SECTION IV

CONTROL TAPE FORMAT DETAILS

4.1 THE COORDINATE SYSTEMS

The coordinate systems of the machine and part print need an explanation of their associated definitions as applied to the Series I CNC. This is discussed before a detailed explanation of Tape Codes and Formats. The final paragraph in this section covers the Part Programming Form.

4.1.1 Machine Coordinate System

The machine axes travel limits under numerical control are thus:

X axis (Table)	18"
Y axis (Saddle)	12"
Z axis (Quill)	5"

It is to be emphasized that tool motion is the accepted method of defining motion relative to the workpiece. Such tool motion can be plus or minus at any time in accordance with the rectangular coordinates defined in Figure 4-1.

The mechanically driven counters in the X and Y axes are factory set so that 0.0 is the tool position in fully minus travel, i.e., with the tool at the front left-hand corner of the machine table. Alteration of this counter is not easily done and it is best left as set at the factory. Thus, at mid-travel the X axis tool coordinate will register 9.0000" and the Y travel at 6.0000". These counters have the best application when registering the coordinates of a locating bore, edge or dowel in a fixture. From these coordinates, any new coordinate requested by the programmer for tape start point can readily be set by the operator using the JOG controls and confirmed by adding or subtracting the incremental motion made to the original coordinates to verify the new. The MDI keyboard will also permit quick setup to the start point.

4.1.2 Control Coordinate System

The control has the capability of utilizing coordinate values of $\pm$999.9999 in each of the axes X, Y and Z, also in the arc offset registers I, J and K. Such coordinates can originate from an origin located in any quadrant and even outside the machine travel limits.

