MILLVISION™

Vision Readout Systems for Mills

REFERENCE MANUAL

ACU-RITE®

MILLVISION
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The modular concept

MILLVISION was designed and built with a modular concept. The chassis assembly, the video unit, the axis modules and the central processing unit (CPU) are modular units. The axis modules and the CPU module are slide-in boards. The module slots are designed so that only the corresponding module can go into each slot.

The viewing screen (CRT) and chassis assembly are not intended to be maintained in the field. The unit should be returned to the distributor if there are problems with the screen, on/off switch, contrast, or keypad.

MILLVISION was designed to make board replacement and installation of additional options (boards) possible on the job site. It should be noted, however, that changing modular boards is the only level of maintenance authorized by ACU-RITE. If the problem is not a board-related malfunction, the entire unit must be returned for service.

Additional axes

The standard 2-axis MILLVISION can be upgraded to 4-axis by the addition of an axis module (PN 387802-6000) to one of the appropriate expansion slots (Figure 2).

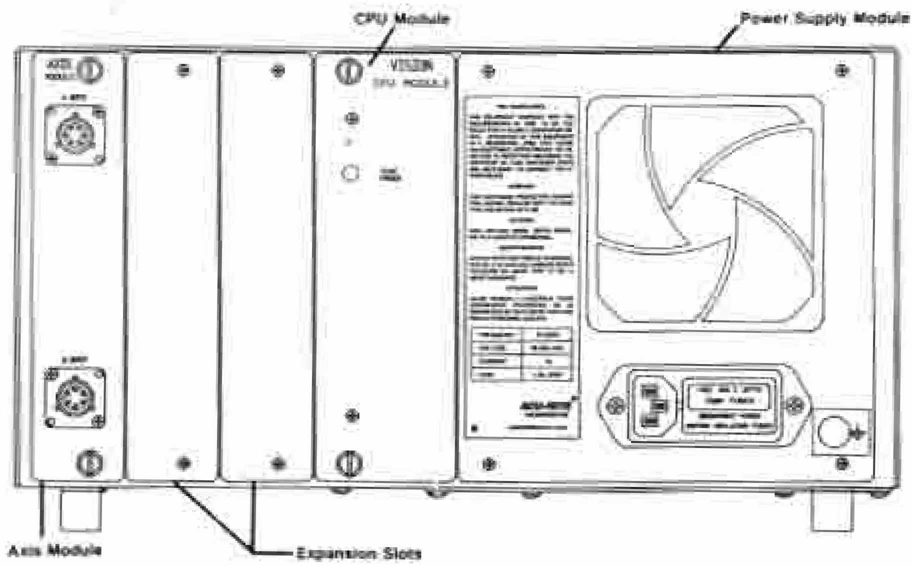


Figure 2. Module Locations.

Option module

The standard MILLVISION can be expanded to a "full-option" VRO by adding the option module (Part Number 387800-4060) into an expansion slot. A full-option MILLVISION has the following capabilities:

* RS-232C Serial Communications
* Electronic Edge Finder Input
* Communication For Program Storage
* Parallel Printer Communications Output
* Foot Switch Input

Installing/removing MILLVISION modules

To remove an axis module or a CPU module, proceed as follows:

1) Turn MILLVISION off, and unplug the unit.

2) Remove the two screws and cover plate from the desired module slot on the back of MILLVISION (Figure 3).

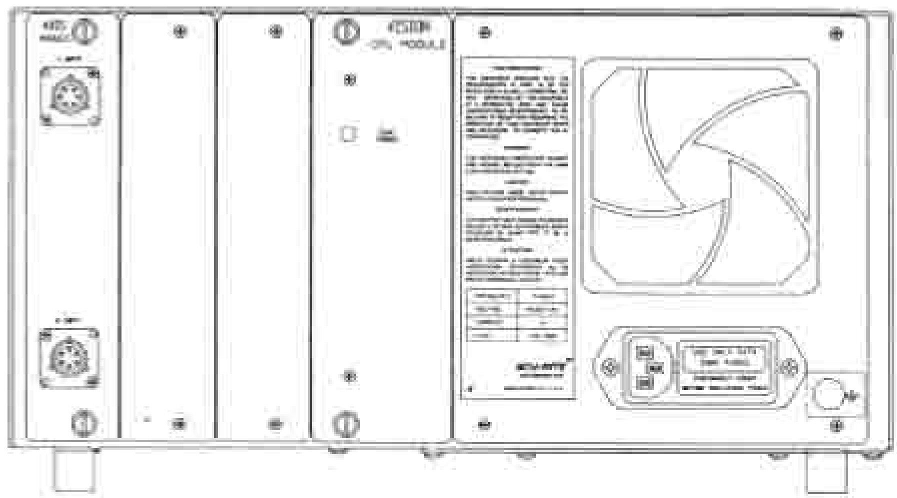


Figure 3. Rear Panel.

3) Gently pull the module out, sliding it along the tracks.

To install a new module, proceed as follows:

4) Slide new module into chassis until rear plate is tight to chassis frame (Figure 4).

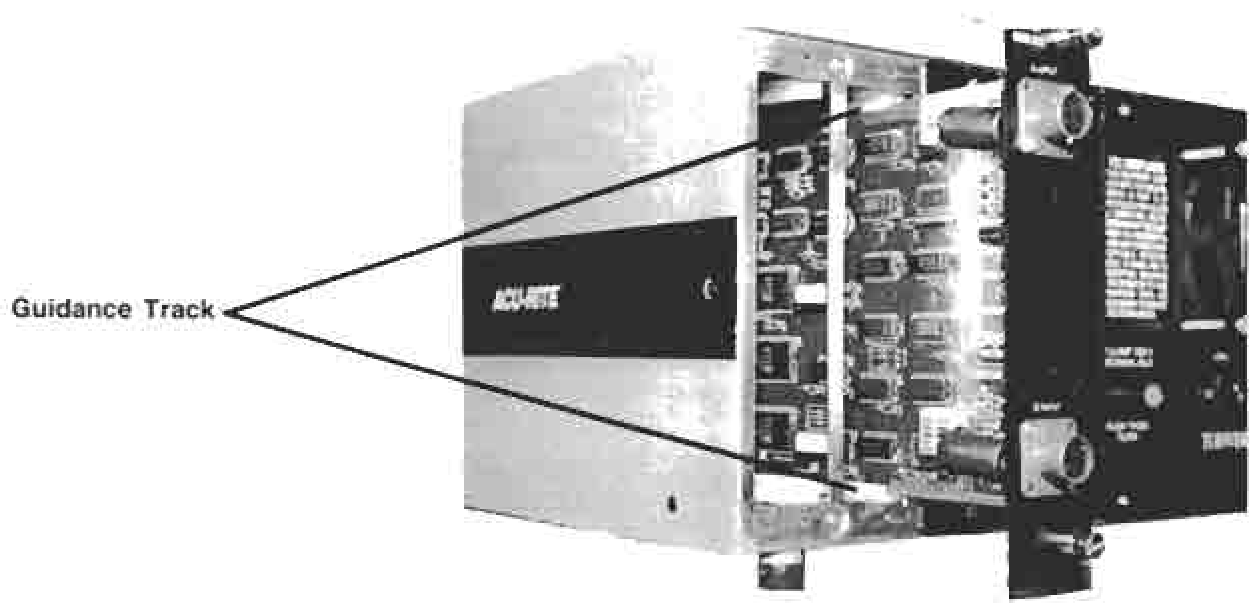


Figure 4. Module Installation.

Some resistance will be felt when pushing the module in the last half inch; the connector on the module is making contact with the connector in the chassis. **Do not force the module in place.**

5) Once the module is in all the way, tighten the retaining screws finger tight.

MILLVISION is now ready to go back to work.

MILLVISION keypad

MILLVISION has 46 tactile keys used to input and manipulate data, a power switch and a contrast adjustment knob. A slight "click" is heard and felt when pressing the tactile keys. The ON/OFF rocker switch powers the unit and the adjustment knob controls the contrast of the screen.

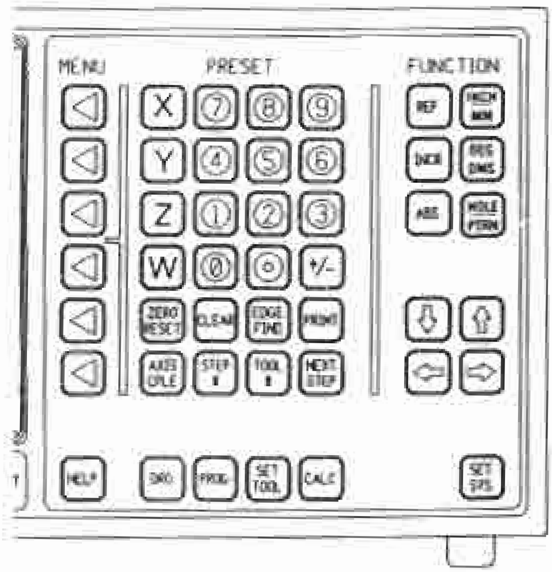


Figure 5. MILLVISION Keypad.

The 46 keys are grouped in five major sections:

MENU keys - There are six menu keys located on the far left of the keypad. The menu keys correspond to an instruction or function enclosed in a box, on the screen. The instruction or function box is activated when the menu key to the right is pressed. If a menu key with no corresponding screen information is pressed, an "Incorrect Keypress" message will be displayed on the screen.

PRESET keys - The PRESET keys consist of the following subgroups:

Numeric keys - keys 0 through 9, the decimal point key, and the +/− sign key, are used to enter numeric values.

Axis keys - X, Y, Z, and W keys are used to select an axis or axes during MILLVISION functions.

ZERO RESET key - used to reset an axis display.

CLEAR key - used to erase previous data, so new values can be entered.

EDGE FIND key - activates the edge find feature. Provides edge locating, distance and center measuring functions.

PRINT key - activates an optional connected printer to print the current screen information.

AXIS CPLE key - (short for Axis Coupling) the capability of mathematically combining (adding, subtracting or averaging) the signals from two parallel linear encoders to display one resultant motion.

STEP # and NEXT STEP keys - used while running or learning a program to move to another step in the program.

TOOL # key - used to indicate a tool to be used for an operation. If tool offsets are assigned to the tool number, MILLVISION adjusts the axes' displays in the DRO and program modes.

CURSOR MOVEMENT (ARROW) keys - located in lower-right of the keypad, these keys move the cursor or highlighted areas on the screen in the direction the arrows point. The right and left arrow keys can also be used to erase the right-most digit when entering present values.

MODE keys - located across the bottom of the keypad, these six keys (HELP, DRO, PROG, SET TOOL, CALC, SET SYS) access a mode of operation.

FUNCTION keys - six keys located in the upper-right of the keypad. Three of the keys, REF, INCR, and ABS, are used to preset an axis. The INCH/MM and DEG/DMS are keys to indicate units of measurement. The HOLE PTRN key is for learning or running hole patterns.

Special function keys

The INCH/MM key

Axis positions, both incremental and absolute, may be displayed in either inches or millimeters for linear encoders. The desired units of measurement (English or Metric) may be selected by pressing the INCH/MM key. This key toggles the display between the two measurements (inch and mm). Conversions from inch to metric are performed immediately. Current units are displayed in the status area of the DRO display. This display can be toggled between the two units at any time.

The DEG/DMS key

This key represents decimal degrees (DEG) and degrees-minutes-seconds (DMS) and is used to toggle between the two formats for angular encoders. This display can be toggled between the two units at any time.

Angular axis position is displayed in the same format as linear axes. Angular axis displays, however, have a degree symbol attached to both the incremental and absolute displays.

The HOLE PTRN Key

This key gives the operator the capability to create hole patterns with up to 99 holes. Angle and radius drawing dimensions can be entered, without having to convert them to cartesian coordiantes, to create a pattern. The HOLE PTRN routine is accessed through the DRO and PROG Modes. Setting up a hole pattern is explained on page 66.

Bench testing

Prior to installation, the following simple bench test should be run:

1) Connect MILLVISION to power. MILLVISION has the following power requirements:

   Voltage - 95 to 130 VAC or 180 to 250 VAC, 47 to 63 Hz

   Amperage - 1.5 Amp

   MILLVISION has a two-position voltage selector switch on the back panel. The 115V position is used for incoming voltages between 95 to 130 VAC. The 230V position is used for incoming voltages between 180 to 250 VAC. To change the voltage selector, slide a screwdriver gently up or down until the correct voltage position is visible.

2) Turn the power switch ON. You should see a "MILLVISION by ACU-RITE" opening screen. This screen also indicates the software version currently installed in memory.

3) Press any key to continue (except HELP).

4) Disregard any messages on the screen and press the SET SYS mode key (bottom right on keypad).

5) Press the "MISCELLANEOUS" menu key.

6) Press the "TESTS" menu key.

7) Press the "KEYBOARD TEST" menu key.

   To check a key, simply press that key and its location on the simulated keypad on the screen should become highlighted. When all keys have been checked, hold down one key for a few seconds to return to the MISCELLANEOUS MENU (Figure 6).

Bench testing (cont.)

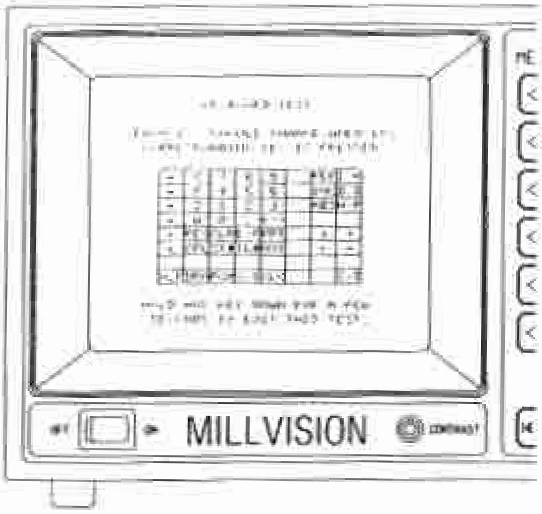


Figure 6. Keyboard Test.

8) Press the "VIDEO TEST" menu key.

The video test displays a grid pattern on the screen. The grid lines should be straight, both vertically and horizontally. Arrows along the right hand side of the screen should line up with the center of the menu keys (Figure 7). Press any menu key to end the video test.

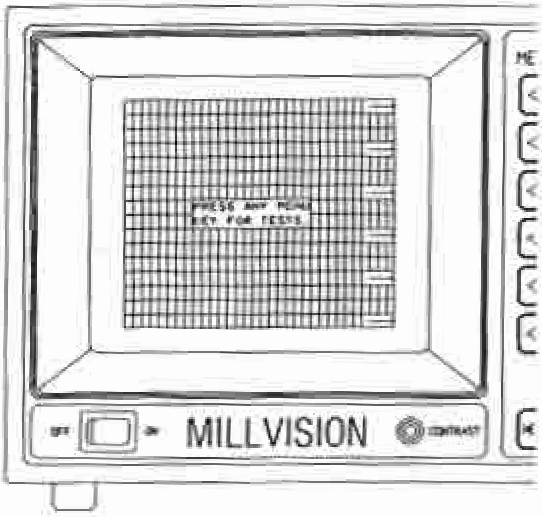


Figure 7. Video Test.

9) Press the "MEMORY TEST" menu key.

The memory test will check both the Random Access Memory (RAM) and the Read Only Memory (ROM). If a bad memory location is detected, the location will be indicated. A Checksum Technique is used to check the ROM memory. A number will appear on the screen when the test is complete. If a memory problem is indicated (bad memory location in RAM or ROM Checksums do not agree) contact your ACU-RITE Distributor or OEM. Press the "TESTS MENU" key to return to the TESTS menu.

10.) When all tests have been conducted, turn the unit off.

If any of the above steps cannot be completed or if any of the screens differ from the above descriptions, contact your ACU-RITE distributor or OEM.

Installation location considerations

Location is an important consideration for proper installation. The following points should be kept in mind when selecting a safe and convenient location:

1) Ease of operator reach.
2) Approximate eye level to the operator.
3) Avoid moving components or tools, and coolant splash.
4) Operating environment must be 0° to 40° C, with a non-condensing relative humidity of 25-95%.
5) MILLVISION's CRT, like all CRTs, can be adversely affected by a strong magnetic field. Therefore, it should be mounted away from any source of magnetism and magnetic base holders should never be set on top of MILLVISION.
6) To avoid overheating, MILLVISION should have adequate airflow around and under the unit. Access to the filter assembly is also needed for periodic maintenance.

   For further information refer to the Troubleshooting "Ventilation system" section in the APPENDICES (page 72).

Proper mounting

ACU-RITE has developed specific mounting kits for MILLVISION which are applicable to most common mounting configurations. The kits are available from your ACU-RITE Distributor and come complete with hardware and mounting instructions.

Careful consideration should be given when fabricating a support device for MILLVISION. It should be large and strong enough to accommodate the readout and any other devices that may be placed on top (printer, etc).

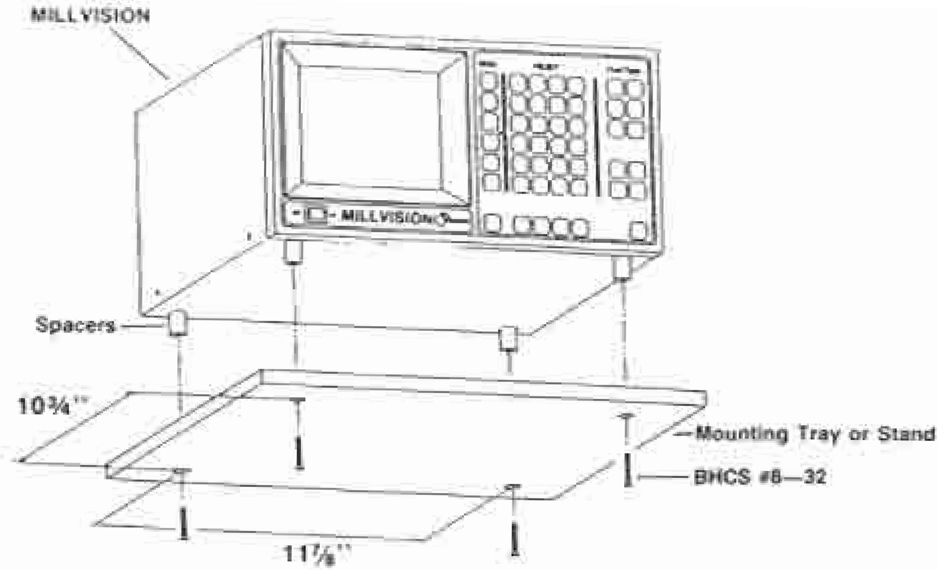


Figure 8. Mounting on Tray or Stand.

Connecting encoders

After axis encoders (scales) have been installed, encoder connectors are plugged into the back of MILLVISION. Insert the male connector with the large spline up, into a mating receptacle and lock in place with a ¼ turn.

Make sure there is enough slack in the encoder cables to allow for full travel of each machine axis.

Connector specifications are given in the APPENDICES. The encoder input receptacles are labeled "A INPUT" and "B INPUT". It is not important which axis is plugged into which receptacle because each input is assigned an axis label (X, Y, Z, or W) in the section called "Assigning Axis Labels" (page 13).

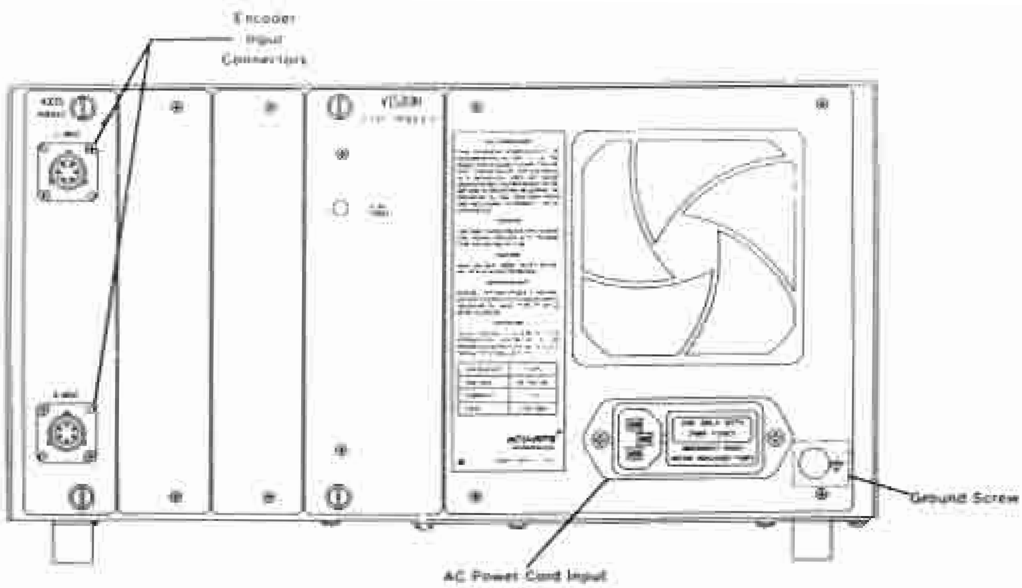


Figure 9. Power and Encoder Connections.

