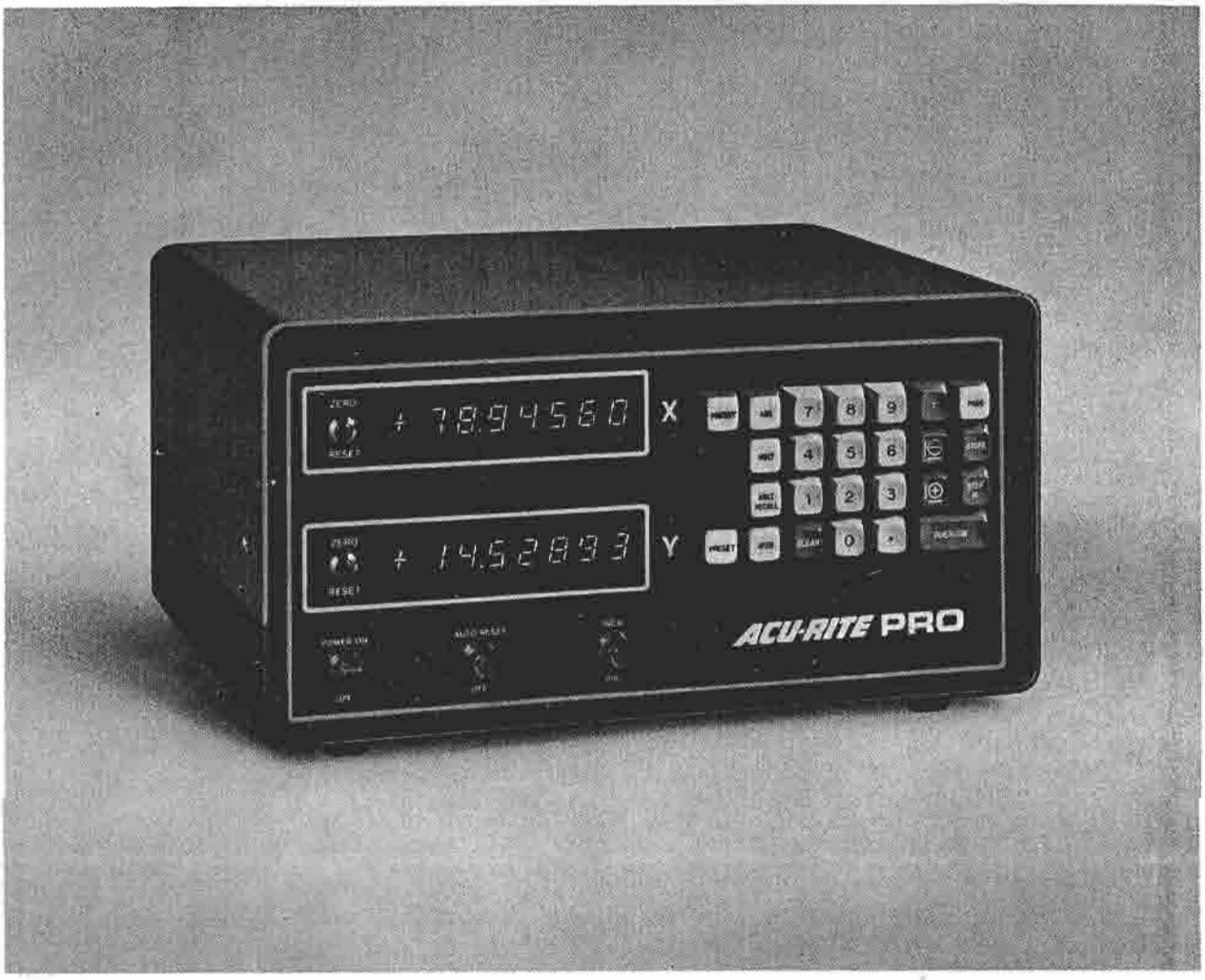
ACU-RITE
INCORPORATED

ACU-RITE PRO®

PROGRAMMABLE DIGITAL MEASURING SYSTEM



OPERATOR'S MANUAL

WARRANTY

ACU-RITE® INCORPORATED warrants ACU-RITE digital measuring systems against defects in material and workmanship for a period of 12 months from date of purchase.

This warranty covers all parts and applies only to equipment which has been installed and operated in accordance with instructions in the operator's manual, has not been tampered with in any way, misused, suffered damage through accident, neglect, or conditions beyond ACU-RITE® INCORPORATED's control, and has been serviced only by authorized ACU-RITE® INCORPORATED distributors or ACU-RITE® INCORPORATED service personnel.

ACU-RITE® INCORPORATED is not responsible for loss in operating performance due to environmental conditions.

There are no other warranties expressed or implied, and ACU-RITE® INCORPORATED shall not be liable under any circumstances for consequential damages.

BEFORE UNPACKING YOUR SYSTEM

The ACU-RITE PRO has been designed and tested to exacting specifications to provide years of trouble-free service. If you experience any problems with your system, notify the authorized ACU-RITE distributor from whom it was purchased. Please unpack your system carefully, and check the items received against those listed on the packing slip. Be sure the items are what you ordered. For your future warranty service or ordering reference, please record the following information in the spaces provided:

ACU-RITE PRO Serial No. _____

Scale Assembly(ies) _____

Model _____ Serial No. _____

Model _____ Serial No. _____

Model _____ Serial No. _____

Date of Purchase _____

ACU-RITE Distributor _____

Distributor Address _____

Distributor Telephone _____

NOTE

Please complete and return the prepaid warranty card that accompanies your PRO. This is to ensure that ACU-RITE® INCORPORATED has a date-of-purchase record for your system.

WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

CONTENTS

SECTION I
GENERAL

1.1. THE PRO SYSTEM

The ACU-RITE PRO digital measuring system consists of the PRO programmable digital readout and as many as three glass linear measuring scales. Designed and manufactured by ACU-RITE® INCORPORATED, the system is an accessory installed on machine tools to accurately measure the travel of moving members of the machine. Movements as fine as .000050"(.001mm) are detected by the scales and shown on the digital display of the readout. PRO not only shows you where you are in a machining operation, but with its programmability, it can show you where you are going and how to get there, precisely.

1.2. HOW TO USE THIS MANUAL

This manual contains complete instructions for programmming and operating the ACU-RITE PRO. Sections are in a sequence intended to guide and ease your learning progress. There are examples to demonstrate how all of the PRO's features are used in common machining operations.

Installation procedures for the console and system checkout techniques are contained in Section 6. For installation of scale assemblies (A-R/5 or Mini-Scale) see the appropriate scale installation manual.

It is recommended that you have an ACU-RITE PRO or the control panel layout (Figure 2-1) in front of you while reading this manual. Read Section 1 to become familiar with terms which are used throughout. Next, Section 2, Control Panel Description and Use, will familiarize you with the control keys and how to operate them in sequence for particular operations.

The sequence in which you machine a workpiece is actually the order in which you program the PRO. To eliminate confusion and error, and to simplify programming, the sequence of machining operations is recorded on a PROgram Chart, discussed in Section 3, PROgram Chart Preparation. Figures 3-1 and 3-2 are examples of a workpiece drawing and the resulting preparation of the PROgram Chart.

Once the PROgram Chart is prepared, review Section 4, Programming the PRO; then you can go directly to the Operational Keying Sequence which gives you the keying sequence to enter information from the PROgram Chart into the PRO memory. To practice a keying sequence you may wish to enter the data on the chart in Figure 3-2.

If further explanation on how to use the control features is desired, Section 5, Programming and Operation by Example, provides a guide for more thorough understanding with example machining operations and how to program for them.

Section 7, Machine Error Compensation, describes what machine geometry errors are, and how to determine and correct them, plus how to use the system to calibrate a machine tool. Functions of internal switches are also described. Section 8, Maintenance, describes the nature of system problems and how to correct them using the System Troubleshooting Table 8-1.

Refer to the table of contents for locating specific procedures. You will not find information on electronic parts replacement or repair in this manual. In case of malfunctions in the electronic network that cannot be remedied using the troubleshooting guide in Table 8-1, contact your ACU-RITE distributor.

1.3. HOW THE PRO WORKS

The PRO utilizes the latest developments in microprocessor electronics. Its memory accepts up to 166 machining operations per axis for a 2-axis counter (125 per axis for a 3-axis counter). A battery backup retains programmed information in memory for about 200 hours while the PRO is off. The battery automatically recharges when the PRO is on.

Each machining operation on the workpiece is identified by a unique step number and dimensional information, both of which are programmed into the PRO memory. While machining, the operator determines the position (or target point, see 3.1.2) to which the machine will be moved. The PRO determines the machine tool's present location and the target point, then calculates and displays the distance the machine must move to reach the target point. When the operator moves the machine the correct distance, the display reads zero.

Measured information is obtained from an ACU-RITE® INCORPORATED glass scale assembly installed on your machine tool in either two or three axes (see appropriate scale installation manual for A-R/5 or Mini-Scale). Together, the PRO and the scale become a system, and the resolution of the system is determined by the model(s) of scales selected: A-R/5 for .0005" and.01mm resolution; and Mini-Scale for .0005, .00025, .0001, .00005, .01mm, .005mm, .002mm, and .001mm. PRO is compatible with all ACU-RITE® INCORPORATED scales, old and new.

Additional conveniences add to the PRO's versatility. Some examples follow:

a. Indicates tool changes at particular steps;
b. Compensates for cutter offsets;

c. Programmable while machining a workpiece;
d. Compensates for shrinkage or expansion factors;
e. Includes software for simple programming;
f. Also useable as a normal incremental/absolute measuring system.

1.4. FEATURE SUMMARY

Below is a listing of the PRO's standard operating features. Though more detailed descriptions and uses of these features follow in this manual, you should familiarize yourself with this list of terms.

- Multiple memory - a. 166-step memory per axis for 2-axis counter.
  b. 125-step memory per axis for 3-axis counter.
- 200-hour power-off battery backup for memory - Allows programs to be retained up to eight days with power off. Provides protection against power emergencies.
- Program step addition and deletion - Saves time when editing a program. Eliminates the need to reprogram major segments when modifying the program. (Refer to paragraphs 4.9.1.d and 5.8.)
- Transfer programming - Permits programming while you machine the first piece. (Refer to paragraphs 4.9.1.m and 5.7.)
- Non-sequential step recall - Permits machining in any order regardless of the order in which machining operations have been programmed (exclusive of tool offsets).
- Electronic diagnostic routine - Provides a functional analysis of the PRO's microprocessor electronics and operating controls. (Refer to paragraphs 4.3 and 4.9.2.a.)
- Reference points - Permit programming with dimensions which do not have to be measured (referenced) point-to-point or from the zero point. Reference points can be any point previous to the step you're on. (Refer to paragraph 4.9.1.c.)
- Lighted keys - Indicate important operations which are in current use, reducing possibility of errors.
- Multiplier - Allows use of shrinkage or expansion factor for mold or die work, or when machining a part to scale. (Refer to paragraphs 4.9.1.j and 5.5.)
- Tool programming - Indicates tool changes on the display. Up to 99 tool numbers can be programmed for use. (Refer to paragraphs 4.9.1.h and 5.3.)
- Tool offset - Uses tool diameter information in the memory to calculate and store offsets at machining locations. (Refer to paragraphs 4.9.1.g and 5.4.)
- Mirror-image (reverse) machining - Provides capability of machining the reverse side of a workpiece or two mating halves from one program. (Refer to paragraphs 4.9.1.l and 5.6.)
- Automatic program recycling - Causes the PRO to restart at the first programmed step after completion of the last step.
- End-of-program display - Uniquely indicates completion of a program cycle. (Refer to paragraph 4.9.1.f.)
- Easy-to-use front control panel - Reduces operator errors in keying and visual interpretation. (Refer to Section 2.)
- Plus all features of the ACU-RITE III standard digital readout, including:

  a. Inch-metric conversion
  b. Incremental measurement
  c. Absolute measurement
  d. Error compensation
  e. Diameter readout
  f. Preset (lighted key)
  g. Auto reset: for use with specially-marked scales that produce an output pulse automatically zero resetting
  h. Floating zero reset
  i. Glare-free, easy-to-read display
  j. Easy to repair modular layout
  k. Fault indicator
  l. Durable quality construction
  m. Warranty (1-year parts and labor)

SECTION 2
CONTROL PANEL
DESCRIPTION AND USE

2.1. PANEL LAYOUT AND FEATURES

Figure 2-1 is a drawing of the PRO's control panel. Its keys are easy to use and the LED display format is easy to read. When you familiarize yourself with the panel layout, programming and operation will be much simpler to learn.

Table 2-1 lists the features and functions of the control panel, and includes programming/operating notes. Read this table carefully and completely to a point of understanding. This section also provides status examples of the display format for various operations. These will become familiar as you deepen your knowledge of programming and operating the PRO. At the end of this section, you'll find a thorough description of the auto reset feature with a procedure for its use.

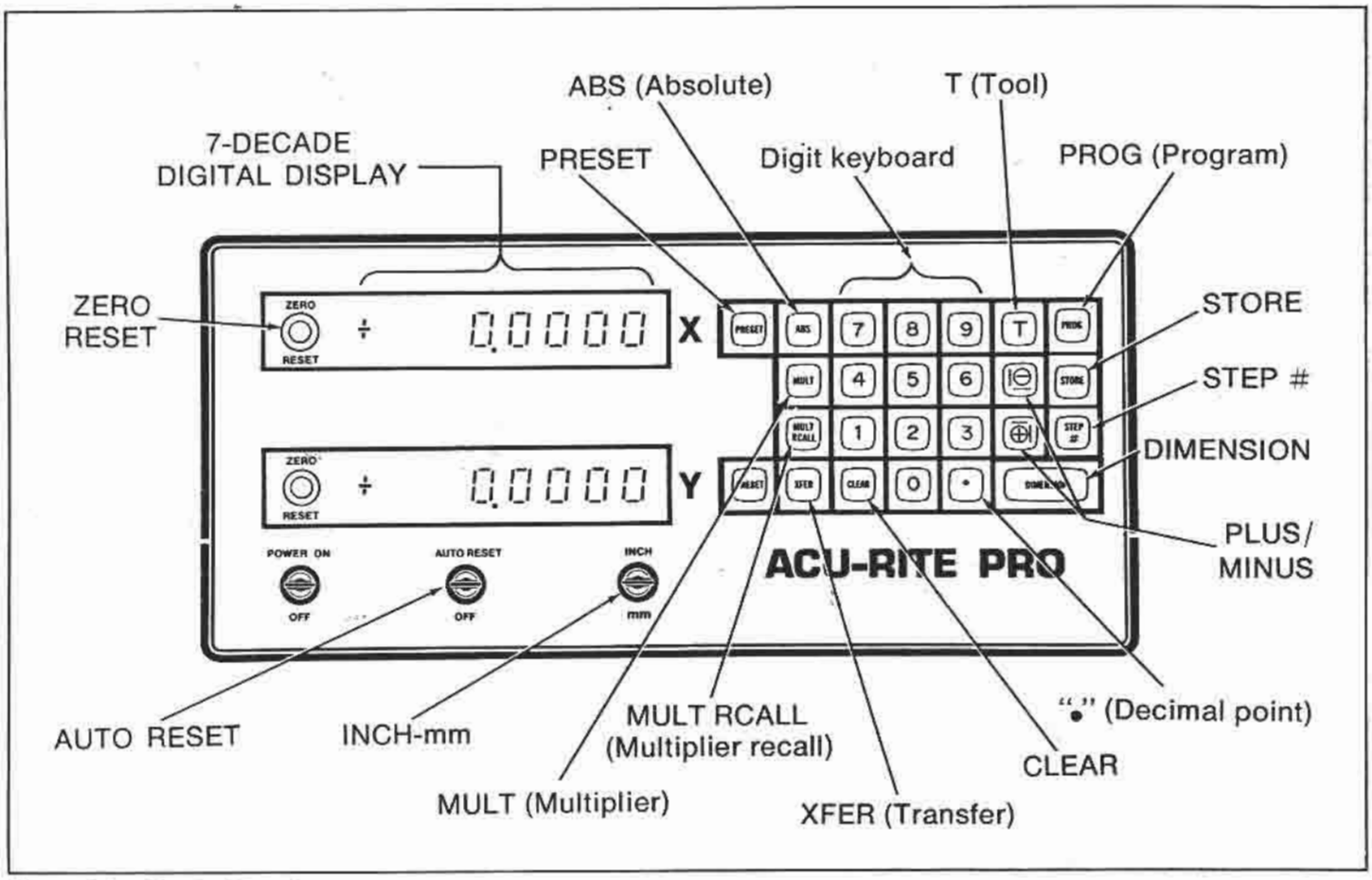


Figure 2-1. Control Panel

Table 2-1. Control Panel Key Functions

KEY/FEATURE	FUNCTION			PROGRAMMING AND OPERATING NOTES
	GENERAL	PROGRAM MODE (PROG KEY LIT)	RUN MODE (PROG KEY UNLIT)	
ABS key Incremental and absolute measurement modes.	Two separate distance measurement memories keep track of distance which the machine tool moves. The incremental mode (ABS key unlit) shows the point-to-point measurement since the display was last reset to zero. The absolute mode (ABS key lit) always shows the present distance of the tool from a pre-established zero datum point.	Both the incremental and absolute memories continue to simultaneously keep track of distance, even when other features are in use, and when something other than a measured distance is shown on the display.		To use the absolute mode: 1) select a zero point for the workpiece; 2) move the machine tool to that point, 3) press the ABS key so that it is lit, 4) then press the ZERO RESET button The absolute memory will now keep track of the machine tool's distance moved from that point. This distance will be shown if the ABS key is lit. Resetting the incremental distance memory to zero does not affect the absolute distance memory and vice versa.
ZERO RESET button Reset displays to zero.	One button for each axis sets distance measurement memory and display to zero. Used to separately zero the incremental (ABS key unlit) and absolute (ABS key lit) distance memories.	The incremental (ABS key unlit) and absolute (ABS key lit) memories can be set to zero in either mode when other features are in use, and even when the display is showing something other than a distance measurement.		To reset the incremental memory to zero, the ABS key must be unlit. To reset the absolute memory, the ABS key must be lit. Each memory must be reset separately. Resetting one memory does not affect the other.
INCH/mm switch Instant Inch-to-millimeter conversion.	Causes display to show all dimensions, measured and programmed, in either inches or millimeters.	Same in either mode. Both Metric and English measurements can be entered into memory for the same workpiece.	The position of the switch can be changed at any time during operation to show the dimension in either inches or millimeters. Changes preset memory also.	The LED display indicates English dimensions to four decimal places, and metric to three or two decimal places.

Table 2-1. Control Panel Key Functions (Cont'd)

KEY/FEATURE	FUNCTION			PROGRAMMING AND OPERATING NOTES
	GENERAL	PROGRAM MODE (PROG KEY LIT)	RUN MODE (PROG KEY UNLIT)	
PROG key Program mode/Run (operate) mode.	The PROG key can be lit or unlit. When lit, the system is in the Program mode and can be programmed. When the key is unlit, the system is in the Run mode and will not accept programming, except for tool diameter or multiplier.	Dimensions, tool numbers, tool offset sign, and step number/reference point are programmed in this mode. Also used for transfer programming from the first workpiece (see XFER below).	In the Run mode, the PRO determines programmed dimension information, programmed tool size/offset information, and distance measurement information; then calculates and displays the distance necessary to reach a desired point on the workpiece.	Display shows the distance to reach a desired point based upon where machine tool is currently located. Operator moves machine until display reads zero.
DIMENSION key Display of a programmed dimension or distance measurement.	Dimension refers to a distance. The key is used to display distance information. If a tool has been inserted at a particular step, it will be displayed the first time the DIMENSION key is pressed. Then the second time, the dimension is displayed.	Dimensions entered from drawing into the memory can be inspected using this key.	Display dimensions (in all axes) machine must move to reach a desired point. The operator determines and selects the target point, presses the DIMENSION key to show the distances to that point then moves the machine table until the displays read zero. (Target points may be selected in an order other than the one in which they were programmed, except when a tool offset is involved.)	In the Run mode, the PRO performs calculations internally to determine the distance to reach the next point. The calculation considers the present machine tool location, the target point, and the tool size and offset.
PRESET key		When lit, this key is used to enter a dimension, tool offset, tool diameter or multiplier into the display or into the memory.	Inactive	When the PRO is used in the standard digital readout mode (PROG key unlit, XFER key lit, PRESET keys unlit), the PRESET key can be used for tool offsets, to preset a position other than zero, or to display drawing dimensions so that operator works to zero.

Table 2-1. Control Panel Key Functions (Cont'd)

KEY/FEATURE	FUNCTION			PROGRAMMING AND OPERATING NOTES
	GENERAL	PROGRAM MODE (PROG KEY LIT)	RUN MODE (PROG KEY UNLIT)	
CLEAR key Clear digit keyboard and display.	Used with the PRESET key, with the MULT RCALL key and in the standard digital readout mode. CLEAR key causes the display to go blank except for a decimal point. Digits can then be entered into the display.	See General	Used to clear the preset memory (PRESET key lit) or multiplier memory (MULT RCALL lit).	Pressing CLEAR key affects neither the incremental nor absolute distance measurement memories.
STORE key Store information in memory.	Used when programming to store information in the PRO memory.	Used in the following procedures to store information in memory: clear memory, insert or delete step number, program/correct dimension, insert or delete tool numbers, transfer, insert end-of-program.	Inactive	4.9, Operational Keying Sequences, indicates when STORE key is used. NOTE: If the display shows a blinking a series of dots the program memory will be erased when the STORE key is pressed.
STEP#key Entry or display of step number.	Press this key to enter a step number, display current step number and reference point. Read detailed description in far column.	Pressing the STEP #key and then the desired digital key advances the PRO to that step number. The decimal key is pressed to inspect the reference point. Pressing the decimal key and then a digit key enters a new reference point number. Pressing the STEP #key repeatedly advances and displays the step number and reference point for inspection.	Used to select a desired step number. Does not permit changing reference points.	On the workpiece drawing, all points which are the beginning and end points of a machine tool movement should be numbered sequentially in the logical order that the machining is to take place (see Figure 3-1). Moving from one point to another is called a machining step. The number of the target point to which you are moving is the step number. That target point is dimensioned or measured relative to another lower-numbered point, called a reference point. The step numbers are used in the PRO to tag all information related to that step such as dimensions, tool diameters, and tool offset signs.

