CHAPTER 4

OPERATION IN SET UP MODE

4.1 SYSTEMS OPERATION

The Set Up mode is the default condition following system start up after the self check diagnostic tests have been completed. The Set Up LED in the STATUS column will be on. Use this mode to prepare the milling machine for execution of a part program. The Set Up keys are located in the dark green area of the Front Panel, see Figure 4-1. The following operations are available:

1. Establishment of machine/part program coordinate system

2. Axis jog

3. Entering tool data

4. Loading part programs

5. Clearing tool/text registers

6. Editing functions

Before entering the Run mode of operation there should be a part program ready to run in the text buffer. If no program exists, it will be necessary to either load or create a program.

The instructions and explanations required for the preparation and operation of the system are addressed in the following sections.
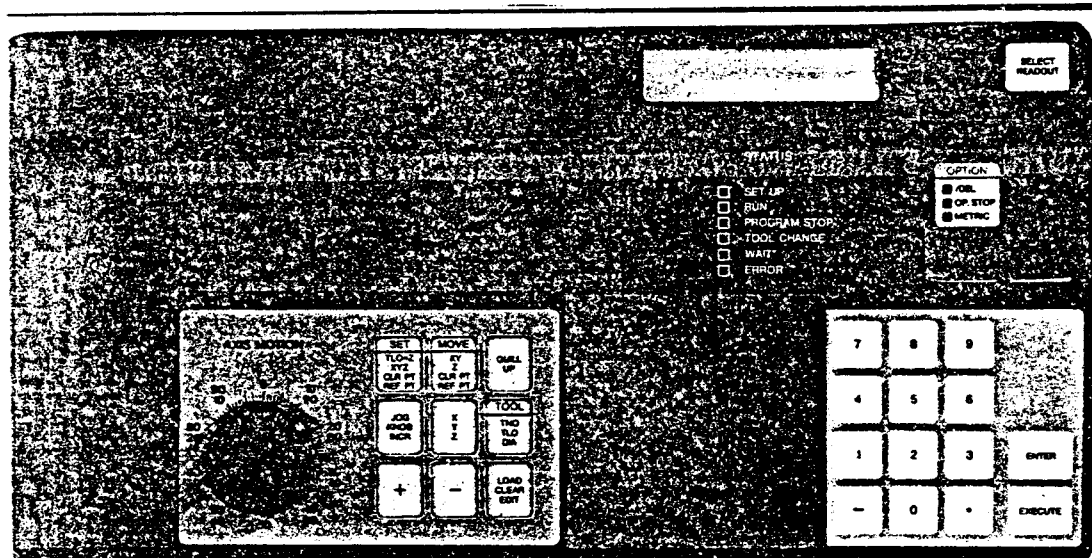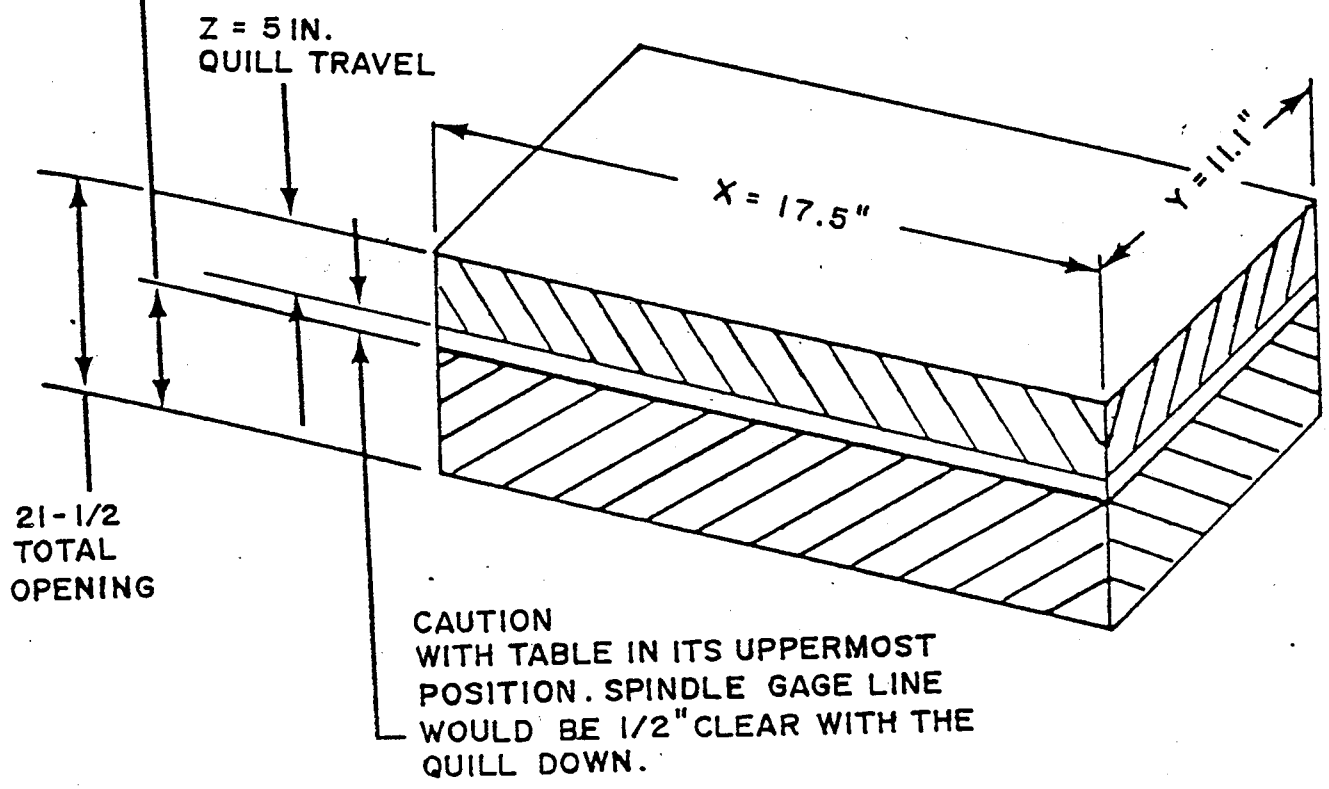
Figure 4-1: Set Up Mode Keys