Modes of operation

MILLVISION has seven operational modes. The first mode is the Power-Up mode, automatically entered when MILLVISION is turned on or when there has been a power interruption. The other six modes are selected from the keyboard using the tactile mode keys along the bottom of MILLVISION's keypad. The six user modes are as follows:

Set System Mode - used to set parameters for the incoming encoder information and to display it to the operator. The encoder parameters should be entered into the unit during the installation of the system as explained on page 15.

Programming Mode - the operator can create programs for machining repetitive parts. This mode has routines to create, view, edit, run and learn programs (see the "PROGRAM OPERATION" tab section).

Set Tool Mode - used to enter and store tool offset dimensions. MILLVISION can retain information for up to 99 tools with offsets in three axes (see page 48).

DRO Mode - the "workhorse" mode within MILLVISION. Standard machining (without a program) is done in the DRO mode (see the "STANDARD MACHINING PROCEDURES" tab section).

Calculator Mode - gives access to a four-function calculator, taper calculator, and RPM calculator. The standard calculator allows the operator to do calculations using information directly from the preset register, and add the calculation result back into the preset register (see page 55).

NOTE: Axis positions are maintained while every mode is active; positional information is never lost while the readout is on.

Help Mode - an "Operator's Manual" that is only an arm's reach away. The Help mode key accesses screens covering all topics of concern to the operation of MILLVISION. It is accessible from any mode and will offer help relating to the screen the operator is viewing when entering the help mode. After reading the information provided, in most modes, the operator can ask for "More Help", or return to the screen displayed prior to pressing the HELP key.

The HELP mode

To access the General HELP INDEX, from another mode, press the HELP key twice. Note: Pressing the HELP key once will access help for the current operation.

Each section in the following General HELP INDEX has its own index. When moving through various HELP screens, press the top menu key to get back to the index for that section.

The following is a "tree"-type diagram which illustrates the software structure sequences in the HELP Mode. Many help screens offer "More Help" (additional help screens). Each "More Help" screen is identified with a sequential number ([1], [2], etc) in the upper left of the screen.

GENERAL HELP INDEX
1. **HOW HELP WORKS**
2. **SET SYS HELP**
3. **OTHER MODES**
4. **TABLES**
5. **RESUME**

1. **HOW HELP WORKS**
    - GENERAL INDEX

2. **SET SYS HELP**
    - GENERAL INDEX
    - SETTING AXIS INFORMATION
        - LABELING THE AXES
        - SETTING THE AXIS PARAMETERS
        - USING ERROR COMPENSATION
            - SINGLE INTERVAL COMP
            - AUTO SINGLE INTERVAL COMP
            - MULTIPLE INTERVAL COMP
            - AUTO MULTIPLE INTERVAL COMP
    - SETTING REFERENCE POINTS
    - SETTING DRO DISPLAYS
    - MISCELLANEOUS
        - RESETTING ALL MEMORY
        - TESTS
            - KEYBOARD TEST
            - VIDEO TEST
            - MEMORY TEST
            - HARDWARE IDENTIFICATION
            - JUMPING TO WHERE SET SYS WAS LEFT
            - OPTION CONFIGURATION
                - PARALLEL PRINTER PORT

5. **RESUME**
Returns the screen back to the previous mode or function. To exit the HELP mode, press the "RESUME" menu key.

The sleep screen

Another unique feature of MILLVISION, is the "sleep screen". This feature extends the life of the screen by blanking the screen (except for a "SLEEPING" message) during long periods of nonuse. After approximately 10 minutes without any activity on the keyboard or information coming from the encoders, MILLVISION will go into its "sleep" mode. As soon as any key pressed, the screen will return to the previous display. The only mode, however, that never "sleeps" is the HELP mode.

The SET SYS mode

Setting parameters

MILLVISION's internal working memory requires certain information before it can start performing. Axis and encoder labels and parameters must be programmed before MILLVISION can go to work. To set parameters, a password must first be entered (see below).

Password protection

A password is required to change axis parameters and to reset memory. Passord protection is a safeguard against accidentally changing axis parameters (axis labels, error compensation, etc.). The following page contains the password for this MILLVISION. If desired, the page can be removed.

Password: **8891**

MILLVISION default states

MILLVISION comes from the factory with default values for the axis and encoder parameters. If encoder requirements match the default states, it is not necessary to reset any axis or encoder parameters.

AXIS LABELS	1A - X 1B - Y 2A - Z 2B - W
AXIS MOTION	LINEAR, ALL AXES
AXIS RESOLUTION	10 MICRON, ALL AXIS
FTOs AVAILABLE	YES, ALL AXES
COUNT DIRECTION	POSITIVE, ALL AXES
ERROR COMPENSATION	0 PPM, ALL AXES
ROUND OFF VALUES DRO MODES 1 AND 2	.01mm (.0005") ALL AXES
NEAR ZERO VALUES DRO MODES 1 AND 2	0
MULTIPLIER	+ 1, ALL AXES

Figure 10. MILLVISION Default States.

Assigning axis labels

Individual axis encoders are randomly plugged into any of the available connectors on the back of MILLVISION's axis modules. Axis labels are then assigned as follows:

1) Press [Set Sys] mode key.

2) Press "SET AXES" menu key.

3) Enter password. "8891"

4) Press "LABEL AXES" menu key.

The AXIS LABELS screen represents the input ports, 1A through 3D, on the back of MILLVISION.

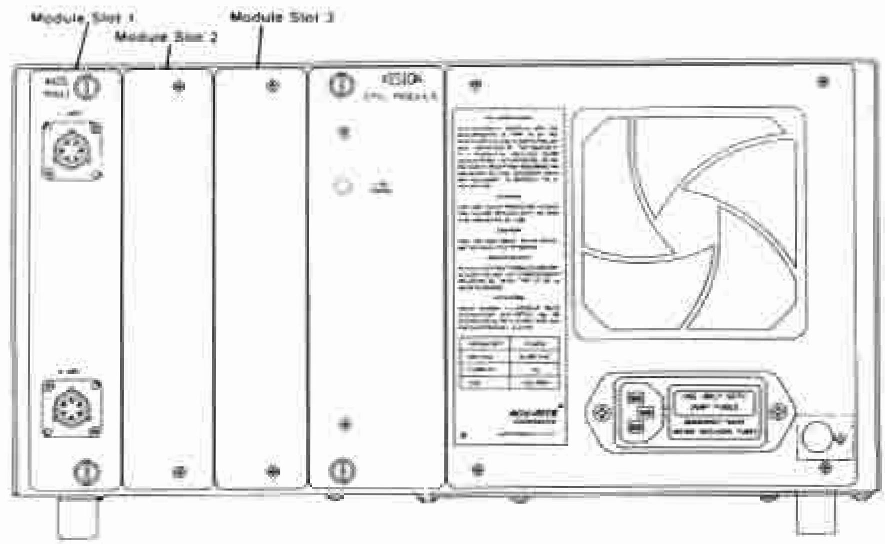


Figure 11. Axis Module Locations.

5) Highlight an input axis by using the arrow keys. Axes marked "N/A" are not available with current hardware, but can be upgraded with additional axis modules.

6) Clear current label using the [Clear] key or leave the default axis label.

7) Assign the desired axis label by pressing X, Y, Z, or W axis key. **If the desired axis label is already displayed on another axis, it must first be cleared from its present assignment.**

Repeat the above process for each input slot that has an encoder connected to it. When all axis labels have been assigned, return to the Set Axis Menu by pressing the "FINISHED" menu key (see Figure 12).

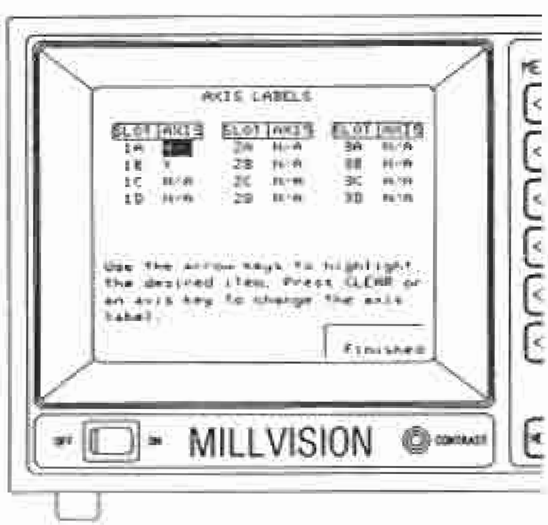


Figure 12. Axis Labels Screen.

Setting encoder parameters

After axis labels have been assigned to each input slot, it is necessary to program specific facts about the individual encoders associated with each axis label (see Figure 13). Program encoder parameters as follows:

1) Press the "SET PARAMETERS" menu key (Set Axes menu screen).

   The SET PARAMETERS menu screen shows an axis and four facts concerning that axis. The four facts are listed in a format with the current value or status shown for each parameter.

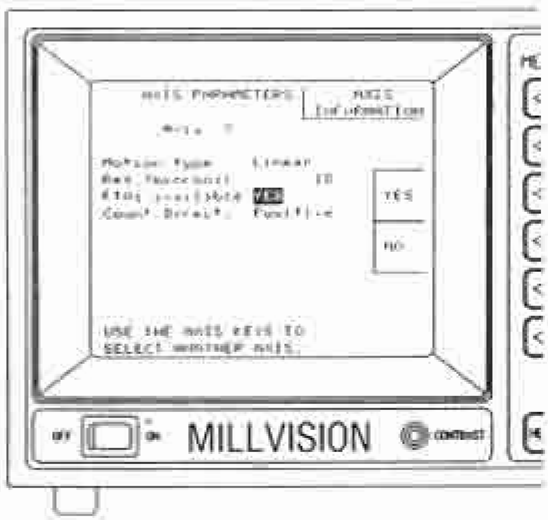


Figure 13. Axis Parameters Screen.

2) To change a parameter, highlight the parameter by using the up or down arrow keys. As each parameter is highlighted, available choices are displayed.

3) To select a new value or status, press the menu key to the right of the chosen value. The new parameter value will then be displayed.

Encoder parameters/ descriptions and values

"**Motion type**" refers to the type of motion the encoder is measuring. Two types are available — linear and angular.

"**Resolution**" is the size of the increment of position that the encoder indicates. For linear encoders standard resolutions are as follows:

1000 μm	50 μm	2 μm	.1 μm
500 μm	20 μm	1 μm	.05 μm
200 μm	10 μm	.5 μm	.02 μm
100 μm	5 μm	.2 μm	.01 μm

MILLVISION™

To select one of these values, use the menu keys "Finer" and "Coarser" until the correct value is shown for "Res. (microns)". To accommodate English-ruled linear encoders and linear encoders with resolutions not listed, direct keyboard entry can be used to define the resolution.

Clear the current resolution by using the CLEAR key and enter the scale resolution in **microns** by using the numeric keys on the keypad.

> **Note: All entries (English or Metric ruled encoders) must be entered in microns (.001 mm). For example, to enter a .0005" resolution encoder, multiply .0005" by 25,400 microns/inch. This translates to a metric resolution 12.7 microns which is then keyed in as the scale resolution.**

Standard resolutions for angular motion in counts per revolution (cnt/rev.) are as follows:

36,000,000	1,800,000	72,000	3,600
18,000,000	720,000	36,000	1,800
7,200,000	360,000	18,000	720
3,600,000	180,000	7,200	360

> **Note:** If keyboard entry is necessary for an angular encoder, it must be entered in *counts per revolution*.

"FTO" refers to a signal pulse generated when a fiducial (reference) mark on a scale is sensed by the scale reading head. This reference mark can be used to automatically reset the readout display to zero. If an ACU-RITE linear encoder has FTO signals, it will be indicated on the label as "ABSOLUTE ZERO" or "ABSOLUTE ZERO II". The FTO parameter is a YES or NO selection.

"Count Direction" refers to assigning a positive or negative value to axis motion. This assignment is the preference of the end-user or shop. Some shops feel that if the workpiece is moving to the left of the tool it represents a negative movement while other shops refer to this as a positive movement.

To set the count direction:

1) Press DRO mode key.

2) Move the axis in question, observing the motion polarity (display becoming more negative indicates a *negative* count direction, display becoming more positive indicates a *positive* count direction).

   If this count direction is in agreement with shop standards, no change for that axis is necessary.

   If the count direction is opposite from shop standards, proceed to the following steps:

3) Press the Set Sys mode key.

4) Press the "Jump to where SET SYS was left" menu key. This should return the display to the AXIS PARAMETERS screen.

5) Make sure the axis being worked on is indicated at the top of the screen; if not, press the correct axis key.

6) Use the "down" arrow key to move to the "Count Direction" parameter and then press the *opposite* status.

7) Repeat the above procedure to ensure the axis motion is now in agreement with shop standards.

Finding the home reference point (FTO)

With ACU-RITE ABSOLUTE ZERO linear encoders, FTO reference marks can be used to easily locate the workpiece zero. The FTO reference marks are line patterns on ACU-RITE scales which are placed at regular intervals along the scale. Every time MILLVISION is turned off, or power is interrupted, all axis position information is lost. The readout cannot tell if the encoder has moved while the power is off. When power is restored, MILLVISION resets all axes to 0.0 for both the incremental and absolute displays. Therefore, the current positions of the axes, relative to the mounted workpiece, are lost until the axes positions are reset. **It is very important to find the same home reference point every time MILLVISION is powered up.**

To find the home reference point proceed as follows:

1) Press the [Set Sys] key.

2) Press the "SET REF. POINT" menu key.

3) Press the corresponding axis key for the axis the home reference point (X, Y, Z, W).

   Only axes for which parameters were set indicating they have FTOs are now listed as available for setting home reference points.

4) Move the axis close to an FTO mark on the scale and press the "Ready" menu key.

5) Move slowly through the FTO mark on the scale in the *positive* count direction.

   The FTO mark will only be sensed if the axis is moving in a positive count direction. Once the reading head has passed over an FTO mark on the linear encoder, MILLVISION will indicate the home reference point has been found.

Figure 14. FTO Reference Point Screen.

Finding the home reference point (cont.)

6) Press the "Finished" menu key or press the "Wrong Reference Point" menu key to select a different point (see Figure 14).

7) Once the reference point is acceptable, it is extremely important to draw a line on the scale casing at the approximate location of the reference point (FTO). This will aid in locating the FTO reference point quickly each time there is a need to find the same home reference point. These FTO reference marks and their function **must** be understood by the machine operator.

Repeat the above procedure for each axis requiring a home reference point.

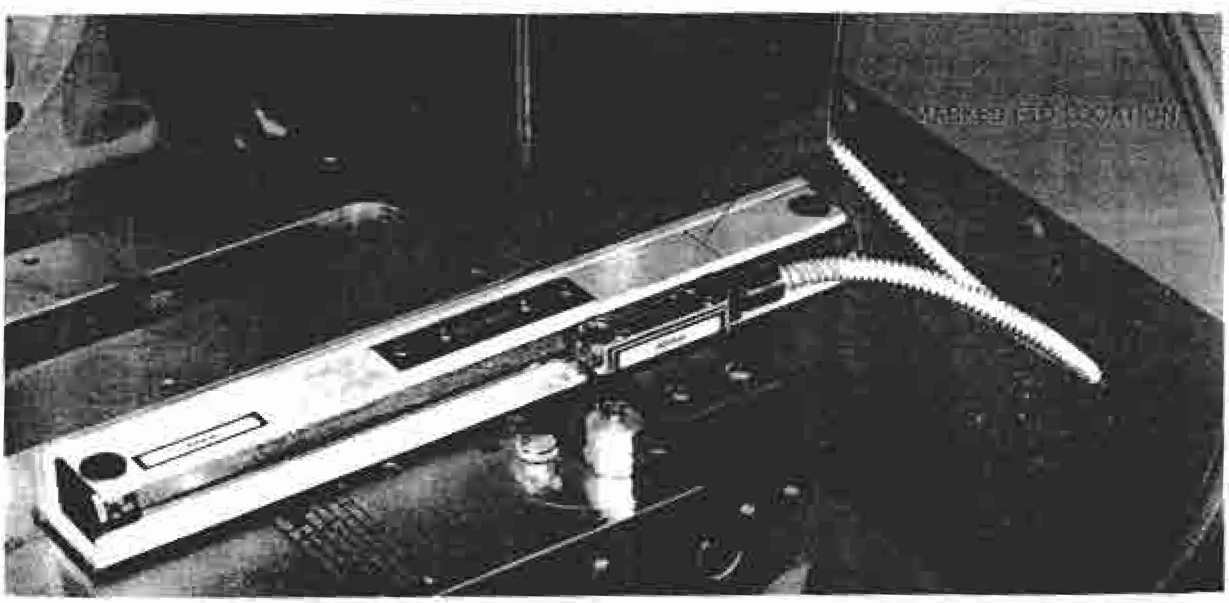


Figure 15. FTO Marker on Linear Encoder.

MILLVISION vs machine geometry error

All machine tools, new or old, contain some error in the accuracy of indicated motion when compared to a standard which is known to be true. MILLVISION helps compensate for this form of error.

To properly program for error compensation, please read this entire section.

Machine error is caused by at least one of the following machine tool deficiencies:

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

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

C. Driving and cutting forces cause deflections (since no material is completely rigid).

D. Temperature gradients can distort machine geometry.

E. Abbe' error - deflections in the machine tool structure, caused by gravity, particularly when a heavy workpiece is placed on a machine with overhanging table or ways (see Figure 16).

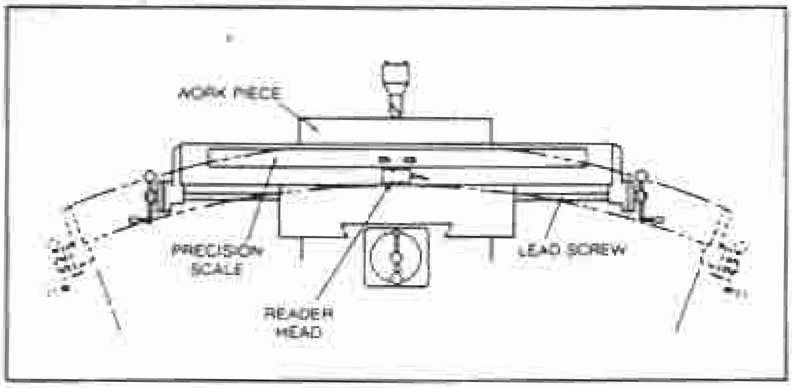


Figure 16. Exaggerated Abbe' Error Curve of Table Travel on a Mill.

Errors caused by C and D (above), must be compensated by using correct machining practices and maintaining the machine in a temperature-stable environment.

Machine inaccuracies caused by A, B and E (above), can be significantly compensated for by programming MILLVISION's error compensation. Since machine tool error is a constant error, it can be measured and graphed. Error compensation values can then be programmed into MILLVISION.

Single and multiple interval error compensation

Error Analysis (Example 1)

Error Analysis (Example 1) - Incremental moves were made along the entire length of an axis. For each move, the readout display was compared with the distance moved by using certified gage blocks or by using a laser interferometer. Both the actual travel and the travel displayed on the readout were recorded. The readout measurements were then subtracted from the actual measurements to represent the error values.

The error values were plotted against the distance traveled. A line was drawn representing the "best-fitting" straight line among the plotted points (the line should pass through the 0, 0 point). From the chart and plot (Figures 17a & 17b), it can be seen that error is increasing at a near constant rate as we move along the axis. This is an example of single interval error compensation.

Distance Measured by Standard	Measurement Displayed on Readout	Difference Between Measurements
0.000	0.000	0
3.0000	3.000	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

Figure 17a. Error Analysis Chart (Example 1).

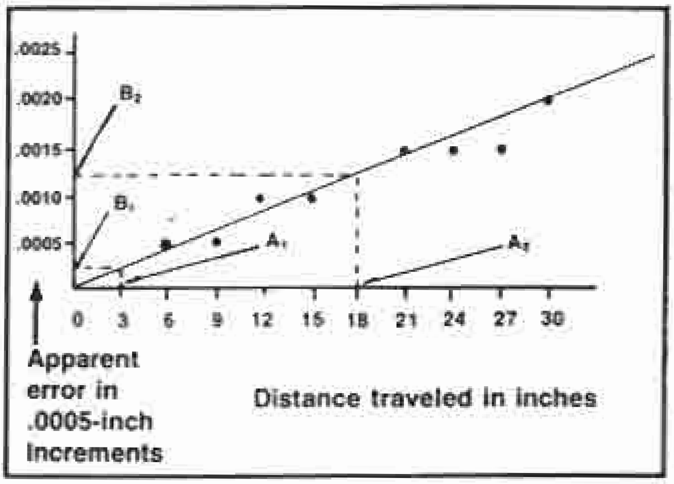


Figure 17b. Error Graph (Example 1).

Error compensation (cont.)