Table 2-1. Control Panel Key Functions (Cont'd)

KEY/FEATURE	FUNCTION			PROGRAMMING AND OPERATING NOTES
	GENERAL	PROGRAM MODE (PROG KEY LIT)	RUN MODE (PROG KEY UNLIT)	
				NOTE: For a particular step number, the dimensions for all axes must be measured (referenced) from the same reference point. Reference point number must be less than the step number.
Decimal point key Data entry and inspection.		Used to: 1. Enter reference point number. 2. Inspect reference point numbers. 3. Enter decimal when entering dimensions and tool diameters.	Used to: 1. Inspect reference point numbers following a step number recall. 2. Enter decimal when entering multiplier or presetting dimensions.	
T Key Tool number and tool offset programming.	Used to program tool number codes, tool diameters, and tool offset sign. Up to 99 tool numbers can be programmed, 9 with offsets (in addition to step data).	Used to: 1. Insert or remove tool number at appropriate step number (tool numbers 1-99) in either Program or Run mode. 2. Program tool numbers and tool diameters (tool numbers 1-9). 3. Program end of program (tool number 0). 4. Program tool offset sign.	Used to: Insert or remove tool number manually at appropriate step number (tool numbers 1-99) in either program or Run mode.	Once a tool number is inserted at a particular step number, the display will show the tool number when the DIMENSION key is pressed, reminding the operator to change a tool or perform some other activity. Pressing DIMENSION again will display the distance to the next target point. A tool diameter is shown for tool numbers 1-9. Only tools 1-9 can be used where an offset must be considered. Tool numbers 10-99 can be used to signify tools where an offset is not considered or for changes in operation such as turning on cutting fluid, lifting tool, etc.

Table 2-1 Control Panel Key Functions (Cont'd)

KEY/FEATURE	FUNCTION			PROGRAMMING AND OPERATING NOTES
	GENERAL	PROGRAM MODE (PROG KEY LIT)	RUN MODE (PROG KEY UNLIT)	
				Tool 0 is always inserted at the end of the program. Once a tool number has been inserted at a step number, the PRO assumes that the tool is used at all subsequent step numbers until another tool number is inserted.
Plus - minus keys To add or subtract.	(See P&O Notes also.) Used to: 1. Enter negative dimensions and multipliers. 2. Enter tool offset sign, both positive and negative. 3. Insert or delete a program step.	To program dimension sign or tool offset sign. Also to enter multiplier.	Multiplier can be entered into memory in the Run mode, also. A minus (-) multiplier is used for mirror image (reverse) programming.	PRO assumes dimensions and multipliers are positive (+) unless the minus (-) key is pressed.
XFER key Transfer programming and incremental/absolute operation.	1. Permits programming of PRO while machining. The PRO transfers distance measurements of tool location into memory. 2. Permits ACU-RITE PRO to be used as a standard ACU-RITE II DRO.	Transfer mode is activated when XFER key is lit.	PRO can be operated as standard digital readout (ACU-RITE II) when XFER key is lit.	
MULT key Multiplier for scaling (up or down).	Multiplier acts as expansion or shrink factor during machining.	Inactive	With MULT key lit, the machine tool movement is scaled to modify the dimension according to the multiplier stored in memory (see MULT (RCALL).	The operator moves the machine tool until the display indicates the dimension from the drawing. However, even though the display shows the dimension from the drawing, the machine tool has actually moved the distance of the multiplier factor times the drawing dimension. This feature is useful in mold work, die work, and in machining scaled pieces.

Table 2-1. Control Panel Key Functions (Cont'd)

KEY/FEATURE	FUNCTION			PROGRAMMING AND OPERATING NOTES
	GENERAL	PROGRAM MODE (PROG KEY LIT)	RUN MODE (PROG KEY UNLIT)	
MULT RCALL key Multiplier recall	For programming of the multiplier factor which is used when the MULT key is lit.	Inactive	MULT RCALL key (when lit) is used with the PRESET key (lit) to enter the multiplier (shrinkage or expansion factor, or mirror image multiplier) into memory.	See MULT above.
AUTO RESET switch Automatic zero reset (see also 2.3 Auto Reset Feature)	Used with scales having special reference (fiducial) marks that, when sensed by the reading head, generate a fiducial trigger output (FTO) pulse. This pulse resets the PRO to zero each time the table is moved across fiducial mark, located approximately 8 inches (200mm) apart.	Not applicable.	Auto reset is used in the Run mode only.	To reset the incremental distance memory, flip the switch to AUTO RESET, and move the machine tool past the fiducial mark on the scale while the PRO is in the incremental mode (ABS key unlit). To reset the absolute mode, the machine tool must pass over the scale mark again while the ABS key is lit (absolute mode).

2.2. DISPLAY STATUS EXAMPLES

Each axis display contains eight LEDs (light-emiting diodes) seven for digits and one for sign. In addition, each LED has a decimal point. There are ten different display conditions listed in Figure 2-2 that you will see in the course of operating the PRO. Positions of digits and decimal points are illustrated with each condition.

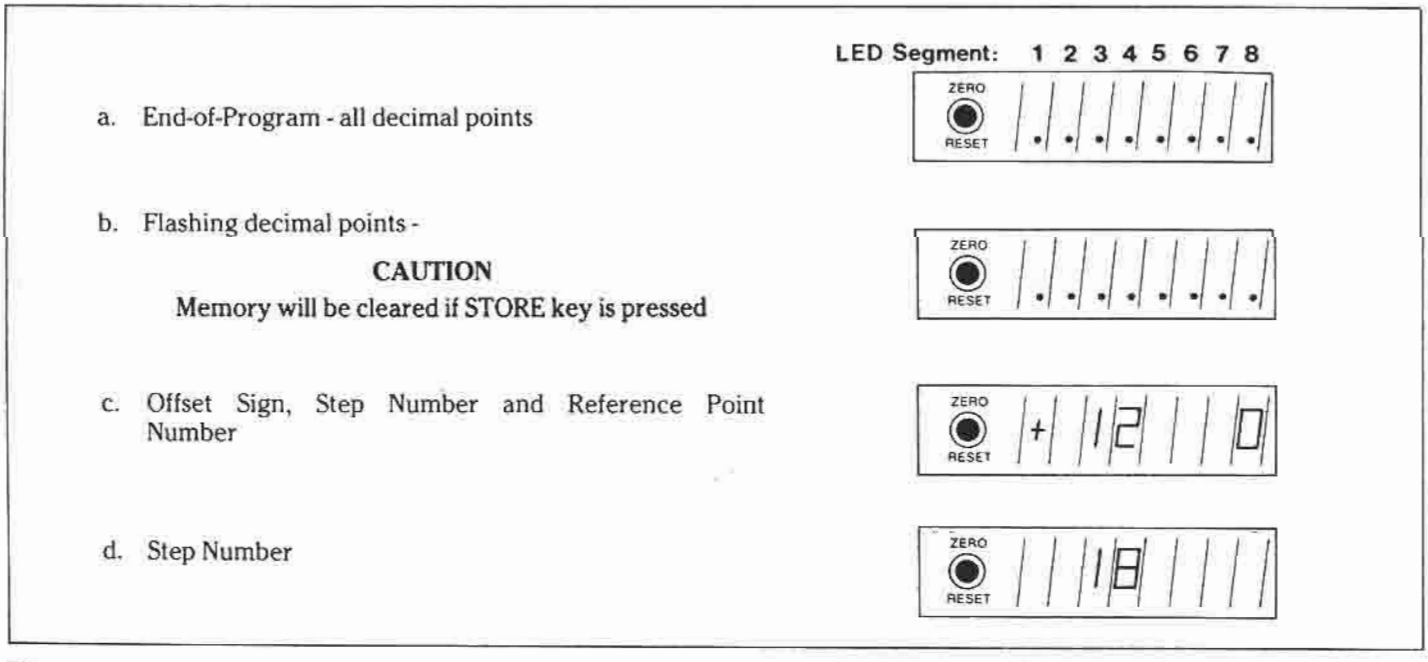


Figure 2.2. Display Status Examples

Figure 2.2. Display Status Examples (Cont'd)

e. Tool Mode

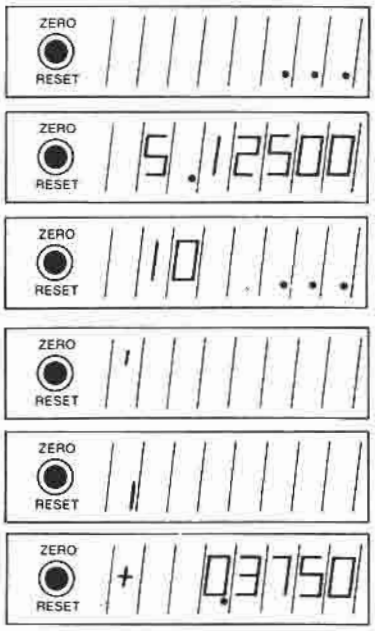
f. Tool Number (1-9) and Tool Diameter

g. Tool Number (10-99) without Tool Diameter

h. Fault Indicator - Lights when power is turned on or when power is interrupted, or when travel speed is excessive.

i. Auto Reset Trigger Indicator - Lights when mark on scale is passed, resetting system to zero.

j. Sign and Dimension



A flashing display can mean one of the following:

a. Memory will be cleared if STORE key is pressed (see item b above). Press the STEP#key if you do not wish to clear the memory.

b. Reference point number is equal or larger than step number. To correct, press STEP#key, enter step number, press DECIMAL key and enter the correct reference number (i.e., less than step number).

c. Step number is larger than memory capacity. Memory size is 166 for two-axis counter and 125 for three-axis counter. In this case, to stop the flashing, press STEP#key, then CLEAR key.

d. A step number being deleted is used as a reference point number for another step number. Press STEP#key to stop the flashing.

e. When flashing display contains a step number and a plus or minus sign, do not press STORE key unless you want that step number to be added to or deleted from memory. Otherwise, to stop flashing, press STEP#key.

2.3. AUTO RESET FEATURE

Auto reset is a convenience feature that establishes a permanent zero reference for your machine table travel. It's handy for either of the two following situations:

a. When machining identical production parts, using a fixture, auto reset provides a distance reference to your first machining operation so your location is exact each time. This saves time, eliminates positioning errors and also eliminates the need to use a surface of the part as a reference location.

b. On occasion, a part may have to be left on the machine overnight or through the weekend. Auto reset keeps you from losing your place. Simply move the table back to the closest zero location then move the known distance to your next machining location according to dimensions on your PROgram Chart.

Special marks are placed on the scale at approximately 8-inch (200mm) intervals, the first one being anywhere from 0" to 8" from the end of the glass scale (depending on mark location when the scale is cut). When the reading head senses this mark, a fiducial trigger output (FTO) pulse is produced that causes the console to zero and display all zeros on the specific axis. These FTO pulses are generated when the AUTO RESET switch is in the AUTO RESET position. Otherwise, the system functions normally.

The reading head includes a separate LED and photo-transistor for sensing the mark, and the display will indicate when the reading head passes over the mark from either direction. However, to avoid possible errors in display readings, always try to approach a mark from the same direction.

To use the auto reset feature in either the incremental mode (ABS unlit) or the absolute mode (ABS lit), proceed as follows:

a. Place the AUTO RESET switch in the AUTO RESET position.

b. Approach the point to be measured, preferably in the positive direction (lower number to higher number). The display will automatically reset when passing the FTO mark closest to the point being measured.

c. When the console resets, place the AUTO RESET switch in the OFF position.

d. Center the tool (endmill, dial indicator, etc.) at the point to be measured. The distance displayed on the console indicates the measured distance between the FTO mark and the point location. For future reference, record the measured distance.

e. To relocate this point at any time, follow steps a. through d. until you come back to your recorded measurement.

SECTION 3
PROGRAM CHART PREPARATION

3.1. PROGRAM INFORMATION PLANNING

Planning a sequence of machining operations on the workpiece drawing and numbering them (see Figure 3-1) is a requirement in preparing to program the PRO. This sequential information is then transferred to the PROgram Chart (Figure 3-2), a simple and organized listing that includes dimensional and tooling information necessary to machine the workpiece. PROgram Chart information segments are described below.

For a supply of PROgram Charts, either photocopy the blank chart packed with the console or order from ACU-RITE® INCORPORATED: pt. #38-75-28 in pads.

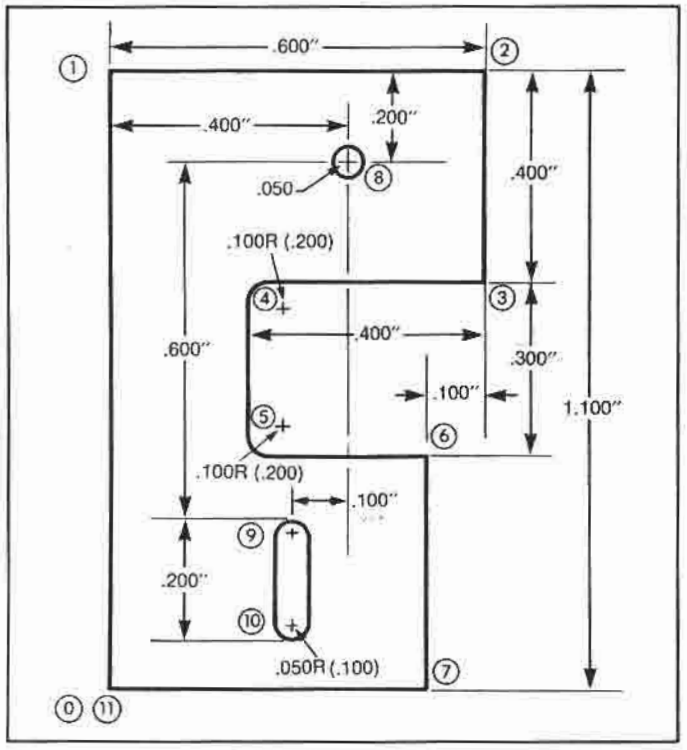


Figure 3-1. Example Workpiece Drawing

3.1.1. Point Numbering

Workpiece operations for which the machine tool is positioned must be numbered sequentially. Beginning with a zero reference "point" on the machine table, assign it the number "0" (see Figure 3-1). Determine the next point to which the tool must be moved and assign it point number "1". Continue this procedure until you have all tool movements laid out and numbered on the part drawing in the order you intend to machine. In preparing the PROgram Chart, point numbers are used as (a) tool-movement target locations, (b) tool-movement reference points, and (c) numbers for programming and operating steps (see 3.1.3). A point may have two or more numbers if it is used in more than one machining operation; e.g., points "0" and "11" in Figure 3-1.

3.1.2. Target Points and Reference Points

There are two types of points used in programming:

a. Target points, which denote locations toward which the tool must be moved; and
b. Reference points, which denote locations from which you reference the dimensions of the target points. The primary reference point is point number 0.

Each target point is measured from a reference point. A reference point number, therefore, must always be smaller than a target point number, and a target point must always be measured from the same reference point in all axes--X, Y, and Z. In Figure 3-1, for example, if point 8 is measured from 1 in the X-axis, it cannot be measured from point 6 in the Y-axis; it must also be measured from point 1 on the Y-axis.

ACU-RITE® PRO PROgram Chart

PAGE____OF____

DWG NO: For Example Workpiece, Figure 3-1
DWG DESCRIP
DWG DATE
PART NO
MATERIAL
TOLERANCE
PROGRAM DATE
PROGRAMMED BY
APPROVED BY
PROGRAM NO
AXIS COORDINATE SYSTEM
MULTIPLIER

4 TOOL USE TABLE

TOOL NO	TOOL DIAM.	DESCRIPTION
1	0.100"	
2	0.200"	
3	0.050"	End Mill
0	END-OF-PROGRAM	

PROGRAM COLUMN GROUPS IN THE ORDER INDICATED BY THE NUMBERED BOXES ☐

1 STEP NO.	1 REF POINT NO.	2 DIMENSION & SIGN X	2 Y	2 Z	3 TOOL OFFSET SIGN X	3 Y	3 Z	5 TOOL NO.	5 TOOL DIAMETER
0	0	0	0		−	+		2	0.200"
1	0	0	-1.100		−	−			
2	1	0.600	0		+	−			
3	2	.0	0.400		+	+			
4	3	-0.400	0		+	+			
5	4	0	0.300		+	−			
6	3	-0.100	0.300		+	−			
7	2	-0.100	1.100		+	+			
8	1	0.400	0.200					3	0.050"
9	8	-0.100	0.600			+		1	0.100"
10	9	0	0.200			−			
11	0	0	0						
12	0	End of Program						0	.....

FOR LONGER PROGRAMS USE ADDITIONAL SHEETS

Figure 3-2. Example PROgram Chart

3.1.3. Step Numbering

Every time you move the machine table or tool from one point to another, you are performing a step. The target point number to which you move is also the number of the step. When programming your operating information, step numbers will be numbered in sequence, and all other programmed information (see following descriptions) will relate to that sequence.

3.1.4. Dimension

A dimension is the distance to the target point from the reference point as taken from the part drawing. Dimensions are entered into the PRO for each step number.

NOTE

The dimension to a target point can be from any smaller reference point number. It does not have to be from the last reference point number or from point 0. Each dimension (X, Y and Z) for a particular step number must have the same reference point.

3.1.5. Tool Number

Up to 99 tool numbers can be assigned to the 166 available step numbers. Used mainly as a reminder to the operator, the tool number is displayed with each step number, and changes only when a new tool or separate task is required (programmed) for a chosen step number. Tool numbers 1 through 9 should be reserved for machining operations that require a tool offset, and numbers 10 through 99 are for other operations (such as coolant on/off). Tool numbers need not be programmed or used sequentially, and only one tool number will be accepted for each step number.

3.1.6. Tool Diameter

For tool number 1-9, tool diameters can be programmed in the memory. The PRO then calculates tool offsets for steps where required.

3.1.7. Tool Offset

A plus (+) or minus (–) must be entered to give the proper tool (cutter) offset direction. Offsets are only calculated for tools for which a tool diameter is in memory (tool numbers 1 to 9) and a sign is indicated. See 3.2.8, Assign Tool Offset Sign. Step number 0 will never contain an offset.

3.2. PREPARATION INSTRUCTIONS

3.2.1. Select a Zero-Reference Point

The zero-reference point for the workpiece is typically the point of intersection of the vertical and horizontal workpiece edges from which most measurements are referenced. Also, it should be easy to zero the machine tool over this point (start point).

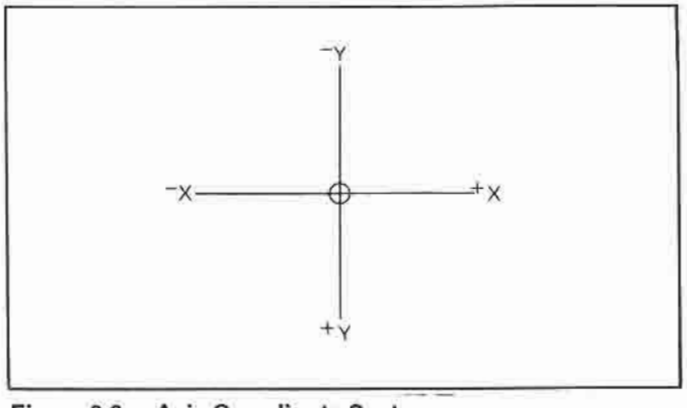


Figure 3-3. Axis Coordinate System

3.2.2. Establish an Axis Coordinate System

Draw a small axis coordinate system (see Figures 3-2 and 3-3) near the zero point on the part drawing. These coordinates are used to determine the sign of the direction for dimensions and tool offsets.

Refer to these coordinates when determining plus or minus signs for dimensions and tool offsets. Note that this is the accepted (i.e., conventional) use of signs for a manual machining operation in U.S. and Canada. Refer to Figure 3-5 and paragraph 3.2.5 for an example of how the coordinate system is used.

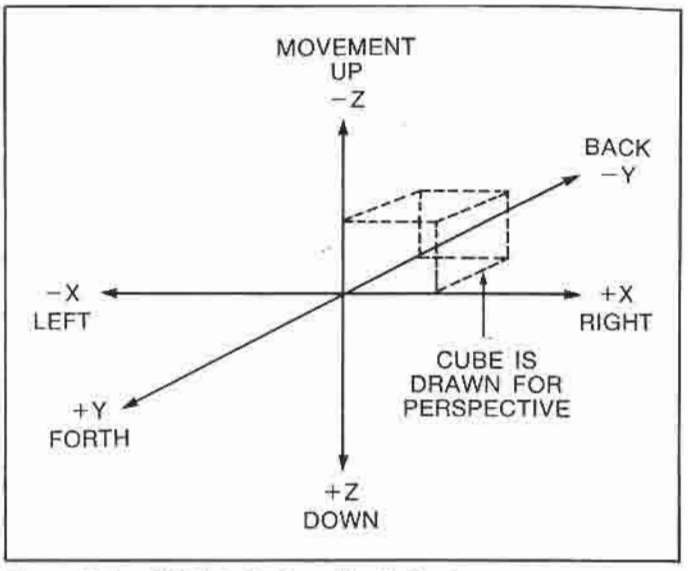


Figure 3-4. X-Y-Z Axis Coordinate System

NOTE

If your shop uses the opposite of the sign placement in Figure 3-3, refer to the System Checkout section of the appropriate scale installation manual (A-R/5 or Mini-Scale).

If your PRO is a three-axis system, the signs in the axis coordinate system will be as shown in Figure 3-4.

3.2.3. Assign Point Numbers

Determine the sequence in which the machining operations will take place. Beginning at point 0, number sequentially the end of each vertical and horizontal machine tool movement necessary to machine the workpiece or to reposition the tool. See Figure 3-1.

3.2.4. Complete Step Number and Reference Point Columns

Refer to group 1 on the PROgram Chart, Figure 3-2. The step numbers are simply a sequential listing from zero to the last point number on the drawing. One additional step number after the last point number is listed as the End-of-Program step number.