4.2   MACHINE COORDINATE SYSTEM

The R2E3 control contains an internal, absolute reference system (machine coordinates) that continually tracks each axis position with respect to the Home position of the machine axes, see Figure 4-2.   The operator may establish a Reference Point, based on the part to be machined, which is expressed in these absolute coordinates.

For convenience in programming, a part program zero point can also be designated where all X and Y axes moves will provide convenience for the programmer or operator. This is a separate and independent coordinate system which can be set manually by the operator through the SET XYZ function, see Section 4.5.2.

ADJUSTMENT OF KNEE

Z = 5 IN.
QUILL TRAVEL

X = 17.5"

Y = 11.1"

21-1/2
TOTAL
OPENING

CAUTION
WITH TABLE IN ITS UPPERMOST
POSITION. SPINDLE GAGE LINE
WOULD BE 1/2"CLEAR WITH THE
QUILL DOWN.

TOTAL MACHINE TRAVEL ENVELOPE

MACHINE COORDINATE DISPLAY
X = 8.75, Y = 5.55

42"

4-3/8"

8-3/4"

5.55"

12-1/2 " WORKING
SURFACE

MACHINE COORDINATE
"HOME" POSITION
X & Y AXIS ZERO POINT
(BOSS PROVIDED FOR
BORED HOLE BY CUSTOMER)

8.75"
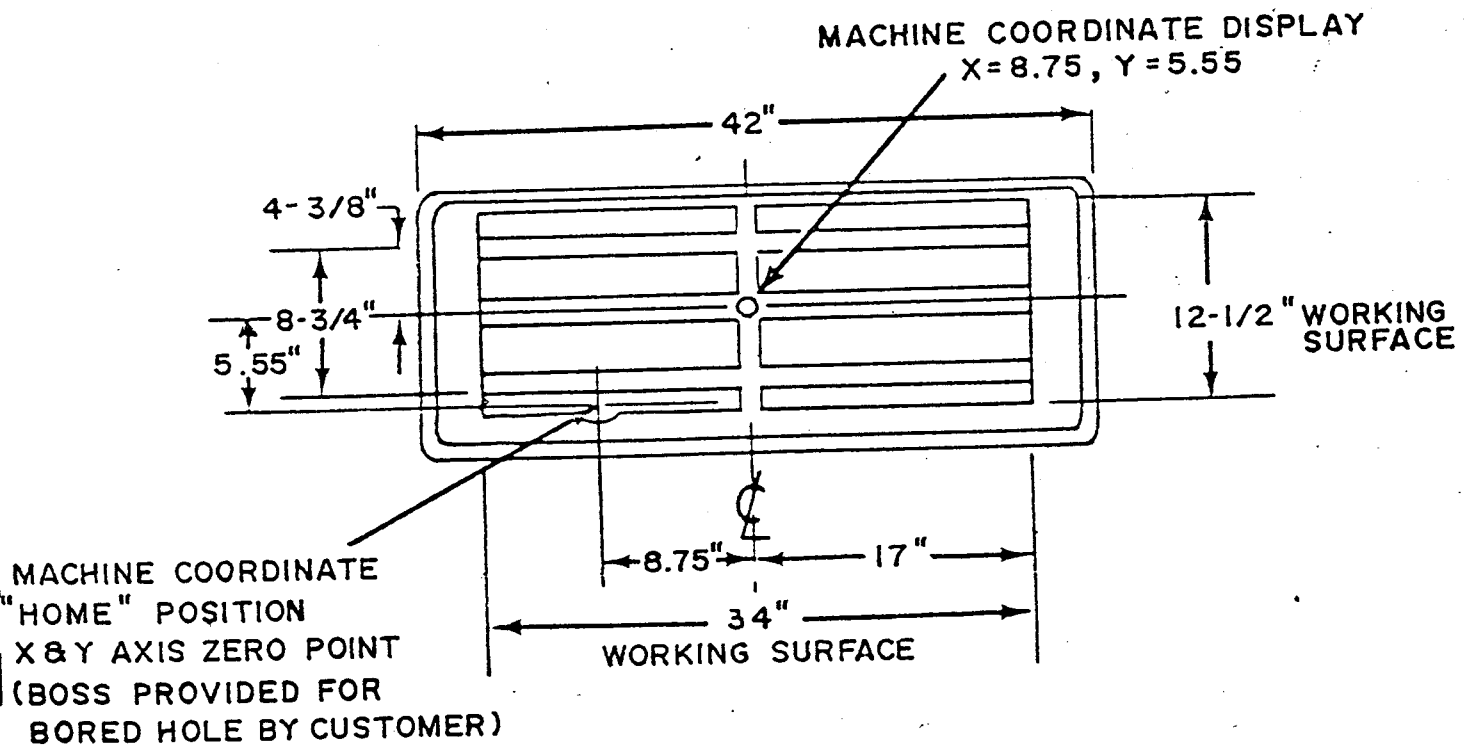
17"