Error Analysis (Example 2) (See next page)

The same procedure was followed for a second axis (Figures 18a & 18b). From the plot of this axis, it can be seen that the error does not increase in the same manner as the first axis. This plot has several different error rates as indicated by the lines with different slopes. It is important when "best-fitting" straight lines are developed for these graphs, that they are based on a number of points spread over a significant interval, not just two or three points close together. If this concept of the "best-fitting" straight line is not used, true error slopes will not be shown.

Points close together can appear to have a large error for the amount of distance traveled. This is especially true for scales with relatively course resolutions. The scale measurement between close points can easily be off by one resolution. This *apparent* error occurs because of the digital nature of the scale, i.e. the readout can increment two units, after moving just slightly more than one full unit.

Distance Measured by Standard	Measurement Displayed on Readout	Difference Between Measurements
0.0	0.0000	0
1.0000	1.0000	0
2.0000	1.9998	.0002
3.0000	2.9999	.0001
4.0000	3.9998	.0002
5.0000	4.9996	.0004
6.0000	5.9993	.0007
7.0000	6.9990	.0010
8.0000	7.9988	.0012
9.0000	8.9985	.0015
10.0000	9.9982	.0018
11.0000	10.9975	.0025
12.0000	11.9970	.0030
13.0000	12.9967	.0033
14.0000	13.9963	.0037
15.0000	14.9964	.0036
16.0000	15.9964	.0036
17.0000	16.9964	.0036
18.0000	17.9964	.0036
etc.	etc.	etc.

Figure 18a. Error Analysis Chart (Example 2).

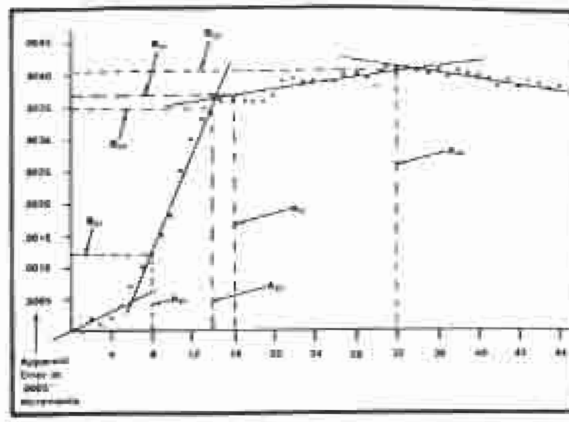


Figure 18b. Error Graph (Example 2).

Error compensation (cont.)

Example Requirements

As shown by examples 1 & 2, error compensation can demand different solutions. The first axis requires a constant error correction factor of 67 counts per million to correct for the measurement displayed. The second axis requires several different error correction factors in each of the different intervals to compensate for the errors.

MILLVISION has the capability to handle both types of error compensation. Single interval (linear) error compensation would be required to add in the constant correction factor over the entire length of the axis for example 1. Multiple interval error compensation would be best for example 2. With MILLVISION, eight intervals of correction factors can be used for each axis.

Measuring machine error

Methods for checking and measuring machine error

Step Gage Method (Figure 19a)

1) Set up the step gage on the table at a height and position that coincides with that of a typical workpiece.
2) Insert a dial indicator into the spindle and lower it until the indicator can contact the first reference surface of the gage.

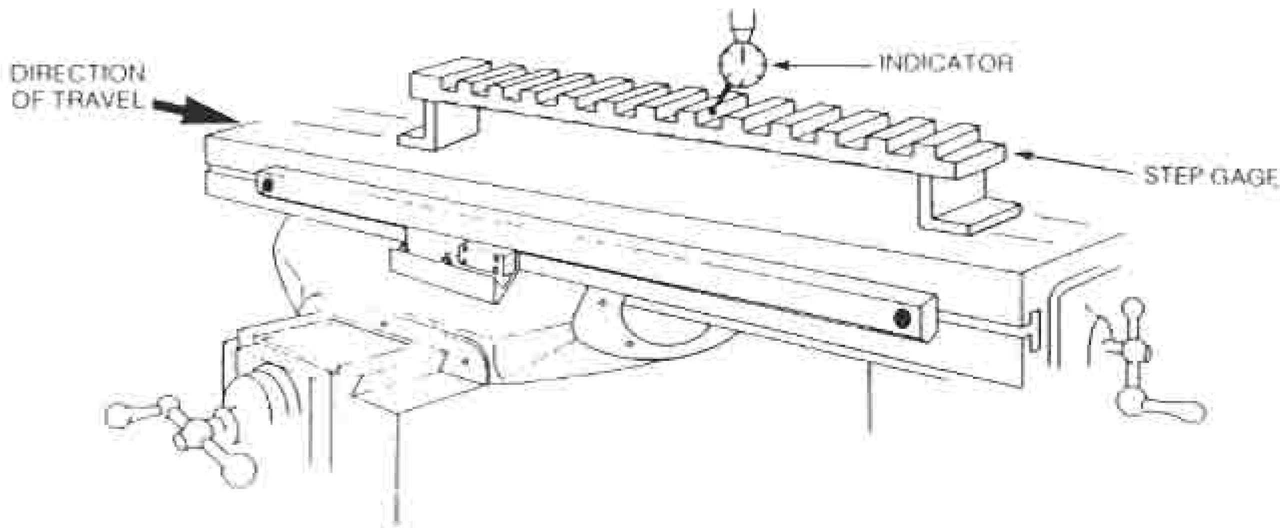


Figure 19a. Using Step Gage as a Standard to Measure Machine Error.

Measuring machine error (cont.)

3) Set the dial indicator to zero.
4) Turn on MILLVISION. In the DRO mode, zero reset all axes: press all axis keys, zero reset key, ABS key.
5) Raise the spindle and carefully move the table in a positive count direction, until the next reference surface is close to the dial indicator.
6) Lower the spindle and carefully move the table until the indicator contacts the gage surface and registers zero.
7) Record the distance moved as measured by the standard and as measured by the system and displayed on the readout. Then record the difference between the two measurements (Figures 19b & 19c)
8) Repeat steps 5 through 7 for the entire length of the standard. Make sure that each measurement is taken in the same direction.

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

Figure 19b. Standard and Displayed Measurements.

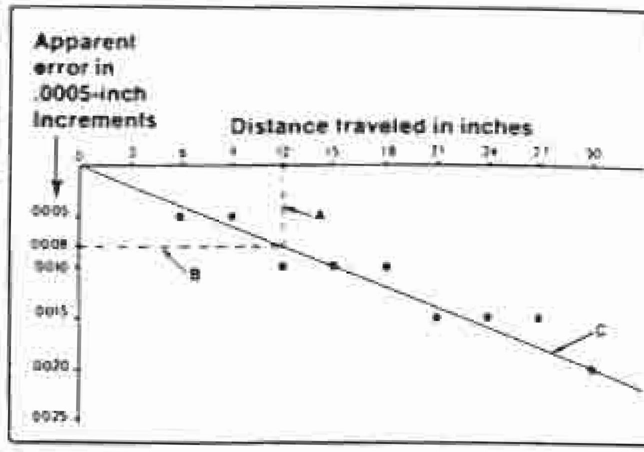


Figure 19c. Error Analysis.

Measuring machine error (cont.)

Simplified Method (Figure 20a)

1) Mount a calibrated standard as shown in Figure 20a (the standard should have a recent certificate of accuracy calibration). Mount the standard at a height at which the work is normally placed.
2) Locate the indicator at Point A. Zero reset both the X-axis on MILLVISION and the Indicator.

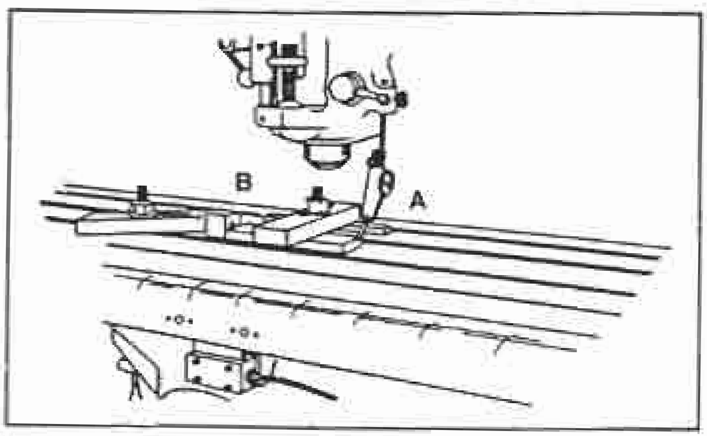


Figure 20a. Simplified Method for Measuring Machine Error.

3) Lower the knee and move the table to point B until the indicator reads zero. Record the value MILLVISION displays.

4) Divide the difference between the standard and the readout, by the standard's designated length.

5) Multiply this result by one million to get an error value in parts per million (PPM).

$$\text{Error} = \frac{B}{A}$$

$$= \frac{.00080\text{ in.}}{12\text{ in.}}$$

$$= .0000667$$

$$.000667 \times 1{,}000{,}000 = 67\text{ PPM}$$

Figure 20b. Error Analysis (Example 1).

Selecting single or multiple interval error compensation

Single interval (linear) error compensation can be used on any axis. **Multiple interval error compensation on MILLVISION requires scales with FTO reference marks.** If the linear encoder does not have FTO signals, single interval error compensation must be used.

If the error analysis plot has a *single* best-fit straight line on the graph, single interval error compensation is the best choice for that axis. If the error analysis plot has *more than one* best-fit straight line, then multiple interval error compensation is the best choice to help compensate for geometry error.

Determining error correction values

MILLVISION automatically calculates error correction values through the *error* compensation routine. These correction values can also be found manually, using error plots and mathematics. While MILLVISION's automatic routines are much quicker and easier to use, in some cases, the accuracy obtained is less than what can be obtained using a manual error analysis.

The following routine is the manual method to find error values for both single and multiple interval compensation. For single interval, the mathematics are done once for each axis being compensated. For multiple interval compensation, the same mathematical procedure will have to be done for each interval being used within an axis. The mathematics for both the manual and the automatic method involves finding the slope of each compensation interval and translating that value into parts per million (PPM). This value can then be used to adjust the display to compensate for machine geometry error.

Manual method

To compute the error correction value manually:

1) On the error plot, draw a vertical line "A1" at one of the first distance measurements (Figure 21a).
2) Draw a horizontal line "B1", where A1 intersects the best-fit straight line (the best-fit line represents the average error).
3) Draw another vertical line "A2" at one of the last distance measurements.

   The lines chosen for "A1" and "A2" should be as far apart as possible for each average error line to achieve best results.

4) Draw another horizontal line "B2" where A2 intersects the best-fit line.

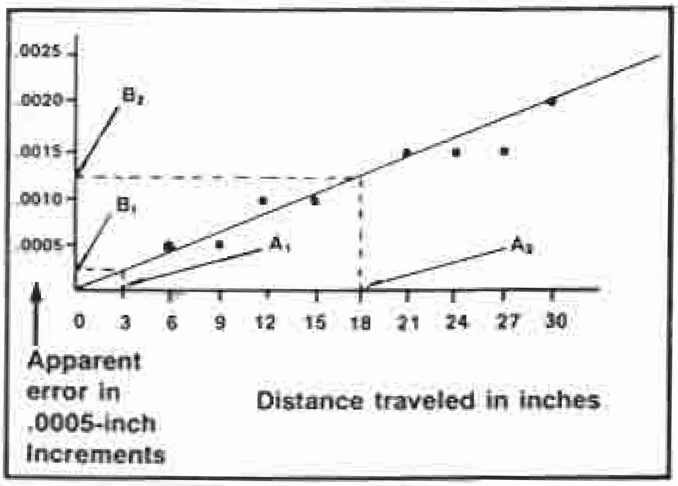


Figure 21a. Error Graph (Example 1).

5) Divide the distance traveled (A2 - A1) into the error (B2 - B1).
6) Multiply the result by 1 million to find the required error correction factor.

   The procedure required to calculate the error correction factors for multiple intervals is the same, but must be performed for each interval. Figures 22a and 22b show examples of the chart and math involved for multiple interval error factor computations.

$$\text{ERROR} = \frac{B_2 - B_1}{A_2 - A_1}$$

$$= \frac{.0012'' \ (-) \ .0002''}{18'' - 3''}$$

$$= \frac{.001}{15''}$$

$$= .0000667$$

$$.0000667 \times 1{,}000{,}000 = 67 \text{ PPM}$$

Figure 21b. Error Analysis (Example 1).

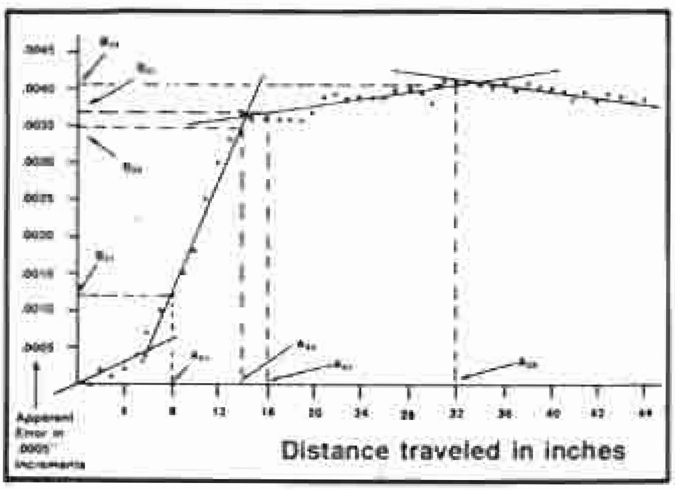


Figure 22a. Error Graph (Example 2).

$$\text{ERROR} = \frac{BN_2 - BN_1}{AN_2 - AN_1} \quad \text{where N is the interval \#}$$

$$= \frac{.0035'' - .0012''}{14'' - 8''} \quad \text{for interval 2}$$

$$= \frac{.0023}{6''} \quad \text{for interval 2}$$

$$= .0003833 \quad \text{for interval 2}$$

$$.0003833 \times 1{,}000{,}000 = 383 \text{ PPM for interval 2}$$

Figure 22b. Error Analysis (Example 2).

Setting up single interval error compensation within MILLVISION

After error correction factors have been computed by the manual method (above), factors can be entered into MILLVISION's memory. To enter single interval error compensation factors proceed as follows:

1) Press the [Set Sys] key.
2) Press the "SET AXES" menu key.
3) Enter the password.
4) Press the "ERROR COMPENSATION" menu key.
5) Press the desired axis key X, Y, Z or W.
6) Press the "EDIT" menu key.
7) Press the [Clear] key to clear any current value.
8) Use the numeric keys to enter the compensation factor (must be in Parts per Million).
8) Press the "SAVE CHANGES" menu key.

Repeat for additional axes by pressing the "SELECT ANOTHER AXIS" menu key. Once error compensation factors have been entered, the axis should be checked against the measurement standard to assure that error compensation has been entered correctly and is working.

Auto error routine for single interval compensation

A measurement standard such as a laser interferometer or a calibration bar is necessary to use MILLVISION's auto error compensation routine. Set up the standard and proceed as follows:

1) Press the [Set Sys] key.
2) Press the "SET AXES" menu key.
3) Enter the password.
4) Press the "ERROR COMPENSATION" menu key.
5) Press the desired axis key.
6) Press the "AUTO ERROR COMP" menu key.
7) Move the axis to the beginning of the measurement standard.
8) Press the "Move Completed" menu key.
9) Move the axis to the end of the measurement standard.
10) Press the "Move Completed" menu key.
11) Enter the actual distance of the standard.
12) Press the "END Comp" menu key.

Repeat for additional axes by pressing the "SELECT ANOTHER AXIS" menu key. Once error compensation factors have been entered, the axis should be checked against the measurement standard to assure that error compensation has been entered correctly and is working.

Setting up multiple interval error compensation within MILLVISION

Establishing a home reference point is the first step in implementing multiple interval error compensation. The home reference point allows MILLVISION to define the same intervals for error compensation every time the unit is turned on (see below or page 17 for establishing a home reference point).

When MILLVISION is turned off, or power is lost due to a power outage, all axes position information is lost and the readout cannot tell if the encoder has moved. This loss of positional memory has a major effect on two areas within the unit.

The first area of impact is *position information* regarding the workpiece already mounted when power was interrupted. When power is restored, MILLVISION resets all axes to 0.0 for both the incremental and absolute displays. Therefore, the current positions of the axes, relative to the mounted workpiece, are lost until the axes positions are reset. This can be done by using the SET REF. POINT routine for each axis or by positioning the axes of the machine to known locations and manually presetting positions.

The other area that is affected by loss of positional memory is *multiple interval error compensation*. Specific segments of the scale, representing specific segments of travel on the machine, can each be given error compensation values. This specific relationship between the scale and actual machine positions requires a home reference point be found every time MILLVISION is turned on. The home reference point must be the same point which was defined prior to establishing the intervals for multiple interval compensation. The point must be relocated to re-establish the correct relationship between the defined intervals in MILLVISION's memory and the actual position of the machine. To find the home reference point proceed as follows:

Establishing the home reference point

1) Press the [Set/Set] key.
2) Press the "SET REF. POINT" menu key.
3) Press the corresponding axis key for the axis the home reference point is to be set.
4) Move the axis close to an FTO mark on the scale and press the "Ready" menu key.
5) Slowly move through the FTO mark on the scale in the *positive* count direction.

   The FTO mark will only be sensed if the axis is moving in a positive count direction. Once the reading head has passed over an FTO mark on the linear encoder, MILLVISION's screen will indicate the home reference point has been found.

6) Press the "Finished" menu key or press the "Wrong Reference Point" menu key to select a different point.
7) Once the reference point is acceptable, it is extremely important to place a mark on the scale casing at the approximate location of the reference point (FTO). This will aid in locating the same FTO reference point quickly each time there is a need to find the home reference point.

These FTO reference marks and their purpose must be understood by the machine operator.

Repeat the above procedure for each axis requiring a home reference point.

Once a home reference point has been established, the individual intervals for multiple interval error compensation can be set. After intervals have been established along an axis, the corresponding error compensation values can then be entered.

Interval definition for multiple interval compensation

Before entering multiple interval error compensation values, it is necessary to define interval boundaries or end points and how they can be found. The boundaries for intervals are referenced within the readout as 1 through 8. Each interval's boundary location is referenced from the home reference point which has been selected for that axis. The beginning of boundary 1 must be the most negative position physically possible on the axis. With the beginning of boundary 1 established, all other interval boundary locations are determined by entering the end points for each interval. The end point of each interval is the beginning of the next interval.

Manual techniques

When using a manual technique to determine error values, the interval end points should correspond to the crossing points of the average error lines (best-fit straight lines). These positions can be determined from the graph in relationship to the actual distance moved along the machine bed. The positions must be entered into the error compensation table within the SET SYS mode, ERROR COMPENSATION Menu, of MILLVISION.

The following procedure is one easy way to establish boundaries for intervals based on the FTO home reference point position. This procedure results in the direct correlation between the position from gage blocks and the prosition from the FTO.

1) Press the "SET SYSTEM" menu key.

2) Press the "SET REF. POINT" menu key and find the home reference point (refer to page 17 or 28 to find the home reference point).

3) Once the reference point is found, press the "FINISHED" menu key.

4) Press the [ORG] key.

   The axis' incremental register now displays position in relationship to the home reference point (readout position 0.000 being the home reference point).

5) Move the axis until the incremental display is 0.0000. Press the axis key, (ZERO RESET) key, and the (ABS) key.

   At this point, a chart and graph is set up to determine boundaries for error intervals.

Example:

1) Move the axis to the most *negative* point.

2) Zero reset the incremental display: Axis key, ZERO RESET key, INCR key.

3) In a negative to positive direction, move the axis 1 inch according to the measurement standard (gage blocks).

4) Following the chart below, record the distance of the measurement standards in the "Gage Step" column (column 2). In the following example, this column is in increments of 1 inch.

5) Record MILLVISION's absolute position in the "Axis Position to Home Reference Point (FTO)" column (column 1). Make sure that if the position is a negative number, to indicate it on the chart.

6) Record MILLVISION's incremental position in the "Readout Position" column (column 3).

7) Column 4 is the difference between the "Gage Step" measurement and the "Readout Position". Make sure to indicate a negative number.

8) Repeat steps 3 through 7 for the entire usable length of the axis.

Following the graph (Figure 23b), plot column 4 (Figure 23a) measurements to show error against distance traveled. When all the points have been plotted, draw in best-fitting straight lines based on a number of points spread over a significant interval, not just two or three points close together. Adjacent plotted points, if connected by a straight line, will not reflect true error slopes.

Column 1	Column 2	Column 3	Column 4
Axis Position to Home Reference Point	Gage Step Position	Readout Position	Difference Between Gage Step Position and Readout Position
−5.2310	0	0	0
−4.2310	1.0000	.9995	.0005
−3.2310	2.0000	1.9990	.0010
−2.2310	3.0000	2.9985	.0015
−1.2310	4.0000	3.9980	.0020
.2310	5.0000	4.9970	.0030
1.2310	6.0000	5.9955	.0045
2.2310	7.0000	6.9940	.0060
3.2310	8.0000	7.9928	.0072
4.2310	9.0000	8.9914	.0086
5.2310	10.0000	9.9897	.0103
6.2310	11.0000	10.9880	0120
7.2310	12.0000	11.9866	0134
8.2310	13.0000	12.9866	0134
9.2310	14.0000	13.9967	0133
10.2310	15.0000	14.9666	.0134
11.2310	16.0000	15.9967	.0133
12.2310	17.0000	16.9666	0134
13.2310	18.0000	17.9870	.0130
14.2310	19.0000	18.9872	.0128
15.2310	20.0000	19.9873	.0127
16.2310	21.0000	20.9874	.0126
17.2310	22.0000	21.9876	.0124
18.2310	23.0000	22.9877	.0123
19.2310	24.0000	23.9879	.0121

Figure 23a. Error Analysis Chart.