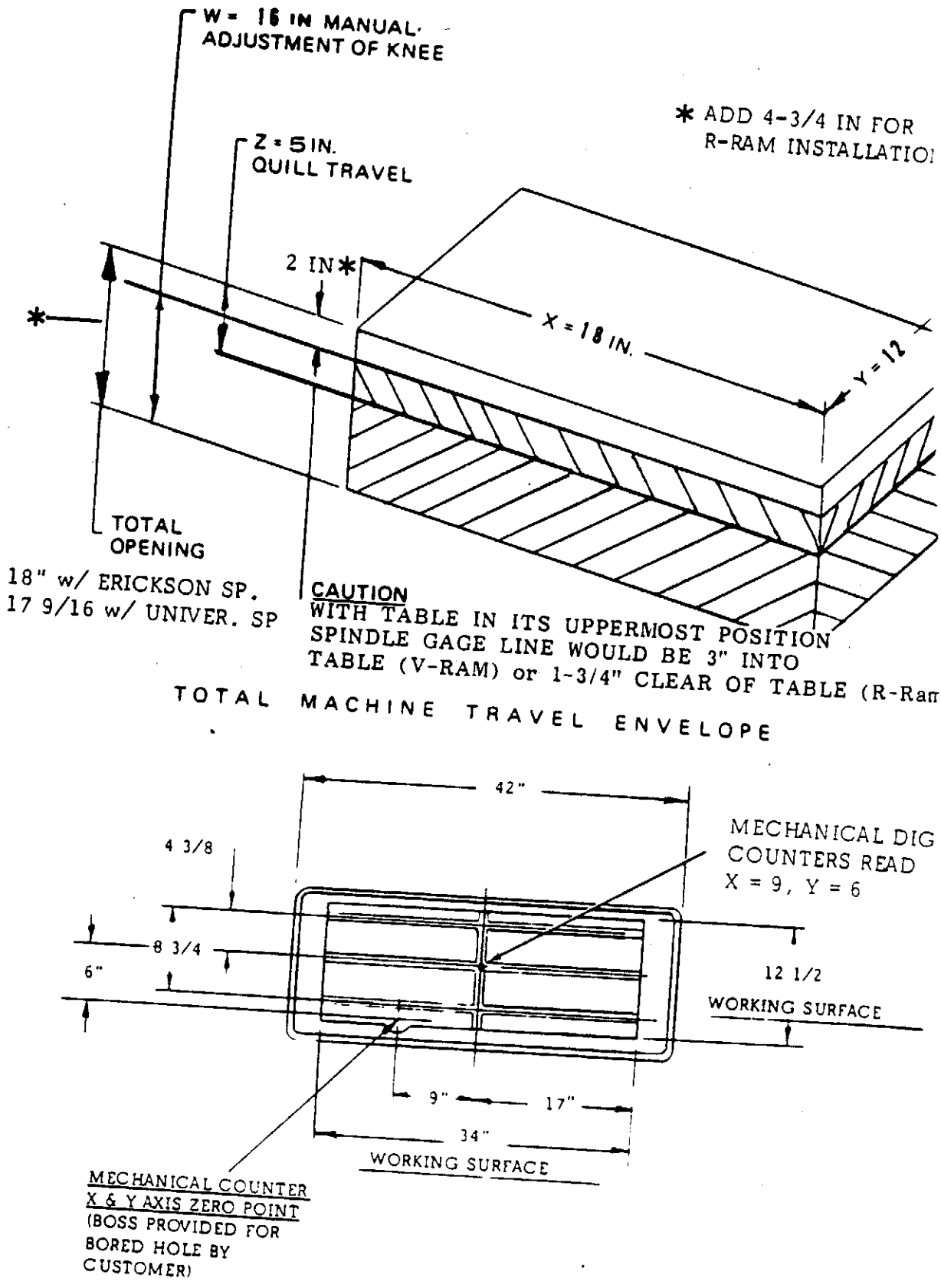


Figure 4-1. Machine Coordinate System

4.1.3 Part Coordinate System

Dimensions shown on a part drawing can have datum lines and reference planes which refer to a zero datum or zero reference some distance from the part itself. If the programmer elects to save calculation time and possible error, he may use the part coordinates directly from the drawing when programming in absolute coordinates. If incremental programming, the drawing coordinates are used only to establish points of departure to generate incremental input by addition and subtraction.