Remember that each step number is the number of the target point to which the machine tool must move. Each target point is measured from a reference point. This measurement is referred to as a dimension. Also, remember the following:

a. The reference point must always be less than the step number. The LED display will flash if the reference number is greater than or equal to the step number, except when both are zero. To stop the flashing, press STEP # key, enter the step number, press the DECIMAL key, and enter the correct reference number.

b. When programming, dimensions on all axes (X, Y and Z) for a particular target point must be measured from only one reference point for that target point. A target point can be referenced from any previous reference point, and different target points can have different reference points.

c. The LED display will flash if the step number is larger than the maximum number of memory locations. There are 166 memory locations in the 2-axis unit and 125 memory locations in the 3-axis unit. To stop the flashing, press STEP # key, then the CLEAR key.

d. In an attempt to delete (see 4.9.1.d and 5.8) a step number which is also used as a reference point for another step number, the display will flash. Do not delete a step number which is also used as a reference point for another step. Press STEP # to stop the flashing.

e. If desired step number and reference point are already displayed, it is not necessary to enter them during programming.

f. Each time you press the STEP key you advance the step number display. See 4.9.1.c.

g. After using the Clear Memory procedure, 4.9.1.d, the PRO assumes that the reference point for all step numbers is zero.

3.2.5. List Dimensions

Refer to group 2 on the PROgram Chart, Figure 3-2. Next to each step and reference point number, record the X and Y dimensions (with sign) to the target point from the reference point. Refer to the Axis Coordinate System above (3.2.2) to determine the sign of the dimension.

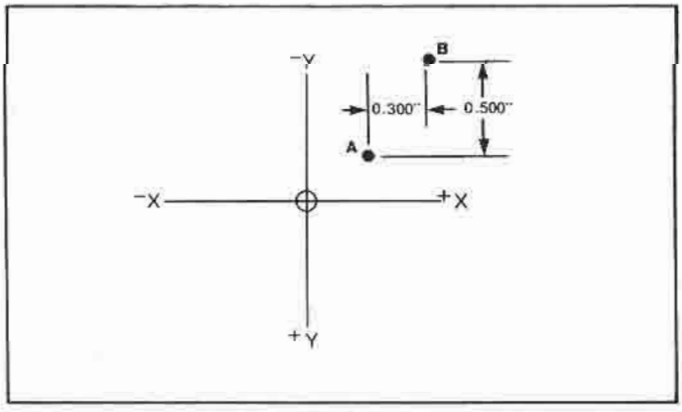


Figure 3-5. Example of Axis Coordinate System Use

The sign of a dimension depends on relative tool movement from the reference point to the target point. Relative tool movement is concerned with the direction of the movement on the workpiece (refer to coordinate system) and not on the direction in which the tool or table moves. (The concept may be simpler to understand if you imagine yourself actually on the workpiece moving from point to point.) For example, refer to Figure 3-5.

If measuring from point A to point B, the signs would be plus (i.e., +0.300") in the X direction and minus (i.e., —.500") in the Y direction, regardless of whether the tool is moved or the table is moved.

In Figure 3-1 the step 6 dimensions are referenced from point 3. To move from point 3 to point 6, you must move to 0.1" in the minus-X direction and 0.3" in the plus-Y direction. Again, both movements represent the path the tool travels with respect to the workpiece. Dimensions for both axes must be measured from point 3.

During programming or presetting, the PRO assumes that a dimension is plus (+) unless a minus (—) is indicated. When working on turning machines, you want the PRO to display the diameter of the workpiece, therefore the dimension in that axis (Y) must be programmed as a diameter. (Refer to Table 6-1 for diameter setting of internal switches.)

3.2.6. Assign Tool Numbers

Tool numbers (group 4 on PROgram Chart, Figure 3-2) can be assigned at particular step numbers to remind the operator to change a tool or perform an activity. The tool number will appear on the display for that step number. The PRO will also calculate the tool offsets at steps where tools are inserted (see 3.2.8).

Using tool numbers 0 to 99, tool number 0 is reserved for End-of-Program, and tools 1 through 9 are used if offsets for the tool will be considered. Only tool numbers 1 through 9 can have the tool diameter programmed into memory and have a tool offset calculated. Tool numbers 10 to 99 are used to signify cutters for which an offset is not relevant (drill, end mill, reamer), or to signify an activity such as turn coolant on/off, lift spindle, sharpen tool, check measurements, etc.

NOTE

If a tool number is assigned, it does not necessarily have to be used; nor do tools have to be used in the sequential order of the tool number.

3.2.7. Assign Tool Number to Step Number

Under group 5, list the tool number and the tool diameter to be used at the various step numbers. List the tool number only for the first step number in a possible series of step numbers where the tool is used. The PRO "remembers" that it is still using a particular tool number once the tool has been assigned at a previous step number. It is important to remember the following:

a. Only one tool number can be inserted at each step number.

b. When a new tool number is inserted at a step number where a tool already exists, the new tool number will cancel the old one, and the new tool will be in use until another programmed tool number comes up.

c. If a step number is recalled out of sequence, the tool to be used for that step number must be specifically inserted at that step number.

3.2.8. Assign Tool Offset Sign

The tool offset is the radius of the cutting tool which must be added or subtracted to adjust the dimension which the tool must move in order to prevent overcutting or undercutting. During operation, the PRO will automatically convert from a diameter (divide by 2) to a radius and factor the tool offset into the required tool movement distance, which appears on the display. Remember, the tool offset can only be used for tools 1 to 9.

The PRO must be instructed whether to add or subtract the tool offset. The sign is determined using the following question: When moving the tool to a new dimensioned point, will the centerpoint of the tool have to be displaced in the plus (+) or minus (–) direction of the axis coordinate system in relation to the edge of the cut which you are machining. For example, (refer to Figure 3-1): At point number 9 (step 9), the centerpoint of the tool must be moved in the –Y direction so the outer edge of the tool is flush with the edge to be machined. Here's a second example To complete the cut from point 0 to point 1 (step 1) the center of the cutter at point 1 would have to be moved in the –X direction as well as the –Y direction from the corner at point 1. Refer to 5.4 Example: Tool Offset for further explanation. Complete group 3, Tool Offset Sign, for each step.

NOTE

There will be no offset for step numbers whose dimension measurements are to the tool centerpoint rather than to the edge of the tool cut.

SECTION 4
HOW TO PROGRAM

Once the PROgram Chart is filled in, actual programming of the PRO is simple. This section explains how to prepare the PRO and transfer data from the PROgram Chart to the memory. Section 5 is intended to teach by example, explaining features using one-axis examples. The Operational Keying Sequences in Section 4 (4.9.1.a-p and 4.9.2.a-f) can be referred to for an abbreviated summary of how to use the features. Review 4.9.3, Important Facts to Remember, in detail for helpful programming information.

4.1. START-UP

The PRO must be installed, connected to ground, and plugged into an outlet with correct voltage before it is ready to operate (see Section 6, Installation). When you flip the POWER switch to ON, a small vertical mark (fault indicator) appears on the left side of each axis display. Follow the start-up/zero-counter procedure below:

a. POWER switch ON.
b. Set INCH/mm switch to appropriate position.
c. Center tool over zero reference (point 0) for workpiece.
d. Press ZERO RESET button - Both incremental and absolute modes are zeroed in each axis (see CAUTION below).

CAUTION

During normal PRO operation, only the mode selected will reset to zero; i.e., ABS key lit for absolute and unlit for incremental.

4.2. PROGRAM ENTRY PREPARATION (CLEAR MEMORY)

Following Start-Up, if the PRO does not already have the desired program in memory, a new program must be entered. Prior to entering the new program, follow the procedure below in order to totally remove (clear) already stored programs from the memory (see CAUTION below). Alternately, a new program can be entered over an existing program if the number of steps is less than the old program.

CAUTION

You may wish to delete one or more specific program blocks rather than wiping out the entire memory. If so, you must individually delete each step in the program block. (See 4.8, Program Blocks.) Otherwise, you must totally reprogram.

a. Press PROG key - PROG key is now lit. (Press again if it is not lit.)
b. Press CLEAR key - The display will flash repeatedly (if you change your mind about wiping out the memory, press the STEP # key and flashing will stop).
c. Press STORE key - The PRO memories are now clear except the preset and distance-measurement memories.

4.3. ELECTRONIC DIAGNOSTIC FEATURE

Before or after clearing the memories, but before programming, the PRO electronics can be checked, if desired. The diagnostic routine tests the display electronics, keyboard electronics, and the microprocessor for proper functioning.

CAUTION

Any data stored in the PRO memory will be erased during the following routine. Do not use the diagnosis if you wish to preserve information in the memory.

The diagnostic routine should be performed about once a month. Always perform the routine before programming.

a. Activate POWER switch to ON.
b. Set INCH/mm switch to INCH.
c. Press PROG key—PROG key lit. Unlit is in Program mode.
d. Press CLEAR key. - Memory is cleared.
e. Press STORE key.
f. Press STEP # key.
g. Press digit key 9 three times—Display flashes !9.9.9.9.9..9.
h. Press STORE key—STORE key causes routine to begin. Pressing any other key before STORE causes PRO to return to normal operation.

The routine will cause numbers to appear sequentially across each axis display, the lower axis always leading others by one segment or two. As this occurs (see below), watch the display for any LEDs (light-emitting diodes) that do not light and, if necessary, call your *ACU-RITE distributor for repair. This part of the* routine also tests the microprocessor, as well as the displays. The routine will continue, with the display changing as follows:

a. A"+!" appears on the left side of the bottom display with all other display segments blank.
b. The "+!" then moves to the next axis display, as the number "8." moves from one display segment to the next on the previous axis. Note any LED segments which are not working properly.
c. After the "8.'s" have moved across each segment, 0's will appear across the display on the lower axis. Next a series of 1's appear across the display. This successive sequence of numbers continues until, after the 9's, a blank display appears and the

PROG light goes out. The same sequence occurs for each axis display until all displays are blank. This process continues to verify proper functioning of the microprocessor and display circuitry, and any deviation from the described sequence indicates that there may be a problem.

4.4. KEYBOARD CHECKOUT

The keyboard can be checked when the microprocessor checkout is complete and the displays are blank. As each key is pressed, the column number and row number of the key's location on the keyboard (Figure 4-1) will be displayed on the upper and lower axes, respectively. For example, if digit key number 2 is pressed, a 4 will appear on the upper axis display and a 3 on the lower axis display to indicate the column-4, row-3 location of digit key 2. All the keys should be tested in a similar fashion to verify that they are functioning. A bad key would be indicated by a blank display or a display of numbers other than the proper column or row number. Of course, keys with lights should light when pressed.

During keyboard checkout two keys will give slightly different indications. The DIMENSION key, located in columns 6 and 7, will be displayed as column 6 only. The Y PRESET key will be displayed as column 1, row 4 on a two-axis counter, but on a three-axis unit will be displayed as column 1, row 2.

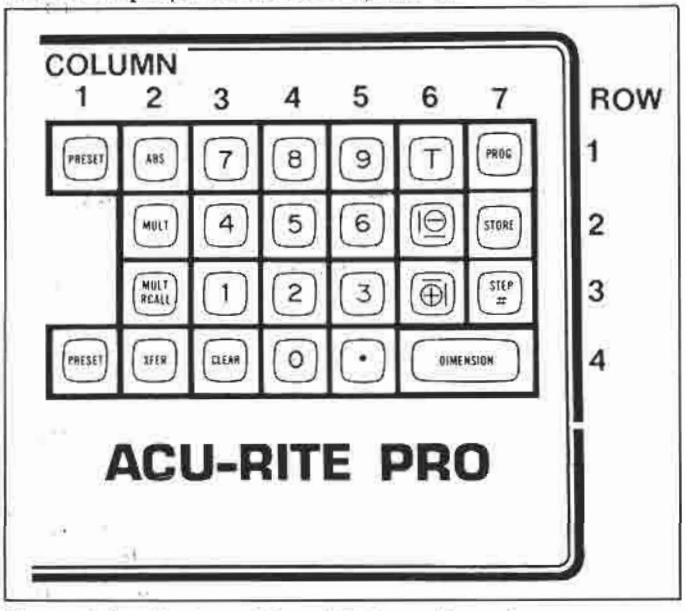


Figure 4-1. Keyboard Row / Column Format

4.5. MEMORY CHECKOUT

Following the keyboard checkout, flip the INCH/mm switch to the mm position and all read/write memories will be automatically checked. A vertical mark (fault indicator) appears on the left side of each axis display indicating that the PRO has cycled back to normal operation and that the memories have functioned properly.

Upon completion of the testing, press the ZERO RESET button for each axis, flip the INCH/mm switch to the desired position and resume operation.

NOTE

This completes the diagnostic routine and memory checkout. Memory is blank, so repeating the Clear Memory procedure (see 4.2) is not necessary.

4.6. SUGGESTED PROGRAMMING METHOD

The PRO is ready to program upon completion of the above procedures. That is, the information on the PROgram Chart can now be entered and stored. Refer to your completed PROgram chart and enter data from each column group (1-5) in sequence. The column groupings and order of entry are:

a. Step numbers and reference point number.
b. Dimensions and signs (X/Y/Z/).
c. Tool offset signs.
d. Tool use table: List tool number and tool diameter.
e. List tool number and tool diameter.

The examples in Section 5, Programming and Operation By Example, will lead you through the entry of column group data into the PRO. Refer to your laminated Programming and Operating Guide for key-pressing sequences used in programming (see also 4.9., Operational Keying Sequence).

4.7. ALTERNATE PROGRAMMING METHOD

Rather than entering data by going down each column group, data can be entered by moving across the PROgram Chart for each step number. The only restriction is that both tool number and tool diameter (column group 4) must be completely programmed before any tool numbers are inserted at any step number.

4.8. PROGRAM BLOCKS

It is possible to enter several separate programs into the PRO memory. That is, if a program only uses part of the 166 or 125 memory steps available (for 2-axis and 3-axis units respectively), then the balance of the unused memory can be used to program another series of steps for a different workpiece. Each series is called a "program block". For example, workpiece A with 15 operations (including zero reference) can be programmed using step numbers 0 through 16 (step 16 is for End-of-Program); while workpiece B, with 30 operations can be programmed using step numbers 20 through 50. Step 50 is for End-of-Program (EOP) and steps 17 through 19 can be reserved for any program additions needed for workpiece A. (Step numbers automatically shift when steps are added or deleted.) Other workpieces can be programmed in the balance of the unused memory.

Each program block can contain any quantity of step numbers up to the quantity available (166 or 125, depending on whether your PRO has two or three axes). EOP should be inserted with the last step number at the end of each program block. When operating (Run Mode), the PRO will return to the beginning of the program block if you press the

DIMENSION key when it reaches EOP. As the example below shows, you can leave blank step numbers between any two successive program blocks, but at the end of a program block, the PRO will return to the step number just after the EOP step of the previous program block.

Example of program block format:

Step Number	Explanation
0	
1	
2	
3	Program block A - Step number 0-15 programmed for workpiece A. Program will return to step number 0 after step number 16 (EOP).
.	
.	
.	
14	
15	
16	End of Program
17	
18	Reserved for added steps (Program A)
19	
20	Program block B - Step numbers 20-50 programmed for workpiece B. Points on workpiece B must begin with 20. Program will return to step number 17 after step number 50. (Step numbers 17 through 47 could be used to program workpiece B, if desired.)
21	
22	
.	
.	
.	
49	
50	End-of-Program

4.9. OPERATIONAL KEYING SEQUENCE

The following are individual keying sequences for specific procedures that you'll find detailed in Section 5, Programming and Operating By Example. Under 4.9.1, Programming and Operating Procedures, are the sequences used when either entering data into the PRO's memory or recalling that data for machining purposes. For checking data in the memory or checking operation of the PRO electronics, use the sequences under 4.9.2, Inspection and Diagnostic Procedures.

See 4.9.3, Important Facts to Remember, for a listing of points it is necessary for you to know to correctly operate your PRO. After you have learned how to program and operate the PRO more confidently, use the Programming and Operating Guide, which includes these keying sequences, in the form of a laminated card for convenience at the machine.

4.9.1. Programming and Operating Procedures

NOTE

Press indicated key or perform action. Status of key is shown in parentheses (e.g., lit, unlit).

a. Start-Up or Zero Counter
   1. POWER switch ON
   2. Make INCH/mm switch selection
   3. Position centerpoint of tool over zero reference point for workpiece
   4. ABS key (lit)
   5. ZERO RESET button for each axis
   6. ABS key (unlit)
   7. ZERO RESET button for each axis

b. Clear Memory
   1. PROG (lit)
   2. CLEAR key
   3. STORE key

c. Program or Correct Step Numbers and Reference Points
   1. PROG (lit)
   2. STEP#
   3. Enter step number if desired step number is not already displayed
   4. Decimal point key
   5. Enter reference point if desired reference point is not already displayed (see 4.9.3, items d and e).

d. Insert or Delete Step Number
   1. PROG (lit)
   2. STEP#
   3. Enter step number
   4. Minus key - if deleting step
   5. Plus key + if adding step
   6. STORE
   (PRO assumes reference point is zero. After inserting step number, use Procedure c. to enter reference point number if it is not zero.)

e. Program or Correct Dimension
   1. PROG (lit)
   2. STEP#
   3. Enter step number
   4. PRESET (lit) on desired axis
   5. CLEAR
   6. Enter dimension (+ is assumed)
   7. −if minus
   8. STORE
   (To program another axis at same step number, start at item 4 above.)

f. End-of-Program
   1. PROG (lit)
   2. STEP#
   3. Enter step number after last step number used in workpiece program
   4. T key
   5. Digit key 0
   6. STORE

g. Program or Correct Tool Offset Sign
   1. PROG
   2. STEP#
   3. Enter step number
   4. PRESET (lit on desired axis, not lit on others.)
   5. T key

6. –if minus
7. + if plus
8. If deleting, press CLEAR key
(To program or correct the tool offset or other axes for this step number, go back to item 4, above, and repeat.

h. Program or Correct Tool Number and Diameter
1. PROG (lit or unlit)
2. T key
3. Enter tool number (from 1 to 9)
4. Any PRESET (lit)
5. CLEAR
6. Enter tool diameter
7. PRESET (unlit). Do not press STORE.

. Insert or Remove Tool
1. PROG (lit)
2. STEP#
3. Enter step number
4. T key
5. Enter tool number
6. If removing CLEAR
7. STORE (see 4.9.3. items c., h., and g.)

j. Program Multiplier
1. PROG (lit or unlit)
2. MULT RCALL (lit)
3. PRESET (lit) on desired axis
4. CLEAR
5. Enter multiplier (+ is assumed)
6. –if minus
7. MULT RCALL (unlit)

k. Use Multiplier
1. PROG (unlit)
2. MULT (lit)

l. Mirror Image
1. Use procedure j. to program a –1 (minus one) multiplier on the axis which is to be machined in opposite direction. (See 5.6, Mirror Image Example in PRO manual.)
2. Use procedure k. for mirror-image machining.

m. Transfer
1. Follow procedure a., Start-Up
2. If clearing entire memory, follow procedure b., Clear Memory
3. PROG (lit)
4. STEP#
5. Enter step number
6. Decimal point key
7. Enter reference point (see 4.9.3u).
8. XFER (lit)
9. PRESET (unlit) for axes not to be recorded
10. Move machine to position
11. STORE
(Repeat for each step number, beginning with item 4 above.)

n. Run (Operate)
1. Follow procedure a., Start-Up
2. PROG (unlit)
3. STEP#
4. Enter step number (0 if operating sequentially)
5. DIMENSION
6. Position machine until display shows zero. Repeat items 5 and 6 alternately.

o. Standard Digital Readout Operation
1. Follow procedure a. Start-Up
2. PROG (unlit)
3. XFER (lit)
4. PRESET (unlit)
5. Move machine. Display will show distance moved.

p. Auto Reset
1. AUTO RESET switch to AUTO RESET position
2. Move machine until display resets to zero
3. AUTO RESET switch to OFF (immediately)

4.9.2. Inspection and Diagnostic Procedures

a. Electronic Diagnostic Procedure*
1. POWER switch ON
2. INCH mode
3. PROG (lit)
4. Follow procedure 4.9.1.b, Clear Memory
5. STEP#
6. Digit key 9 three times
7. STORE
8. Keyboard (After display becomes blank)
9. mm mode
10. ZERO RESET
11. Make INCH/mm switch selection (Machine is now ready to use.)
*This procedure erases the entire memory

b. Inspect Step Numbers and Reference Points
(PROG key can be lit or unlit)
1. STEP#
2. Digit key 0
3. Press STEP# repeatedly
- OR -
1. STEP#
2. Enter step number
3. Decimal point key

c. Inspect Dimension and Inserted Tool
1. PROG (lit)
2. STEP#
3. Digit key 0
4. Press DIMENSION repeatedly
- OR -
1. PROG (lit)
2. STEP#
3. Enter step number
4. DIMENSION key

d. Inspect Tool Offset Sign
Follow procedure b., Inspect Step Number

e. Inspect Tool Number and Diameter
1. PROG (lit or unlit)
2. T key
3. Enter tool number

f. Inspect Multipler
1. PROG (lit or unlit)

2. MULT RCALL (lit)
3. MULT RCALL (unlit)

CAUTION

Multiplier and preset data are removed from memory when power is turned off.