34"

WORKING SURFACE

Figure 4-2: Machine Coordinate System

The Clearance Point, can be used during the tool change operation. This is an arbitrary point, established by the operator, which will allow adequate clearance during the tool change.

The X and Y Reference Point and the Clearance Point are expressed in the machine absolute coordinate system. The part program zero point will be expressed in its own independent coordinates. The use of the two reference systems has two useful advantages.

1. It allows the part program to be written in convenient coordinates of the programmers choice, regardless of the part being produced.

2. It provides a way to regain the part program zero if the workpiece is moved from its position in the fixture.

During part program execution, the X, Y, or Z coordinates displayed on the LCD will be in the part program coordinates. The machine coordinate values are shown only when SET REF PT, SET CLR PT and QUILL UP (and the corresponding designations in MOVE) are keyed in.

4.3 AXIS JOG

Pressing the JOG/KNOB/INCR key the first time will cause the following display:

```
-------------------------------------------------
|J O G                    X                      |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|X 9 . 0 0 0          Y 5 . 0 0 0                |
-------------------------------------------------
```

Pressing the "+" or "-" key will initiate continuous motion of the selected axis in the designated direction. The default condition for JOG is JOG, X axis, continuous motion. This will be the power up state, following system start up.

To select the JOG axis desired, press the X/Y/Z key; after each use the upper screen will read JOG X, Y or Z. When the SELECT READOUT key is pressed, it will alternately exhibit the X and Y, or the Z coordinate value(s) in the lower half of the screen.

Examples of the LCD screen displays are shown below:

With X axis selection

```
-----------------------------------------
|J O G                X                  |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|X 0 . 0 0 0 0        Y 0 . 0 0 0 0      |
-----------------------------------------
```

With Z axis selection

```
-----------------------------------------
|J O G                Z                  |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|                     Z 0 . 0 0 0 0      |
-----------------------------------------
```

To use the AXIS MOTION knob, motion independent of the "+" or "-" keys, press the JOG/KNOB/INCR key again and the screen will display JOG KNOB. The XYZ key will bring the desired axis to the screen. Axis motion will then be controlled by the knob. Full rotation of the knob will cause approximately 0.1 inch of motion in the axis and direction chosen. Positive approximate motion; X axis left, Y axis out, or Z axis up, is initiated by a clockwise rotation; complimentary motion is by the counterclockwise direction. There are 50 detent positions included in one full rotation of the knob; each detent position will provide approximately .002 inches of motion in the axis chosen.

If still greater precision of motion is required to position the axis, the third function, INCR, is pressed. This will enable the "+" or "-" keys again, making each key activation initiate 0.0001 inch of incremental motion in the desired direction. The key indicating desired direction must be pressed for each jog.

```
-----------------------------------------
|J O G   I N C R    Z                    |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|                     Z 0 . 0 0 0 0      |
-----------------------------------------
```

4.4   ENTERING TOOL DATA

Specific tool lengths and diameters must be entered for the tools selected to machine a part. The following information is needed for tool data.