4.1.4 Coordination of Coordinate Systems

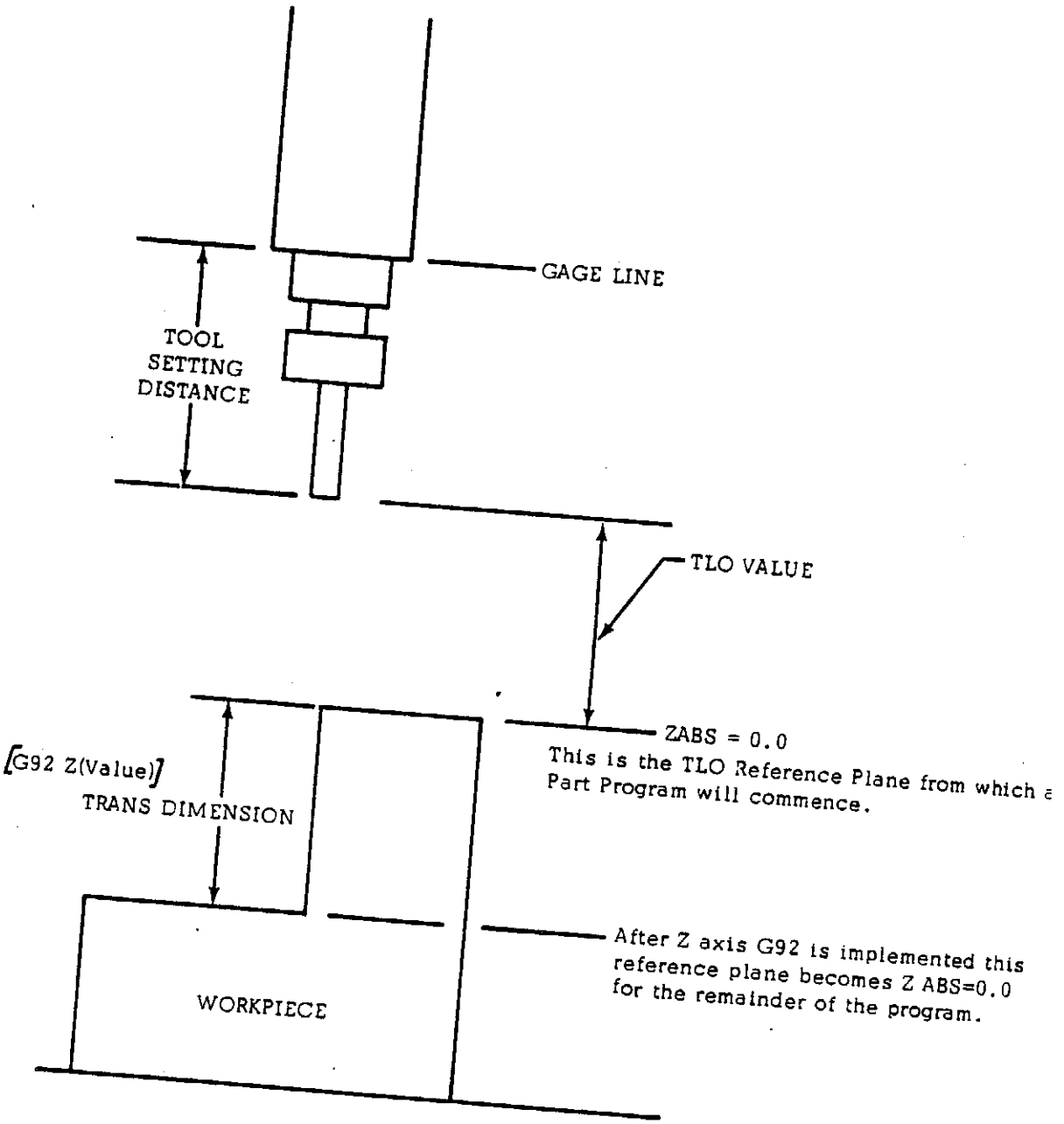
The programmer can consider the tool to be placed initially at a convenient position relative to the part fixture (and, therefore, the part itself) in the XY axes. These XY coordinates on the machine have an equivalent XY coordinate on the part. The machine control can be preset (G92) to accept the part coordinates thus permitting the programmer to utilize all part coordinates thereafter.

When considering similar procedures for the Z axis, the programmer must not translate Z coordinates to new values in his program until some Z axis absolute value has been programmed. When at this value, the same preset (G92) procedure can be followed. (See Figure 4-2)

4.2 TAPE DESCRIPTION

4.2.1 Standard Tape

While in the AUTO modes, the machine is controlled by stored data - sometimes called program text in this manual. Input of the data to storage is by the several methods discussed in the Operating Manual but prepared data is an eight channel, 1" wide punched tape conforming to EIA Standard RS-227. (See Figure 4-3.) A number or letter is expressed as a combination of "holes" and "no-holes" across the tape. There are two standard formats for the tape-coded combinations which represent characters. One format was established by the Electronics Industries Association (RS-244) and is commonly referred to as EIA Standard (odd parity). The other format is known as the American Standard Code for Information Interchange, abbreviated as ASCII (even parity). The Bridgeport CNC System accepts tapes coded in the ASCII format as specified by USAS X3.4-1967. (Note: EIA RS-358 is a subset of this specification.) The codes used are shown in Figure 4-4. For numerical codes, these channels are assigned weighted values of 1, 2, 4, 8 respectively. A "seven" is a combination of holes in channels 1, 2 and 3. This method of individual digit coding is known as Binary Coded Decimal (BCD).



NOTE: If the Part Coordinate at the workpiece top is other than Zero, the ZABS register can also be preset (G92) to any value convenient to the programmer.