4.9.3. Important Facts to Remember

a. STORE key is not used when programming step number, reference point, tool diameter, tool offset sign, or multiplier.

b. Tool Codes:
0 End-of-Program
1 - 9 Tool number with diameter
10 - 99 Tool number without diameter

c. Tool numbers with offset diameter can be programmed, but do not have to be inserted for display purposes. Tool numbers 0 and 10-99 do not have to be programmed, but must be inserted for display purposes at the desired step number, one per step, only.

d. Tool offset sign is determined using the following question: When machining at each numbered point, is the centerline of the tool in the plus (+) or minus (–) direction in relation to the edge of the cut to which the dimension is measured?

e. If the desired step number and reference points are already displayed, it is not necessary to enter them during programming. The reference point number must ALWAYS be less than the step number, except at step number 0.

f. Press STEP# key repeatedly to advance display to desired step number. Press DIMENSION repeatedly to display the dimension of next desired step.

g. When programming or using preset, the PRO assumes a dimension is positive (plus) unless otherwise indicated, and the plus (+) key need not be pressed. To register a minus, the minus (–) key must be pressed.

h. The PRO assumes that the last tool number inserted at any step number is used for all subsequent step numbers until a new tool number is inserted.

i. If the absolute mode (ABS key lit) has not been reset to zero since leaving the zero reference, it can be used to return to the zero reference. Simply, move the machine until the display reads zero in absolute mode.

j. STEP# key and DIMENSION key can be pressed alternately without advancing the step number. Press either key twice in a row and the step number will advance.

k. In the Run mode, the display always shows the dimension to reach the target point after factoring in tool offset where required. Remember, at all times you'll be positioning toward a zero display.

l. The multiplier does not change the dimension in preset or program memories; rather it scales the table movement.

m. When using a turning machine, where diameter readout is displayed, all dimensions must be programmed as diameters.

n. The numbers stored in the preset and multiplier memories are erased when power is interrupted. However, the battery backup ensures that the step number, reference number, tool number, tool offset, and dimension (w/sign) are held in memory.

o. When programming, it is assumed that the centerpoint of the tool is started directly over point 0. Both the incremental and absolute modes should be reset to zero after the tool is centered.

p. The electronic diagnostic procedure erases the PRO memory.

q. If a tool is to be used at a nonsequential step number, the tool to be used must be specifically inserted at the step number during programming.

r. Do not delete a step number which is also used as a reference point for another step number.

s. The PRO assumes a multiplier of +1 unless otherwise indicated. A −1 multiplier is used for mirror image machining. A multiplier can be programmed on only one axis if desired, and a different multiplier can be programmed for each axis.

t. Following electronic diagnostic procedure, or with a clear memory, the PRO assumes all dimensions are zero, unless programmed otherwise. Therefore, only non-zero dimensions must be programmed.

u. Dimensions stored in memory during the Transfer procedure must be point-to-point (i.e., previous step #) or be referenced from zero.

At each step where a tool number has been inserted, the display will show the tool number and tool diameter upon pressing the DIMENSION key. Pressing the DIMENSION key again will cause the display to show the required dimension.

SECTION 5
PROGRAMMING AND OPERATION BY EXAMPLE

5.1. GENERAL

This section contains instructional examples for programming and operating the PRO on various common machining operations. Each example consists of a machining operation, a sample workpiece drawing, PROgram Chart preparation, and subsequent programming and operating procedures in table form. Detailed explanations and display status illustrations are included to show you what happens as you operate the PRO and your machine. Practice the procedures to familiarize yourself with the various displays and keying sequences.

The heading for each example explains what programming function is to be emphasized during the procedure. Looking at the first example, 5.2, you'll notice it deals with how to **store dimensions and step numbers**, and how to subsequently machine a workpiece with this information programmed into the memory. A complete list of examples in this section follows:

5.2. EXAMPLE: DIMENSION/STEP#/STORE
5.3. EXAMPLE: TOOL CHANGE
5.4. EXAMPLE: TOOL OFFSET
5.5. EXAMPLE: MULTIPLY
5.6. EXAMPLE: MIRROR-IMAGE
5.7. EXAMPLE: TRANSFER (REVERSE-ENTRY PROGRAMMING)
5.8. EXAMPLE: STEP INSERTION/DELETION

NOTE

Procedures (tables 5-1 through 5-7) for each example include specific references to 4.9, Operational Keying Sequences, which are summaries of major keying operations (e.g., 4.9.1.d, Insert or Delete Step). These keying sequences can also be found on the laminated Programming and Operating Guide for use at your machine.

5.2. EXAMPLE: DIMENSION/STEP#/STORE

5.2.1. Machining Operation

Using the PRO to indicate required tool movements, mill the series of holes illustrated in Figure 5-1 for 8 workpieces.

5.2.2. PROgram Chart Preparation

a. Sequentially number all points to which measurements are made; that is, the hole centers. Point 0 is the zero reference (start) point over which the center point of the tool is positioned (see Figure 5-1).

b. Draw Axis Coordinate System (Figure 5-1, inset) including polarity signs.

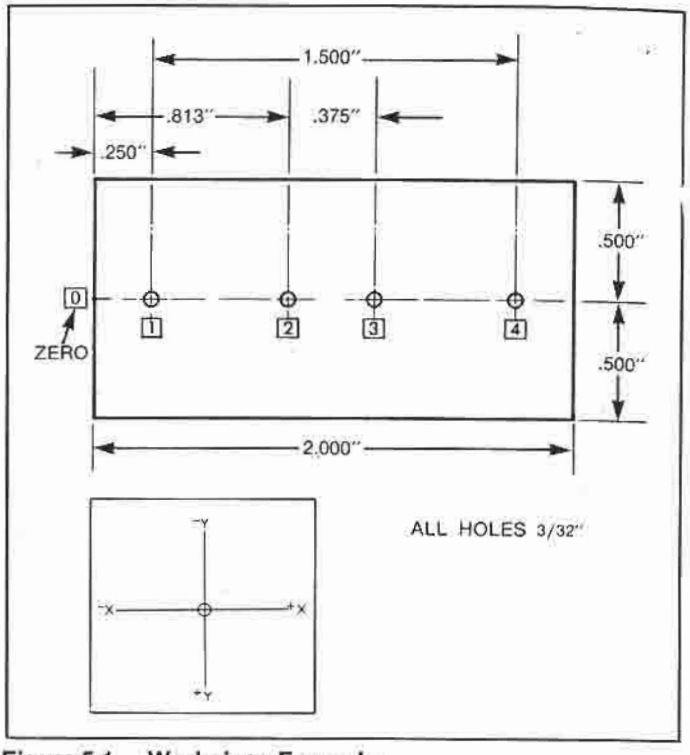


Figure 5-1. Workpiece Example (Dimension/Step # /Store)

ACU-RITE® PRO PROgram Chart PAGE ____ OF ____

DWG. NO. Dimension/Step#/Store
DWG. DESCRIP.
DWG. DATE
PART NO.
MATERIAL
TOLERANCE
PROGRAM DATE
PROGRAMMED BY:
APPROVED BY:
PROGRAM NO.
AXIS COORDINATE SYSTEM
MULTIPLIER

PROGRAM COLUMN GROUPS IN THE ORDER INDICATED BY THE NUMBERED BOXES □

4 TOOL USE TABLE

TOOL NO.	TOOL DIAM.	DESCRIPTION
0	END-OF-PROGRAM	

1 STEP NO.	1 REF. POINT NO.	2 DIMENSION & SIGN X	Y	Z	3 TOOL OFFSET SIGN X	Y	Z	5 TOOL NO.	TOOL DIAMETER
0	0	0							
1	0	+0.250							
2	0	+0.813							
3	2	+0.375							
4	1	+1.500							
5	0	End of Program						0	.....

(FOR LONGER PROGRAMS, USE ADDITIONAL SHEET)

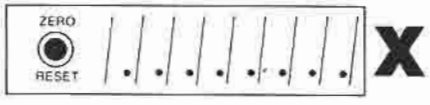
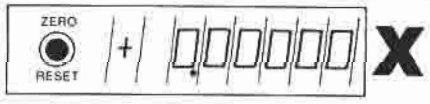
Figure 5-2. PROgram Chart (Dimension/Step # /Store)

c. Complete the PROgram Chart (Figure 5-2).

1. Fill in step numbers, including zero (0) and the reference point numbers. Remember, the step number is the target point to which the tool is moving, and the reference point is the point from which the dimension (distance) to the target point is measured. For example, target point 3 is measured from reference point 2. For the End-of-Program step, fill in the next step number after the last target point number.
2. For each step number, fill in the dimension to the target point from the reference point. Include the sign of the dimension. That is, determine the direction of relative tool movement and refer to the Axis Coordinate System for the sign. (The PRO assumes a plus, unless otherwise indicated.) For the End-of-Program step, fill in a series of 8 dots in the Tool Diameter column.

d. Practice the combination of programming and operating procedures that follow in Table 5-1.

Table 5-1 Power On and Clear Memory Procedure

Operation Sequence	Function Explanation (What happens)	Display
a. Set POWER switch to on.	A short vertical mark appears on the left side of each display.	
b. Press ZERO RESET button for each axis.	Incremental and absolute counters are reset to zero.	
	CAUTION For all other operating procedures where you are resetting to zero, absolute mode will be reset only when ABS key is lit. Otherwise, only incremental mode will be reset.	
c. Press PROG key.	Program (PROG) key is now lit. Unit is ready to be programmed.	
d. Press CLEAR key.	Display shows series of flashing dots to warn operator that he is about to erase the entire memory.	
e. Press STORE key.	All information in memory is now erased. Unit is ready for programming.	

SEE 4.9.1.a and b

Table 5-1 Program Dimension Procedure

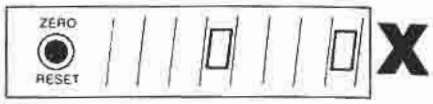
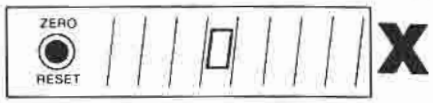
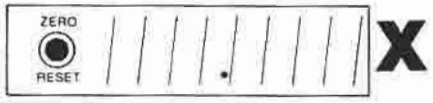
Keying Sequence	Function Explanation (What happens)	Display Status
a. PROG key must be lit. Press again if not lit.	Program mode is activated.	
b. Press STEP # key.	A step number and reference point will be displayed.	
c. Press digit key 0.	This assures that unit is set at step 0.	
d. Press X-axis PRESET key.	PRESET key must be list to enter data.	
e. Press CLEAR key.	To set the preset memory at zero CLEAR (after preset) permits entry of dimension. PRO assumes zero if no dimension is entered.	
f. Press STORE key.	Zero dimension is entered into memory for step 0.	
g. Press STEP # key again.	Display advances to step 1.	
	NOTE If the reference point for the dimension of this step is 0, go to item j. The PRO always assumes reference points are 0, unless otherwise indicated. If it is not 0, go to items h and i.	
h. Press decimal key.		
i. Enter reference point number.	Press digit keys to enter reference point number.	
j. Press X-axis PRESET key	Sequence of items j, k, and l is necessary for the entry of any dimension.	
k. Press CLEAR key.	To set preset memory to zero and permit entry of dimension.	
l. Enter dimension from PROgram Chart.	The dimension for step 1 is 0.250. Include the decimal point. Step and reference numbers will be displayed on the Y axis during this procedure.	

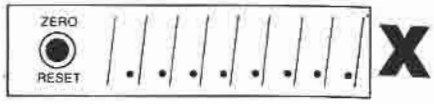
Table 5-1 Program Dimension Procedure (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
m. Press STORE key.	Information is now stored in memory.	
n. Go back to item g in this procedure.		
o. Repeat these procedures (items g-n) to include the entry of steps 2, 3 and 4.		
	NOTE The step number and reference point can be checked at any time by first pressing the STEP#key, and digit key 0. The STEP#key is then pressed repeatedly to advance the step number.	
	SEE 4.9.1.c, d, and e	

Table 5-1 End-of-Program Procedure

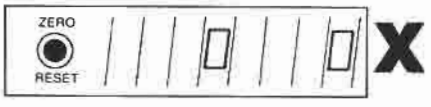
Keying Sequence	Function Explanation (What happens)	Display Status
	NOTE Refer to group 5 on PROgram Chart.	
a. PROG key must be lit.	Program mode must be activated.	
b. Press STEP#key.	PRO is ready to accept a step number.	
	NOTE The End-of-Program number is the next number after the last target point number.	
c. Press T key.	The T key is for inserting tool numbers.	

End-of-Program Procedure (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
d. Press digit key 0.	The tool number 0 signifies End-of-Program; display shows eight dots.	
e. Press STORE key.	The End-of-Program is now in memory at step 5.	

SEE 4.9.1.f

Table 5-1 Inspect Dimensions Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. PROG key must be lit.	PRO must be in Program mode.	
b. Press STEP# key.		
c. Press digit key 0.		
d. Press DIMENSION key. Continue to press DIMENSION key repeatedly.	Unit will advance to next step number and display the dimension. The step number can be viewed separately at any time by pressing STEP# key. Press DIMENSION key again to continue viewing dimensions. The STEP # and DIMENSION keys can be pressed alternately without advancing the step number.	

NOTE

The dimension for a particular step number can be checked by pressing the STEP# key, the step number digit key, and the DIMENSION key. PROG key must be lit.

SEE 4.9.2.c

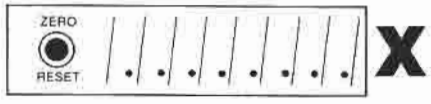
Table 5-1 Correct Dimension Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. PROG key must be lit.	Program mode is activated.	
b. Press STEP# key.		
c. Enter desired step number.	To obtain applicable step number.	
d. Press PRESET key for appropriate axis.		
e. Press CLEAR key.	Old dimension is cleared from preset memory.	
f. Enter new dimension.		
g. Press STORE key.	New dimension is now stored in memory.	
	NOTE Go back to item d. if correcting any other axis for same step number. Go back to item c. if correcting for another step number.	
	SEE 4.9.1.e	

Table 5-1 Operation Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. Center tool over point 0 for workpiece.		
b. Press all ZERO RESET buttons.	Zero incremental mode.	
c. Press ABS key.	ABS key list. PRO is in absolute mode.	
d. Press all ZERO RESET buttons.	Zero absolute mode.	

Table 5-1 Operation Procedure (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
e. Press ABS key.	ABS key unlit. PRO is in incremental mode.	
f. Press PROG key so that it is not lit.	PRO must be in Run mode (PROG key unlit).	
g. Press STEP# key.		
h. Press digit key 0.	This is to start at step number 0.	
i. Press DIMENSION key.	Dimension for step 0 is displayed.	
j. Press DIMENSION key again.	Unit advances to next step. Display shows distance which the tool must be moved in this step. Notice that the display is a negative number. Hole#1 is in the plus direction, therefore, as the machine tool is moved +.2500, this adds to the −.2500 display to equal zero.	
k. Move tool until display indicates zero, signaling arrival at the target point. Alternately press the DIMENSION key and position tool until display reads zero, repeatedly, through the final step.	 When display shows series of 8 dots, program and machining is complete.	
l. Remove completed workpiece, insert new workpiece, and begin at item a. above.		

SEE 4.9.1.n

5.3. EXAMPLE: TOOL CHANGE

5.3.1. Machining Operation

Refer to 5.2 Example: DIMENSION/STEP#/STORE. On this workpiece (Figure 5-3), bore holes of different sizes in the same pattern as on Figure 5-1. Use the PRO to show the tool change in addition to the required tool movement dimensions.

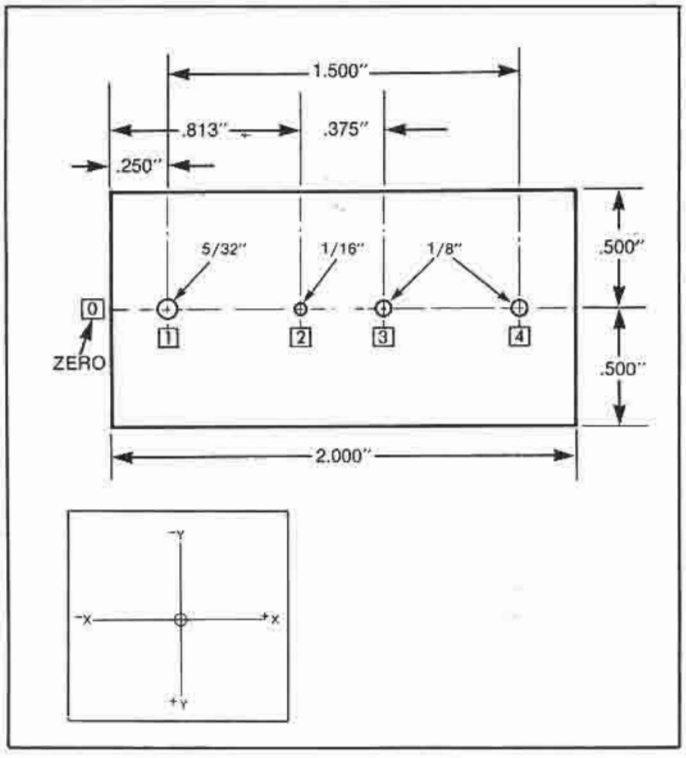


Figure 5-3. Workpiece Example (Tool Change)

5.3.2. PROgram Chart Preparation

Chart preparation for the above workpiece is identical to the chart shown in Figure 5-2, except for the following (see Figure 5-4):

a. Fill in the Tool Use Table (group 4) with tool numbers and tool diameters.

b. The tool numbers 1, 2, 3 are arbitrarily assigned.

c. A tool number of 0 for step 5 indicates End-of-Program and causes the program to restart from step 0.

5.3.3. Programming

Programming sequence is identical to the sequence shown in 5.2. Example: The sequence is:

a. Start-Up

b. Program Dimension

c. End-of-Program

d. Inspect Dimension

e. Correct Dimension

Once the above programming is complete, the tools to be used can be programmed.

ACU-RITE® PRO PROgram Chart PAGE ___ OF ___

DWG NO: Tool Change
DWG DESCRIP:
DWG DATE:
PART NO:
MATERIAL:
TOLERANCE:
PROGRAM DATE:
PROGRAMMED BY:
APPROVED BY:
PROGRAM NO:
AXIS COORDINATE SYSTEM
MULTIPLIER

PROGRAM COLUMN GROUPS IN THE ORDER INDICATED BY THE NUMBERED BOXES ☐

4 TOOL USE TABLE

TOOL NO.	TOOL DIAM.	DESCRIPTION
1	.0625	1/16" Drill
2	.1250	1/8 " "
3	.1562	5/32 " "
0	END-OF-PROGRAM	

1 STEP NO.	1 REF. POINT NO.	2 DIMENSION & SIGN X	Y	Z	3 TOOL OFFSET SIGN X	Y	Z	5 TOOL NO.	TOOL DIAMETER
0	Ø	0							
1	0	0.250						3	.1562
2	0	0.813						1	.0625
3	2	0.375						2	.1250
4	1	1.500							
5	0	End of Program						0	.....

(FOR LONGER PROGRAMS, USE ADDITIONAL SHEETS)

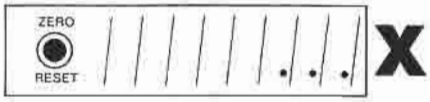
Figure 5-4. PROgram Chart (Tool Change)

Practice the combination of programming and operating procedures that follow in Table 5-2.

5.3.4. Operation

Operation is identical to the sequence described under 5.2 Example: DIMENSION/STEP#/STORE. However, at each step where a tool number has been inserted, *the display will show the tool number and tool diameter* upon pressing the DIMENSION key. Pressing the DIMENSION key again will cause the display to show the required dimension. For example, at step number 1, the display will show 3 and .15620 (tool number and diameter) when the DIMENSION key is first pressed. When the DIMENSION key is pressed again, the display will show −0.2500, the distance which the tool must be moved to reach point 1.

Table 5-2 Program Tool Number & Diameter Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. Press PROG key.	PROG key must be lit. PRO is now is Program mode.	
b. Press T key.	PRO is ready for entry of tool information. Display shows three dots to indicate tool mode; alternately, it may show a tool number, tool diameter or a series of eight dots, depending on your prior use of T key.	
c. Press digit key 1.	Tool number 1.	
d. Press X-axis PRESET key.	X and Y PRESET keys will light.	
e. Press CLEAR key.	PRO is ready for entry of tool diameter.	
f. Enter tool diameter including decimal.	Tool diameter for tool 1 is 0.0625.	
g. Press X-axis PRESET key.	Tool number and diameter are now in memory. PRESET keys become unlit.	
h. Go to item b. above. Repeat This procedure, except press digit key 2 (at item c) and enter 0.1250 for tool, then, for tool 3, press digit key 3 and enter 0.1562.		

NOTE

To change a tool diameter, follow the above procedure for the particular tool number and enter the new tool diameter in item f. To delete a tool, skip item f. and go on to item g.

SEE 4.9.1.h

Table 5-2 Insert Tool and Number at a Particular Step Number Procedure

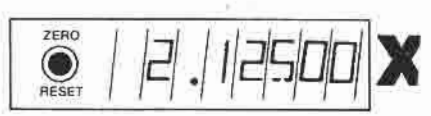
Keying Sequence	Function Explanation (What happens)	Display Status
a. PROG key must be lit.	PRO is in Program mode.	
b. Press STEP# key.		
c. Press digit key 1.	First tool (tool 3) is used during step 1.	
d. Press T key.	T key activates tool mode.	
e. Press digit key 3.	Tool 3(5/32") is used in step 1. (It is not necessary to insert tools in same order as programmed.)	
f. Press STORE key.	Tool 3 is stored at step 1.	
g. Press STEP# key.	PRO advances to next step number.	
h. Press T key.	T key activates tool mode for step 2. Last tool used is displayed.	
i. Press digit key 1.	Tool 1 (1/16") is used.	
j. Press STORE key.	Tool 1 is stored at step 2.	
k. Press STEP# key.		
l. Press digit key 3.	Next tool is used during step 3.	
m. Press T key.	T key activates tool mode for step 3. Last tool used is displayed.	
n. Press digit key 2.	Tool 2 (1/8") is used.	

Table 5-2. Program Tool Number & Diameter Procedure (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
o. Press STORE key.	Tool 2 is stored at step 3.	ZERO RESET | | | 3 | | 2 X

NOTE

Tool 2 is used in both step 3 and step 4. If a tool is used for several sequential steps, it is only necessary to enter it for the first of that series of steps.

SEE 4.9.1.i

5.4. EXAMPLE: TOOL OFFSET

5.4.1. Machining Operation

Mill the slot shown in Figure 5-5 using the PRO to direct tool movements. The slot is the width of the tool diameter (.125).