1. Tool Length Offset (TLO) values - maximum entry is 6.5536 in. (166.46mm)

2. Tool Diameter (DIA) values - maximum entry is +/-3.2768 in. (8323mm)

The data stored in the R2E3 tool buffers is nonvolatile, it will be retained in memory (approx 1 year) with the power off. New tool data may be entered through statements preceeding program execution via part program. Old tool data may be updated in Set Up mode by manually overwriting the old entries.

NOTE

The control memory will retain the last value entered manually, but can not be over written by different values embedded in the part program when it is executed.

4.4.1 Manual Knee Adjustment

It is necessary to have adequate clearance between the tool and the workpiece for tool changes. Minimum clearance for a tool change requires in excess of 2 11/16 inches, the length of the portion of the tool holder which inserts into the spindle. The height of the knee should be adjusted using the longest programmed tool.

1. Place the longest tool in the machine and clamp the work piece to the table.

2. Return quill to the Home position, then set the Z axis to an arbitrary but convenient distance, for example; 0.5 inches.

3. Crank knee upward until tip of the tool just touches, not penetrates the work piece. If the height of the work piece above the table plus the preset 0.5 inches equals at least 2 3/4 inches, the knee height will provide adequate clearance for tool changes. Such tool change position perhaps the CLEAR POINT would be located off the work piece and fixture to obtain that clearance.

4.4.2 TLO Input

TLOs are entered through TLO = Z on the SET key, TOOL key or
through part programs.

SET Key

Use the SET key when TLO value for the tool has not been
premeasured and it is necessary to use the machine coordinate
system to determine the offset.

When the SET key is pressed once, the screen will display TLO = Z
in the upper left of the screen with the current value for the
tool number shown in the lower right.

```
-------------------------------------------
|S E T    T L O = Z     E X E C            |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|T    0 1            M Z    0 1 . 0 0 0 0|
-------------------------------------------
```

To bring another tool number to the screen, you must use the TOOL
key.   Each time TOOL is pressed, screen will scroll through each
of the 24 numbers.

Insert the longest tool into the machine and clamp the work piece
to the table in the desired location. Using the incremental Jog,
move the quill (Z axis) so that the tip of the tool just touches
the "Z" zero usually the top of the work piece.

Insert the next tool in the machine and key in the correct tool
number. With incremental jog, move the Z axis until the top just
touches the top of the workpiece, or "Z" zero point, and press
EXECUTE.   Continue until all TLO values have been determined for
each tool programmed.

To display a specific tool number from the 24 carried in the tool
buffer, use the TOOL key and either of two techniques to select
the desired number:

1. Enter the tool number desired, then press ENTER. Return
    to SET TLO = Z to finish entering the offset value for
    that tool.

2. Continued activation of TOOL will cause the display to
    scroll through each tool number. EXECUTE will load that
    number into the active buffer. Return to SET TLO = Z
    and the selected tool will appear in the display.

NOTE

The Z display exhibits the distance from the Z mechanical
Reference Point (Home), not part program coordinates.

TOOL Key

The TOOL key can be used when tool lengths have been premeasured,
see Figure 4-3. This will allow you to enter TLO values, as well
as tool diameters directly into the tool buffer by keying in the
values using the Keypad.

Pressing TOOL will scroll through the tool data table, from tool
number 1 through 24. ENTER loads the contents of the input field
(prompt in upper screen) into the lower screen display and
EXECUTE loads the contents into the tool table and brings up the
next tool number.

To load the tool buffer, press the TOOL key once to bring the
display TOOL T to the screen. The tool number is keyed in,
followed by ENTER, which brings the message TOOL TLO ·for the
keyed in tool number.

```
----------------------------------------------
|T O O L                T                     |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|T 0 1 /   1 . 2 5 0 0 / -   0 . 5 0 0 0|
----------------------------------------------
```

The same procedure will also allow the tool diameter (TOOL DIA)
to be entered. Pressing EXECUTE will introduce these values to
the data buffer and return the screen display to TOOL T so that
different tool numbers and their values can be entered. Pressing
ENTER without keying in numeric data will generate a null, no
change will take place and the screen display will advance to the
next field.