Figure 4-2. Translating the Z Coordinates

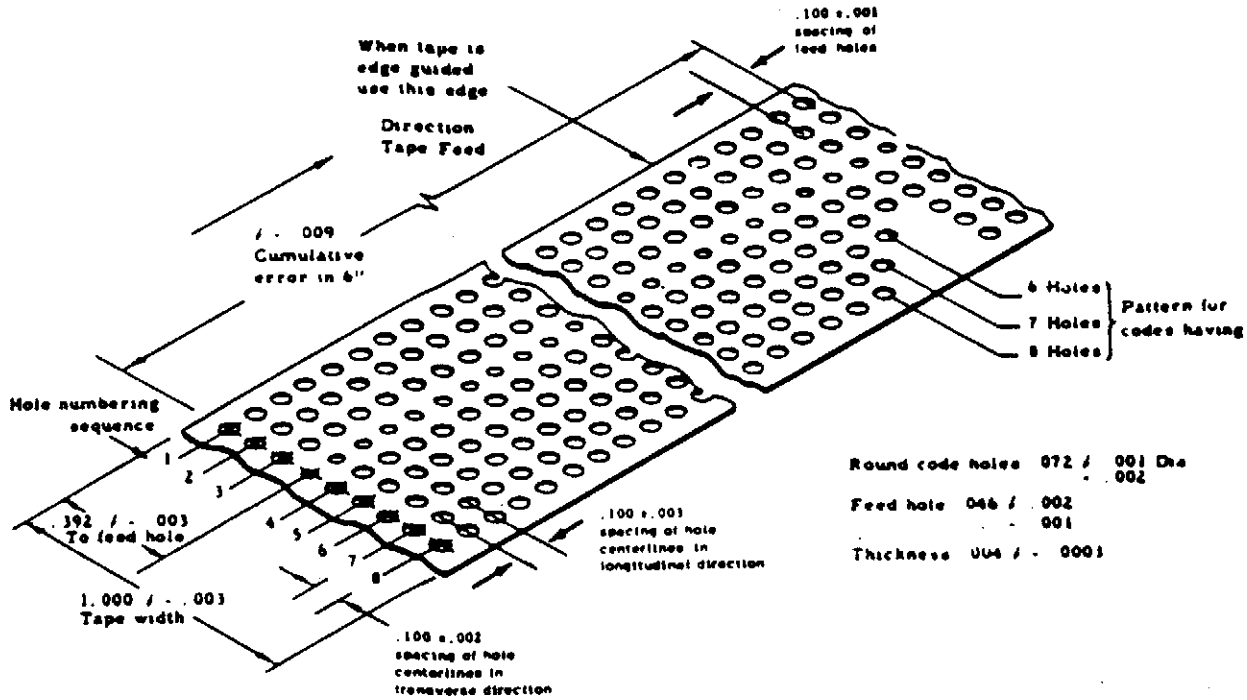


Figure 4-3. One Inch Perforated Tape

The following terms are used to describe the numerical control tape:

channel	A path parallel to the edge of the tape.
row	A path perpendicular to the edge of the tape.
bit	The presence or absence of a punched hole along a row.
character	A group of bits in a row.
word	A string of characters.
block	A group of words that provide one complete instruction to the control system.

The basic unit of program input to the system is called a block, each block contains adequate information for the machine to perform a movement and/or a function. Blocks are a combination of words or a single word. Each word is a combination of characters which represent an axis coordinate, sequence number, feedrate, etc. The first character of a word must be a letter address code. The letter address may be followed by as many as 6 digits. The last character of every block is the end of block (EOB) code.

4.2.2 Tape Codes

The tape codes shown in Figure 4-4 are the functional characters recognized by the control: 10 numbers, 15 letters and 9 special characters. It is the combination of these characters that directs the machine.

An address letter must be the first character of each word. It is never necessary to enter a plus sign (it is ignored) in the program. The control interprets the absence of a direction sign as being a plus sign. The end of block must terminate each block of information.

Some tape codes also shown in Figure 4-4 are non-functional and are ignored by the control. They appear on a program text tape as a result of the tape preparation process or may be inserted by the programmer to facilitate the reading of the tape image printout.

NOTE: In the EDIT mode of operation, the BOSS will recognize an additional character set in accordance with USAS X3.4-1967. These are the Command characters. (See the Operating Manual for details.)