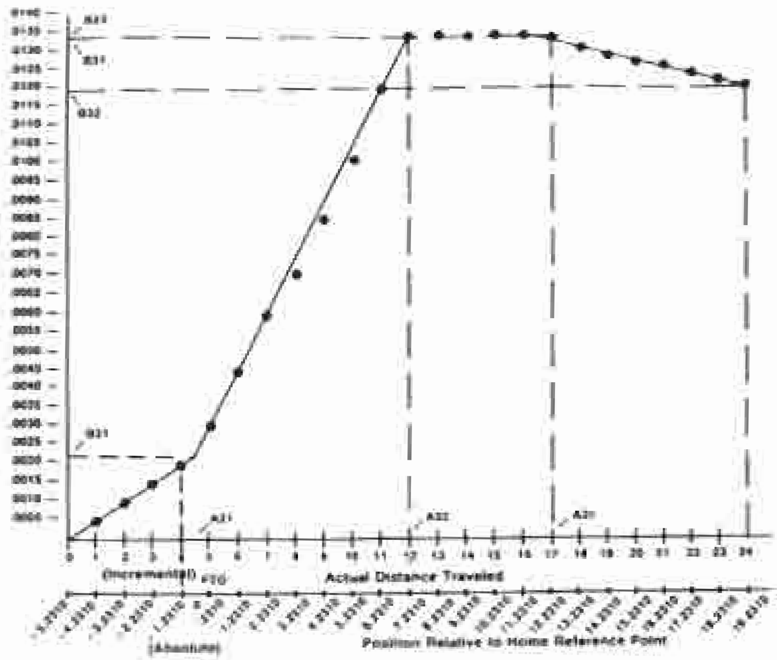


Figure 23b. Error Analysis Graph.

Interval definition for multiple error compensation (cont.)

The error correction factors must now be calculated for each interval. Follow the procedure to calculate parts per million for each interval. The second interval in the above example is calculated below:

$$\text{ERROR} = \frac{BN_2 - BN_1}{AN_2 - AN_1} \qquad N = \text{the interval number}$$

$$= \frac{.0134 - .00225}{12 - 4.3} \qquad \text{for interval 2}$$

$$= \frac{.01115}{7.7} \qquad \text{for interval 2}$$

$$= .001448 \qquad \text{for interval 2}$$

$$.001448 \times 1{,}000{,}000 = 1{,}448 \text{ PPM for interval 2}$$

Figure 23c. Calculating Error Correction Factors.

After parts per million have been calculated, they must be entered into MILLVISION. Follow the "Steps for Setting Multiple Interval Error Compensation" on page 32.

Automatic multiple interval error compensation

When using the automatic compensation routine, it is necessary to initially establish the approximate locations for each interval into which the axis is to be divided. These selected intervals (up to eight intervals for each axis) can be of any length. It is assumed that the axis has a consistent error factor within the specified area. Normally, the area(s) where the majority of machining is done will be divided into more intervals than the unused areas. Approximate locations are required so the calibrated standard can be roughly centered on each interval prior to being measured. The actual interval boundaries, as established by the auto error compensation routine, are established for each interval at one-half of the distance from the center of the calibrated standard to the center of the calibrated standard as located and measured, in the adjacent interval.

In the auto compensation routine, a calibrated standard is measured within each selected interval along the axis. For greater accuracy, the calibrated standard should be no less than ⅓ of the length of that interval. The auto error routine will indicate the distance measured (moved), and "ask" for the actual (calibrated) distance moved. These numbers are used to calculate the error factor and boundaries for a particular interval. The standard is then moved to the center of the next interval and the procedure is repeated.

Steps for setting multiple interval error compensation

To set multiple interval error compensation, using either the manually determined values or using the auto compensation feature, follow these steps:

1) In the SET SYS mode, press the "SET AXES" menu key.
2) Enter password.
3) Press the "ERROR COMPENSATION" menu key.
4) Select the axis to be programmed, by pressing an Axis key.

   Note: The axis selected must have had a home reference point previously established (see page 17 or 28).

To place the interval boundaries and related error correction factors (found through the error analysis described on page 20) directly into the table through the EDIT routine, proceed as follows:

5a) Press the "EDIT" menu key.

6a) Starting with interval #1, press the [Clear] key.

7a) Enter the end point location of interval #1 using the numeric keys. The end point location is referenced from the home reference point (FTO). Following example 23b, the end point location (−1.2310) is the position on the "Position Relative to Home Reference Point" line, where the first interval ends (the dotted line intersects the FTO line).

8a) Using the arrow keys, move to the "PPM Comp" column and enter the desired Parts Per Million value for interval #1.

9a) Using the arrow keys, move through the table indicating the interval end points (no end point is necessary for the last interval) and the corresponding PPM compensating values. When finished, press the "Save Changes" menu key.

Once an axis has been programmed, it should be checked again against the measurement standard to assure error compensation has been entered correctly and is working.

10a) Press the "SELECT ANOTHER AXIS" menu key and repeat the above steps, if necessary.

To enter boundaries and establish error factors using Auto Error Compensation, proceed as follows:

5b) Press the "AUTO ERROR COMP" menu key.

6b) Move the axis to the beginning of the measurement standard which must be located and roughly centered in interval #1. Press the "Move Completed" menu key when the axis is in position.

7b) Move the axis to the end of the measurement standard and press the "Move Completed" menu key.

8b) Enter the actual distance traveled (standard value) by using first the [Clear], then the numeric keys.

9b) Select "END Auto-Error Comp" if this is the last interval, or press the "Go to NEXT Interval" menu key to continue. Move the standard into the next interval and repeat steps 6b through 9b for interval #2. Continue until all intervals have been completed.

After an axis has been programmed, it should be checked against the measurement standard to assure that error compensation has been entered correctly and is working.

Repeat the above procedure for all required axes.

Editing procedures for both single and multiple interval error compensation values

To edit the values for **single** interval error compensation, proceed as follows:

1) From the SET SYS mode, press the "SET AXES" menu key.
2) Enter password.
3) Select the "ERROR COMPENSATION" menu key.
4) Select the axis to edit.

   Note: An axis which has had a home reference point defined, will initially display the multiple interval error compensation table. If single interval error compensation is used for the selected axis, interval #1 will be shown with the note "AXIS END" for the end boundary. To edit, use the procedure for multiple interval error, but change the PPM value for interval #1 only, or press the "SINGLE INTERVAL COMP" menu key and continue with the edit routine.

5) Press the "EDIT" menu key. This will highlight the current error compensation value.
6) To change the current value, press the [Clear] key and then the numeric keys to enter the correct value. Be sure to include the correct sign (+ or −) for the error compensation value.

Editing procedures (cont.)

7) Press the "Save Changes" menu key to put the new value into memory. This will return the display to the single interval screen for the selected axis. Verify the new value.

8) If other axes require editing, press the "SELECT ANOTHER AXIS" menu key and repeat steps 4 through 7, or press the "AXIS INFORMATION" menu key to return to the Axis Information screen.

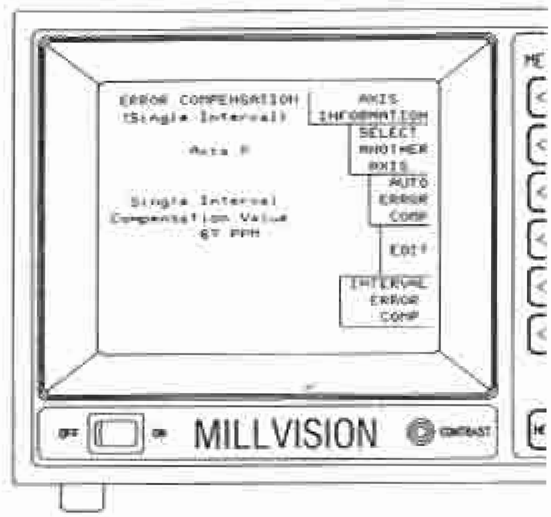


Figure 24. Single Interval Error Compensation Screen.

To edit the values and/or intervals for axes with **Multiple** Interval Error Compensation, proceed as follows:

1) From the SET SYS Mode, press the "SET AXES" menu key.

2) Enter password.

3) Select the "ERROR COMPENSATION" menu key.

4) Select the axis to edit.

   NOTE: If just powering up, press the "INTERVAL ERROR COMP" menu key. Press the "Find Reference Point" menu key. Move the axis near the reference point (FTO) and press "READY". Move through the reference point. When the screen indicates the reference point has been found, press the "Finished" menu key.

5) Press the "EDIT" menu key. This will display the Multiple Interval table for the selected axis.

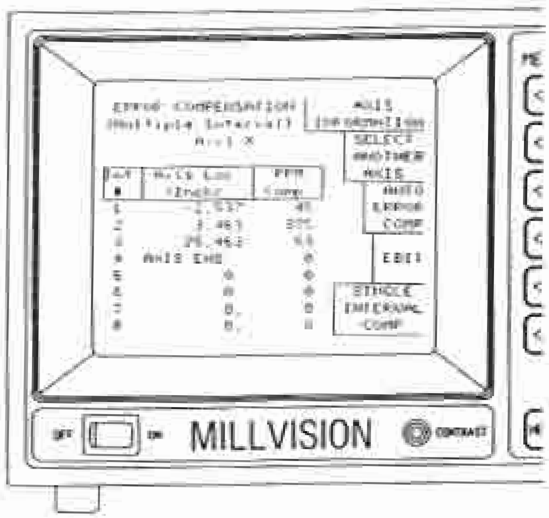


Figure 25. Multiple Interval Error Compensation Screen.

6) Use the arrow keys to select either the "interval end point (Axis Loc)" or the "PPM Comp" value. The item that can be edited is highlighted.

7) To change the current value, press the numeric keys to enter the correct value. Be sure to include the correct sign (+ or −) for both the "interval end point location" and the "PPM Comp" value.

8) When all changes have been made for the selected axis, press the "Save Changes" menu key. This enters the changes into memory and will return the display to the Error Compensation (Multiple Interval) screen for the selected axis. Verify the new values.

9) If other axes require editing, press the "SELECT ANOTHER AXIS" menu key and repeat steps 5 through 8 or press the "AXIS INFORMATION" menu key to return to the Axis Information Screen.

Powering up

When powered up, MILLVISION presents the operator with an opening "welcome" screen. This screen also includes the version number and software copyright information. In addition, every time MILLVISION is turned on, a start-up routine is automatically executed which checks information within its memory, checks RAM (Random Access Memory) for successful battery backup and checks the expansion slot module configuration for changes.

If MILLVISION's battery backup has failed, it will perform some internal housekeeping in preparation for functioning. This preparation defaults all software parameters to the factory default values (page 13).

Figure 26. MILLVISION Opening Screen.

The opening screen notes to "Press any key to continue", indicating that MILLVISION has completed the power-up routines. The next screen prompt will be one of the following:

> **Proceed to DRO** - this prompt indicates that internal memory was successfully backed-up and that MILLVISION is ready to begin.
>
> **Proceed to SET SYS to establish a home reference point** - this prompt indicates that internal memory was successfuly backed-up and at least one axis is programmed using a home reference point that must be found at this time (as explained on page 17).
>
> **Proceed to SET SYS to verify the system parameters** - this prompt indicates that the internal memory was successfully backed-up, but there has been a change in the hardware configuration. The SET SYS values should all be checked to ensure that they are in agreement with the actual hardware configuration. Page 15 goes through the necessary steps required to check installed parameters for axes.

Proceed to SET SYS to initialize the System Parameters.
Default settings have been made - this prompt indicates the internal memory has not been successfully backed-up. All axis parameters must be re-entered. This procedure is covered on page 15. This prompt also indicates the unit's internal battery may be weakening and requires service. Notify your ACU-RITE distributor to arrange for the appropriate service procedures.

The DRO mode display

The DRO mode screen will be seen most often by the operator in day-to-day machining. The DRO Mode display consists of two major areas. The upper 75% of the screen is used to display axis position information, with the lower 25% of the screen displaying various pieces of information about the status of the unit.

It is beneficial for the operator to become very familiar with the layout of the DRO mode screen because it contains most of the information needed for machining.

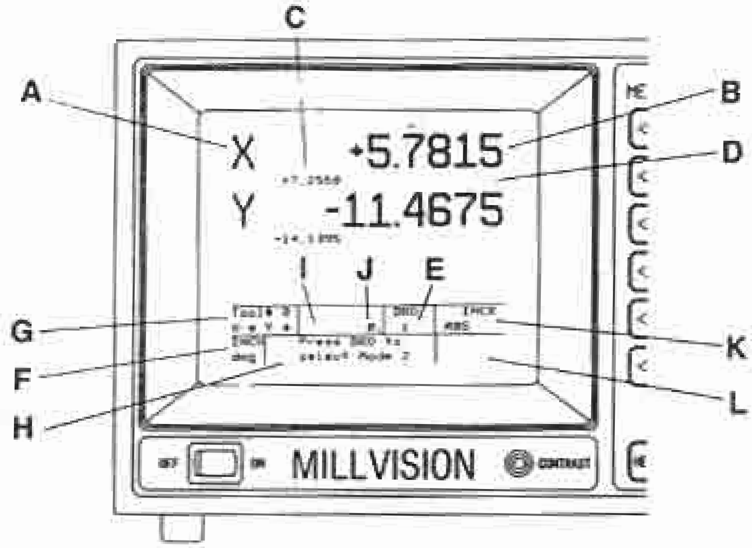


Figure 27. DRO Display Information.

The upper 75% of the screen contains the following information:

ITEM A - Individual Axis Label
MILLVISION is capable of displaying up to 4 axes of motion. These axes are labeled X, Y, Z, W.

ITEM B - Primary Axis Position, Incremental/Absolute
The axis position displayed in the primary display position (larger numbers) can be either the incremental or absolute. The relative positions of the two pieces of display information are as indicated by Item K. The relative position of the display (incremental/absolute) can be changed by pressing the menu key opposite Item K.

DRO mode display (cont.)

ITEM C - Secondary Axis Position, Incremental/Absolute
The display in this position is either incremental or absolute information, depending on which is in the primary position (see Item B).

ABSOLUTE vs INCREMENTAL

MILLVISION axis information is displayed in two positional formats, absolute and incremental.

Absolute position represents the distance from the current tool position to the workpiece zero position. Workpiece zero is usually set once at the start of machining a piece and not changed.

Incremental position represents the distance from the current tool position to a desired tool position (point to point). Incremental position is relative to values the operator presets into the display. These presets can be the amount of movement required to go to the next desired point, or may be the amount of distance traveled since the incremental position was last reset to zero.

ITEM D - Individual Axis Status Display
This area contains information corresponding specifically to that particular axis. It notes if the axis has been frozen, etc. The different messages will be explained and expanded upon as they are needed.

Items A, B, C, and D are the same for all axes being displayed on the screen. The number of axes displayed depends on how the unit is configured in Setting the DRO display mode which is covered on page 40.

The size of the letters and numbers making up the information for items A, B, C, and D is controlled by the number of axes being displayed. If three or less axes are being displayed, the information will be in a large size format. If four axes are being displayed, the information will be in a medium size format. A typical three-axis and four-axis example is shown below.

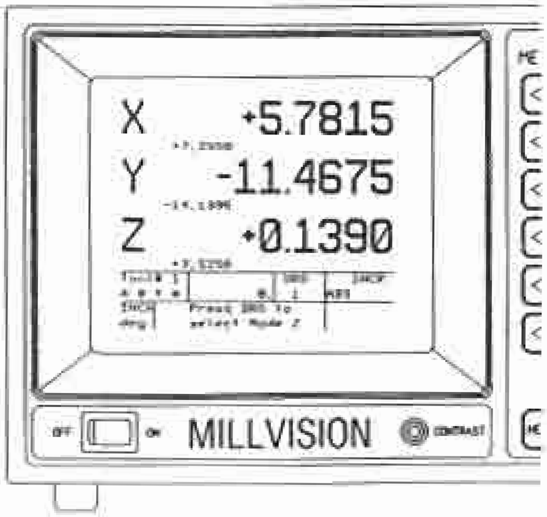


Figure 28a. Typical 3-Axis Display.

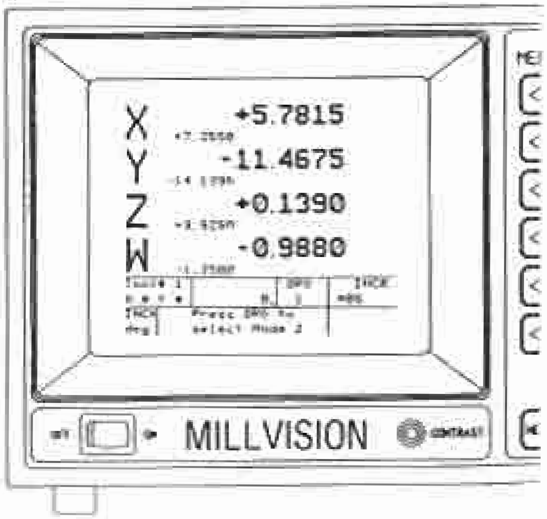


Figure 28b. Typical 4-Axis Display.

DRO mode display (cont.)

The size of the three-axis display is approximately 33% larger than the four-axis display. In both the larger and smaller formats, the display consists of eight full digits with the decimal points vertically aligned for all axes on the screen. The common decimal point position is located so the axis with the highest resolution has all of its decimal digits displayed to the right of the decimal point. If a number is larger than can be displayed with the common decimal point, the decimal point, for that axis only, shifts to the right. This will *decrease* the axis resolution, but *increases* the magnitude of the number that can be shown.

The lower portion of the DRO mode display contains general readout status information:

ITEM E - Current DRO Mode & Current Program Step Number
The DRO mode that is currently selected — DRO mode 1 or DRO mode 2. This area also gives the current program step number while a program is being "run" or "learned".

ITEM F - Current Measurement Units
This section shows the current unit of measurement for the displayed axis or axes. This information pertains to both angular and non-angular axes. INCH or MM will be displayed for non-angular axes. DMS (degrees, minutes, seconds) or DEG (degrees) will be displayed for angular axes.

ITEM G - Current Active Tool Number
This display indicates the selected or current tool number and offset sign. This tool number corresponds to a specific tool offset in MILLVISION memory. This information is used to compute movement compensation factors relative to tool geometry. The tool offset sign indicates which side of the point of cut the tool center is located.

ITEM H - Message Area
This area is used to prompt the operator on how to use certain DRO features and how to remedy certain error conditions. Normally, it will indicate how to select a different DRO mode. It is also used in conjunction with the TOOL # key and the STEP # key to be discussed on following pages.

ITEM I - Axis Preset Labels
This area displays axis labels (X, Y, Z, or W) if any of the axes are being preset.

ITEM J - Preset Register Value
This area displays the preset value for the axes indicated in Item I or the last preset value used.

Items I and J contain the preset information. It is possible to preset or zero reset more than one axis at a time. The preset value can have up to eight digits and a decimal point.

ITEM K - DRO Menu Key

ITEM L - DRO Menu Key

Items K and L are the two menu keys available in the DRO mode. Their labels change depending on the special DRO function currently active.

The DRO mode

MILLVISION supplies two user-defined display modes: DRO display mode 1 and DRO display mode 2. With two modes, the operator can design two different display formats for machining. The operator chooses information to be displayed and eliminates information that is not needed. Each display mode is configured separately and can have different resolutions, near zero points, couplings, and number of axes.

The current DRO display mode is noted on the screen in the DRO status area (Figure 27, Item E). To change the mode, press the DRO key. This key toggles between the two DRO modes.

Note: If an axis is not being displayed, incoming information from the encoder is still processed and maintained internally. There is no loss of position information.

By setting different display resolutions for mode 1 and mode 2, the operator can work in one display mode using a coarse resolution for rough cutting and the other display mode using a finer resolution for finish machining.

Near zero display indicator

The near zero feature gives the operator a visible indication of approaching zero. When the encoder moves into the programmed near zero region, the axis label flashes until the incremental display reaches zero, moves through zero, or the encoder leaves the near zero region. The near zero feature is reactivated and reset when the incremental display value is outside of the near zero "boundary". The near zero region is valid for approaches made from either direction. The near zero warning is set while configuring the DRO display modes as explained below.

Setting the DRO display modes

The DRO display modes are configured in the DRO mode and SET SYS mode with the special function keys and the menu keys. The areas that must be configured are the axes to be displayed, display resolutions, and near zero points.