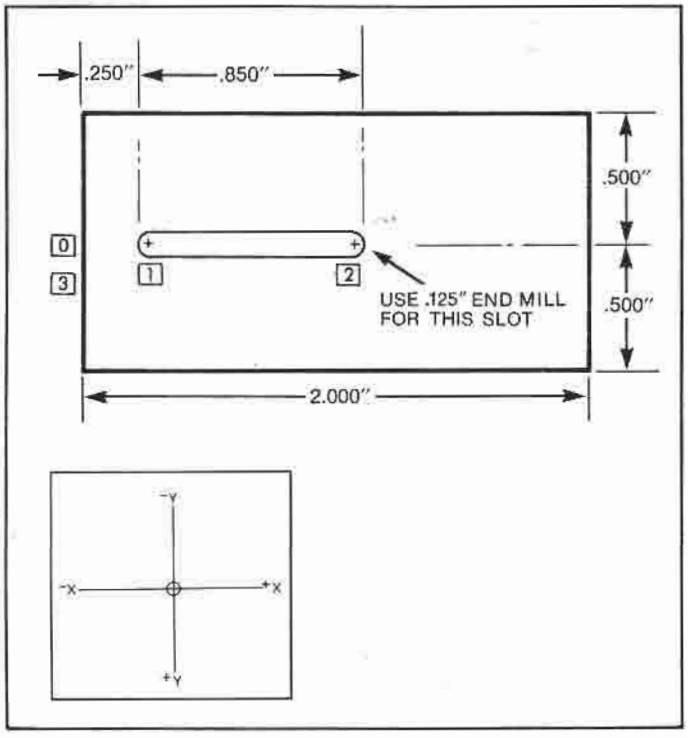


Figure 5-5. Workpiece Example (Tool Offset)

5.4.2. PROgram Chart Preparation

For further details on programming dimensions, tool information, or step numbers, refer to examples 5.2, Dimension/Step #/Store, and 5.3, Tool Change.

a. Number sequentially all points to which measurements are made. Point 0 is the start point for the tool centerpoint (see Figure 5-5).

b. Draw Axis Coordinate System with signs (Figure 5-5, Inset).

c. Complete the PROgram Chart (Figure 5-6) as follows:

1. Fill in step numbers including zero and reference point. Include an additional step number after the last machining step (target point) to be used as an End-of-Program step.
2. Fill in dimensions including sign. For End-of-

ACU-RITE® PRO PROgram Chart PAGE ___ OF ___

DWG NO: Tool Offset
DWG DESCRIP
DWG DATE
PART NO
MATERIAL
TOLERANCE
PROGRAM DATE
PROGRAMMED BY
APPROVED BY
PROGRAM NO
AXIS COORDINATE SYSTEM
MULTIPLIER

PROGRAM COLUMN GROUPS IN THE ORDER INDICATED BY THE NUMBERED BOXES ☐

4 TOOL USE TABLE

TOOL NO	TOOL DIAM	DESCRIPTION
1	0.125	1/8 Mill
0	END-OF-PROGRAM	

1 STEP NO.	1 REF. POINT NO.	2 DIMENSION & SIGN X	Y	Z	3 TOOL OFFSET SIGN X	Y	Z	5 TOOL NO.	TOOL DIAMETER
0	0	0						1	0.125
1	0	0.250			+				
2	1	0.850			−				
3	0	0							
4	0	End of Program						0	.....

(FOR LONGER PROGRAMS, USE ADDITIONAL SHEET)

Figure 5-6. PROgram Chart (Tool Offset)

Program fill in a series of 8 dots in Tool Diameter column.

3. Fill in tool number and tool diameter in both the Tool Use Table and specific column. A tool number of 1 is arbitrarily assigned. The number 0 for step 4 signifies End-of-Program.
4. Complete Tool Offset Sign column. The sign is determined using the following question: When machining at each point number, is the centerpoint of the tool in the plus (+) or minus (–) direction (Figure 5-5, inset) from the edge of the cut to which the dimension is measured? For example, at point 1, the center of the tool is the X dimension at the edge of the cut to which the dimension is measured. This only applies where dimensions are measured to the edge of a cut. There is no tool offset where the dimension is measured to the location of the tool centerpoint at the end of a cut.

5.4.3. **Programming**

a. Follow the standard start-up sequence described in Example 5.2, Dimension/Step#/Store.

b. Using the PROgram Chart, program, check, and correct the dimensions per Example 5.2, Dimensions/Step#/Store.

c. Program the tool number, tool diameter, and End-of-Program per Example 5.3, Tool Change.

d. Practice the combination of programming and operating procedures that follow in Table 5-3.

Table 5-3 Program Tool Offset Sign Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. PROG key lit.	Program mode is activated.	
b. Press STEP# key.		
c. Press digit key 1.	Step 1 is first step where an offset sign is necessary.	
d. Press X-axis PRESET key.	X-axis PRESET key is now lit.	
e. Press T key.	Tool mode is activated.	
f. Press plus (+) key.	The offset sign is plus in step 1. The sign is automatically stored in memory. PRESET key becomes unlit.	
g. Press STEP# key.		
h. Press digit key 2.	To obtain step 2.	
i. Press X-axis PRESET key.	PRESET key is now lit.	
j. Press T key.	Tool mode is activated.	

Table 5-3. Program Offset Sign Procedure (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
k. Press minus key (tool offset sign).	Offset sign for step 2 is minus. PRESET key becomes unlit.	
Programming is now complete.		
	SEE 4.9.1.g	

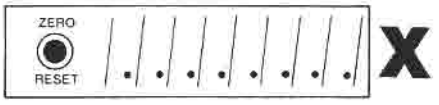
Table 5-3 Inspect Offset Signs Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. PROG key may be lit or unlit.		
b. Press STEP#key.		
c. Press digit key 0.	PRO set to step 0.	
d. Press STEP#key repeatedly.	Step number will advance automatically each time STEP#key is pressed. Tool offset sign will appear on left side of display.	  
	SEE 4.9.2.d	

Table 5-3 Operation Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. Position center point of tool over point 0 for workpiece.		
b. Press ZERO RESET button.	Incremental memory is set to zero.	
c. Press ABS key.	ABS key is now lit. Unit is in absolute mode.	
d. Press ZERO RESET button.	Absolute memory is set to zero.	
e. Press ABS key.	ABS key is no longer lit. PRO is in incremental mode.	
f. Press PROG key so that it is unlit.	PRO is in Run mode.	
g. Press STEP# key.		
h. Press digit key 0.	PRO set to step 0.	
i. Press DIMENSION key.	Display shows tool number and tool diameter.	
j. Press DIMENSION key, again.	Display shows distance which tool must be moved in this step. Display indicates no movement for step 0.	
k. Press DIMENSION key, again.	Display shows distance for step 1. The PRO has already factored in the tool radius (.250 + $\frac{.1250}{2}$ =.3125).	
l. Move tool until display indicates zero.		
m. Press DIMENSION key.	Display shows distance which tool must be moved in step 2. Again, the tool radius has been factored into the value (.850 - $\frac{.125}{2}$ - $\frac{.125}{2}$ =.725).	
n. Move tool until display reads zero.	Begin milling.	

Table 5-3 Operation Procedure (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
o. Press DIMENSION key.	Display indicates End-of-Program.	
p. Remove workpiece, insert new workpiece and begin at item a., above.		

SEE 4.9.1.n

5.5. EXAMPLE: MULTIPLY

5.5.1. Machining Operation

A scale model one-fourth the size of the full-sized component is to be machined. Figure 5-7 shows the full-size dimensions on the drawing. The PRO is to be used with the drawing to machine the scaled-down model.

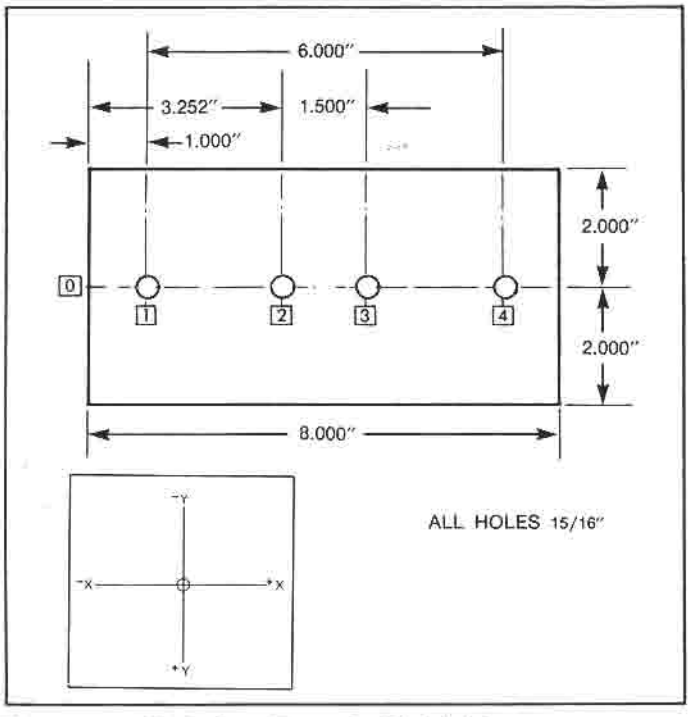


Figure 5-7 Workpiece Example (Multiply)

5.5.2. PROgram Chart Preparation

a. Complete PROgram Chart as explained in Example 5.2. Use dimensions indicated in Figure 5-7 and write multiplier in space provided.

b. Perform the Start-Up or Zero Counter sequence (see 4.9.1.a, Start-Up and Zero Counter).

ACU-RITE® PRO PROgram Chart

PAGE ___ OF ___

DWG. NO. Multiply
DWG. DESCRIP.
DWG. DATE
PART NO.
MATERIAL
TOLERANCE
PROGRAM DATE
PROGRAMMED BY
APPROVED BY
PROGRAM NO.
AXIS COORDINATE SYSTEM
MULTIPLIER 1/4 (.250)

PROGRAM COLUMN GROUPS IN THE ORDER INDICATED BY THE NUMBERED BOXES ☐

4 TOOL NO.	TOOL DIAM.	DESCRIPTION
0	END-OF-PROGRAM	

1 STEP NO.	REF. POINT NO.	2 DIMENSION & SIGN X	Y	Z	3 TOOL OFFSET SIGN X	Y	Z	5 TOOL NO.	TOOL DIAMETER
0	0	0							
1	0	1.000							
2	0	3.252							
3	2	1.500							
4	1	6.000							
5	0	End of Program						0	

FOR LONGER PROGRAMS, USE ADDITIONAL SHEET

Figure 5-8. PROgram Chart (Multiply)

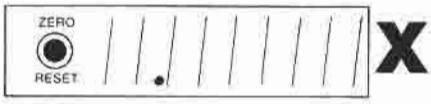
5.5.3. Programming

a. Perform Program Dimension (4.9.1.e.) and End-of-Program (4.9.1.f.) sequences to program from the PROgram Chart (Figure 5-8).

b. Program Multiplier (see Table 5-4).

c. Practice the combination of programming and operating procedures that follows in Table 5-4.

Table 5-4. Program Mulitplier Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. Press MULT RCALL key.	MULT RCALL key is now lit.	
b. Press PRESET key for X-axis.	PRESET key is now lit.	
c. Press CLEAR key.	Previous multiplier is cleared.	
d. Use digit keys and decimal key to enter multiplier.	Enter .250 since a model 1/4 the size is to be machined. PRO assumes a plus (+) unless minus is entered.	
e. Press MULT RCALL key.	MULT RCALL key is no longer lit. The multiplier is now in memory.	

NOTE

a. The multiplier in memory is erased when the PRO is turned off.

b. A different multiplier can be programmed for each axis.

c. The PRO assumes a multiplier of 1 unless otherwise indicated.

d. A multiplier can be used on only one axis, if desired. This is done by programming a multiplier for only that one axis. Multipliers for other axes must be +1.

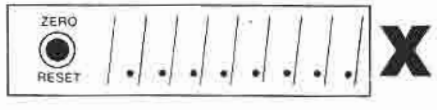
e. When the product of the multiplier and the dimension is very small (less than .001"), there is no perceivable affect on machine travel.

SEE 4.9.1.j

Table 5-4 Operation Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. Position center point of tool over point 0 on scaled-down blank workpiece.	Use a 3/32" end mill.	

Table 5-4. Operation Procedure (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
b. Press ZERO RESET button.		
c. Press ABS key.	ABS key lit; PRO is in absolute mode.	
d. Press ZERO RESET button.	Zero absolute mode.	
e. Press ABS key.	ABS key unlit; PRO is in incremental mode.	
f. Press PROG key so that it is unlit.	PRO is in Run mode.	
g. Press MULT key.	MULT key is lit. When MULT key is off, the multiplier is retained in memory, but measments are not affected.	
h. Press STEP#key.		
i. Press digit key 0.	This is to start at step 0.	
j. Press DIMENSION key.	Dimension for step 0 displayed.	
k. Press DIMENSION key again.	PRO advances to next step number. Display shows distance which the tool must be moved in this step (1.000).	
l. Move tool until display reads zero.	The PRO electronically multiplies the tool movement by 4 (1 divided by a .25 multiplier) so that the display indicates full dimension movement when the tool has only moved 1/4 the full dimension.	
m. Continue to alternately press DIMENSION key and move machine tool repeatedly, until display reads zero.	When display shows series of 8 dots program and machining is complete.	
n. Remove completed workpiece.		

5.6. EXAMPLE: MIRROR-IMAGE

5.6.1. Machining Operation

After machining the workpiece shown in the 5.3 Example: Tool Change, counterbore the holes on the reverse side (see Figure 5-9).

5.6.2. PROgram Chart Preparation

Use the PROgram Chart (Figure 5-4) from the 5.3 Example: Tool Change. If the program is in the PRO memory, do not clear it.

5.6.3. Programming

a. Follow programming procedure in 5.3 Example: Tool Change. If PRO is already programmed, it is only necessary to program the multiplier.

b. Program negative one (–1) multiplier to accomplish mirror image.

c. Practice the combination of programming and operating procedures that follows in Table 5-5.

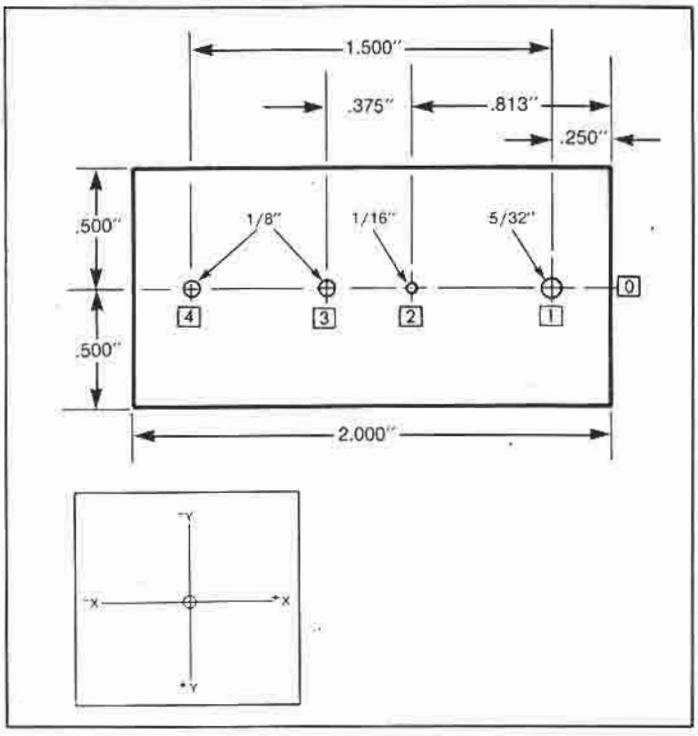


Figure 5-9. Workpiece Example (Mirror Image)

Table 5-5 Mirror Image Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. Press MULT RCALL key.	MULT RCALL key must be lit.	ZERO RESET +0.0000 X
b. Press PRESET key on X-axis.	PRESET key must be lit.	
c. Press CLEAR key.		ZERO RESET + X
d. Press digit key 1.	Enter multiplier.	ZERO RESET +1. X
e. Press minus (–) key.	PRESET key becomes unlit and minus factor is inserted.	ZERO RESET -1. X
f. Press MULT RCALL key.	MULT RCALL key becomes unlit.	ZERO RESET +0.0000 X

SEE 4.9.1.j, k, and l

5.6.4. Operation

The workpiece is turned over and positioned as shown in Figure 5-9. The holes keep the same numbers as the reverse side.

a. Position the tool centerpoint over workpiece point 0 (now on the right side of the workpiece).

b. Press MULT key; it must be lit. Operation is identical to the 5.3 Example: Tool Change; the only difference is that the displayed numbers will have the opposite sign.

5.7. EXAMPLE: TRANSFER (REVERSE ENTRY PROGRAMMING)

5.7.1. Machining Operation

The PRO can be programmed while machining the first workpiece. During the machining of the piece (Figure 5-10), program the PRO so that additional pieces can be machined identically without layout.

5.7.2. Preparation

a. Number points on drawing in order to keep track of machine tool movements.

b. Layout first workpiece.

NOTE

The PROgram Chart can be prepared from the PRO display during the inspection procedures after the unit has been programmed.

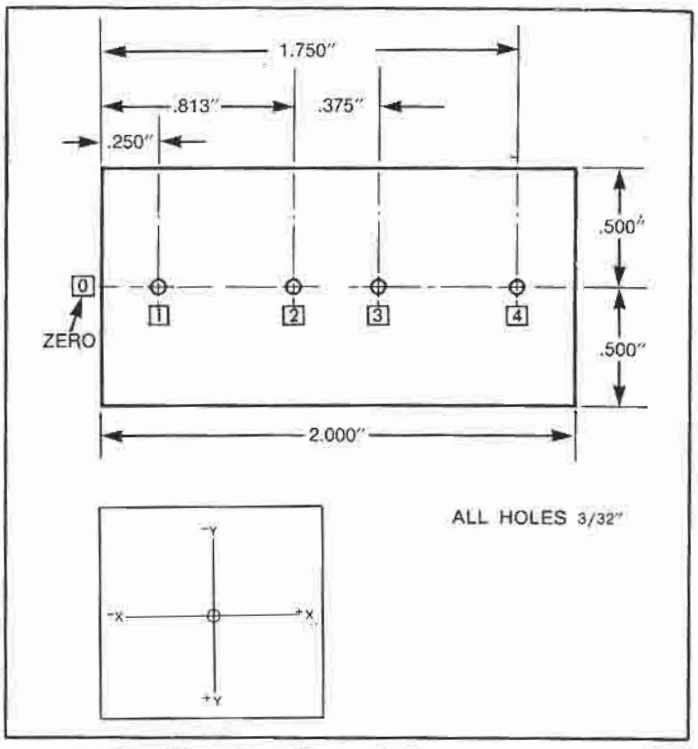


Figure 5-10. Workpiece Example (Transfer)

5.7.3. Programming

a. Perform 4.9.1.a. Start-Up or Zero Counter procedure.

b. Machine the part and program the PRO, concurrently, according to Table 5-6.

Table 5-6 Transfer Machine and Program Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. PROG key is lit.	Program mode is activated.	
b. Press STEP# key.		
c. Press digit key 1.	Step 1 is recalled.	
	NOTE If reference number is "0" as in this case, items d and e are omitted.	
d. Press DECIMAL key.	This prepares unit for input of reference point.	
e. Press digit key 0.	Target point 1 is measured from reference point 0.	

Table 5-6 Transfer Machine and Program Procedure (Cont'd)

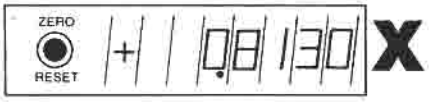
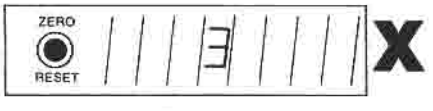
Keying Sequence	Function Explanation (What happens)	Display Status
f. Press XFER key.	XFER key and PRESET keys for all axes become lighted.	
g. Press PRESET keys except for X-axis.	Only X-axis PRESET key is lit.	
h. Move machine tool to point 1.	Display changes from 0 to the point 1 dimension, .2500.	
i. Press STORE key.	Dimension for step 1 is stored in memory. XFER key and PRESET key are automatically unlit.	
j. Press STEP# key.	Display advances to next step.	
	NOTE If reference number is "0" as in this case, items k and l are omitted.	
k. Press DECIMAL key.	Unit is ready for input of reference point for step 2.	
l. Press digit key 0.	Target point 2 is measured from reference point 0.	
m. Press XFER key.	XFER key and PRESET keys for all axes become lighted.	
n. Press PRESET keys except X-axis.	Only X-axis PRESET key is lit.	
o. Move machine to point 2.	Display changes from 0.2500 to 0.8130.	
p. Press STORE key.	Dimension for step 2 is stored in memory.	
q. Press STEP# key.	Display advances to step 3.	
r. Press DECIMAL key.	Reference point can now be entered.	
s. Press digit key 2.	Target point 3 is measured in reference to point 2.	

Table 5-6 Transfer Machine and Program Procedure (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
t. Press XFER key.	XFER and PRESET keys for all axes become lighted. Display shows total incremental movement.	
u. Press PRESET keys except X-axis.	Only X-axis PRESET key is lit.	
v. Press ZERO RESET button.	Incremental memory and display is zero at point 2, since distance to point 3 is measured from point 2.	
w. Move machine to point 3.	Display changes from 0.0000 to 0.3750.	
x. Press STORE key.	.3750" dimension is now stored in memory as the step 3 distance referenced from point 2.	
y. Press STEP# key.	Display advances to step 4.	
	NOTE If reference number is 0, as in this case, items z and aa are omitted.	
z. Press DECIMAL key.		
aa. Press digit key 0.		
ab. Press XFER key.		
ac. Press PRESET keys except X-axis.	Only X-axis PRESET key is lit.	
ad. Press ABS key.	Absolute key is now lit. Dimension from point 0 is displayed.	
ae. Move machine to point 1.	Display changes from 1.188 to 1.750.	
af. Press STORE key.	Dimension for point 4 is now stored.	
ag. Press ABS key.	ABS key is now off.	