Entering a T value will set the input tool number as the current,
active tool and the screen will display the TLO/DIA values for
that tool. CE, CLEAR ENTRY key, pressed once, will delete the
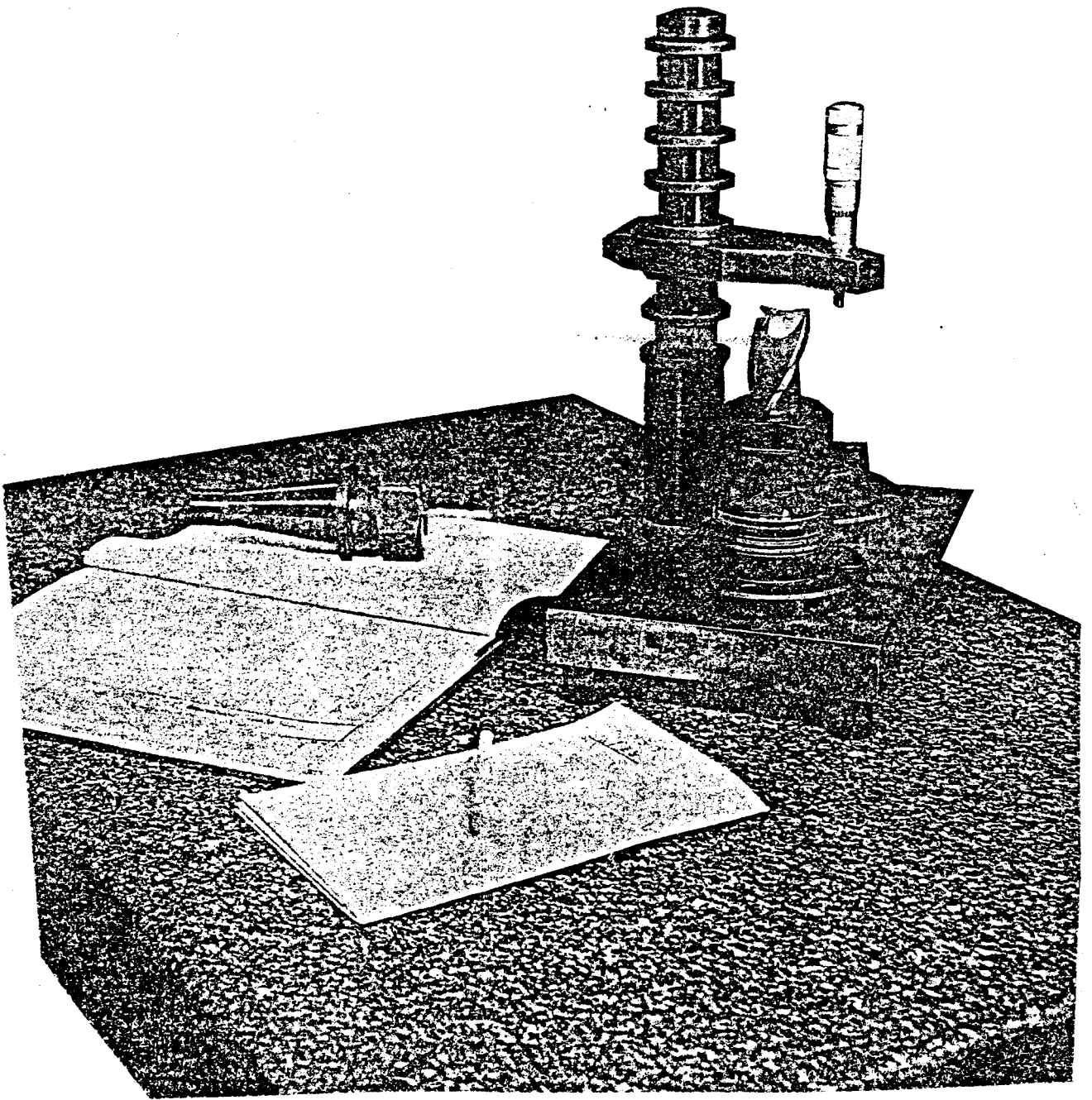last numeric character entered. Pressed twice it will delete the
entire input field.

Figure 4-3: Preset TLO Measurement

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Programming

New TLO values can be entered by defining their values in the the
part program. When TLOs are entered this way, the values are not
moved into the tool tables until the block in which the TLO data
is defined is executed. Note that if a TLO, other than zero,
already exists for a particular tool it will not be overwritten
by TLOs contained in the part program.

4.4.3 Tool Diameters

Tool diameters are entered two ways, with the TOOL key or through
the part program. This is the same as described for TOOL TLO.

When the tool diameter(s) are not the same as those called for by
the part program, Cutter Diameter Compensation must be used.

4.4.4 Cutter Diameter Compensation

Differences in tool diameter are due to wear during use and to
losses during regrinding. When a tool diameter is less than the
one called for in the part program, the operator must compensate
for that difference. Provision to automatically calculate a new
tool pathway, based on those differences, is embedded in the BOSS
8 I firmware.

    1.   Calculation of compensation value

        The compensation value to be entered is the difference
        of the programmed diameter and the actual diameter.

