacturer identifier assigned by the American Apparel Manufacturers Association (AAMA),
- Cid* = the cutter identifier character address code followed by a unique cutter machine identifier assigned by the manufacturer,
- Ddata* = the data stream character code followed by any data stream supposedly recognizable by cutter C, and
- ** = the end of block character that indicates the end of the machine specific data.

8.4.3 Machine specific commands should only be used to implement machine features which cannot otherwise be implemented by this practice. Manufacturers should make machine specific commands available to software developers and clients.

9. Format Classification Interrogation

9.1 The purpose of these commands is to allow automatic configuration of a cut file generating program. This is made possible by the information supplied to the generating program by the cutter controller via these interrogation commands. This requires two-way communication between the cutter controller and the cut-file-generating system.

9.1.1 The format classification interrogation of the cutter must occur before receipt of the start, or “%”, character in the cut file.

9.2 *Format Classification*—The format classification information gives the format requirements of a particular cutter. It includes a listing of the functions which are included in the implementation of that cutter such as speeds of the cutter and area bounds. Other information which will clarify the individualities of a particular cutter should be included.

9.3 *Format Detail*—This detail gives the decimal system used by a particular cutter as well as the length of words required by the control system.

9.4 *Format Classification Commands*:

9.4.1 The format classification commands and their meaning are:

9.4.1.1 *#S#*—This command requests the cutter to supply the information contained in the format classification shorthand. This information will be sent exactly as outlined in ANSI/EIA-274-D preceded by *#S#* and is followed by the end of block character.

9.4.1.2 *#D#*—This command requests the cutter to supply the format detail. This information should be exactly the same as what appears in the format specification document for the individual cutter. It is begun with *#D#* and concluded with the end of block character.

9.4.1.3 *#G#*—Upon receipt of this command, the cutter will transmit the numbers of all G codes which it recognizes in the form *#G#G01G37G59*, for example. It is concluded with the end of block character.

9.4.1.4 *#M#*—This command instructs the cutter to transmit the numbers of all the M commands that it recognizes. The form is *#M#M01M02M05*, etc. concluded with the end of block character.

9.4.1.5 *#Q#*—This command instructs the cutter to transmit

the manufacturer identifier number and the cutter identifier number. The form of response is *#Q#QMidCid**.

9.4.1.6 *#F#*—The F command instructs the cutter to transmit in decimal formats. This query is needed for those cutters which support multiple decimal point formats within the same system (English or Metric). The form for the response is *#F#E33E42M51**, where E indicates an English format and M indicates a Metric format. Each is followed by a two digit number, where the first digit specifies the number of digits in a coordinate which precede the implied decimal point and the second digit specifies the number of digits which follow the implied decimal point.

9.4.1.7 *#W#*—This command instructs the cutter to transmit its work dimensions. The form for this data is *#W#X30FY1F** where X and Y represent the two axes, and F is for feet, inches or spindle speed of each tool as applicable. Inches or metres may be used instead with the I or M character replacing the F character as desired. It is concluded by the end of block character.

9.4.1.8 *#T#*—This command instructs the cutter to transmit the numbers of all cutter tools which it possesses along with the feed range or spindle speed of each tool as applicable.

9.4.2 When conducting a machine specific interrogation utilizing the *#T#* command, the transmission response will be in the form of *#T#T01F.01F200IPMT06S20S1800RPM**, for example. In this form, each tool function begins with the tool number (for instance T01 for knife), followed by the minimum and maximum feed or spindle speed rates for that tool, followed by the units of interpretation for those speeds. The end of block character concludes the form. The following interpretation codes may be used:

- 9.4.2.1 *I*—Inches,
- 9.4.2.2 *F*—Feed rate, when appearing in a speed position
- 9.4.2.3 *F*—Feet, when preceding P,
- 9.4.2.4 *M*—Meters, when appearing immediately before a P,
- 9.4.2.5 *M*—Minutes, when appearing immediately after a P,
- 9.4.2.6 *P*—Per,
- 9.4.2.7 *S*—Spindle speed, when appearing in a speed position,
- 9.4.2.8 *S*—Second, when following a P, and
- 9.4.2.9 *R*—Revolutions.

9.5 *Usage*:

9.5.1 Any defined function code from ANSI/EIA-274-D may be used for its defined purpose in an individual implementation provided that the function code has not been defined for a different purpose within this practice. Should an application require a function code which has no analog in either this practice or ANSI/EIA-274-D, the application developer should use a machine specific code.

9.5.2 Any fabric cutter manufacturer wishing to employ the machine specific command must obtain a manufacturer identifier from the American Apparel Manufacturers Association (AAMA).³

10. Keywords

10.1 code; communication; contouring; controlled; cutting;

³ The American Apparel Manufacturers Association, 2500 Wilson Boulevard, Suite 301, Arlington, VA 22201.

fabric; interrogation; numerical; positioning; tool

APPENDIX

(Nonmandatory Information)

X1. CODE DESCRIPTIONS

X1.1 This appendix describes each of the preparatory and function codes and what parameters may or must be used with each.