Table 5-6 Transfer Machine and Program Procedure (cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
	NOTE Dimensions stored in memory during transfer must be point-to-point, or be referenced from zero; but there is no need to reference every step (target point) to zero.	
	SEE 4.9.1.m	

Table 5-6 End-of- Program Procedure

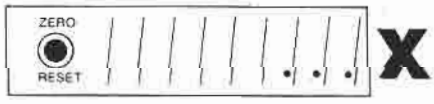
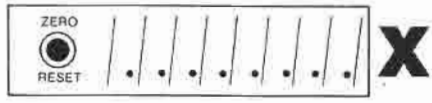
Keying Sequence	Function Explanation (What happens)	Display Status
a. Press PROG key. (lit).	Program mode must be activated.	
b. Press STEP#key.	PRO is ready to accept a step number.	
c. Press digit key 5.	The End-of-Program number is the next number after the last target point number (4). See previous procedure (Machine and Program).	
d. Press T key.	The T key is for programming tool numbers and reminder codes. Three dots on display signify T mode (see Table 5-2, Program Tool, item b.)	
e. Press digit key 0.	The tool number 0 signifies End-of-Program. Display shows eight dots.	
f. Press STORE key.	The End-of-Program is now in memory at step number 5.	
	SEE 4.9.1.f	

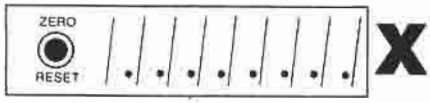
Table 5- 6 Inspect Dimensions Procedure.

Keying Sequence	Function Explanation (What happens)	Display Status
a. Press PROG key (lit).	PRO must be in Program mode.	
b. Press STEP#key.		
	NOTE This example assumes that the first point in the program is 0. First point can also be other than 0 when more than one program is stored at one time.	
c. Press digit key 0.		
d. Press DIMENSION key.	Continue to press DIMENSION repeatedly. PRO will advance to the next step number and display the dimension. The step number can be viewed separately at any time by pressing STEP#key. Press DIMENSION again to continue viewing dimensions.	
	NOTE The dimensions for a particular step number can be inspected by pressing the STEP#key, the step number, and the DIMENSION key. PROG key must be lit.	
	SEE 4.9.2.c	

Table 5-6. Operation Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. Position center-point of tool over point 0 for workpiece.		
b. Press ZERO RESET button.	Zero incremental mode.	

Table 5-6 Operation Procedure (cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
c. Press ABS key.	ABS key lit. PRO is in absolute mode.	
d. Press ZERO RESET button.	Zero absolute mode.	
e. Press ABS key.	ABS key unlit. PRO is in incremental mode.	
f. Press PROG key so that it is not lit.	PRO must be in Run mode (PROG key unlit).	
g. Press STEP# key.		
h. Press digit number key 0.	This is to start a step number 0.	
i. Press DIMENSION key.	Dimension for step 0 is displayed.	
j. Press DIMENSION key again.	Unit advances to next step. Display shows distance and direction which the tool must be moved in this step.	
k. Move tool until display reads zero. Continue to alternately press DIMENSION key and machine until display reads zero.		
	When display shows series of 8 dots, program and machining are complete.	
l. Remove completed workpiece, insert new workpiece, and begin at item a, above.		

SEE 4.9.1.n

5.8. EXAMPLE: STEP INSERTION AND DELETION

5.8.1. Machining Operation

After maching the workpiece shown in 5.2. Example, use the PRO to machine a similiar piece according to the drawing in Figure 5-1.

5.8.2. PROgram Chart Preparation

The above workpiece is similiar to the workpiece in 5.2. Example, except that the old hole 4 has been deleted and a new hole 3 has been added. Therefore, the chart in Figure 5-3 can be used for this example to remove (delete) programmed information for point 4 and add (insert) information for the new point 3.

Practice the combination of programming and operating procedures that follows in Table 5-7.

5.8.3. Operation

Operation is identical to the sequence shown in 5.2 Example, Table 5-1, Operation Procedure. However, the PRO has automatically shifted the point numbers so that the old point 3 changes to the number 4 and the new point 4 is referenced from point 2.

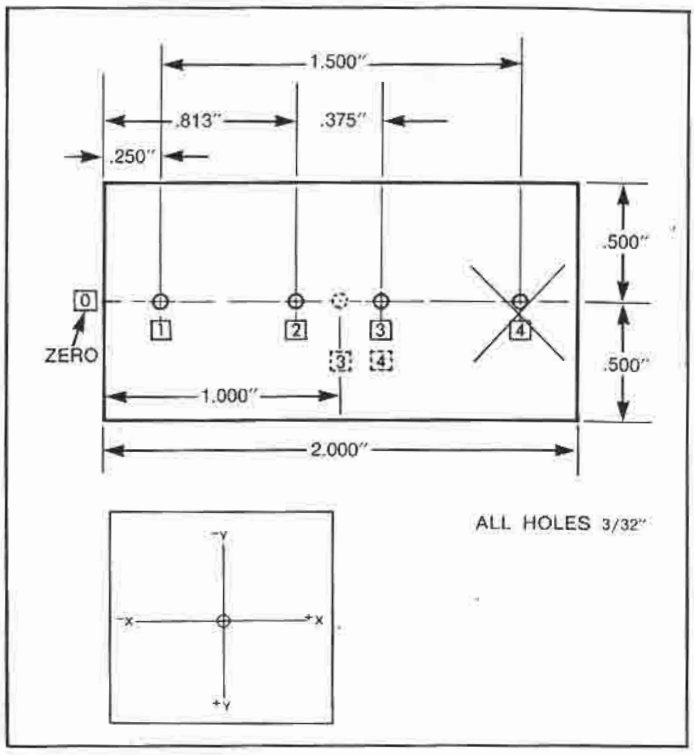


Figure 5-11. Workpiece Example (Step Insertion and Deletion)

Table 5-7. Insert and Delete Procedure

Keying Sequence	Function Explanation (What happens)	Display Status
a. PROG key must be lit.	Program mode is activated	
b. Press STEP# key.		
c. Press digit key 4.	Old step 4 is to be deleted.	
d. Press minus (–) key.	Minus indicates delete this step. Notice that display flashes number –4. Flash indicates memory change.	ZERO RESET |-|||4||| X
e. Press STORE key.	Deletion of step 4 (hole) becomes permanent.	
f. Press STEP# key.		
g. Press digit key 3.	The center of the added hole will become point 3. PRO automatically references the new step 3 to point 0. If changing reference point, press decimal point key and desired digit key.	

Table 5-7. Insert and Delete Step Procedures (Cont'd)

Keying Sequence	Function Explanation (What happens)	Display Status
h. Press plus (+) key.	Plus indicates add. Display flashes +3.	
i. Press STORE key.	PRO automatically moves up all steps following the added step. The old step 3, referenced to step 2 becomes step 4 referenced to 2. The new step 3 still contains the previous data.	
j. Press DIMENSION key.	PRO is prepared for entry of dimension.	
k. Press PRESET key for X-axis.		
l. Press CLEAR key.		
m. Use digit keys and decimal key to enter dimension of point 3 from reference point.	Dimension is 1.000".	
n. Press STORE key.	Dimension is now stored in memory at the new step 3.	
	Programming is complete.	

SEE 4.9.1.d

5.9. EXAMPLE: LATHE APPLICATION

Programming and operating the PRO for use on a lathe is similar to doing so for other standard machine tools. However, there are some basic differences. A review of Section 1 through 4 will provide you with information and procedures common to all machine tools. Differences are listed below, followed by an example procedure for machining a workpiece on a lathe.

a. When programming for lathe work, all reference points are zero.

b. Diameter readout is on the Y-axis display.

c. The centerline of the workpiece represents zero for Y-axis movement: plus (+) movement is toward the operator, minus (–) is toward the cut, or zero.

d. Point numbers are assigned to the intersections of each set of finished X and Y dimensions.

e. As in normal lathe operation, a number of cuts are usually taken to reach zero on the Y-axis diameter display.

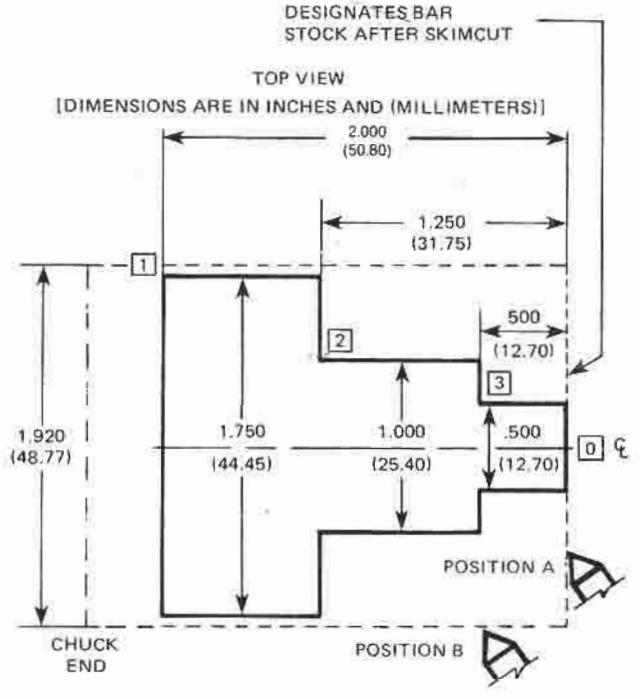


Figure 5-12. Lathe Workpiece "A"

5.9.1. Machining Operation

Figure 5-12 illustrates the finished dimensions of a part machined on a lathe from round bar stock. Step numbers are assigned in order to machine the part using the PRO. They are designated as points [1], [2] and [3], with the [0] representing the centerline (or axis) of the workpiece (refer to Figure 5-14, Program Chart).

5.9.2. System Set-Up

a. If a .00025" (.005mm) resolution scale is used on the lathe crossfeed (Y-axis), diameter switch number 9 on the axis board (see 6.1.6, Internal Switch Settings) is turned off on the particular axis board used for diameter measurements. The resolution switches should be set for .0005" (.01mm) resolution. The resolution of the diameter readout is .0005" (.01mm).

b. If a .0005" (.01mm) resolution scale is used, the resolution switches can be set for .0005" (.01mm) and switch number 9 turned on for .001" (.02mm) resolution diameter readout.

c. When working with diameter measurements on the display, the display must subtract (negative direction) as the tool moves toward the center line of the workpiece, and add (positive direction) as the tool moves away from the center line. If the +/– directional count is the reverse of what is desired, change as follows: first disconnect the line cord, then remove the console top cover and unplug and rotate the axis plug 180° (see Figure 5-13). Be sure pins are aligned and firm contact is made when the plug is replaced on the board connector.

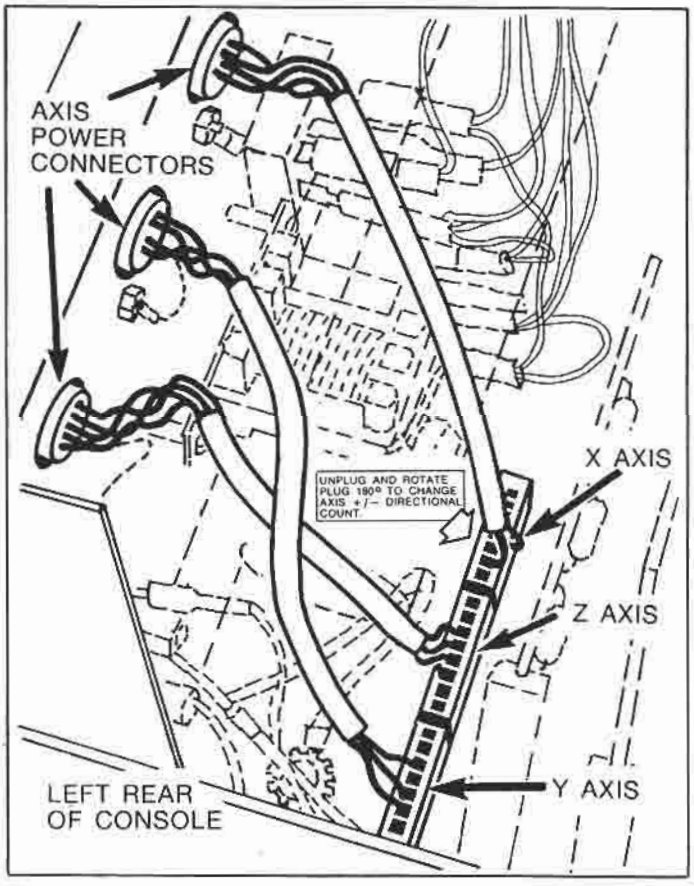


Figure 5-13. Axis Plugs (Rotation)

5.9.3. PROgram Chart Preparation

a. Sequentially number all points which are the final end points of each series of right to left cuts. Zero is on the rotational center line of the workpiece.

b. Draw the Axis Coordinate System including polarity signs. Note that tool movement toward the center line is negative while the tool movement away from the center line is positive.

ACU-RITE PRO PROgram Chart

PAGE ___ OF ___

DWG NO: Lathe Program 'A'

AXIS COORDINATE SYSTEM

PROGRAM COLUMN GROUPS IN THE ORDER INDICATED BY THE NUMBERED BOXES

4 TOOL NO	TOOL DIAM	DESCRIPTION
0	END-OF-PROGRAM	

1 STEP NO	REF POINT NO	2 DIMENSION & SIGN X	Y	Z	3 TOOL OFFSET SIGN X	Y	Z	5 TOOL NO	TOOL DIAMETER
0	0	0	0						
1	0	0	0						
2	1	-2.000	1.750					1	Turn
3	1	-1.250	1.000					1	Turn
4	1	-0.500	0.500					1	Turn
5	0	-2.000	Cut off piece					2	Cut off
		End of Program						0	.....

Figure 5-14. Program Chart "A"

c. Complete PROgram Chart (Figure 5-14) as follows:

1. Fill in step numbers including zero. Since all diameters are referenced from zero, all other dimensions must be referenced from zero. Add one additional step for End-of-Program.

2. For each step number, fill in the dimension. All diameters are positive and are referenced from zero. Convert all X-axis dimensions so that they are measured from zero. This is necessary because dimensions on both axes must use the same reference point, and the reference point must be zero on the Y-axis. In this example, the X-axis dimensions will be negative because the zero point is on the right side and measurements are made to the left of zero. See Figures 5-12 (inset) and 5-14.

d. Programming:
Use standard programming procedures from the Programming and Operating Guide to program the PRO from PROgram Chart data.

5.9.4. Operating Procedure

a. Skim-cut piece and carefully "mike" the diameter.

b. Press STEP#, 1. Enter the diameter by pressing PROG. PRESET on the Y-axis, CLEAR, and enter the value. Be sure to STORE the entered value.

c. Press STEP#, 2. The diameter dimension in Y will be material to be removed. Machine to 0 for distance of 2, or until X = 0. Move back to end of workpiece.

d. Face workpiece, zero-reset the incremental and absolute counters in "X" axis.

e. Press STEP#, 3 and machine to 0 in both axes.

f. Press STEP#, 4 and machine to 0 in both axes.

g. Press STEP#, 5 and move X to zero and cut off workpiece.

h. Because the piece is machined by a series of cuts, the display must be watched and interpreted carefully. Use the following procedure to finish each of the three diameters:

1. For step 1 (PROG key unlit during RUN operation, press STEP# key, and digit key 1) the Y-axis will show +.1700, which is the thickness that must be removed to reach the diameter of 1.750.

2. Move the tool to the right, past the point where you want to initiate the cut.

NOTE

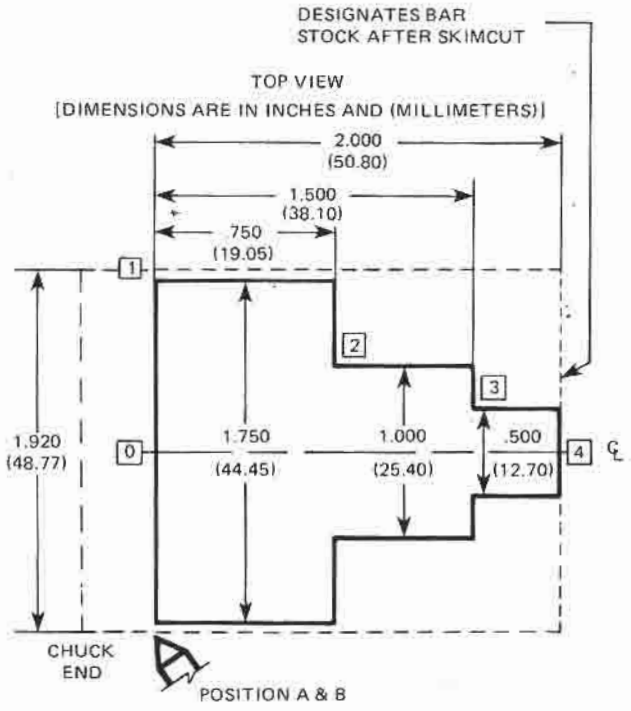
Good machining practice on a lathe often dictates that the workpiece should be rough cut with one tool and finish cut with the same tool redressed. However, if the lathe is equipped with a tool indexing turret, both tools can be used at separate stations and indexed to position.

3. Set the depth of the cut on the Y-axis and begin cutting. Continue making cuts by setting the depth of cut and moving from right to left until the X-axis indicates zero. Continue making cuts until both the X and Y axes indicate zero. This is point 1.

4. Repeat this procedure for subsequent steps. That is, press the DIMENSION key, back the tool bit off the workpiece and move it to the right. Set the depth of the cut desired. (The Y-axis may indicate zero, but must never be negative, which indicates too great a depth of cut.) Move the tool until the X-axis display indicates zero. Continue taking cuts until both displays read zero.

5.9.5. Alternative Programming Method

The previous example measured dimensions from the right side of the workpiece. Below is an alternative method of programming as indicated by Figures 5-15 and 5-16. Here, X-axis dimensions are measured from the left side.



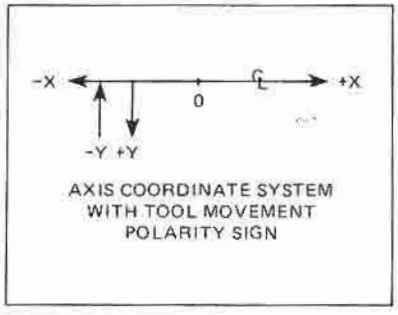


Figure 5-15. Lathe Workpiece "B"

ACU-RITE® PRO PROgram Chart PAGE ___ OF ___

DWG NO	Lathe Program 'B'
DWG DESCRIP	
DWG DATE	
PART NO	
MATERIAL	
TOLERANCE	
PROGRAM DATE	
PROGRAMMED BY	
APPROVED BY	
PROGRAM NO	

AXIS COORDINATE SYSTEM

MULTIPLIER

4 TOOL USE TABLE		
TOOL NO	TOOL DIAM	DESCRIPTION
0	END-OF-PROGRAM	

PROGRAM COLUMN GROUPS IN THE ORDER INDICATED BY THE NUMBERED BOXES ☐

1		2 DIMENSION & SIGN			3 TOOL OFFSET SIGN			5	
STEP NO	REF POINT NO	X	Y	Z	X	Y	Z	TOOL NO	TOOL DIAMETER
0	0	0	0						
1	0	0	+1.750						
2	0	+.750	+1.000						
3	0	+1.500	+.500						
4	0	+2.500	0						
5	0	End of Program						0	.....

Figure 5-16. Program Chart "B"

SECTION 6
SYSTEM INSTALLATION

This section includes complete installation instructions for the PRO system, which consists of the digital readout, measuring scales, and power connections. Separate installation instructions for the A-R/5 and Mini-Scale are packaged with the scales. These instructions include procedures for checking out the system with your machine tool in preparing for operation. Finally, there is a complete list of operating specifications for your PRO.

6.1. INSTALLATION OF CONSOLE

6.1.1. General

Console installation procedures consist of locating the console on one of the two types of stands: machine-mounted or floor-mounted. Procedures for making electrical connections and internal switch settings are also described.

6.1.2. Console Location

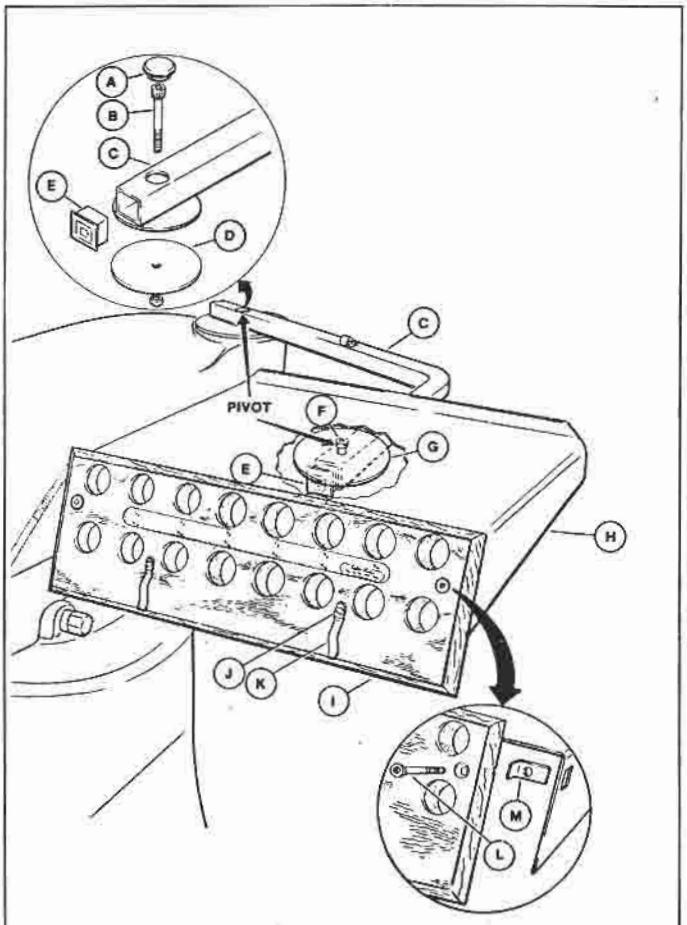
When selecting the proper location for the console, be sure of the following for safety and convenience:

- The operator can easily reach the panel controls.
- The console is mounted at eye level for comfortable reading of the display and controls.
- There is no interference with operation or loading of the machine tool.
- The console is located away from coolant splash and flying chips.