To set the DRO display mode configuration proceed as follows:

1) Press the [Set Sys] mode key.
2) Press the "SET DRO DISPLAY" menu key.
3) Press the display mode to be set (either mode 1 or mode 2).
4) Select the axes to be displayed in the order they are to be displayed on the screen. Use the arrow keys to move the highlighting bar to the desired screen position below "Axes Displayed:".

   Press the [Clear] key to remove any axis currently in that position.

   Press the desired axis key for the screen position highlighted.

5) Press the "Display Format" menu key to access the Round Off Values (display resolution values) and the Near Zero Values table.

6) To set the Round Off Values, use the arrow keys to highlight the axes desired and then use the "Finer" or "Coarser" menu key to select the value. The values are "mm" and "decimal degrees" or "inches" and "decimal degrees". Units are indicated at the top of the screen and can be changed by pressing the INCH/MM key. *The displayed resolution should never be set finer than the encoder resolution.*

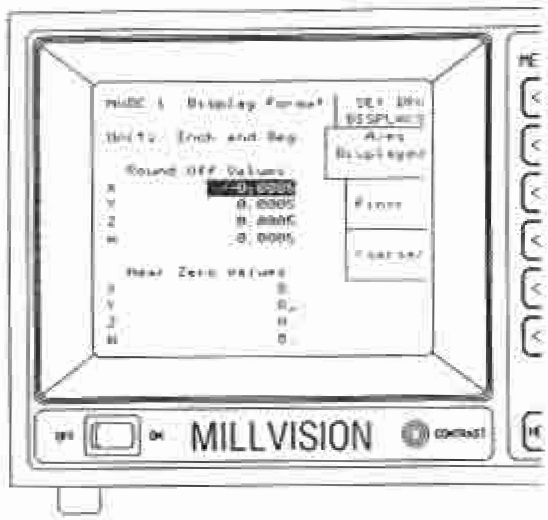


Figure 29. Setting DRO Display Modes.

7) To set the Near Zero Values, use the arrow keys to highlight the axis desired. Press the Clear key to erase any current value and the numeric keys to enter the beginning of the near-zero boundary desired.

Multiple scale coupling

Multiple Scale Coupling (MSC) allows the capability of mathematically combining the signals from two parallel linear encoders. The two encoder signals are electronically added, subtracted, or averaged to display one resultant motion, relative to the workpiece.

MILLVISION has three ways of performing Multiple Scale Coupling between axes. Coupling can be done using the Set System mode, the DRO mode, and/or the PROG mode.

Coupling established in the SET SYS mode (SET DRO DISPLAYS routine) can be displayed in any position of the DRO display. This method of MSC remains in existence until changed in the SET DRO DISPLAYS routine. The coupling can be added, subtracted, or averaged.

SET SYS coupling

To establish multiple scale couplings in the SET DRO DISPLAYS routine, proceed as follows:

Note: The following routine can be programmed while setting the DRO DISPLAYS modes, step 4 on page 40.

1) From the SET SYS mode, press the "SET DRO DISPLAYS" menu key.
2) Select the DRO display mode (1 or 2) in which coupling is to be displayed.
3) Use the arrow keys to highlight the axis position selected to display coupling. **Press the [Clear] key.**
4) Press the [AXIS CPLE] key.
5) Use the axis keys to select the first axis to be coupled.
6) Select the coupling function (ADD, SUBTRACT, AVERAGE), by pressing the corresponding menu key (Figure 30).

Figure 30. Multiple Scale Coupling (MSC).

7) Press the second axis key (to be coupled with the first).

Repeat steps 3 through 7 for any other couplings required.

Immediate mode coupling

Immediate coupling is established with the AXIS CPLE key while in the DRO and PROG Modes. An advantage of this method is that coupling can be established and discontinued easily within the DRO and PROG modes. Immediate mode coupling remains visible only for the present DRO or PROG Mode. The coupling is erased if the display is changed to another mode (including another DRO mode). The coupling is not erased when the HELP mode is accessed.

Immediate multiple scale couplings include the following limitations:

1. Only two axes may be coupled together.
2. The coupling must be either addition or subtraction.
3. Only one immediate mode coupling can be operational at a time.

An immediate mode coupling is displayed in the last axis position in the DRO and PROG Mode screens. If there are four axes being displayed, the coupling will override the fourth axis. The fourth axis remains active and will reappear when the coupling is removed.

To establish immediate mode couplings, using the AXIS CPLE key, proceed as follows:

1) From the DRO mode, or PROG RUN/LEARN, press the AXIS CPLE key.
2) Use the axis keys to select the first axis to be coupled.
3) Using the menu keys (ADD, SUBTRACT), select the coupling function.
4) Select the second axis to be coupled.

The immediate mode coupling can be erased at any time by changing the DRO display mode, leaving the DRO mode, or by pressing the AXIS CPLE key. When the coupling is erased, the display configuration (as it appeared prior to the coupling) will return. While programming immediate coupling, the sequence can be aborted by pressing the AXIS CPLE key.

Comparing SET SYS and immediate mode coupling

With either method of MSC, a coupling cannot be identified as a unique axis for presetting, edge finding or zero resetting. Presets, however, made on an axis which is included in the coupling will affect the coupling position.

Near zero indication capabilities remain active while axes are coupled. The near zero boundary for a coupled axes display, established in the SET DRO DISPLAYS routine, is set as part of that routine. The near zero boundary for immediate mode couplings is set to zero (not active).

The display resolution for permanent couplings is set in the SET DRO DISPLAY routine. The display resolution for immediate mode couplings is defined as the coarsest resolution of the axes being coupled.

Display multipliers

Display multipliers are used to scale a part from an existing drawing. Individual axis multipliers are used for machining molds or patterns requiring expansion and contraction factors.

To set display multipliers proceed as follows:

1) From the SET SYS mode, press the "SET DRO DISPLAYS" menu key.
2) Select the "Multipliers" menu key.
3) Highlight the desired axis with the arrow keys.
4) Erase the existing value with [Clear] key.
5) Enter the new value with the numeric keys.

All displayed axes MUST have a multiplier. During normal machining, the multiplier will be "1". No axis should have a value of 0.

Multipliers are in effect for DRO display modes 1 and 2, but the PROG mode requires multipliers be entered as part of the program (see page 59).

Machining to zero

MILLVISION was developed with a specific machining principle; *always machining to zero*. By machining to zero, the operator does not have to remember a long number at which to stop the cut. When MILLVISION's incremental display reads zero, the movement has been completed.

MILLVISION makes machining to zero possible by presetting the axis displays. There are four different types of axis presetting: Absolute, Incremental, Reference, and Zero Reset.

Absolute presetting

Absolute presetting changes the absolute display to the entered value and zeros the incremental display. Absolute presetting specifies the distance from the current tool position to workpiece zero. In standard machining, most operations are performed relative to workpiece zero. Therefore, if it is changed and not indicated on the work print, it could create confusion for the operator.

Incremental presetting

Incremental presetting is used to indicate a distance from the current tool position to a desired tool position. Incremental presetting is typically used in point-to-point machining.

Reference presetting

Reference presetting sets the incremental display to the distance required to get to a position relative to the workpiece zero, rather than from the current position. Reference presetting automatically subtracts the desired position from the current tool position. Example: Assume the tool position in the X-axis is located 6 inches in the positive direction from workpiece zero, and the operator wants to move it so that it is positive 8 inches from workpiece zero. The operator would enter X (the axis key), 8 (the preset value) and REF. Initially, the X-axis incremental display would read "−2 inches". Hence, the X-axis table slide, must be moved in the positive direction to get to zero. When the move has been made, the incremental display for the X-axis will read "zero" and the absolute display will show "+8 inches". **When a REF preset is entered, the value of the incremental axis is changed to show the distance needed to achieve the reference preset position (the absolute axis is unaffected).**

Zero resetting

The ZERO RESET key is a special key used with various presetting functions. It is only used to preset the value of zero in the display. Zero Reset is always used with either the absolute or the incremental preset function.

Zero Reset, when used with the incremental function, zeros the incremental display, but does not affect the absolute display.

Zero Reset, when used with the absolute function, zeros both the incremental and absolute displays at the same time. Zero Resetting the absolute display is normally done only once on any workpiece because it moves the position of workpiece zero.

Axis presetting procedures

Presetting is a three step operation: an axis selection, presetting a value, and presetting a function. Any of the following keystroke sequences can be used to preset an axis (or axes):

1) **AXIS SELECTION, PRESET VALUE, PRESET FUNCTION**
2) **PRESET VALUE, AXIS SELECTION, PRESET FUNCTION**
3) **PRESET VALUE, PRESET FUNCTION, AXIS SELECTION**
4) **PRESET FUNCTION, PRESET VALUE, AXIS SELECTION**

If axis selection is specified first in the sequence, the axis label will appear in the axis preset area. If, however, the preset function is specified first, its name (REF, ABS, INCR) will appear in the axis preset area.

The preset value consists of up to eight digits (ten spaces including the decimal point and sign) and may be entered with a maximum of six decimal places. No more than one zero preceding the decimal point may be used. The degree of accuracy of the preset value (as indicated by the number of digits to the right of the decimal point) cannot be greater than the programmed resolution entered into the SET SYS mode, SET PARAMETERS table at time of installation. If a greater precision value is entered, it will be rounded off to match the linear encoder or display resolution. Rounding off will be determined and made for each axis when using multiple presets.

Only one preset value and preset function can be used for any one preset operation, but more than one axis can be selected. Each axis selected for a particular presetting function has its label displayed in the axis preset area. Multiple axis presets can be done while using sequences 1 and 2 (see axis presetting procedures on page 45), when the axis selection is not the last item in the sequence. The CLEAR key can be used to remove the entire contents of the preset register.

When a number is entered into the preset register, it remains there until another number is entered or it is cleared by the CLEAR key. This means that the last preset value may be reused (for example, several holes located an equal distance apart) in subsequent preset operations without having to re-enter the value.

An angular preset can be made in DEG (degrees) or DMS (degrees, minutes, seconds). If a single decimal point is used, it is assumed to be DEG (degrees); this is the standard input method. If the DRO mode is in DMS units, a DMS preset can be made using multiple decimal points.

Example: 123.42.18 = 123° 42' 18''

If only one decimal point is used it is assumed to be DEG input.

Example: 123.42 = 123° 25' 12''

The FREEZE feature

The FREEZE function is used only in conjunction with absolute presetting and zero resetting. The "FREEZE" menu key becomes available whenever a preset operation is started. This feature permits the operator to select one or more axes and "freeze" the current display values. This is especially useful if the operator wants to write down the current values on the display without the risk of changing them by bumping the table. It is also useful if the operator wants to move the table out of the way to measure a cut and compare it with the displayed value. When the freeze function is active, it will maintain the frozen axes' displays on the screen even if the axes are moved. If the axes are moved, the information is not lost; it is recorded and the display is updated once the freeze has been "thawed", "cancelled", or a preset has been completed. When a display has been "frozen", the "THAW" menu key will cancel the operation. Incremental and reference presets can also be made to frozen axes, but their net effect is as if it hadn't been frozen.

An example of the FREEZE feature with the absolute preset function is when an operator takes a trial cut and wants to set the X absolute display to establish the initial dimension. Before moving the tool away from the part, the operator would press the X-axis key, then the "FREEZE" menu key. The X-axis would freeze its display, thereby allowing the operator to pull the tool back without losing the cutting position. Next, the operator would measure the part, enter the dimension as a preset value, and press the ABS function key. The displayed position at which the "FREEZE" menu key was pressed, would be replaced by the entered preset dimension and the display would become "unfrozen". The tool would no longer be at the cutting position, but the current tool position would be displayed, considering the new location of workpiece zero just entered.

The MIDPOINT feature

The MIDPOINT feature provides the operator with the means to determine the midpoint or center of a particular part. In simple terms, it presets the selected axis to *one half* of its current displayed value. A manual edge finder, feeler gage, or skim cutting operation can be used to accomplish this. The readout does not require an electronic edge finder for this feature.

The MIDPOINT feature may be used to perform two forms of center presetting; incremental and absolute. In the case of incremental midpoints, only the incremental display is affected. With any absolute preset, however, the absolute midpoint preset will affect both the incremental and absolute displays. In either case, the affected displays will read zero after successful completion of the MIDPOINT operation when the tool is placed at the center.

To find the midpoint of two locations proceed as follows:

1) Move to the first point on the midpoint line.
2) Press the desired axis key.
3) Press the [Zero Reset] key.
4) Press either the [INCR] or [ABS] key. This will zero the display at the first point so a net distance to the next point is available later to the readout.
5) Move to the second point on the midpoint line.
6) Press the desired axis key.
7) Press the "MIDPOINT" menu key.
8) Press either the [INCR] or [ABS] key for the MIDPOINT function.

   The MIDPOINT function will preset the readout with one half of the current axes display. The previous Zero Reset is very important because the midpoint or center is now one half of the current display.

The MIDPOINT function may be performed for more than one axis at a time, just as any preset may.

NOTE: This function is a simple one half preset of the current incremental and absolute displays; the Zero Reset is necessary only for finding the midpoint. Several different combinations of presetting, resetting and "midpointing" may be used to satisfy the application.

Tool offsets

For machinery operations using various tools, it is helpful to have a means of referencing tool cutting edges to a common tool point, or to each other, for each axis. This referencing process, called *tool offsets*, can be used to update the unit for a tool change. Updating maintains the true position of the cutting surface in relation to the workpiece.

The SET TOOL mode provides a quick and easy means to compensate for the difference in dimensions of the tools to be used during a particular machining operation. Storing tool offsets in MILLVISION frees the operator from manually presetting a compensation value for the selected tool. Tool offsets are *not* cumulative — the effects of tool offsets are always removed before being replaced by those of a new tool.

Tool offset values are set in the SET TOOL mode. To enter tool offsets proceed as follows:

1) Press the [Set Tool] key.
2) Use the "Edit Tool Offsets" menu key.
3) Use the arrow keys to select the tool number and dimension (diameter and length). To jump to a tool number use the [Tool #] key. There are 99 different tool numbers available.

NOTE: Tool #0 is a default tool and always has dimensions of zero. It cannot be assigned tool dimensions. There must always be an active tool. However, the effects of tool offsetting can be removed by selecting tool #0.

4) Use the numeric keys to enter the diameter and length (Figure 31).

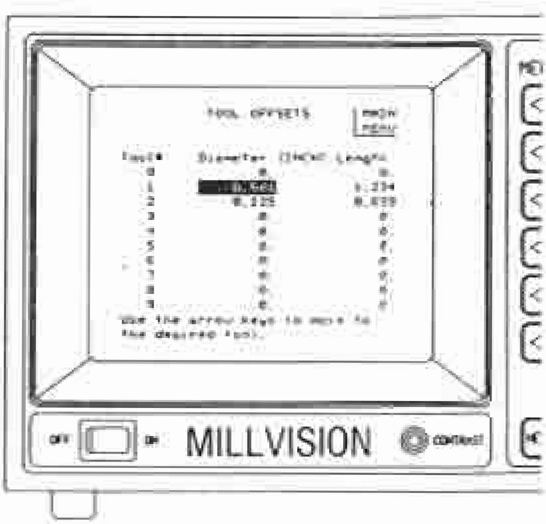


Figure 31. Setting Tool Offsets.

After tools have been assigned offset values in the SET TOOL mode, they can be selected from the DRO display mode. To select a tool in the DRO mode, proceed as follows:

1) Press the DRO key.

2) Select the tool by pressing the TOOL # key and then enter the desired tool number by using the numeric keys. Valid tool numbers are 0 through 99. As the tool number is entered, it will appear as the current tool # in the Tool # status area.

3) Use the down arrow key to move to the X-axis offset sign (the highlighted area will automatically move in about 5 seconds if you do not use the cursor arrow key).

   The offset sign indicates which side of the point of cut the tool center is located. Therefore, the followng question must be ansered to determine the offset sign: When machining at each point, is the center of the tool in the in the + or − direction or centered, in relation to the edge of the cut which is being machined? See Figure 32.

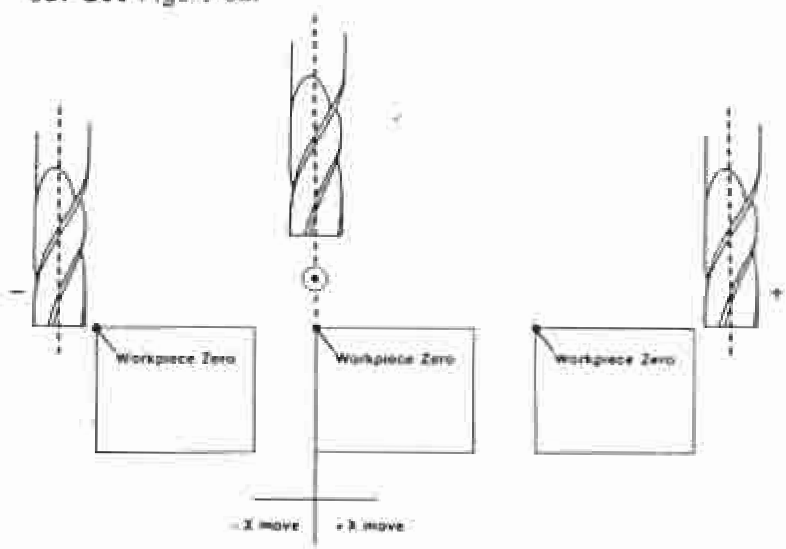


Figure 32. End Mill With Tool Offset Signs Relating to Workpiece Zero

4) Press the +/− key to toggle this sign to plus, minus or centered. The tool center can be at the point of cut (⊙), or the tool center can be to the left or right of the workpiece (− or +). The plus or minus sign is based n the count direction of each axis, determined in the SET SYS, encoder parameters.

5) Use the right arrow key to move to the Y-axis offset sign and repeat step 3 (Figure 33).

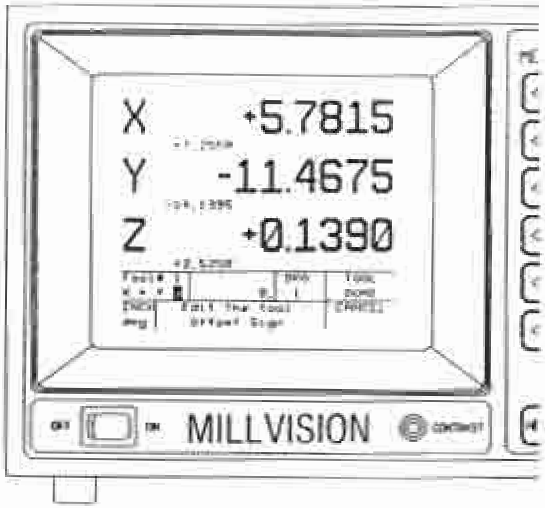


Figure 33. Tool Offset Signs.

6) Press the "tool done" menu key when finished. At this point, MILLVISION will automatically adjust the DRO display to compensate for the tool offset values.

Tool adjust

The tool adjust feature gives the operator an easy way to compensate for tool wear or resharpening.

To adjust for tool wear or resharpening proceed as follows:

1) Press the [Set Tool] key.
2) Press the "Tool Adjust" menu key.
3) Enter the tool number to be adjusted.
4) Use the down arrow key to move the highlight bar to the "Adjustment" field.
5) Enter the adjustment value and press the "Make Adjustment" menu key. Only the item, diameter, or length, which is highlighted, is affected by the "Make Adjustment" menu key. MILLVISION automatically calculates the new offset values.

Edge finder input

MILLVISION's edge find function can be used with a manual edge finder or an electronic edge finder. ACU-RITE offers quality electronic edge finder probes. Contact your ACU-RITE distributor for more information on edge finders and the full line of ACU-RITE products. If an electronic edge finder is used, MILLVISION must be equipped with the option module, part number 387800-4060.

MILLVISION's edge find function provides the following capabilities:

1) **Standard Edge Find Function**
2) **Workpiece Positioning**
3) **Two Point Calculations**

Please read the following notes pertaining to all three of the edge find functions.

The edge find functions only work for one axis at a time. All other axes maintain normal counting functions and are unaffected by the edge find operation.

All edge find functions use the ball radius and the length of the edge finder as "tool offsets". It is very important, therefore, to enter this information in the SET TOOL mode (see page 51).

The selection of a function, not related to the edge find function, will cancel the edge find operation. The "CANCEL" menu key also cancels the edge find operation.

The edge find operation can be aborted at any time by pressing the EDGE FIND key.

The X and Y tool offset signs are automatically updated according to the direction the edge finder was moving when the touch occured. The offset signs can be edited at any time during the edge find operation. If the "Manual Touch" method is used, the offset signs *must* be selected manually. By manually entering the offsets, the position displayed is at the edge of the ball (not the center).

Entering edge finder offsets

All edge find functions use the ball radius and the length of the edge finder as "tool offsets". This information must be entered in the SET TOOL mode.

To enter edge finder offsets, proceed as follows:

1) Press the [Set Tool] key.
2) Press the "Edit Edge Finder Offsets" menu key.
3) Enter the ball diameter. This value can be either inches or millimeters, and can be changed instantly by pressing the INCH/MM key.
4) Press the down arrow key and enter the length of the edge finder. The length is measured from the end of the ball.
5) Press the DRO key to return to the DRO mode.