        Example:

            Programmed Cutter = .500" Dia. End Mill
            Actual Cutter   = .485" Dia. End Mill

                .485" Actual
              -.500" Programmed

              -.015" Dia.

        Compensation entered is: -.015"

    If the actual cutter is smaller than that programmed,
    the input value is _always_ negative. If a larger cutter
    than that programmed was used, the compensation value
    will always be positive.

2.   Entry in Set Up mode

   o   Enter Set Up mode and press the TOOL key,
       conformation is on the LCD screen.

   o   Continue to press the TOOL key until the tool number
       desired appears on the screen, upper line.

   o   Press ENTER to scroll through TLO and DIA.

   o   Key in compensation value from numbers in the yellow
       section on the Keypad.

   o   Press EXECUTE to insert value into the tool buffer.

3.   Entry in part program

   Cutter Diameter Compensation values may be programmed at
   the beginning of the program text, or embedded in the
   program using the Tn/d command. These values will be
   activated when cutter compensation is turned on by a G41
   or G42 function.

   Example:

            T1//.5   - Tool #1 .5"   Compensation
            T2//.25   - Tool #2 .25"   Compensation
            T3//.187 - Tool #3 .187"   Compensation

Note that if a cutter diameter already exists for a particular
tool, it will be overwritten by cutter diameters contained in the
part program.

The BOSS 8 I Control for Cutter Diameter Compensation computes
new points for the tool, ahead of the currently programmed tool
motion. Such points generate new blocks of data internally
within the control. This data is dependent upon the stored
program text containing the preparatory functions and the use of
stored values of compensation.

4.5   SETTING REFERENCE POINTS

Reference coordinates are tracked by two separate registers,
depending on the reference system chosen. Table 4-1 summarizes
the Reference Points and their applicable tracking registers.

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REFERENCE POINT	TRACKING REGISTER	AXES INVOLVED
1. Machine	Machine Coord	Z Home, XY to Home
2. Reference	Machine Coord	Z Home, XY to Position
3. Part Program	Part Program	XYZ
4. Clearance	Machine Coord	Z Home, XY to Position

Table 4-1: Reference Points and Tracking Registers

NOTE

When setting the various reference points before running
a part program, it is important to begin with the machine
Home operation then follow the order shown in Table 4-1.
This is only necessary if the operator desires to set a
new reference point.

4.5.1 Reference Point

The Reference Point will provide absolute coordinate values
relative to the machine coordinate zero points (Home site for
each axis). Use JOG to move the axes to a convenient location;
a bore, dowel pin or other location edge. EXECUTE will load the
values from the absolute coordinate registers to the machine
Reference Point register.

Reference Point will allow a return to an important location on
the fixture or the work piece to determine whether it has moved
from its originally clamped position.

```
------------------------------------------------
|S E T   R E F P T   X                         |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|X 9 . 5             Y 6 . 0                    |
------------------------------------------------
```

SET REF PT allows you to define a convenient point in the machine
coordinate system from which indicator devices can be used to
pick up the part program coordinate system. The use of the REF
PT setting is optional. If this feature is used the CLR PT and
part program zero are set to the machine coordinate zero (X,Y
axis home). The following sequence should be used with REF PT.

1.   Reference Point

2.   Part Program Zero Point

3.   Clearance Point

NOTE

Important

Failure to set the machine Reference Point first will
result in loss of the XY offset values (Part Program
Zero) and the Clearance Point values.

4.5.2 Part Program Zero (SET XYZ)

Use JOG to place the X, Y and Z axes at the part program zero
point.   (The   Z   axis will be determined relative to the longest
tool and, usually, the lowest depth for that tool, the most
negative Z axis position.) When axes are in position, key in SET
XYZ with the SET key.

```
-------------------------------------------
|S E T   X Y Z        X                    |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|X 1 . 5 0 0 0        Y 4 . 0 0 0 0        |
-------------------------------------------
```

The operator has the choice of. assigning any coordinate value to
each axis by keying in the numbers as the appropriate axis prompt
appears on the upper portion of the screen. During execution of
the program, the axis coordinates which appear in the screen will
reflect the coordinates from part programming zero.

NOTE

QUILL UP or M6 cancels the SET Z and automatically loads
the TLO from the tool table.