6.1.3. Column-Mounting Kit Assembly

This kit is installed on the ram or column of the machine tool. Install the kit as follows (refer to Figure 6-1):

1. Drill and tap hole adequate for the pivot bolt (B) at the mounting location as shown.
2. Attach the arm assembly (C) to the machine as shown in Figure 6.1.
3. Place the center of the tray support plate (G) and the center of the tray (H) over the hole in the arm assembly and assemble using the pivot bolt (F).
4. Tighten all nuts and screws securely.
5. Attach the board mounting retainers (M) to the tray. Mount the collet board (I) to the tray as indicated in Figure 6-1. Attach spring clips (K) to collet board with spring mounting screws (J).
6. Attach hole plug (A) and end cap (E) as indicated in Figure 6-1.
7. If mounting to vertical or angular machine surface is required, locate the adjustable mounting bracket at desired tray height.
8. Locate drill and tap 4-5/16-18 holes. Take care to avoid machine damage.
9. Cut off adjustable brace to desired length and install.
10. Tighten all bolts when Collet master is in level position.



BILL OF MATERIAL

Ref. No.	Description	No. Req.
A	Plug	1
B	Bolt, Pivot w/lock nut, ⅜"x16x4" SHCS	1
C	Arm Assembly	1
D	Washer, Mounting Plate, 3⅛ dia.	1
E	Cap, End	2
F	Bolt, Pivot w/lock nut, ¼"-20x1½"	1
G	Tray	1
H	Collet Board	1
I	Screw, Clip Mtg., w/nut, #8-32x1"	2
J	Clip, Spring	2
K	Screw, ¼"-20x1½"	2
L	Retainer, Board Mtg.	2
M	Series 1020 Adjustable mtg. brackets w/hardware Instructions & Parts List	1

Figure 6-1. Column-Mounted Console Bracket Kit

6.1.4. Floor Stand Assembly

The floor stand should be located behind and to one side of the machine where it will not be bumped and does not obstruct table travel or routing of cables, etc.

1. Assemble base (J) to riser tube (I) with bolt and lock washer (K) and washer (L).
2. Attach tray (B) to riser Tube (H) with Bolt (A). Place riser tube (H) to riser Tube (I) and level with leveling pads (M).

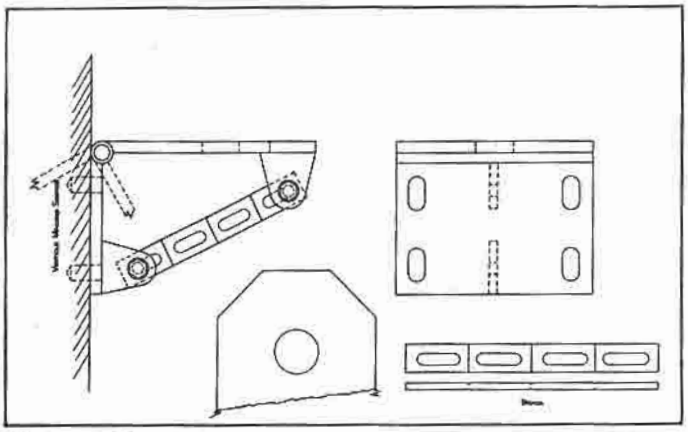
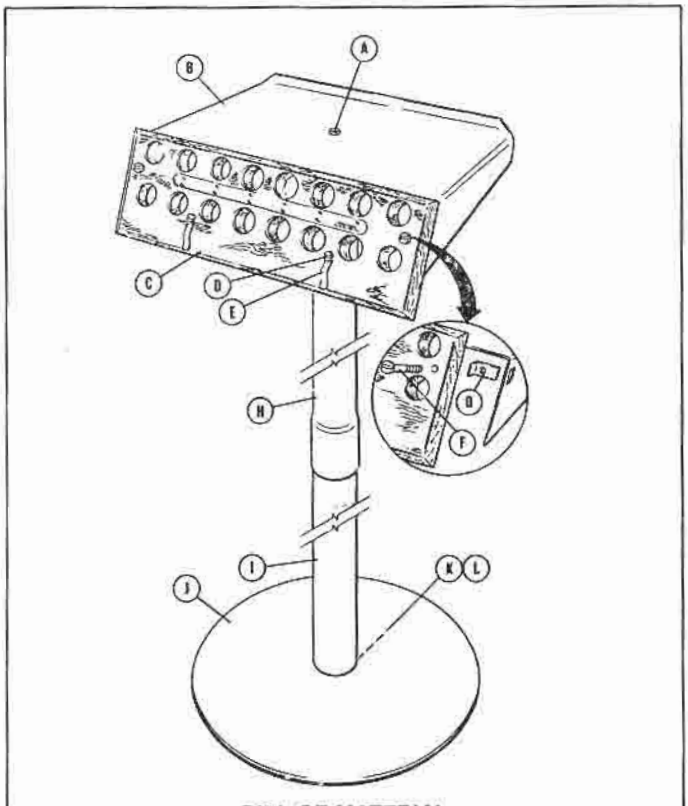


Figure 6-2. Adjustable Mounting Bracket

3. Attach board mounting retainers (G) to the tray. Mount Collet board (C) with bolts (F) and install spring clip (E) with spring mounting screws (D).



BILL OF MATERIAL

Ref. No.	Description	No. Req.
A	Bolt, ¼"-20x1½" hex. hd.	1
B	Tray	1
C	Collet Board	1
D	Screw w/nut, #8-32x1⅛ truss hd.	2
E	Clip, Spring	2
F	Screw, ¼"-20x1½" truss hd.	2
G	Retainer, Board Mtg.	2
H	Riser Tube, Upper	1
I	Riser Tube, Lower	1
J	Base	1
K	Bolt w/lockwasher, ½"-13x1½" hex. hd.	1
L	Washer, 4½" dia.	1
M	Leveling Pads	3
N	Instructions and parts list	

Figure 6-3. Console Floor Stand Kit

CAUTION

Make sure that all screws are tight and that the floor stand is rigid before placing the console on the tray.

6.1.5. Electrical Connections

CAUTION

Do not operate the system with a supply voltage other than that marked on the console nameplate. Incorrect voltage can damage the system.

a. Refer to Figure 6-4. Connect a heavy-gauge braided ground strap or copper wire from the thumbscrew terminal on the rear of the console to a convenient point on the machine base. Check that the ground wire is a minimum length and routed so that it will not be pulled or rubbed during machine operation. Ground the machine base by connecting it to a cold-water pipe or other solid earth ground. A metal stake driven several feet into the ground will suffice if no other ground is available. (No special ground is required for scale assemblies.)

b. Plug the console power cord into a properly grounded outlet of the correct voltage.

c. Turn the console on and check that the fault indicator at the left of the display lights. If the fault indicator does not light, check the line voltage connection to be sure there is power to the outlet.

If the fault indicator still will not light, refer to System Troubleshooting in Section 8.

6.1.6. Internal Switch Settings

There are up to three identical printed-circuit axis display boards (one for each axis) at the left inside of the console. A typical board is shown in Figure 6-5. On each board there is a nine-switch assembly. The individual switches must be set in accordance with your particular system and installation. Instructions for setting switches 1 through 5 are given in the Error Correction Procedure in Section 7. Set the remaining switches as indicated in Table 6-1.

NOTES

1. The switches in your console have been set for .0005" scales on all axes. Check the setting and change if required.
2. Some consoles have internal switches with slightly different labeling, in these switches "open" corresponds to OFF.

WARNING

Always disconnect the line cord before attempting to remove the cover.

Table 6-1. Internal Switch Settings

Scale	S1 Switch Settings								
Resolution	1	2	3	4	5	6	7	8	9
.0005"	See					OFF	OFF	OFF	OFF
.00025"*	Error					OFF	OFF	OFF	OFF
.0002"	Correction					OFF	ON	OFF	OFF
.0001"	in					ON	OFF	OFF	OFF
.01mm	Section 7					ON	OFF	ON	OFF
.001mm						ON	ON	ON	OFF
.002mm						OFF	ON	ON	OFF
.005mm (linear)						OFF	OFF	ON	OFF
.005mm**						ON	OFF	ON	OFF

* The .00025" Mini-Scale is used for diameter measurement only. It reads out in .0005" increments.

** When the .005mm scale is used for diameter measurements, it reads out in .01mm increments.

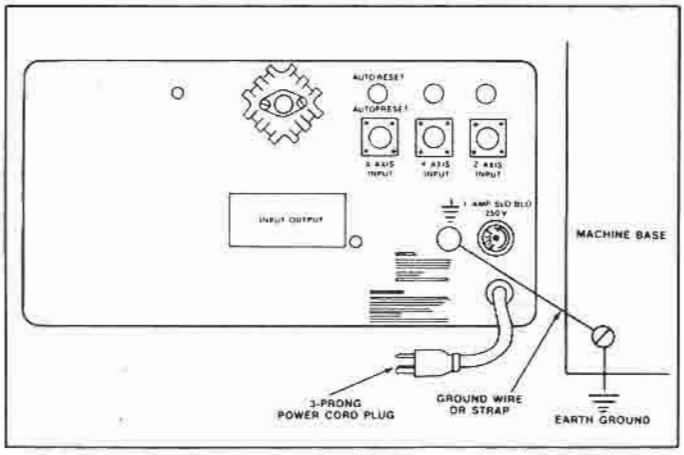


Figure 6-4. Console Electrical Connections

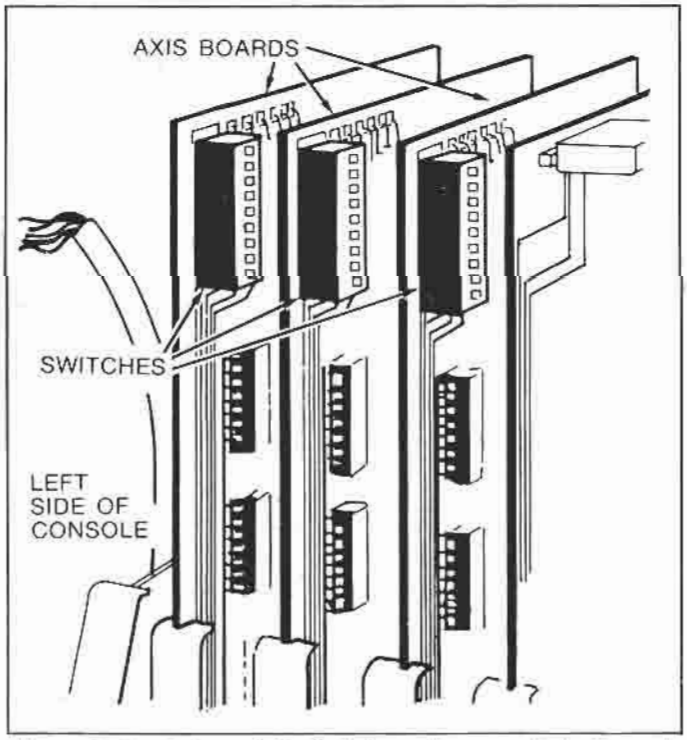


Figure 6-5. Internal Switch Locations on Axis Boards

6.2. SPECIFICATIONS

6.2.1. Console

Capacity:	Two or three axes of 7 decades each.
Display:	Each axis (2 or 3) has a full 7 decade of 7-segment LED's; long life, readable to over 20 feet at 120° viewing angle, plus and minus sign and power fail indication.
Circuitry:	Micro processor-based circuitry.
Inputs:	TTL compatible quadrature square waves (input noise filtered by signal sampling technique).
Front Panel Controls:	Power On/Off Switch, Zero Reset Buttons, mm-Inch Selector Switch, Preset Keys, Digit Keyboard, Plus-Minus Keys, Clear Key, ABS Key, Program Key, Store Key, Step Number Key, Tool Key, Dimension Key, Decimal Key, Transfer Key, Multiplier Key, Multiplier Recall Key, Auto Reset Switch.
External Connections:	Two or three signal inputs.
Diameter/Radius Display:	Internal selectable diameter or radius display.
Fault Indicator:	Power interruptions and excessive count rate are flagged in the display.
Linear Corrections:	Output count can be modified in increments of ±15 parts/million up to a maximum of ±225 parts/million (with expansion to 900ppm) to compensate for some types of machine or temperature error.
Auto Reset:	Selects normal operation or automatic zero reset in conjunction with Fiducial Trigger Output (FTO) signal on special scales, only.
Power:	115VAC ±10%, .6A, 50-60 Hz, convertible to 100V, 220V, 240V.
Ambient Temperature:	0° C (32° F) to 40° C (104° F).
Resolution:	PRO is internally switch-settable to match any of the following scale resolutions (Specify). .0015"/.01mm/.005mm. .0001"/.002mm. .00025" (opt. for dia. readout).
Dimensions:	W13" x H7" x D10" (330mm x 178mm x 254mm)
Weight (net):	15 pounds

DISPLACEMENT RANGES - Acu-Rite Scale Assemblies:

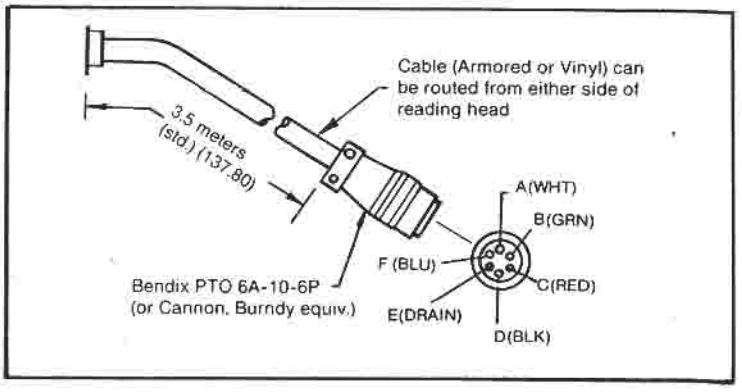
Measuring Range mm (inches)	AR-5 10 μm (.0005") 3820	MINI 10 μm (.0005") 3831	MINI 5 μm (.00025") 3832	MINI 2 μm (.0001") 3807	MINI 1 μm (.00005") 3834
50 (2")	—	383102	383202	380702	383402
100 (4")	—	383104	383204	380704	383404
150 (6")	—	383106	383206	380706	383406
200 (8")	—	383108	383208	380708	383408
250 (10")	—	383110	383210	380710	383410
300 (12")	382012	383112	383212	380712	383412
350 (14")	—	383114	383214	380714	383414
400 (16")	382016	383116	383216	380716	383416
450 (18")	382018	383118	383218	380718	383418
500 (20")	382020	383120	383220	380720	383420
600 (24")	382024	383124	383224	380724	383424
650 (26")	382026	383126	383226	380726	383426
750 (30")	382030	383130	383230	380730	383430
900 (36")	382036	383136	383236	380736	383436
1000 (40")	—	383140	383240	380740	383440
1050 (42")	382042	383142	383242	380742	—
1225 (48")	382048	383148	383248	380748	—
1375 (54")	382054	383154	383254	380754	—
1525 (60")	382060	383160	383260	380760	—
1625 (65")	382065	—	—	—	—
1800 (72")	382072	—	—	—	—
2000 (80")	382080	—	—	—	—
2250 (90")	382090	—	—	—	—
2550 (100")	382091	—	—	—	—
2800 (110")	382092	—	—	—	—
3050 (120")	382093	—	—	—	—

RACK & PINION SYSTEMS

CATALOG NO.	USABLE LENGTH
38-28-05	3067mm.(120.74")
38-28-06	3305mm.(130.11")
38-28-07	3457mm.(136.11")
38-28-08	3660mm.(144.11")
38-28-09	3864mm.(152.11")
38-28-10	4067mm.(160.11")
38-28-11	4305mm.(168.48")
38-28-12	4457mm.(175.48")
38-28-13	4660mm.(183.48")
38-28-14	4864mm.(191.48")
38-28-15	5067mm.(199.48")
38-28-16	5305mm.(208.85")
38-28-17	5457mm.(214.85")
38-28-18	5660mm.(222.85")
38-28-19	5864mm.(230.85")
38-28-20	6067mm.(238.85")
38-28-21	6305mm.(248.22")
38-28-22	6457mm.(254.22")
38-28-23	6660mm.(262.22")
38-28-24	6864mm.(270.22")
38-28-25	7067mm.(278.22")
38-28-26	7305mm.(287.59")
38-28-27	7457mm.(293.59")

CATALOG NO	USABLE LENGTH
38-28-28	7660mm.(301.59")
38-28-29	7864mm.(309.59")
38-28-30	8067mm.(317.59")
38-28-31	8305mm.(326.96")
38-28-32	8457mm.(332.96")
38-28-33	8660mm.(340.96")
38-28-34	8864mm.(348.96")
38-28-35	9067mm.(356.96")
38-28-36	9305mm.(366.33")
38-28-37	9457mm.(372.33")
38-28-38	9660mm.(380.33")
38-28-39	9864mm.(388.33")
38-28-40	10m.067mm.(396.33")
38-28-41	10m.305mm.(405.70")
38-28-42	10m.457mm.(411.70")
38-28-43	10m.660mm.(419.70")
38-28-50	12m.067mm.(475.07")
38-28-58	13m.660mm.(537.81")
38-28-65	15m.067mm.(593.18")
38-28-73	16m.660mm.(655.92")
38-28-80	18m.067mm.(711.29")
38-28-88	19m.660mm.(774.03")

STANDARD CABLE CONNECTOR



ENGINEERING & QUALITY

Resolution μm (inches)	AR-5 MINI 3820 3831 10 μm (.0005")	MINI 3832 5 μm (.00025")	MINI 3807 2 μm (.0001")	MINI 3834 1 μm (.00005")
Line Density lines/mm (lines/inch)	25 (635)	25 (635)	62.5 (1588)	125 (3175)
Accuracy μm in 50 mm (inches) (2 inches)	—	—	±2 μm (±.00008")	±1.5 μm (±.00006")
μm in 250 mm (inches)(10 inches)	—	—	±4 μm (±.00015")	±2.5 μm (±.0001")
μm in 1000 mm (inches)(40 inches)	±10 μm (±.0004")	±10 μm (±.0004")	±5 μm (±.0002")	±5 μm (±.0002")
Slew Speed mm per sec (inches)	1000 (40)	1000 (40)	500 (20)	250 (10)

STANDARD SPECIFICATIONS - Acu-Rite Scale Assemblies:

Repeatability	Within one resolution count (all scales)
Backlash	1.5 μm (.00006) (all scales)
Operating Conditions	0°C to 50°C (32°F to 122°F) 25% to 95% relative humidity (non-condensing)
Storage Conditions	-40°C to 65°C (-4°F to 149°F) 20% to 95% relative humidity (non-condensing)

ELECTRICAL CHARACTERISTICS

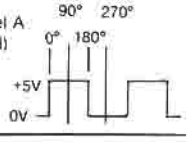
TTL compatible. Transistor collector output with internal pull-up resistor to Vcc.

Logic "1" level = pull-up to Vcc through a resistor.

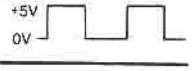
Pull-up resistors
Signal outputs = 900±25% ohms
Fiducial outputs = 1.8K±25% ohms

Logic "0" levels
Signal outputs = -0.4 Vdc to 0.5 Vdc at -7mA
Fiducial outputs = -0.4 Vdc to 0.5 Vdc at -2mA

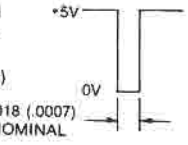
PIN A
Channel A (Typical)



PIN B
Channel B (Typical)



PIN F
Fiducial Trigger Output (Typical)



PIN	INPUT/OUTPUT
A	Channel "A" square wave signal
B	Channel "B" square wave signal in quadrature (90° nominal phase relationship) with channel "A" signal
C	Vcc, ±5.1±.1 Vdc power, 200mA max
D	Common (power supply and signal return)
E	Shield, reading head case ground
F	Fiducial trigger output signal (when provided)

SECTION 7
MACHINE TOOL ERROR COMPENSATION

7.1. WHY ERRORS OCCUR

In every machining operation, there is always some degree of error or inacurracy due to at least one of the following machine tool deficiencies:

a. Gravity causes deflections in the machine tool structure (see Figure 7-1) particularly when a heavy workpiece is placed on a machine with overhanging table or ways. A result of these deflections is commonly called Abbe error. (The following paragraphs provide further explanation.)

b. The fit between mating surfaces is loose, because of either manufacturing tolerances, subsequent wear, or improper gib adjustment.

c. The ways are not scraped straight or are not aligned perfectly at assembly.

d. Driving and cutting forces cause deflections, since no material is totally rigid.

e. Temperature gradients can distort machine geometry.

In addition, machine tables and ways can be forced out of alignment if you use the locks improperly. Tables that are not completely locked in position can be caused to shift from the forces of machining and eventually wear.

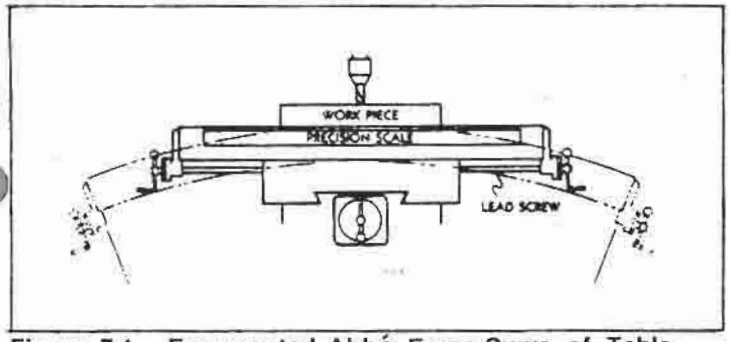


Figure 7-1. Exaggerated Abbé Error Curve of Table Travel on a Milling Machine with an Overhanging Table

Abbe error is a progressive fault occurring in machine tool tables or beds. Gibs and table ways can wear due to an increase in pressure at the edge of the machine way, on both the knee and at the center of the table. This causes increased wear at these points as the weight of the table moves to increase the overhang.