Standard edge find function

The standard edge find function freezes the *absolute* display when the edge finder touches the workpiece. The display is the actual edge touch position (the edge finder ball radius is taken into consideration). The *incremental* display is zeroed at the edge find touch, but will continue to count showing how far the edge finder continues to move.

Follow the steps below to use the standard edge find function while in the DRO mode.

1) Press the [Edge Find] key.
2) Press the desired axis key.
3) Touch the edge finder to the desired point. The absolute display freezes, while the incremental display freezes at the edge find touch and continues to count showing how far the edge finder continues to move.

   Once the axis is thawed, the edge find operation is complete and the display returns to normal DRO operation.

Workpiece positioning

The workpiece positioning operation has two functions, locate edge dimension and zero reset on edge. The locate edge function freezes the edge find axis when the edge finder touches the workpiece. The zero edge function zero resets the edge find axis when the edge finder touches the workpiece. The zero edge function is an easy way to set the edge of the part as workpiece zero.

To use the **locate edge** dimension function, proceed as follows:

1) Press the [Edge Find] key.
2) Press the desired axis key.
3) Press the "Work. Position" menu key.

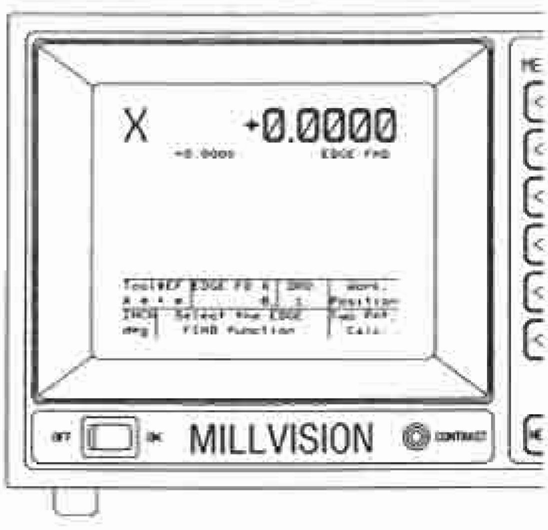


Figure 34. Screen Illustration.

4) Press the "LOCATE EDGE" menu key.
5) Touch the edge finder to the desired point. If using an electronic edge finder, the edge find axis absolute display will automatically freeze. If using a manual edge finder, press the "MANUAL TOUCH" menu key to freeze the absolute display. The incremental display is zeroed at the edge find touch, but will continue to count showing how far the edge finder continues to move.

6) Verify the point by pressing the "VERIFY POINT" menu key. If the wrong point was touched, press the "TRY AGAIN" menu key and touch the part again.

NOTE: When the edge find operation is finished, the edge finder remains the current tool number. If the edge finder is replaced with another tool, be sure to enter the correct tool number and offsets.

To use the **zero edge** function, proceed as follows:

1) Press the Edge Find key.
2) Press the desired axis key.
3) Press the "Work. Position" menu key.
4) Press the "ZERO EDGE" menu key.
5) Touch the edge finder to the desired point. If using an electronic edge finder, the edge find axis absolute display will automatically zero reset. If using a manual edge finder, press the "MANUAL TOUCH" menu key to zero reset the absolute display. The incremental display is zeroed at the edge find touch, but will continue to count showing how far the edge finder continues to move.

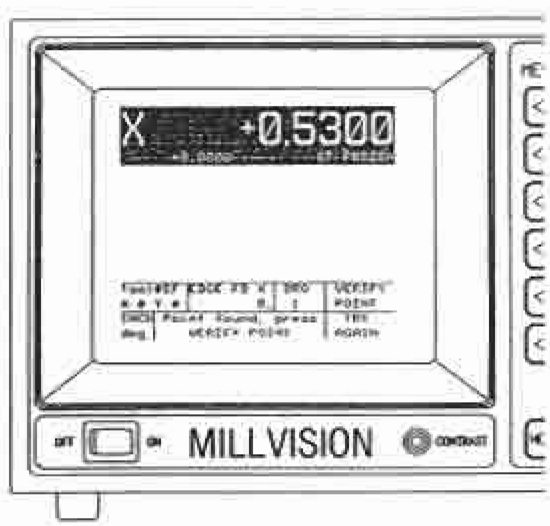


Figure 35. Screen Illustration.

6) Verify the point by pressing the "VERIFY POINT" menu key. If the wrong point was touched, press the "TRY AGAIN" menu key and touch the part again.

NOTE: When the edge find operation is finished, the edge finder remains the current tool number. If the edge finder is replaced with another tool, be sure to enter the correct tool number and offsets.

Two point calculation

The two point calculation function allows the operator to measure the distance and center between two consecutive edge findings.

Follow the steps below to use the two point calculation function while in the DRO mode:

1) Press the Edge Find key.

2) Press the desired axis key.

3) Press the "Two Pnt. Calc." menu key.

4) Touch the edge finder to the first point on the workpiece. If using a manual edge finder, press the "MANUAL TOUCH" menu key. The absolute display is frozen, displaying the touched position. The incremental display is zeroed at the edge find point, but continues to count showing how far the edge finder continues to move. Press the "VERIFY POINT" menu key to confirm the point (or press the "TRY AGAIN" menu key and touch the first point again). When the first point is verified, the absolute display is thawed.

5) Touch the second point on the workpiece. If using a manual edge finder, press the "MANUAL TOUCH" menu key. The axis display is now frozen. Confirm the point by pressing the "VERIFY POINT" menu key (or press the "TRY AGAIN" menu key and touch the second point again). When the second point is verified, the absolute display is thawed.

The DRO message area now displays the distance and center point between the two points.

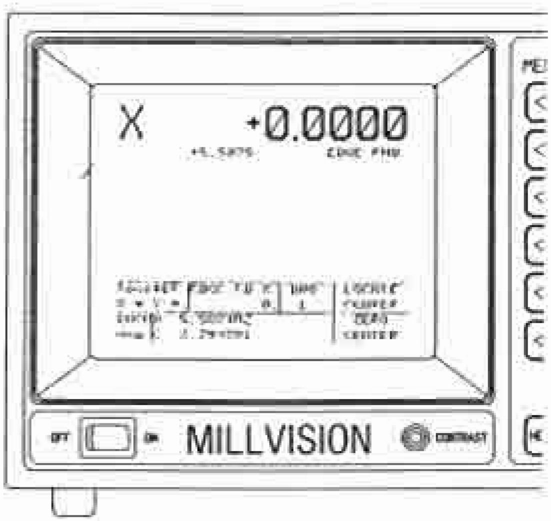


Figure 36. Screen Illustration.

6) Press the "LOCATE CENTER" or "ZERO CENTER" menu key.

If **"LOCATE CENTER"** is selected, a reference preset of the center value is performed. This allows the operator to locate the center position by moving the axis until the incremental display reads zero.

If **"ZERO CENTER"** is selected, the workpiece zero position is set to the center position.

NOTE: When the edge find operation is finished, the edge finder remains the current tool number. If the edge finder is replaced with another tool, be sure to enter the correct tool number and offsets.

The calculator mode

MILLVISION's built-in calculator provides the capabilities of an eight digit, four-function calculator. MILLVISION also features the ability to automatically calculate taper angles and rpm. An operator does not need to leave the machine to calculate simple math operations. The calculator mode can be accessed from any MILLVISION mode by pressing the CALC key. Numbers entered in a calculation may be entered with the numeric keys or copied from the current value in the DRO preset register in the general readout status area (in the DRO display).

Keys used in the calculator mode are as follows:

(Numeric keys)	The numeric keys are used to enter numbers in manually.
(+/− key)	The plus/minus key toggles the value sign from + to −.
(decimal pt key)	The decimal point key can be used when entering numeric values.
(CLEAR key)	The clear key is used to erase a current number. Press twice to erase the entire calculation (preset remains unchanged).

While in the main calculator mode, all other MILLVISION front panel keys (except menu keys) cannot be engaged.

There are two menus controlled by the menu keys. The far right menu keys contain the arithmetic function keys and "equals" sign. To toggle to the second set of menu keys, press the top menu key. The arrow on top of the screen will extend and highlight the three function menu keys. These menu keys are used to access the DRO display preset register.

PRESET STORE	Copies the value displayed as the operation result to the preset. The old preset value is overwritten.
PRESET RECALL	Copies the preset value to one of the number entry fields.
ADD TO PRESET	Adds the value displayed as the operation result to the preset.

Taper calculator

A feature within the calculator mode is the ability to automatically calculate the taper angle of piece by touching it in two places with a cutting tool or dial indicator. Very few keys are needed to use this mode because most of the operation is automatic.

The "Taper Calc" mode is initiated by pressing the CALC key while in the standard calculator mode.

To calculate taper angles:

1) Press the "SELECT AXES" menu key. The current axis labels will disappear from the display and two new axes are available for labeling.

   Ths step can be omitted if the default axes X and Y satisfy the needs of the operator.

2) With the cutting tool or dial indicator (zeroed), touch one point of the taper and press the "RECORD FIRST POINT" menu key. MILLVISION will record this point of the taper, as the initial point of the taper.

3) Move the cutting tool or dial indicator (zero at second point) to a second point on the taper and press the "RECORD SECOND POINT" menu key. MILLVISION will now calculate the taper angle.

   Four values will appear on the screen as a result of a completed taper calculation. The upper displayed answer for each axis is in DMS format, while the lower displayed answer is in decimal degrees.

   The range of values for each axis is between 0 an 90 degrees of taper. The sum of both will *always* be 90 degrees. The two values displayed beside each axis represent the angle between the tapered edge and the indicated axis.

4) Another taper may be calculated by pressing the Clear key. To exit the taper calculator mode press any mode key or press the CALC key again to enter the RPM calculator mode.

Coordinates for a taper calculation can also be entered manually. To manually enter taper points, proceed as follows.

1) Press the CALC key while in the standard calculator mode.
2) Press the "Enter Taper Points" menu key.
3) Enter the "First Point" measurements using the numeric and decimal point keys. The coordinates may be entered in inches or metric (INCH/MM key).
4) Move the highlight bar to enter the "Second Point" measurements.
5) Press the "Compute Taper" menu key.

Taper angles, representing the angle between the tapered surface and the indicated axis, are calculated and displayed in two formats — degrees, minutes seconds and decimal degrees.

RPM calculator

Within the calculator mode is an RPM calculator that computes mill RPM requirements. Correct cutting speeds are important to good tool life and efficient machining. Excessive high cutting speeds will cause overheating and premature cutting edge failure. Slow cutting speeds reduce productivity and increases manufacturing costs. The RPM calculator makes it easy for the operator to quickly calculate the correct RPM for maximum productivity.

To use the RPM calculator proceed as follows:

1) Press the [CALC] key to enter the calculator mode.
2) Press the [CALC] key two more times to toggle through the taper calculator and access the RPM calculator.
3) Use the numeric keys to enter the tool diameter. The diameter can be put into the calculator in inches or mm. Change the units by pressing the [INCH/MM] key.
4) Use the down arrow key to highlight the value for "Surface Speed in Meters per Minute" (SMM) (Figure 37).

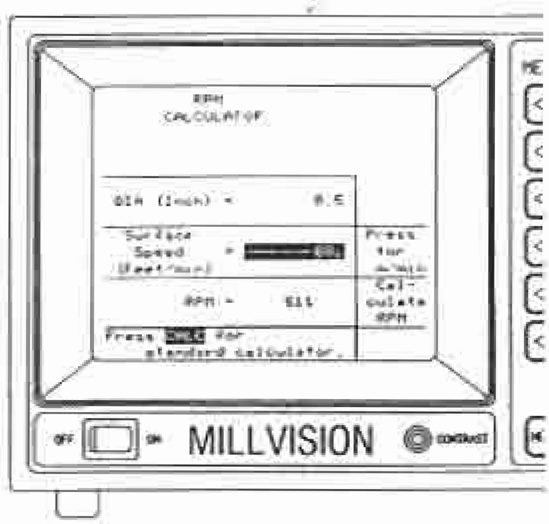


Figure 37. RPM Calculator Screen.

5) Use the numeric keys to enter the Surface Speed. Press the menu key to the right to toggle between Surface Feet per Minute and Surface Meters per Minute.

   The surface speed values are usually selected from standard tables which indicate the recommended cutting speed, the stock material, and the type of cut (rough or finish). MILLVISION has such a table in memory. To access the table, press the [Help] key and then the "Surface Speed Table" menu key. Other tables are available and can be accessed by pressing the "SELECT A TABLE" menu key. When finished with the tables, press the "RESUME" menu key

NOTE: All tables are based on optimum machining conditions.

6) To calculate the RPM (once the DIA and "Surface Cutting Speed" have been entered) press the "Calculate RPM" menu key.

7) Press any mode key to exit RPM calculator or press the [CALC] key to return to the calculator.

Resetting MILLVISION memory

MILLVISION has a convenient routine to restart all operations, making the unit "fresh out of the box" again. The "RESET ALL MEMORY" routine within the SET SYS mode will erase MILLVISION's entire memory and reprogram the factory defaults (Figure 10, page 13) for all parameters.

CAUTION

IF "RESET ALL MEMORY" IS USED, ALL PROGRAMS AND TOOL OFFSETS ARE LOST.

To RESET ALL MEMORY proceed as follows:

1) Press the [Set Sys] key.

2) Press the "MISCELLANEOUS" menu key.

3) Press the "RESET ALL MEMORY" menu key.

4) Enter password.

5) Read the warning and verify the intent to reset all memory.

6) Read the second flashing warning and again verify the intent to reset all memory.

7) The welcoming screen is displayed and indicates that all memory has been erased and factory defaults have been reprogrammed.

8) At this point, all home reference point locations, axes parameters, axes labels, error compensation values, tool offsets, display formats and machining programs will have to be re-entered as required.

Programming with MILLVISION

MILLVISION's program capabilities offer the ability to machine repetitive parts easily and efficiently. A program displays the information the operator requires to machine a part without referring back to a print. Program memory can hold 8 programs with a total of 250 steps.

Programming is comprised of 3 functions:

Programming - contains routines to enter new programs, view entered programs, edit existing programs, and erase old programs.

Running a Program - Entered programs are run in the PROG mode. While running a program, every step involves the operator machining to zero.

Learning a Program - allows the operator to enter a program by machining a part. Subsequent parts can then be machined with the learned program by running the program (above).

All presets applicable to an operation, conform to the philosophy of machining to zero. With this idea, the machining operation is not complete until the displays read zero. This eliminates the possibility of the machinist getting lost during an operation — the constant known destination is always zero.

Program multipliers

When creating a program, each axis is programmed with a multiplier. This is useful when machining mirror images or allowing for differing expansion and contraction factors. All real numbers (positive or negative), up to six digits to the right of the decimal point, can be used as a multiplier. It is important that the multiplier value is never zero.

Examples:

1) When working from a full size, scaled drawing, a multiplier of "1" must be used.
2) When machining a mirror image part, a multiplier of "–1" would be used.
3) To machine a part one half the size of the drawing, a multiplier of ".5" is used.

Z/W coupling

Z/W coupling is a feature that couples (mathematically combines) the Z and W axes while running or learning a program. The operator no longer needs to preset each axis to make a combined movement.

To set Z/W coupling while creating a program, proceed as follows:

1) Press the PROG key.
2) Move the highlight bar to the desired program (or create a new program) and press the "EDIT NAMED PROGRAM" menu key.
3) Move the highlight bar to the "Z/W Coupling:" function. Press the desired function — "OFF", "Z+W", or "Z–W".

To cancel the Z/W coupling, the operator must edit the program and repeat the steps above. The function must be "OFF".

While using Z/W coupling there are a few things to note:

While running or learning a program, the Z and W axes will not have individual axis displays.

A manual MSC can be used in addition to the Z/W coupling (see page 43).

While learning a program:

> All presets are recorded as the couplings absolute position and is learned as a Z preset.
>
> The near zero value is set to zero, and the display resolution is set to the coarsest of the Z and W encoder resolutions.

While running a program:

> If a preset is made to either the Z axis or W axis, it will affect the **coupled** display.
>
> The near zero and display resolution values are taken from the last Z or W preset in the program step.

Program step information

Each program step contains seven areas of information:

Axis - Each step can be programmed for two axes, each with a separate preset, function, round off value, and near zero flashing point. However, only axes which are to be machined with the same tool can be used in the same step.

Preset - A preset is a machined dimension from the work print (drawing) that is programmed into memory. When incorporating into a program, presets operate the same as in the DRO modes 1 and 2. In a step, however, a preset may refer to the previous step (i.e. current tool position) or to any previous step in the program.

Function - Function refers to the ABS, INCR, and REF function keys. These keys represent the type of move the preset value represents.

ABS refers to an absolute preset which moves workpiece zero. Absolute presets can be made in a program, but usually it is not advised because of the loss of the original workpiece zero.

INCR is an incremental move which represents the distance from the present location to the next desired point.

REF is a reference move which is the distance from the end point of the reference step indicated, to the next desired point. If REF function is used, the step # of the referenced point must be indicated. A reference step to workpiece zero is indicated as REF 0.

NOTE: Zero Reset Incremental can be used to remove incremental tolerance build-up on the display. At the same time, however, it builds up tolerances on the part.

Round Off - The round off value is the resolution displayed for this step. The displayed resolution, however, should never be finer than the encoder resolution. A round off value is defined for each axis in the step.

Flashing - Flashing indicates the near zero value. This value sets the boundaries for the near zero display indicator (see page 40). Each axis is assigned a value.

Auto Step - Auto step links the next step with the current step. This makes it possible to display four axes of motion on the screen simultaneously. When auto step is active, the linked second step overwrites all previous information from the first step, except for different axes and display variables (preset, function, round off, flash). It is important that the linked steps use the same tool number. Be careful that the same axis is not programmed in both steps, because the second programmed preset will overwrite the first preset.

Tool Number - This is used to reference the tool numbers as programmed in the Tool Offset Table (see page 48). The tool number must also indicate and offset sign (·, −, +). To determine the offset sign, the following question must be answered: When machining at each point, is the center of the tool in the + *or* − *direction*, or centered in relation to the edge of the cut which is being machined?

The default offset sign is · indicating the tool is centered. This offset is used when drilling holes. To change the offset sign press the +/− key to toggle between ·, −, *and* +.

The step presets are modified by the tool offsets. Make sure offsets have been programmed in the SET TOOL Mode for the tools chosen in a step.

Entering a program

To enter a program, proceed as follows:

1) From within the PROG mode, press the "CREATE PROGRAM NAME" menu key.

2) Select letters from the screen by moving the highlighted block with the arrow keys. When a chosen letter is highlighted, press the "ENTER LETTER" menu key. A name can also contain numbers (by pressing the numeric keys). If a character or number is entered incorrectly, press the "BACK SPACE" menu key to erase the last entry. A name can have up to 8 characters.

3) When the name is complete, press the"NAME DONE" menu key.

   This will return the display back to the program directory screen. The new program name should be listed.

   Note: the highlighted bar must be on the new program name to continue entering the program.

4) Press the "EDIT NAMED PROGRAM" menu key.

5) Enter the desired program multipliers (as explained on page 59). Mutipliers have a default value of "1" unless changed.

Entering a program (cont.)

6) Enter Z/W coupling selection. The Z and W axes can be combined as Z + W, Z − W, or OFF (explained on page 59).

7) Press "CREATE NEW STEP" menu key.

   This will display the first program step. Check the program name and the measurement units at the top of the screen. Units can be changed by pressing the INCH/MM and the DEG/DMS keys.

8) Indicate the axis using the axis keys.

9) Enter the axis preset required by using the CLEAR key and then the numeric, decimal point, and sign key.

   Note: for angular encoders, all presets, round off, and flashing values can be entered in either DEG (decimal degrees) or DMS (degrees, minutes, seconds). To enter the degree, minute, second values, use a decimal point between each value.

10) Press the desired function key (REF, INCR, ABS). This will automatically move the highlight bar to that field.

    If REF is chosen, it is necessary to enter the step number from which this move is referenced. A reference step to workpiece zero is indicated as REF 0. To enter the reference number press CLEAR and the new number.

    Example: A target point (current step) is measured from a reference point (a previous step). The same step does *not* have to be referenced for all axes. The X-axis may reference one step number and the Y-axis may reference a different step number.

11) Move the highlight bar to "Round Off". Set the desired resolution by pressing the "FINER" or "COARSER" menu key.

    The display round off should not be set finer than the actual scale resolution.

12) Move the highlight bar to "Flashing" and indicate the near zero boundary desired for the first axis.

13) Repeat steps 8 through 11 for the second axis in this step.

14) Move the highlight bar to "Auto Step" and press the "YES" or "NO" menu key. If auto step is desired, the current step and the next step will be displayed at the same time with the second step parameters controlling the screen display.

15) Move the highlight bar to "Tool Number" and indicate the tool number required to machine this program step.

16) Move the highlight bar to the right of "X:" and indicate the tool offset sign. Repeat for "Y:".