SUBSET OF U.S.A. STANDARD CODE FOR INFORMATION INTERCHANGE, EIA STANDARD RS 358

EVEN PARITY ISO								CHARACTER	FUNCTION
8	7	6	5	4		3	2	1		
		6	5		o				0	NOTE: Any character not listed is illegal.
8		6	5		o			1	1	
8		6	5		o		2		2	
		6	5		o		2	1	3	
8		6	5		o	3			4	
		6	5		o	3		1	5	
		6	5		o	3	2		6	
8		6	5		o	3	2	1	7	
8		6	5	4	o				8	
		6	5	4	o			1	9	
	7				o			1	A	ANGLE (BOSS 5 or 6 only)
8	7					3		1	E	TAPE REWIND (TAPE READER ONLY)
8	7				o	3	2		F	FEED CODE
	7				o	3	2	1	G	PREPARATORY FUNCTION
8	7			4	o			1	I	X COORDINATE OF ARC CENTER
8	7			4	o		2		J	Y COORDINATE OF ARC CENTER
	7			4	o		2	1	K	Z COORDINATE OF ARC CENTER
	7			4	o	3		1	M	MISCELLANEOUS FUNCTION
	7			4	o	3	2		N	SEQUENCE NUMBER
8	7		5				2		R	RADIUS (BOSS 5 or 6 only)
	7		5		o		2	1	S	**REFERENCE ONLY BY CONTROL**
8	7		5		o	3			T	TOOL WORD
										IGNORED BY CONTROL
8	7		5	4	o				X	X COORDINATE
	7		5	4	o			1	Y	Y COORDINATE
	7		5	4	o		2		Z	Z COORDINATE
		6		4	o	3	2		.	DECIMAL POINT
8		6		4	o	3			,	IGNORED BY CONTROL
8		6		4	o	3	2	1	/	BLOCK DELETE & TLO/-DWELL
		6		4	o		2	1	+	IGNORED BY CONTROL
		6		4	o	3		1	-	MINUS
8		6			o				SPACE	IGNORED BY CONTROL
8	7	6	5	4	o	3	2	1	DELETE	IGNORED BY CONTROL
8				4	o	3		1	CARRIAGE RETURN	**END OF BLOCK - BOSS 5, 6**
8		6			o	3		1	%	REWIND STOP (TAPE READER ONLY)
				4	o			1	TAB	IGNORED BY CONTROL
				4	o		2		LINE FEED	**END OF BLOCK - BOSS 3.0, 4.0**
					o				BLANK TAPE	IGNORED BY CONTROL
									VIRGIN TAPE	IGNORED BY CONTROL
		6			o	3			$	MACRO END
8		6		4	o		2		*	MACRO VARIABLE
8		6					2	1	#	MACRO START
8		6	5	4		3		1	=	MACRO OR LOOP CALL STATEMENT

NOTE: Channel 8 is stripped when outputting to a terminal in the EDIT mode.

Figure 4-4. Input Tape and Program Text Codes

4.3 PROGRAMMING FORM

Figure 4-5 shows the most convenient programming form layout. The lette address to each word is labeled at the top of the several columns.

Many columns can be used with a different address. This will occur when:

Two or more Z inputs are required in deep hole drilling cycles (G83) or (G87). Three X and two Y inputs can be used in the G78 Pocket Mill Cycle and similarly two Y inputs are used in the G77 Facing Cycle.

The form carries a spare column which can be used to refer to Location Points used by the programmer on the part drawing.

PREPARED BY	DATE
CHECKED BY	DATE
SHEET OF	TAPE NO.

Bridgeport. TEXTRON

Bridgeport Machines Division of Textron Inc.

PART NO.
PART NAME
COMPANY NAME

NUMERICAL CONTROL PROGRAM

NOTES	N	G	X/Y	X/Y/Z	Y/Z/I/J	Y/Z/J/K	F	S	T	M

P-1378 RF MB

Figure 4-5. Programming Form