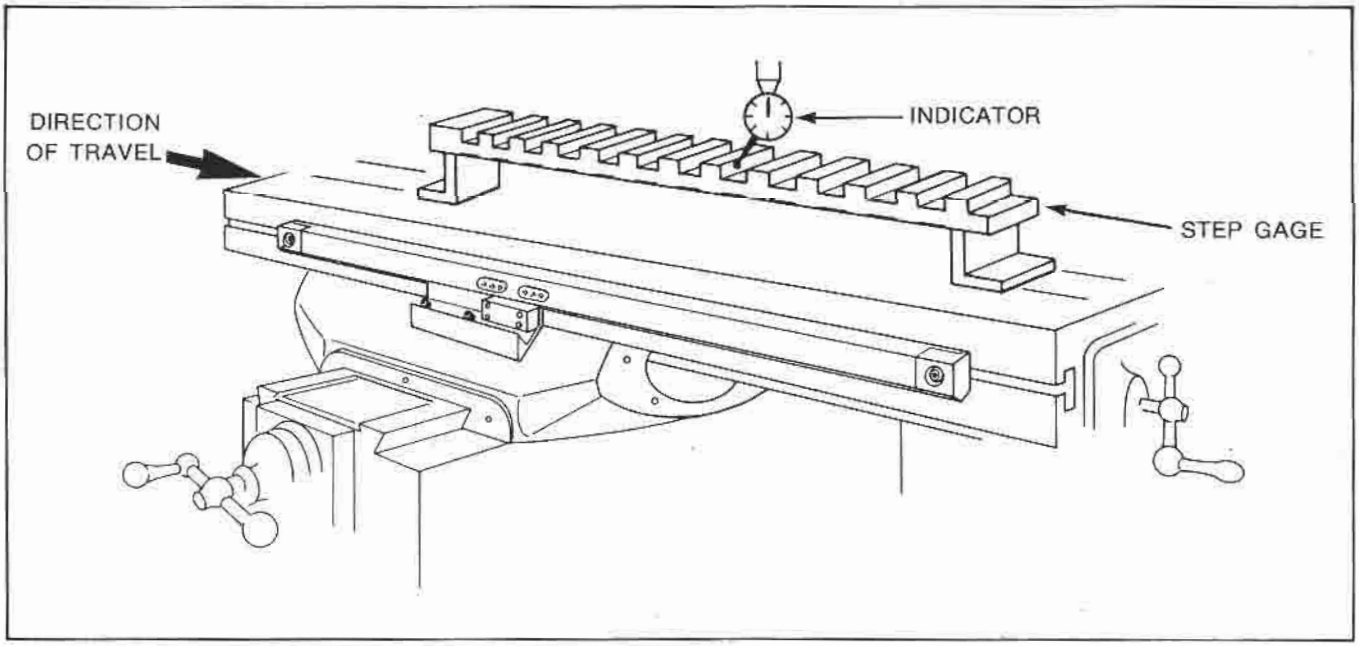
Because the increase of weight is gradual as a table moves from center, so is the wear. The result is the formation of an arc shape along the table and knee, concave to the ways. Pressure of the gib against the way causes the gib to wear. Often when a short travel is used, retightening the gib causes localized wear of the way.

The scale attached to the table measures its horizontal motion with respect to the fixed reader head. A worn table, however, follows the curvature of the arc, resulting in an error in the movement of the workpiece relative to the cutter. In the case of the milling machine, the workpiece is moving too far.

7.2. HOW TO MEASURE ERRORS

Most errors resulting from the above conditions can be measured with a simple step-by-step procedure. You will need an accurate indicator and a recently calibrated measuring standard. Procedures vary slightly from one machine to another, but the concept remains the same.

a. Take measurements at the height above the machine surface where tooling is normally located.



b. Locate the standard on the machine table at the height where most machining takes place. Jo blocks, a step gage, a laser interferometer or other standards can be raised on parallels to meet this requirement.

c. When using a step gage, or similar standard (with the indicator located in the spindle), take measurements along the standard at 2- to 6-inch intervals. All measurements should be taken in the same direction of table motion.

d. If the standard selected has not been recently calibrated, have the standard inspected to establish current length.

Below are two specific procedures for measuring machine table errors. The first (7.2.1.) is relatively simple, and sufficient for shorter-length measurements on small mills, jig borers, etc. The second (7.2.2.) is a bit more detailed and dependent upon availability of the step gage standard required (permits maximum accuracy). Also, see "NOTE" under 7.3, Error Correction Procedure.

7.2.1. Simplified Procedure

a. Select (and support on parallels) Jo blocks, gage rods, or other standards preferred for accurate *length* measurement.

b. Take measurements of the standard on (or near) the table centerline (X-axis) starting at table height. Raise the standard 2" or 4" and repeat the measurement. Then raise to 6" to 8" as desired, and take the third measurement.

c. Determine the error by noting the difference between each of the measurements and averaging the results.

d. Correct the error according to 7.3, Error Correction Procedure.

NOTE

The same procedure as above can be used at three table surface locations on the Y-axis of the table. This will determine any horizontal error.

7.2.2. Step Gage Procedure

The following is an example procedure using a step gage as the measuring standard (see Figure 7-2).

a. Set up the step gage on the table at a height and position that coincides with that of a typical workpiece.

b. Insert a dial indicator into the spindle and lower it until the indicator can contact the first reference surface of the gage.

c. Set the dial indicator to zero.

d. Turn on the console and reset it to zero.

e. Raise the spindle and move the table until the next reference surface is close to the dial indicator.

f. Lower the spindle and carefully move the table until the indicator contacts the gage surface and registers zero.

g. Record the distance moved as measured by the standard and as measured by the system and displayed on the console. Then record the difference between the two measurements.

NOTE

Make sure that each measurement reading is repeatable.

Table 7-1. Standard and Displayed Measurements (Inch)

Distance Measured by Standard	Measurement Displayed on Readout	Difference Between Measurements
0.0000	0.0000	0
3.0000	3.0000	0
6.0000	5.9995	-.0005
9.0000	8.9995	-.0005
12.0000	11.9990	-.0010
15.0000	14.9990	-.0010
18.0000	17.9990	-.0010
21.0000	20.9985	-.0015
24.0000	23.9985	-.0015
27.0000	26.9985	-.0015
30.0000	29.9980	-.0020

h. Repeat steps 5 through 7 until you have moved the length of the standard.

Table 7-1 is an example of a set of recorded measurements from the standard and the display taken at 3" intervals over a 30" travel. The difference between these measurements can be plotted on a graph to determine what compensation is required to minimize the apparent error.

Figure 7-3 is a graph using the standard measurements to represent one coordinate and the range of apparent error to represent the other coordinate. By plotting coincident points on the graph, a best-fitting straight line "C" can be drawn through the approximate center of the points plotted.

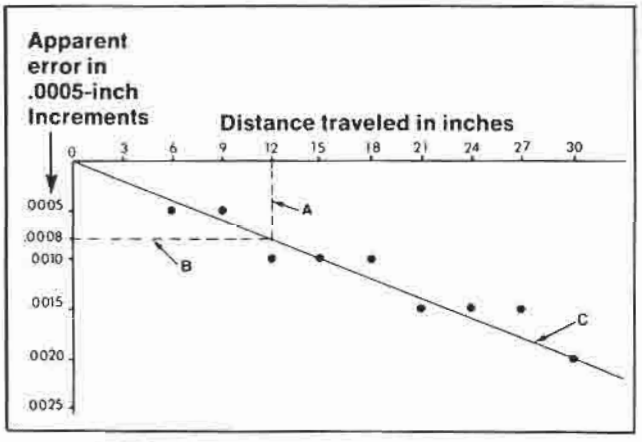


Figure 7-3. Error Slope Plotted in Inches

Drawing a vertical line "A" at any of the selected distance measurements and a horizontal line "B" where 'A" intersects line "C", we determine the amount of correction necessary to reduce the total error. The following formula is used to compute the error:

$$\text{Error} = \frac{B}{A} = \frac{-.00080}{12 \text{ in.}} = -.0000667$$

Moving the decimal point 6 places to the right, the resultant correction (or compensation) factor for the error is 66.7 parts per million. See 7.2, Error Correction Procedure, below, which explains how to use this number.

Below, Table 7-2 and Figure 7-4 repeats the same examples for determining error in metric measurements.

Table 7-2. Standard and Displayed Measurements (Metric)

Distance Measured by Standard (mm)	Measurement Displayed on Readout (mm)	Difference Between Measurements (mm)
0.0	0.00	0
76.2	76.200	0
152.4	152.388	.012
228.6	228.588	.012
304.8	304.775	.025
381	380.975	.025
457.2	457.175	.025
533.4	533.362	.038
609.6	609.562	.038
658.8	658.762	.038
762	761.950	.050

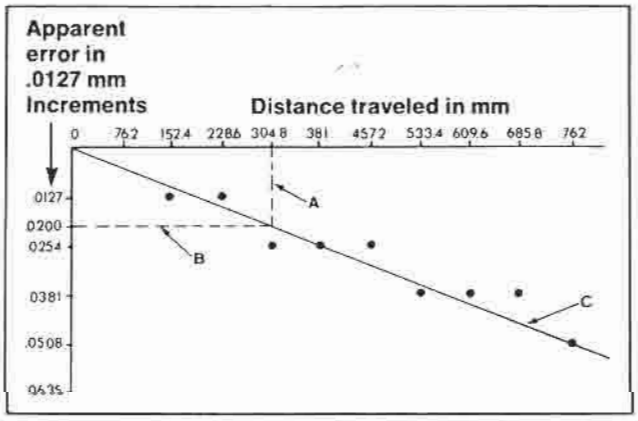


Figure 7-4. Error Slope Plotted in mm

7.3. ERROR CORRECTION PROCEDURE

NOTE

Sometimes error corrections are made based on a particular workpiece weight. When there is a weight deviation, a new error factor will be introduced. Therefore, additional measurements will be required, followed by a recorrection of the error. After computing the error, select the nearest available correction factor from the list provided in Table 7-3 (60ppm in this case). Unplug the line cord, then remove the cover from the

Table 7-3. Switch Assembly S1, Settings for Error Correction

Correction Factor (ppm)	Switch Number #1	#2	#3	#4	#5
No Correction	off	off	off	off	Either off (+) or on(-)
+/- 15	on	off	off	off	off/on
+/- 30	off	on	off	off	"
+/- 45	on	on	off	off	"
+/- 60	off	off	on	off	"
+/- 75	on	off	on	off	"
+/- 90	off	on	on	off	"
+/-105	on	on	on	off	"
+/-120	off	off	off	on	"
+/-135	on	off	off	on	"
+/-150	off	on	off	on	"
+/-165	on	on	off	on	"
+/-180	off	off	on	on	"
+/-195	on	off	on	on	"
+/-210	off	on	on	on	"
+/-225	on	on	on	on	"

NOTES

1. When switch #5 is off (+) forward pulses are added to forward motion, and reverse pulses added to reverse motion. Switch #5 on (−) will add reverse pulses to forward motion and forward pulses to reverse motion.

2. In some consoles the internal switches may not be labeled as indicated above. For these switches, the designation "OPEN" corresponds to the "OFF" position and there will be no designation corresponding to the "ON" position.

console; you will note that each axis/display board contains one set of switches (S1). Switch set S1 contains nine switches. Switches 1 through 5 control the transfer (machine tool) error correction factor. (See Section 6, Installation, Internal Switch Settings for use of switches 6 through 9.) Use these switches on each axis board to make linear corrections according to position selection in Table 7-3. Be sure that the sign (+ or −) of the correction switch (5) is chosen correctly. Since in this case the readout is displayed a shorter measurement than the standard, the procedure is to add a correction factor to make them equal.

CAUTION

Check the readout display. A mistake here will double instead of cancel the error; therefore, the mistake can be very easily recognized and corrected by repositioning the sign switch. (#5).

Cross check by repeating the calibration procedure (step 3 through 8 above) after the switches have been set. If the measurement data is not sufficiently reproduced, it is a sign of inadequate machine geometry, loose or excessive local wear on ways, or too much gravity-induce deflection, particularly on large machines. Your machine tool must be thoroughly checked for misalignments.

SECTION 8
MAINTENANCE

8.1. GENERAL

This section is primarily devoted to troubleshooting the PRO system. Table 8-1 will assist you in isolating the problem and making the proper repair.

NOTE

All of the procedures that follow in this section are based on a 2-axis system.

The PRO can be conveniently serviced because of its modular design. Therefore, any malfunction can usually be traced to an easy-to-replace, modular part. Some malfunctions that may occur in the PRO system can be corrected in the field with a minimum of down time, if you have some electrical or electronic background. Replacement of circuit boards and reading head assemblies is relatively simple.

8.2. PRELIMINARY TROUBLESHOOTING

All malfunctions will exhibit symptomatic readings on the digital display. However, different causes can sometimes produce similar symptoms. A simple diagnostic procedure combined with the correct interpretation of the symptoms will aid in isolating the faulty component. The first step is to determine the location of the malfunction by one of the two preliminary procedures below:

a. Switch the reading head cables from one axis to the other. If the symptoms change from one display to the other, the malfunction is in the reading head or scale assembly. If the symptoms do not change axes when the cables are switched, the malfunction is in the console.

b. Using the same reasoning, individual circuit boards can be switched from one axis to the other to help in locating the faulty circuit board.

NOTE

Problems in the console that cannot be remedied by simple parts replacement should be handled by a qualified electronic technician and must be referred to your ACU-RITE® INCORPORATED service representative.

Table 8-1 contains a list of possible problems that may occur in the system. Each is followed by the probable cause and procedures used to remedy the problem. Be sure to read Preliminary Troubleshooting, above, before using this table.

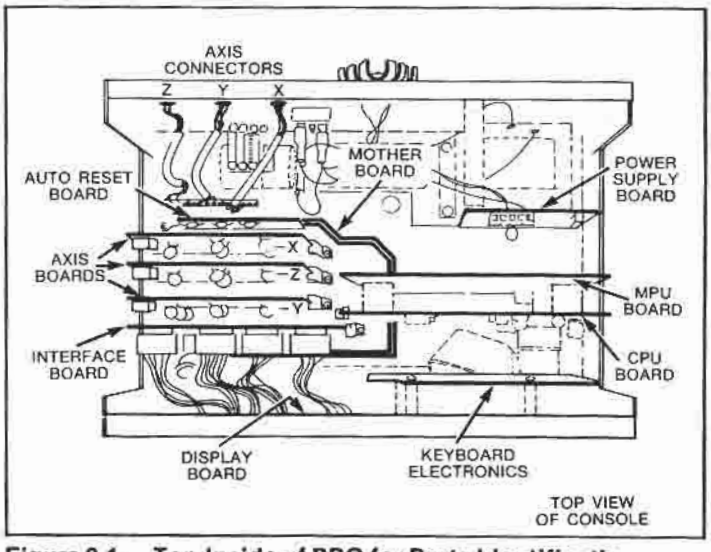


Figure 8-1. Top-Inside of PRO for Parts Identification

Table 8-1. System Troubleshooting

PROBLEM	PROBABLE CAUSE	REMEDY
a. Console is turned on, but fault indicators do not light up.	1. Power cord not plugged, or improperly plugged, into the power outlet.	Check to make sure that the 3-prong power cord is properly plugged into the power outlet.
	2. Blown Fuses.	Disconnect line cord, then check the fuse on the console back panel. (Spring inside fuse will be compressed if blown.) Replace if necessary. Check the fuse on the power supply board. Replace if necessary.
	3. Improper or no line voltage at the power outlet.	Check the line voltage at the power outlet. It should match the rating on the serial number plate (rear of console).

Table 8-1. System Troubleshooting (Cont'd)

PROBLEM	PROBABLE CAUSE	REMEDY
	4. Inadequate +5VDC.	For qualified electronic technician only: Check +5V D.C. (must be +5.1V ±.1V on pin C of axis connector. See Figure 8-1).
	5. A short in the cable connecting the reading head to the console.	Disconnect the reading head cable from the console, replace reading head cable assembly (see Reading Head Replacement in this section.)
b. Fault indicator lights up, but no digits appear when ZERO RESET button is pushed.	1. Internal Connection is not making proper contact.	Disconnect the line cord, remove the console cover, and inspect all display board connections for proper contact (see Figure 8-1). Unplug and properly reinsert all connectors.
	2. Axis printed-circuit board is faulty.	Interchange the faulty board with a good board to verify that the board is faulty (see Figure 8-1).
	3. Component-level repair or replacement is required.	Contact your ACU-RITE distributor service representative for repair or replacement of the faulty components or repair of the console.
c. One or several LED segments do not light up.	1. Faulty LED components.	Perform diagnostic test (see 4.3. and 4.9.2).
	2. Component-level repair or replacement is required.	Contact your ACU-RITE distributor service representative for repair or replacement of the faulty component or repair of the console.
d. Console will not preset properly.	1. The procedure for presetting has not been done properly.	Check the procedure for presetting in the Operation section. Repeat if necessary.
	2. Faulty connection between the keyboard and the power supply board.	Disconnect the line cord and remove console cover. Unplug and check the cable connection between the keyboard and the mother board. Check for bent or broken pins.

Table 8-1. System Troubleshooting (Cont'd)

PROBLEM	PROBABLE CAUSE	REMEDY
	3. Faulty LEDs or connection.	Perform diagnostic test (see 4.3. and 4.9.2).
	4. Component-level repair or replacement is required.	Contact your ACU-RITE distributor service representative for repair or replacement of the faulty component or repair of console.
e. Diagnostic test doesn't perform properly.	1. Battery back-up has discharged and memory has incorrect codes in it.	Perform memory clear procedure: PROG (from unlit to lit state), CLEAR STORE. Perform diagnostic test (see 4.3. and 4.9.2.).
f. Counting occurs only on least significant digits.	1. Faulty reading head assembly.	Interchange reading head cables between axes to isolate the problem to the reading head assembly or console, Replace reading head, if necessary. See procedure later in this section.
	2. Reading head out of alignment.	Check reading head alignment. Realign if necessary. Refer to appropriate scale installation manual (AR/5 or Mini-Scale) for details of installing and aligning the reading head.
	3. Faulty connection from mother board to input connector.	Unplug line cord, then check connection at rear of mother board and input connector for loose wires or plug. Correct if necessary.
	4. Component-level repair or replacement is required.	Contact your ACU-RITE distributor service representative for repair or replacement of the faulty component or repair of the console.
g. Counting occurs in one direction only.	1. Faulty reading head assembly.	Interchange reading head cable between axes to isolate the problem to the reading head assembly or console.
	2. Reading head is not aligned correctly.	Check the reading head alignment. Refer to appropriate scale installation manual (A-R/5 or Mini-Scale) for details of installing and aligning the reading head.
	3. Axis board is faulty.	Unplug line cord and replace the axis board.
	4. Component-level repair or replacement is required.	Contact your ACU-RITE distributor service representative for repair or replacement of the faulty component or repair of the console.

Table 8-1. System Troubleshooting (Cont'd)

PROBLEM	PROBABLE CAUSE	REMEDY
h. System will not repeat to within a least count.	1. Scale assembly is not aligned correctly.	Check the spar brackets for alignment and stability. Refer to appropriate scale installation manual (A-R/5 or Mini-Scale) for details of installing and aligning spars and scale assemblies.
	2. Low supply voltage.	For qualified electronic technician only: Check pin C on the head signal input connector for low 5V D.C. supply.
	3. Glass scale is dirty.	Gently clean the scale with a cotton swab and isopropyl (rubbing) alcohol to remove foreign matter. Keep swab saturated while cleaning.
	4. Reading head is defective.	Replace the reading head. Refer to appropriate scale installation manual (A-R/5 or Mini-Scale) for Mounting of Reading Head or to Reading Head Replacement in this section. Be sure to install temporary alignment bracket.
i. Error accumulation on display.	1. Reading head and/or scale out of alignment.	Check head/scale alignment. Refer to appropriate scale installation manual (A-R/5 or Mini-Scale) for Scale Mounting.
	2. Low voltage supply.	For qualified electronic technicians: Check pin C on the axis input connector for a low 5V D.C. supply.
	3. Improper ground from console to machine tool base, or improper cable connections.	Check the ground wire and connectors of the console and machine tool. Correct if necessary.
	4. Machine tool geometry error has accumulated.	Refer to Machine Error Compensation section (Error Correction Procedure) for corrective action.
j. Fault indicator lights up frequently during operation.	1. Machine tool table is either operating at an excessive speed or it is vibrating.	Check the machine tool operation for excessive speed or vibration, and correct as required.
	2. Reading head is not aligned properly.	Check the head for proper alignment. Refer to appropriate scale installation manual (A-R/5 or Mini-Scale) for Scale Installation procedure.
	3. Loose or improper ground connection.	Check all ground connections. Make sure the scale housing reading head and console are properly grounded.

Table 8-1. System Troubleshooting (Cont'd)

	PROBABLE CAUSE	REMEDY
	4. Loose wire, component or board.	Disconnect the power cord, remove the console cover, and tighten any loose connections. Unplug and reconnect all axis boards.
	5. Glass scale is dirty.	Clean scale (see h.3. above).
k. Fault indicator appears or spurious (false) counts occur when machine tool (or shop equipment is turned on or off.	1. Power outlet is on a circuit that should not be used for the system.	Transfer the power cord to another power outlet on a circuit with no potentially high or disruptive noise or surges.
	2. Loose or improper ground connections.	Check all ground connections (see Section 6, Installation).
	3. Machine tool generates line power surges or noise.	For qualified electronic technician only. Suppress machine tool circuit breakers with R-C networks or tran sient voltage suppressors.
	4. System is not protected against line power surges or noise.	For qualified electronic technician only: Interface a line noise filter or isolation transformer between power cord and power source.
l. Unstable display (flickers) and/ or keyboard locks up.	1. Loose wire, component or board connection.	Disconnect the power cord, remove the console cover and tighten any loose connections. Unplug and reconnect all boards.
m. Auto Reset doesn't work properly.	1. Improper reading head alignment.	Check the head for proper alignment. Refer to Scale Installation procedure in appropriate scale installation manual (A-R/5 or Mini-Scale).
	2. Reading head and/or scale assembly not equipped with F.T.O.(Fiducial Trigger Output)	If desired, install scale assemblies equipped for auto reset.
	3. Dirty scale.	Clean scale (see h.3. above).
	4. Loose wire, component or board connection.	Disconnect power cord, remove console cover, and check input cables and Auto Reset switch connector for proper connections. Unplug and reconnect Auto Reset board (see Figure 8-1). Check switch operation.
n. Inch/mm conversion does not work.	1. Poor connection or bad switch	Disconnect line cord and check Inch/mm switch connection and switch operation.
	2. Data to be converted is out of range causing overflow.	Check for proper data entry. Reenter correctly.
o. Counter does not maintain memory.	1. Battery backup is discharged.	Plug counter in outlet and allow unit to recharge.
	2. Battery backup is faulty.	Disconnect line cord and replace MPU board.

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