All other program steps follow the same input procedure. To continue with the next step in the program, press the "CREATE NEW STEP" menu key. This will display a screen representing the information required in the next step. **Note that the information entered from the last step remains on the screen.** The only area that is different is the "STEP #" at the top of the screen. This allows the operator to change only the areas which need different values. **Note: "Auto Step" will always reset so it will not be carried accidentally from step to step.**

"DELETE STEP" and "PRIOR STEP" menu keys are active while inputting a program and can be used to make changes as required.

"DELETE STEP" deletes the step that is currently visible.

"CREATE NEW STEP" creates a step *after* the step currently visible.

When the last step of the program has been entered, press the "PROGRAM DIRECTORY" menu key. Press the "RUN or LEARN PROGRAM" menu key to run the program.

Viewing a program

To view a program:

1) Enter the PROG mode.
2) Highlight the program to be viewed.
3) Press the "VIEW PROGRAM" menu key.

   Note: No changes can be made while in the "VIEW PROGRAM" routine.
4) Review the program by using the NEXT STEP key or the "PRIOR STEP" menu key.
5) To jump to a specific step, press the STEP # key and desired number (numeric keys).
6) To exit the "VIEW PROGRAM" routine, press the "PROGRAM DIRECTORY" menu key.

Editing a program

To edit a program:

1) Enter the PROG mode.
2) Highlight the program to be edited.
3) Press the "EDIT NAMED PROGRAM" menu key.
4) Make changes, as necessary, with the CLEAR, numeric, and menu keys. Move through the steps with the "NEXT STEP" and "PRIOR STEP" menu keys.
5) To jump to a specific step, press the STEP # key and the desired number (numeric keys).
6) When all changes are made, exit the program by pressing the "PROGRAM DIRECTORY" menu key.

Deleting a program

To delete a program:

1) Enter the PROG mode.
2) Highlight the program to be deleted.
3) Press the "DELETE PROGRAM" menu key.
4) Verify the program to be deleted.
5) The "YES" menu key will delete the program and return the display to the PROGRAM DIRECTORY.

   "NO" will abort the delete routine and return the display to the PROGRAM DIRECTORY.

RUNning a program

Executing a program must be completed in the PROG mode. The PROG screen display is the same format as in the DRO mode, page 37.

To run a program:

1) Press the PROG mode and highlight the desired program.
2) Press the "RUN OR LEARN PROGRAM" menu key.
3) The PROG mode will display the chosen program name in the message area of the screen.
4) Highlight the word "RUN" (menu key).
5) Begin the program by pressing the NEXT STEP key.
   While executing a program, the programmed presets may be temporarily changed by making "real-time" presets. These presets allow the operator to "override" the programmed presets for the current machining operation, without changing the actual program. Presets manually entered while in the PROG mode are completed in the same manner as other DRO mode presets.

   Note: When running a program, the DRO display defaults to the INCR position display in large numbers and the ABS position display in small numbers.

   The STEP # key can be used to "jump" to any step in the program. When a jump is performed, the entire program is recalculated, up to and including, the destination step.

   Other keys active during a program operation are the INCH/MM, DEG/DMS and the HOLE PTRN (explained on pages 4 & 5).
6) Work through the program, always machining to zero. When you are at the last program step, the step number will flash. The program can be run again by pressing the NEXT STEP key.

The LEARN routine is a unique feature of MILLVISION which allows the operator to create a program while machining. This feature can also be used to add new steps on to the end of an existing program.

1) Press the PROG mode key. If the learn routine is used to create a new program, a name must first be assigned in the PROGRAM DIRECTORY. Press the "CREATE PROGRAM NAME" menu key and enter the name.

   If the LEARN routine is used to add steps to the end of an existing program, that program must be highlighted in the PROGRAM DIRECTORY.

2) Highlight the desired program name.

3) Press the "RUN OR LEARN PROGRAM" menu key.

4) Highlight the word "LEARN" (menu key).

5) To learn a program, the operator machines a part using presets to set the displays. Each time a machining operation is completed, the NEXT STEP key should be pressed. MILLVISION automatically enters the distance between the cutting surface's current position and the workpiece zero location for each axis (for all the axes that have moved). The values are used to create program reference presets for each step. The presets are entered into the program step as reference presets (referenced from the absolute zero of each axis). At the same time the presets are entered into memory, the current tool number is also entered, with the current measurement units. **Only axes that have moved will be used to create a new step.**

   Note: If the operator wishes to display axes which are not part of the current step he must move the axis and return it to where it was, so MILLVISION records a movement made with that axis. If more than two axes have changed since the last step entry, the first two axes which showed movement will be used to create the next program step. The remainder of axes indicating movement within that display will be used to create a subsequent step. This activates the Auto Step feature to link the two steps. The same tool number will be used for both steps.

   Once the NEXT STEP key has been pressed, the operator is ready to begin the next machining operation. Continue this process until the part is completely machined.

   It is recommended that absolute presets and absolute zero resets not be used. These presets move workpiece zero which may cause improper execution of subsequent learned steps.

   Exit the "LEARN" routine by selecting "RUN" or pressing a mode key.

   Once a program is learned in the "LEARN" routine, it can be run, viewed, edited, or deleted (see pages 63-64).

Hole patterns

MILLVISION has the capability of machining hole patterns with up to 99 holes. This feature provides the operator the means to use the angle and radius dimensions directly from a drawing without converting, through trig functions, to cartesian coordinates. MILLVISION also has the capability of "learning" hole patterns. This allows the operator to enter a hole pattern while machining a part. Hole pattern information can be entered in the DRO mode or the PROG mode.

Hole patterns in the DRO modes 1 & 2

To create a hole pattern in DRO mode 1 or DRO mode 2:

1) Press the HOLE PTRN key. A hole pattern information screen (Figure 38) will appear displaying information from the last hole pattern operation. If none of this information needs to be changed, press the "MAKE PATTERN" menu key. If new values need to be entered, continue.

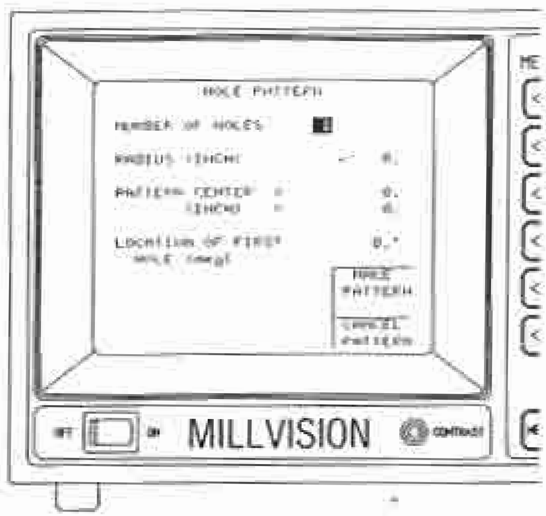


Figure 38. Hole Pattern Information Screen.

2) With the arrow keys, move the highlight bar to the "NUMBER OF HOLES" field. Enter number of holes (numeric keys) in the pattern operation.
3) Move the highlight bar to the "RADIUS" field and enter the desired value. This value can be entered in either inches or millimeters by pressing the INCH/MM key.
4) Move the highlight bar to the "PATTERN CENTER" field and clear any existing value. Enter the pattern center as dimensioned from the workpiece zero.
5) Move the highlight bar to the "LOCATION OF FIRST HOLE" field. This first hole offset is a DEG (degrees) or DMS (degrees-minutes-seconds) value, referenced from the X + axis or zero degrees axis (See Figure 39).

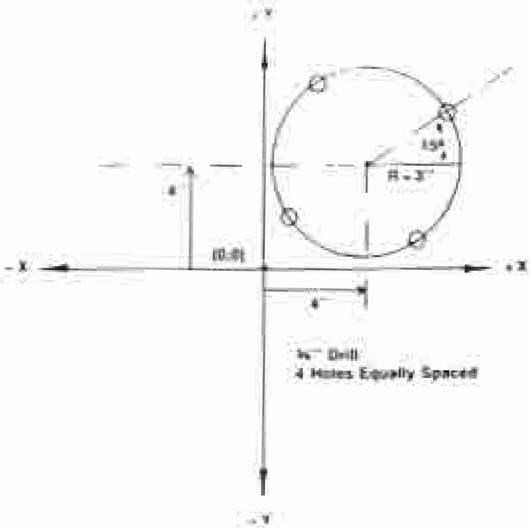


Figure 39. Hole Pattern Location Based On Cartesian Coordinate System.

Hole patterns (cont.)

6) Make sure all values have been entered and press the "MAKE PATTERN" menu key. This will return the display to the DRO screen.

7) When ready to machine the hole pattern, press the "NEXT HOLE" menu key. The X and Y preset values are then calculated into the corresponding display. At this point, the tool offsets are centered ((•), but can be changed to an offset if desired.

8) Move both axes until the readout displays read zero (machining to zero). Then continue to machine the hole.

9) Repeat steps 7 and 8 until the hole pattern is complete.

10) When the hole pattern operation is complete, press any key to get back to the normal DRO mode or press the "REPEAT PATTERN" menu key to repeat the operation.

Note: This hole pattern is retained in the hole pattern screen only until another pattern is created. It is short term and not saved in MILLVISION memory. A hole pattern can only be saved if created in the PROG mode.

Hole patterns in the program mode

In the PROG mode, it is possible to "run" or "learn" a hole pattern. To RUN a hole pattern in the PROG mode, an existing programmed hole pattern can be used, or a hole pattern can be inserted while operating a program. Hole patterns within a program can also be entered as steps of the program. LEARNing a hole pattern allows the machinist to enter a hole pattern by machining a part. This routine can be incorporated into an existing program or created as a hole pattern program.

Hole patterns (cont.)

To LEARN a hole pattern proceed as follows:

1) Press the PROG key.

A program directory will appear with available existing programs.

If the hole pattern is to be added to an existing program, proceed to step 2A.

If a new program is to be created specifically for a hole pattern, proceed to step 2B.

2A) Move the highlighted bar to the desired program name.

2B) Press the "CREATE PROGRAM NAME" menu key. Use the arrow keys to highlight a letter and press the "ENTER LETTER" menu key after each letter. Eight spaces are available to make up a program name. When the program name is entered, press the "NAME DONE" menu key.

3) Press the "RUN OR LEARN PROGRAM" menu key.

4) Make sure the highlight bar is on the word "LEARN". The display is toggled between RUN and LEARN by pressing the corresponding menu key.

5) Press the HOLE PTRN key. Enter the information as described in "Hole patterns in the DRO modes", page 66.

6) Press the "MAKE PATTERN" menu key.

7) Press the "NEXT HOLE" menu key to begin the hole pattern.

8) Move the axis or axes so the readout display(s) read zero (machine to zero). Continue to machine the hole.

9) Press the Next Step key to record the hole position.

10) Press the "NEXT HOLE" menu key. MILLVISION automatically changes the readout display(s) to reflect the next hole position.

11) Repeat steps 8, 9 and 10 until the hole pattern is complete. The operator is alerted to the last step of a hole pattern by a flashing step number.

Additional pieces can be machined using this program by highlighting the word "RUN". Run the program by pressing the NEXT STEP key.

To run a hole pattern proceed as follows:

1) Press the PROG key.

A program directory will appear with available existing programs.

2) Move the highlight bar to the desired program name.

3) Press the "RUN OR LEARN PROGRAM" menu key.

4) Make sure the highlight bar is on the word "RUN". The display is toggled between RUN and LEARN by pressing the menu key to the right of the words.

5) Press the NEXT STEP key to begin running the program. A number one should appear in the DRO message area indicating that step 1 is ready to be run.

6) Move the axis or axes so the readout display(s) read zero (machine to zero). Then continue to machine the hole.

7) Press the NEXT STEP key. MILLVISION automatically changes the readout display(s) to reflect the next hole position.

8) Repeat steps 6 and 7 until the program is complete. The operator is alerted to the last step of the program by a flashing step number.

To enter a hole pattern within an existing program proceed as follows:

1) Press the [PROG] key.

A program directory will appear with available existing programs.

2) Move the highlight bar to the desired program name.

3) Press the "EDIT NAMED PROGRAM" menu key.

4) At this point, move to the step in the program that the hole pattern is to be inserted after. This can be done by pressing the NEXT STEP key as many times as necessary to get to the step *or* by pressing the STEP # key and entering the step number with the numeric keys.

Note: The hole pattern will be inserted *after* the step currently displayed.

5) Press the [HOLE PTRN] key. Enter the information regarding the hole pattern as explained on page 66.

Note: If the operator wishes to display the Z & W axes, a step(s) must be individually inserted later.

6) Press the "MAKE PATTERN" menu key. If desired, change the existing "Round Off" and "Flashing" values.

Note: The tool offsets are automatically centered while creating a hole pattern, but can be changed when returning to the program or while running the program.

7) Press the "MAKE PATTERN" menu key. MILLVISION enters the hole pattern information into memory and then returns to the program step where the hole pattern ends. The pattern has now been inserted with every hole being a step in the program.

Multiple hole patterns

Multiple hole patterns or "nesting" can be programmed by entering each pattern in a program (Figure 40).

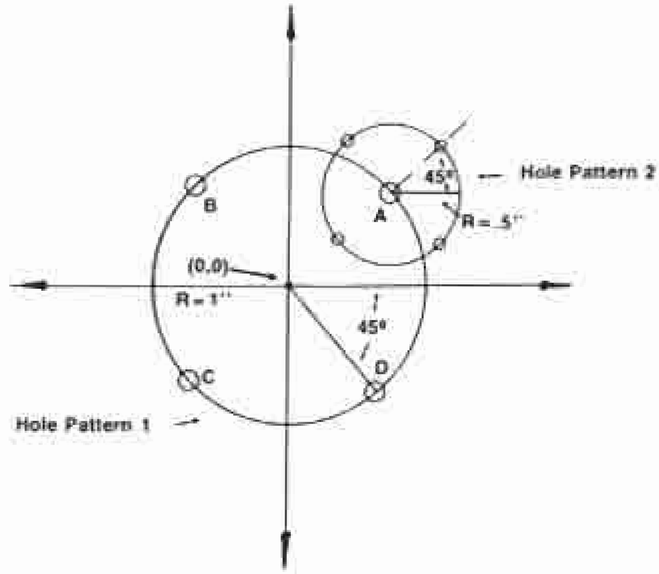


Figure 40. "Nested" Hole Patterns.

To create a program "nesting" the above illustrated hole patterns, the operator should proceed as follows:

1) Create a program name by pressing the "CREATE PROGRAM NAME" menu key. Enter the desired characters.
2) Press the "NAME DONE" menu key.
3) Press the "EDIT NAMED PROGRAM" menu key.
4) Press the [HOLE PTRN] key.
5) Enter the information regarding hole pattern 1 (Figure 41a).

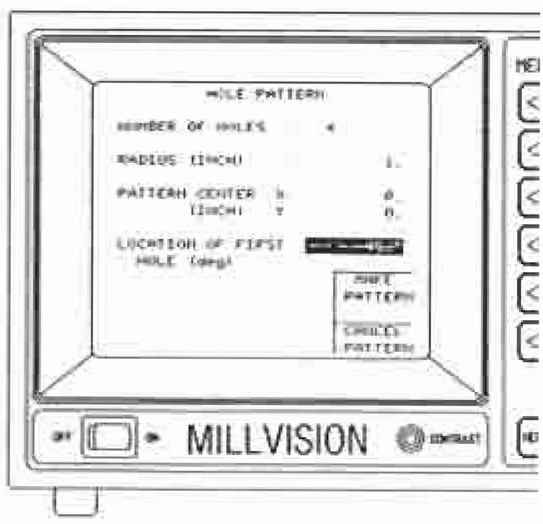


Figure 41a. Hole Pattern 1.

Hole patterns (cont.)

6) Press the "MAKE PATTERN" menu key. This brings up the HOLE PATTERN INFORMATION screen.

7) Press the "MAKE PATTERN" menu key. MILLVISION will now record the hole pattern in memory, creating one step for every hole. The screen will now read "EDIT PROGRAM STEP #4".

8) Press the "PRIOR STEP" menu key three times, the screen will read "EDIT PROGRAM STEP #1".

9) Press the [HOLE PTRN] key and enter the information for hole pattern 2 (Figure 41b).

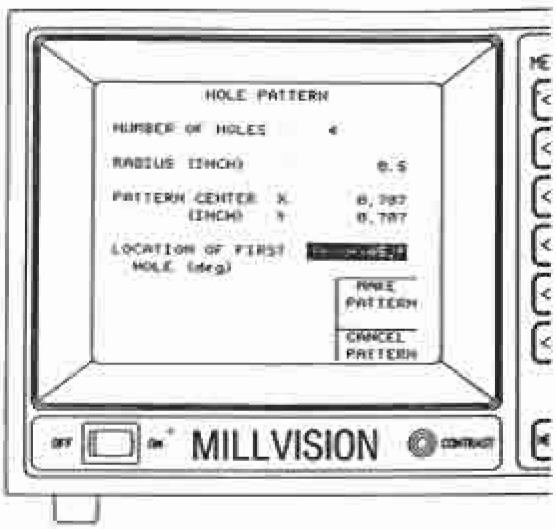


Figure 41b. Hole Pattern 2.

10) Press the "MAKE PATTERN" menu key. This brings up the HOLE PATTERN INFORMATION SCREEN.

11) Press the "MAKE PATTERN" menu key. MILLVISION will now record the hole pattern in memory, creating one step for every hole. The screen will now read "EDIT PROGRAM STEP #5". Essentially, 4 steps were inserted after step one, bringing up the step #5 screen. There is, however a total of 8 steps in the program.

12) Press the "PROGRAM DIRECTORY" menu key. To run the "nested" hole pattern program, press the "RUN OR LEARN PROGRAM" menu key.

Introduction

Powerful capabilities are added, when your standard MILLVISION is upgraded with ACU-RITE's option module (part number 387800-4060):

Footswitch

MILLVISION's footswitch offers three "hands-free" functions — PRINT key, NEXT STEP key, PRINT and NEXT STEP keys.

Edge Finder

The option module features a ⅛" phono jack edge finder input for use with an electronic edge finder.

Centronics Parallel Communications

The parallel communications option gives the operator means of making hard copy documentation of positional or other screen information.

External Video Monitor

The video monitor option allows the operator to monitor all MILLVISION operations on an external CRT.

RS-232 Communications

MILLVISION's RS-232 option can be configured to support three functions — printer, program storage, and computer communications.

Be sure to refer to the "INSTALLATION" tab section, page 2, to correctly install the options module.

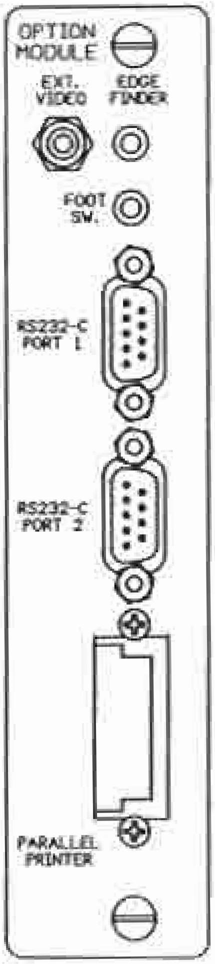


Figure OP1. Option Module.

Footswitch input

MILLVISION's footswitch option can perform three "hands-free" functions:

1. PRINT key
2. NEXT STEP key
3. PRINT **and** NEXT STEP key

The footswitch can function as the PRINT key for a hard copy of a formatted DRO or program screen with virtually every screen being able to be printed. The second function the footswitch option can perform is the NEXT STEP key for running or learning a program. The operator's hands never have to leave the machining operation. The footswitch can also function as both the PRINT and NEXT STEP keys. If "PRINT KEY AND NEXT STEP" is selected, the print function will be performed first.

Connect the footswitch cable to the "Foot Sw." input on the back of MILLVISION. To select the function, proceed as follows:

1) Press the [Set Sys] key.

2) Press the "OPTION-MODULE CONFIGURATION" menu key.

3) Press the "FOOTSWITCH FUNCTIONS" menu key.

4) Select the desired footswitch function.

   The footswitch can now replace a key press for "hands free" actuation.

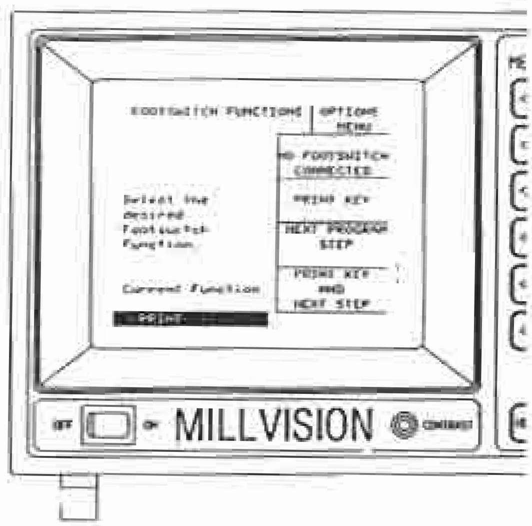


Figure OP2. Footswitch Configuration Screen.