4.5.3 Clearance Point

Use QUILL UP to move the Z axis to the Home position. Then jog the X and Y axes to any convenient point away from the work piece where other operations can take place eg. program stop or tool change.   Enter SET CLR PT and press EXECUTE to load the X and Y coordinates as the CLR PT coordinates.

```
-------------------------------------------
|S E T    C L R P T      E X E C            |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-| .
|M X 1 . 7 5 0 0          Y 3 . 2 5 0 0     |
-------------------------------------------
```

4.6 MOVE OPERATION

When MOVE is pressed, the screen will read MOVE XY and the coordinate value of X is keyed in;   ENTER will load the contents of the X value into a buffer and advance the entry field to the Y axis.   When Y is entered, EXECUTE will initiate axis motion in the XY plane. MOVE Z will do the same in the Z axis, EXECUTE will initiate motion.

```
-------------------------------------------
|M O V   X Y          X                     |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|X 1 . 7 5 0 0        Y 0 . 3 7 5 0 0       |
-------------------------------------------
```

```
-------------------------------------------
|M O V   Z            Z                     |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|                     Z 0 . 7 5 0 0         |
-------------------------------------------
```

When MOVE CLR PT is pressed, the upper screen will display the coordinates of the previously established Clearance Point;   the current position is shown in the lower screen.   EXECUTE will initiate motion and move the quill to the Home position and the axes to the CLR PT.

```
-------------------------------------------
|C X 4 . 3 7 5 0    Y 2 . 0 0 0 0           |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|M X 1 . 7 5 0 0    Y 0 . 2 5 0 0           |
-------------------------------------------
```

When MOVE REF PT is pressed, the absolute coordinates of the current position are displayed on the lower part of the screen. The previously stored coordinates for Reference Point will appear in the upper screen.   EXECUTE will move the axes to the REF PT.

A Z axis move up (+Z) will occur before the X, and Y axes move.

```
-------------------------------------------
|R X 4 . 3 7 5 0    Y 2 . 0 0 0 0          |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|M X 1 . 7 5 0 0    Y 0 . 2 5 0 0          |
-------------------------------------------
```

4.7 LOADING PART PROGRAMS

Part programs can be loaded by any one of the following:

1. Teletypewriter

2. Paper tape

3. EZ-FILE

4. Remote computer console

5. EZ-CAM

4.7.1 Baud Rate

It is first necessary to set the transmit/receive baud rate within the control to match the peripheral equipment. Scroll the OPTION key to display the baud selection. In this selection, the screen will show:

```
-------------------------------------------
|O P T   B A U D     [ A ]                 |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|[ A ] 3 0 0      [ B ] 9 6 0 0            |
-------------------------------------------
```

The initial values displayed will be the current setting. Keying in another baud rate, followed by ENTER, will store the new rate for Port A and enable the baud rate for Port B to be entered. EXECUTE will initiate action with this newly entered rate. The baud rates available in this system are 110, 300, 600, 1200, 2400, 4800 and 9600.

NOTE

If any other baud rates are attempted, the system will maintain the existing rate.

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4.7.2 Input From Peripheral Equipment

After setting baud rates loading from peripheral devices will be through the LOAD/CLEAR/EDIT key, the screen display, and the plug connectors located on the left side of the Power Equipment Enclosure.
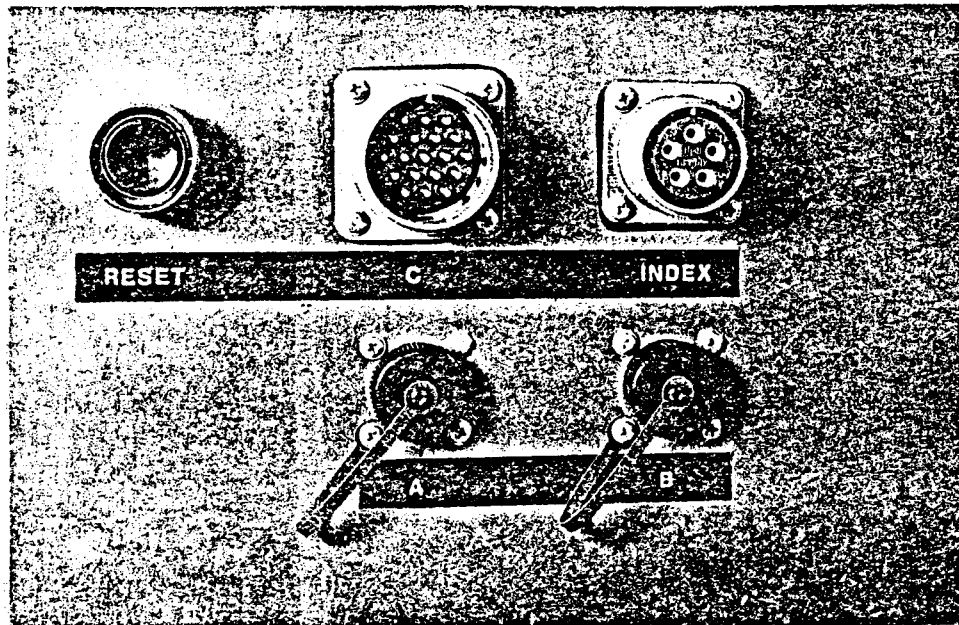