X1.1.1 *Preparatory Codes:*

X1.1.1.1 *G00*—Point to point positioning. Used to move the cutter arm in two dimensional space above the cutting table.

X1.1.1.2 *G01*—Linear interpolation. A mode of contouring control which uses the information contained in a block to produce a straight line in which the vectorial velocity is held constant.

X1.1.1.3 *G02*—Circular interpolation arc clockwise. An arc generated by the coordinated motion of two axes in which curvature of the path of the tool with respect to the work piece is clockwise, when viewing the plane of motion in the negative direction of the perpendicular axis.

X1.1.1.4 *G03*—Circular interpolation arc counter-clockwise. An arc generated by the coordinated motion of two axes in which curvature of the path of the tool with respect to the work piece is counter-clockwise when viewing the plane of motion in the negative direction of the perpendicular axis.

X1.1.1.5 *G04*—Dwell. A timed delay of programmed or established duration, not cyclic or sequential, that is, not an interlock or hold.

X1.1.1.6 *G06*—Parabolic interpolation. A mode of interpolation used in contouring to produce a segment of a parabola. Velocities of the axes used to generate this curve are varied by the control.

X1.1.1.7 *G08*—Acceleration. A controlled velocity increase to programmed rate starting immediately.

X1.1.1.8 *G09*—Deceleration. A controlled velocity decrease to a fixed percent of the programmed rate starting immediately.

X1.1.1.9 *G25*—Inhibit next overcut. Overcut is defined by the cutting blade moving an extra predefined cut distance in the current direction at piece corners where a lift and plunge motion of the knife is normally executed. The *G25* code instructs the cutter not to overcut at the next place where it would normally do so.

X1.1.1.10 *G26*—Inhibit next overcut and advance. In addition to inhibiting the next overcut, the lifted cutting blade is advanced forward in the new cutting direction before plunging and continuing the cut.

X1.1.1.11 *G27*—Enable automatic sharpen. A modal command which enables the automatic sharpening of the knife tool and requires no parameter.

X1.1.1.12 *G28*—Disable automatic sharpen; requires no parameters.

X1.1.1.13 *G29*—Sharpen. A non-modal command which causes the knife to be sharpened. Requires no parameters.

X1.1.1.14 *G36*—Turn off knife intelligence. A modal com-

mand requiring no parameters.

X1.1.1.15 *G37*—Turn on knife intelligence. A modal command requiring no parameters.

X1.1.1.16 *G38*—Null knife intelligence. A modal command requiring no parameters.

X1.1.1.17 *G70*—Inch programming. A modal command requiring no parameters. Causes all X and Y coordinates to be interpreted in inch units.

X1.1.1.18 *G71*—Metric programming. A modal command requiring no parameters. Causes all X and Y coordinates to be interpreted in metric units.

X1.1.1.19 *G90*—Absolute dimension input. A modal command requiring no parameters. Causes all coordinates to be interpreted as absolute.

X1.1.1.20 *G91*—Incremental dimension input. A modal command requiring no parameters. Causes all coordinates to be interpreted as incremental.

X1.1.2 *Miscellaneous Function Codes:*

X1.1.2.1 *M00*—Program stop. Terminates further program execution after completion of other commands in the block.

X1.1.2.2 *M01*—Optional stop. Similar to *M00* except that the cutter ignores the command unless the operator has validated the command.

X1.1.2.3 *M20*—Message stop. A code that flags up to 30 contiguous characters that follow as a message to be displayed on the operator console and stops the cutter. Operation is resumed when the operator manually restarts the cutter. The *M20* command is followed by the message string enclosed by the same start and end delimiters as used for a labeler, see Table 3.

X1.1.2.4 *M21*—Lift and plunge corner. Usually used to cut precise corners, this command causes the knife blade to lift and plunge with the blade pointed in the new direction of cutting.

X1.1.2.5 *M22*—Set origin. Stops the machine. After the operator has the opportunity to move the cutting head and restart the machine, the new head position is assumed as the new coordinate origin point.

X1.1.2.6 *M23*—Edge clip. This is a null command whose purpose is to mark the position in the cut file where an edge clip was performed in order to facilitate rewinding the file to this position for restarting.

X1.1.2.7 *M30*—End of data. Stops the machine. Used to reset control or machine, or both. Resetting control will include rewind of tape to the end of record character, progressing a loop tape through the splicing leader, or transferring to a second tape reader.

X1.1.2.8 *M47*—Return to program start. Continues program execution from the start of program, unless inhibited by an interlock signal.

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