Figure 4-4: Plug Connectors for Communications

PORT C shown in Figure 4-4, accepts the paper tape reader/loader option. This is done through the LOAD/CLEAR/EDIT key which will display the following message after pressing LOAD:

```
-----------------------------------------------
|L O A D                                        |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|0 P T R    1 D N C    2 R E M                  |
-----------------------------------------------
```

The lower screen provides the option of loading part program text through a paper tape reader, DNC LINK, or a remote communication device (REM). When "0", "1" or "2" is keyed in, EXECUTE will enable the chosen device. EXECUTE will enter the LOAD submode and a "*" prompt will appear at the extreme lower left portion of the screen.

```
-------------------------------------------------
|L O A D   P T R                                |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|*                                              |
-------------------------------------------------
```

If LOAD REM is selected, the screen will display:

```
-------------------------------------------------
|L O A D   R E M     :                          |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|O F R O M   R E M   1 T O   R E M              |
-------------------------------------------------
```

LOAD FROM REM loads a part program (per RS-491-II protocol) into the R2E3 text memory from Port B. LOAD TO REM reads the program currently stored in the R2E3 text memory out to the remote storage device.

LOAD FROM REM with program number loads the specified program into R2E3 text memory from the EZ-FILE, EZ-CAM or any Host computer that supports the EZ-LINK protocol. At the end of LOAD, the LCD display will show the following:

```
-------------------------------------------------
|L O A D E D :          C H A R   8 2 5         |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|N 1 G 0 0 G 9 0 X 4 . Y 4 . T 1 M 0 6          |
-------------------------------------------------
```

1. The upper screen will show the total number of characters present. The system is capable of storing up to 12000 characters in the text buffers.

2. The lower screen will exhibit the first block of data in the loaded program; up to 20 characters.

To abort LOAD in progress, press the LOAD/CLEAR/EDIT key. This will set the system to CLEAR and terminate the LOAD program.

NOTE

All new data is loaded at the end of previously stored data.

The DNC LINK is designated primarily to allow the R2E3 to execute part programs longer than 100 feet in length, the maximum storage space in the text memory. The program is run with the remote device (EZ-CAM or EZ-FILE) acting as the excess storage space. DNC OFF is the default condition.

Part programs can also be loaded from a teletypewriter through the Editor. This uses the Port A receptacle at the lower left, Figure 4-4, while the LOAD/CLEAR/EDIT key is pressed 3 times to bring the following screen display:

```
---------------------------------------------
|E D I T                                      |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|*                                            |
---------------------------------------------
```

The system is now in the EDIT mode, refer to Chapter 5 for instruction in editing.

4.8   CLEARING DATA

To clear out various data or text in memory the LOAD/CLEAR/EDIT key is pressed 2 times followed by EXECUTE. The screen will diplay:

```
---------------------------------------------
|C L E A R                                    |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|0 R U N        1 P R G M        2 T O O L    |
---------------------------------------------
```

When "0", "1", or "2" is entered, EXECUTE will bring about the following action.

0 CLEAR RUN clears out the part program run buffer and any data entered in the system run registers. It also aborts DNC link.

1 CLEAR PRGM clears out the part program text area. The following will be displayed:

```
---------------------------------------------
|C L E A R                                    |
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|0 A L L   1 M A C             < P R G M >|
---------------------------------------------
```

   o   CLEAR PRGM ALL ("0") clears out the entire part program text area.

   o   CLEAR MAC ("1") clears out the macro library (all part program text up to the first designated program number).

   o   PRGM NUM - When a number of up to 5 digits (other than the single digits 1 or 0) is entered after the prompt in the upper screen, the figure is interpreted as a part

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program number. The R2E3 will search for this number, and if found, will delete that program from memory.

2 CLEAR TOOL clears out the tool data table.

4.9 EDITING

Editing is possible while in Set Up mode and is used to insert, modify or delete blocks of part programs in the run buffer. This is entered by pressing the LOAD/CLEAR/EDIT key three times.

Using the EDIT key, a local console with an alphanumeric keyboard is used to modify, locate or insert part program text. It is entered by pressing EXECUTE. The display will exhibit a "*" indicating EDIT is active.

```
-------------------------------------------
|E D I T                      C H A R   8 2 5|
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
|*                                           |
-------------------------------------------
```

The screen will also display the number of characters in the part program text area.

NOTES

1. If EDIT was entered it can be exited by pressing the LOAD/CLEAR/EDIT key again. (This is a useful feature when EDIT has been entered inadvertently.)

2. At the end of EDIT, the "*" prompt character will disappear indicating EDIT is no longer active.

A more detailed explaination of EDIT is presented in Chapter 5.