Edge finder input

MILLVISION's option module allows the edge find routines to be performed with an electronic edge finder. Refer to pages 50-55 for instructions on how to use MILLVISION's edge find routines.

Centronics parallel communications output

The parallel communications output option gives the operator means of making hard copy documentation of positional or other screen information. ACU-RITE part number 388000-103 is a compact 110 VAC parallel printer ideal for use with this option. With the proper printer connections, the Print key will give a formatted print of any display screen. The only screen information that will not print, is the menu key information.

Connection

Communication to a parallel printer is via the parallel printer port on the back of the option module. A male 16 pin SDL connector, with a centronics compatible pinout is required for proper connections. ACU-RITE offers a parallel printer cable, part number 388000-104.

Pin-out definition:

pin	1 - strobe (active low)	(out)
	2 - data 1	(out)
	3 - data 2	(out)
	4 - data 3	(out)
	5 - data 4	(out)
	6 - data 5	(out)
	7 - data 6	(out)
	8 - data 7	(out)
	9 - data 8	(out)
	10 - acknowledge (active low)	(in)
	11 - busy	(in)
	12 - paper empty	(in)
	13 - select	(in)
	14 - auto feed	(out)
	15 - N.C.	
	16 - GND	

Setting printer parameters

After proper connections have been made, the parallel printer option is activated and configured as follows:

1) Press the [Set Sys] key.

2) Press the "OPTION-MODULE CONFIGURATION" menu key.

3) Press the "PARALLEL PORT FUNCTIONS" menu key.

4) A highlight bar will be on the first field. To activate the printer, make sure the "Parallel Status" indicates "On" by pressing the "On" menu key.

5) Press the [↓] key to move the highlight bar to the next parameter. The "Output Tail" is the desired number of blank lines that will follow the end of each printout. Enter the desired number of lines by pressing the corresponding number key (0-9).

6) Press the [↓] key to move the highlight bar to the next parameter. "LF after CR" can be selected as "Yes" if the connected printer requires a line feed after a carriage return. If a line feed is not needed, select "No" by pressing the corresponding menu key.

7) Press the key to move the highlight bar to the last parameter, "Printer Size". If the connected printer width is less than 40 columns wide, press the "Less than 40 columns" menu key. If the connected printer width is more than 40 columns wide, press the "40 columns or more" menu key.

Parameters are now set for the parallel printer option and need not be set again, unless changes are desired. Press the "Options Menu" menu key or a mode key to exit the screen.

A formatted print out will be similar to the following:

```
Tool# 2 X:o Y:o
X      INC       +2.9710   IN
       ABS       +2.9710   IN
Y      INC       +0.0435   IN
       ABS       +0.3685   IN
```

Figure OP3. DRO Printout.

```
   PROGRAM DIRECTORY

  PROGRAM NAME    STEPS
                  IN USE
    AB1              3
    AB2              4
    4444             4



STEPS AVAILABLE    239
```

Figure OP4. Program Mode Printout.

If the PRINT key is pressed when the printer is busy, not accepting characters, or not connected, the following screen will appear:

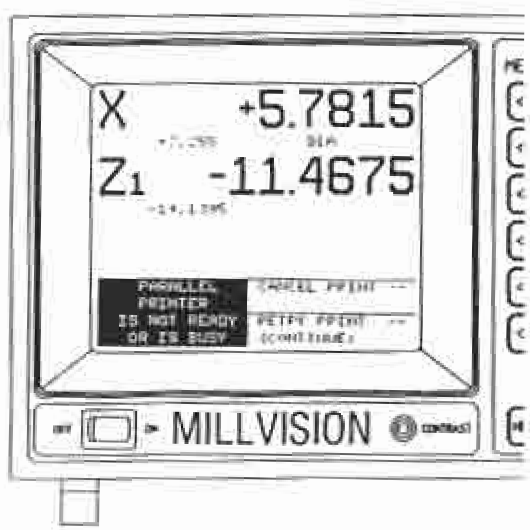


Figure OP5. Printer is Busy Screen.

Two menu options are available. The operator can cancel the print function or retry the print function.

Program printing

There are two ways to print program steps: a short form and a long form. The short form prints out a short version of the entire program (see Figure OP6 below). The long form prints out a detailed version of each desired step number (see Figure OP7 below).

For program mode print outs, proceed as follows:

1) Press the PROG mode key.

2) Press the "VIEW or PRINT PROGRAM" menu key.

3) Press the desired print form — short or long.

```
PROGRAM NAME: AB2
MULTIPLIERS: X =          1.
             Y =          1.
             Z =          1.
             W =          1.
   Z/W Coupling: OFF
STATUS: INCH  deg

STEP     PRESET  FUNCTION TOOLXY

 1  X       0.  REF   0    1 o+
    Y      -2.  REF   0

 2  X       1.  REF   0    1 -+
    Y      -2.  REF   0

 3  X       1.  REF   0    1 --
    Y     -0.5  REF   0

 4  X     1.25  REF   0    2 oo
    Y    0.625  REF   0

      END OF PROGRAM
```

Figure OP6. Short Printout.

```
VIEW PROGRAM STEP #  1
Name: AB2
Units: INCH/deg
Axis   Preset    Function
X             0. REF   0
Y            -2. REF   0

   Round Off    Flashing
X     0.0005          0.
Y     0.0005          0.
Auto Step    :NO
Tool Number : 1 X:o Y:+
```

Figure OP7. Long Printout.

External video monitor

The video monitor option allows the operator to monitor all MILLVISION operations on an external CRT. No parameters need to be set, just plug the female phone plug into the "EXT. VIDEO" port on the back of MILLVISION.

MILLVISION's external interface is compatible with NTSC (National Television System Committee) composite input monochrome monitors. It is recommended that all monitors to be used with the option module, be equipped with external horizontal width and vertical size controls.

RS232 communications

The MILLVISION Option Module is equipped with two RS232 ports. These ports can be configured to support any of the following three functions:

1. Printer Port
2. Program Storage
3. Computer Communications

Connection

Communication to support any of these functions is via one of the RS232-C ports on the back of MILLVISION. A female 9 pin, D-subminiature connector cable is required for proper connections.

Serial Port Pin Assignments

Pin	I/O	Description
2	I	Incoming Data
3	O	Out going data
4	O	When active (logic "0", +12V), it informs the other device that MILLVISION is available to communicate.
5		Signal ground
6	I	When active logic "0", +12V), it indicates that the other device is available to communicate.
7	O	When active (logical "0", +12V), it indicates that MILLVISION is ready to receive data.
8	I	When active (logical "0", +12V), it indicates the device is available to receive data.

Setting protocols

Protocols are needed to configure the port to communicate properly with the printer, computer or remote storage device connected. Protocols define the handshaking and the way data is exchanged between MILLVISION and the external device. To set these protocols, follow the procedure below:

1) Press the SET SYS key and then the "OPTION-MODULE CONFIGURATION" menu key.
2) Press the "RS-232 PROTOCOLS" menu key.
3) Press the desired port — "Port 1" or "Port 2".
4) Use the arrow keys to move through the protocols and make the appropriate choice for each handshaking field. An explanation of each protocol is described below. To exit the "RS-232 PROTOCOLS" screen, press a mode key.

Baud Rate

Baud rate is the speed at which information will travel over the communication link. Although MILLVISION allows very fast baud rates (up to 19,200 bits/second) there is a point which the system throughput will no longer increase with faster baud rates — faster is not always better.

MILLVISION can process information at a relatively fixed rate. If MILLVISION cannot process the information as fast as it is coming in, one of two things will occur:

1. If no handshaking is used, input buffer overflow will occur, and MILLVISION will produce a System Error.
2. If handshaking is used, MILLVISION will "tell" the other device to stop sending data until it can catch up.

For most applications, MILLVISION's optimum baud rate is 1,200 bits/second. Speeds higher than this will *not* significantly improve performance. The chosen baud rate must be the same as the device interfaced.

Parity

Parity is a form of error checking on the received data. When data is transmitted, an additional bit of information is attached. This bit is checked at the receiver, and if it is incorrect, an error condition is flagged. MILLVISION can be configured for three of the most common forms of parity (even, odd, or none). The chosen type of parity must be the same as the device interfaced.

Data bits

Since ASCII information is being transferred, only seven data bits are required. Some devices, however, require eight data bits. Therefore, MILLVISION is configurable for either. The chosen number of data bits must be the same as the device interfaced.

Stop bits

Stop bits signify the end of a piece of data. Only one is required, with MILLVISION, unless the interfaced device requires two. Both devices must be configured for the same number of stop bits.

XON/XOFF

XON/XOFF is a form of software handshaking. Handshaking is a method of controlling the flow of information so the receiving device will be ready for incoming information when it arrives. If the receiving device is not ready, it must tell the transmitting device not to send anything for a while. This is accomplished with the XON/XOFF protocol. If a device is not ready to receive, it sends an XOFF character to tell the other device not to send any data. When it is ready to process more information, it sends an XON character to tell the other device "it is ok to send now".

If this protocol is enabled, *both* devices must be capable of transmitting and responding to the XON/XOFF characters.

Hardware Handshaking Signals

Pins 4, 6, 7, and 8 on each serial port are hardware handshaking signal lines. Hardware handshaking performs the same task as software handshaking, but in a different manner.

The signals on pins 4 and 6 are handshake signals that allow each device to tell the other device it is available for communications. Pin 4 is an output for MILLVISION that, when active (logical "0", + 12V), signals the remote device that MILLVISION is available for communication. The signal on pin 6 is an input to MILLVISION that, when active (logical "0", + 12V), indicates to MILLVISION that a remote device is connected to the other end of the serial cable and that the remote device is ready to communicate.

Note: MILLVISION requires an active (logical "0", + 12V), signal on pin 6 to enable it to communicate with another device. If the attached device does not provide such a signal, it will be necessary to wire pin 4 to pin 6 on the MILLVISION end of the serial cable. This jumper will provide the necessary signal on pin 6 to allow communications.

The signal on pin 7 is an output from MILLVISION that can be described as "ready to receive". When this output is active (logical "0", + 12V), it signifies that MILLVISION is ready for incoming information. When MILLVISION cannot accept more data, it sets this output inactive (logical "1", – 12V).

The signal on pin 8 is an input to MILLVISION. When the signal is active (logical "0", + 12V), MILLVISION knows that it can send data. When the signal is inactive (logical "1", – 12V), it tells MILLVISION to "shut up". The handshake signal is ignored if "CTS" is designated as inactive in the protocols for that port in "SET SYS", "RS-232 PROTOCOLS".

Hardware vs software handshaking

Both types of handshaking address the same problem: regulation of data flow. Using both hardware and software handshaking is redundant, but the system will work with both (assuming the other device supports both methods). At low baud rates, handshaking may not be required at all. At higher baud rates, the system will fail unless some form of handshaking is used.

The form of handshaking the operator chooses, depends on the device interfaced. Some devices are only capable of one form of handshaking, either hardware or software. MILLVISION's option module was designed for flexibility, allowing either form of handshaking. MILLVISION must be configured to the same form of handshaking as the device interfaced. If the interfaced device does not support either form of handshaking, slower baud rates must be used.

Pin outs

The following pin outs are examples of interfacing PCs with a 9-pin and a 25-pin connector.

MILLVISION Interfaced to a 25-pin Computer (IBM-PC):

MILLVISION pin #	Name	direction	Computer pin #	Name
2	RxD (Receive Data)	<------	2	TxD (Transmit Data)
3	TxD (Transmit Data)	------>	3	RxD (Receive Data)
4		------>	6	
6	Handshake	<------	20	Handshake
7	Lines	------>	5	Lines
8	See page OP8	<------	4	
5	signal ground	-------	7	signal ground

MILLVISION interfaced to a 9-pin Computer (IBM PC-AT):

MILLVISION pin #	Name	direction	Computer pin #	Name
2	RxD (Receive Data)	<------	3	TxD (Transmit Data)
3	TxD (Transmit Data)	------>	2	RxD (Receive Data)
4	Handshake	------>	6	Handshake
6	Lines	<------	4	Lines
7	See page OP8	------>	8	
8		<------	7	
5	signal ground	-------	5	signal ground

Printer port function

The RS232 printer function gives the operator means of making hard copy documentation of positional or other screen information.

By configuring one of the RS232 ports for the print function, the Print key will perform a formatted print of any display screen. The only screen information that will not print, is the menu key information.

Setting printer parameters

After proper connections have been made, protocols and parameters regarding the printer must be defined in the SET SYS mode. To set protocols refer to page OP7. To set parameters proceed as follows:

1) Press the [Set Sys] key.
2) Press the "OPTION-MODULE CONFIGURATION" menu key.
3) Press the "RS-232 FUNCTIONS" menu key.
4) Press the desired RS-232 port — "Port 1" or "Port 2" menu key.
5) For the "Port Function" field, press the "Printer" menu key.
6) Press the [↓] key to move the highlight bar to the next parameter. The "Output Tail" is the desired number of blank lines that will follow the end of each printout. Enter the desired number of lines by pressing the corresponding number key (0-9).
7) Press the [↓] key to move the highlight bar to the next parameter. "LF after CR" can be selected as "Yes" if the connected printer requires a line feed after a carriage return. If a line feed is not needed, select "No" by pressing the corresponding menu key.
8) Press the [↓] key to move the highlight bar to the last parameter, "Printer Size". If the connected printer width is less than 40 columns wide, press the "Less than 40 columns" menu key. If the connected printer width is more than 40 columns wide, press the "40 columns or more" menu key.

Parameters are now set for the printer function and need not be set again, unless changes are desired.

Program storage function

The program storage interface allows the operator to save to, load from, and delete programs on a vision remote storage device. This remote storage device can be any device which supports the protocols for program storage. The appendices for this section of the manual contains the required file format and command information needed to write a program for a computer or other storage device to allow it to act as a remote storage device for MILLVISION. MILLVISION programs are stored in MSDOS format to allow for easy manipulation, duplication and deletion. A program which configures an IBM, IBM-AT or an IBM compatible to provide storage transfer capability is available on floppy disk from ACU-RITE (1-800-344-2311).

Setting remote storage device parameters

After proper connections have been made, protocols and parameters regarding the chosen remote storage device must be defined in the SET SYS mode. To set protocols, refer to page OP7. To set parameters proceed as follows:

1) Press the [Set Sys] key.
2) Press the "OPTION-MODULE CONFIGURATION" menu key.
3) Press the "RS-232 FUNCTIONS" menu key.
4) Press the desired RS-232 port — "Port 1" or "Port 2" menu key.

5) For the "Port Function" field, press the "External Storage" menu key.

6) The next three parameters, "Output Tail", "LF after CR", and "Printer Size" fields only pertain to the printer function and are ignored when the external storage function is selected. Parameters are set and this screen can be exited by pressing a mode key or by pressing the "Port Select Menu".

Program transfers

During program transfers between, MILLVISION and a vision remote storage device, MILLVISION is always the **issuer** of commands and the remote storage device is always the **respondent.** Three program transfer functions are available and are performed in the program mode:

SAVE - allows the transfer of a program from within MILLVISION to a remote storage device.

LOAD - allows a program stored in the remote storage device to be loaded back into MILLVISION for use.

DELETE - allows a program in the remote storage device to be deleted.

To SAVE, LOAD, or DELETE a program, proceed as follows:

1) Press the PROG key to enter the "Program Directory".
2) Move the highlight bar to the program to be transferred.
3) Press the "PROGRAM TRANSFERS" menu key.
4) Select the RS232 port to be used. Only ports which have been configured will be listed as available. If only one RS232 port is available, MILLVISION knows which port has been configured, and this step is skipped.
5) Select the function to be performed. A confirmation message should appear, indicating the transfer was successful.

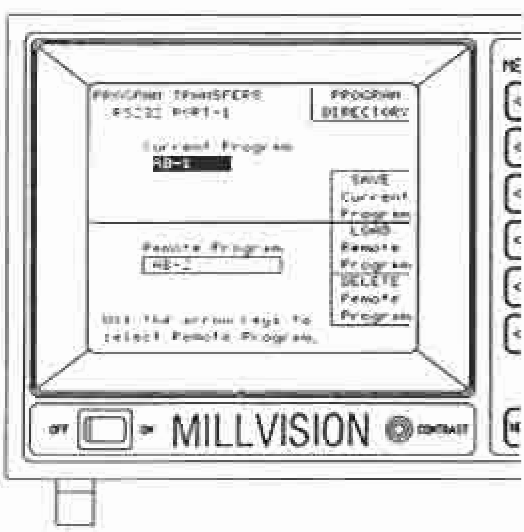


Figure OP8. Program Transfers Screen.

Program transfer SAVE

The "SAVE" function requires that there be a program created in MILLVISION, and that the remote storage device has enough storage to hold the program. After a "SAVE" command, the file is displayed in the "Remote Program" window. Programs saved on the remote storage device are stored alphanumerically.

The remote storage device can support a maximum of 25 programs per disk directory. This limitation makes finding a program easier and reduces the risk of saving a program to a full disk.

MILLVISION will not save to a remote storage device if the disk is full. A message will appear warning the operator that there is insufficient storage. The "SAVE" function can be cancelled, by pressing the "CANCEL" menu key. If MILLVISION is in the middle of the function, however, the "CANCEL" key must be pressed for a few seconds to cancel the transfer.

To help the operator maintain revision control of a program, the remote storage device automatically provides a revision level which is placed in the filename extension. The first time a program is saved on a particular diskette or subdirectory in the remote storage device, the program name will have a suffix of ".000". This revision level increases each time the program is saved — it will not overwrite an existing program. The revision level does not become part of the program filename; rather, is used as a visual aid to keep track of various program generations. Any program revision may be deleted. The revision level will not revert to ".000" unless every copy of the program has been removed.

Program transfer LOAD

Only the program currently displayed in the "Remote Program" window can be loaded from the remote storage device. A program is located by scrolling through the remote storage device directory with the up and down arrow keys. The "Remote Program" window cannot be scrolled past the last program in the Remote Storage directory. MILLVISION automatically calculates available memory in the program directory and loads the program *only* if there is enough memory. If there is not enough memory to hold the program, the "LOAD PROGRAM" menu key is removed from the display and the following message is displayed.

"Insufficient Readout Memory to Load Program".

If the LOAD operation is CANCELLED, none of the program will be transferred. MILLVISION and the Remote Storage Device will not transfer a partial program.

After a program is loaded successfully, a confirmation message appears on the screen. This message remains until the operator exits the screen or another program function is selected.

Note: Only programs which are compatible with MILLVISION software can be loaded.

Program transfer DELETE

Only the program currently displayed in the "Remote Program" window can be deleted from the remote storage device program directory. If a program is deleted, the next program in the directory is displayed in the "Remote Program" window.

When the "DELETE PROGRAM" function is selected, MILLVISION asks the operator to confirm the command. The "YES" menu key *must* be selected for the program to be deleted. Any other keypress will terminate the operation.

Program transfer errors

If a transfer was *not* successful, one of the following messages may appear:

"Insufficient Readout Memory to Load Program" - This message indicates that MILLVISION's program directory is full, but programs *can* be SAVED to or DELETED from the remote storage device.

"Insufficient External Storage to save Program" - This message indicates the Remote Storage Device directory or disk is full, but programs *can* be LOADED or DELETED from the remote storage device.

"The External Storage does not respond" - This message indicates that there is *no* communication between MILLVISION and the remote storage device. Check to ensure proper connections have been made.

"Program not LOADED - invalid program" - This message indicates that an incompatible program was attempted to be loaded. Only programs which are compatible with MILLVISION software can be loaded.

Each data transfer is "guarded" by a checksum technique to ensure data has been properly transferred. Data communication errors may, however, occur. The following are possible errors:

ERROR: Remote Storage Device fails to respond.

ERROR: Disk read error.

ERROR: Program NOT SAVED - Disk write protected.

ERROR: Program not SAVED - communication error.
(also triggered by a cancelled "SAVE")

ERROR: Program Not Found.

ERROR: Program not LOADED - communication error.

ERROR: Program not LOADED - invalid program.

If an error occurs, MILLVISION will not retry the transfer. The operator is instructed on how to first, fix the problem, and then repeat the operation. An error message is displayed until the operator exits or repeats the transfer.

RS232 computer communication

MILLVISION can respond to remote simulated keypresses from a computer and to a variety of commands through the RS-232 ports. Both RS-232 ports are identical in operation, and yet, completely independent of each other.

The RS232 computer function offers two options: data requests and a remote keyboard. The data request function allows the operator to request such information as tool position, axis positions, and MILLVISION's current mode. The keyboard function allows a computer to simulate MILLVISION's keyboard.

Setting computer parameters

After proper connections have been made via one of the two RS232 ports on the back of MILLVISION, parameters protocols regarding the chosen computer must be defined in the SET SYS mode. Refer to page OP7 to set protocols. To set parameters proceed as follows:

1) Press the [Set Sys] key.
2) Press the "OPTION-MODULE CONFIGURATION" menu key.
3) Press the "RS-232 FUNCTIONS" menu key.
4) Press the desired RS-232 port — "Port 1" or "Port 2" menu key.
5) For the "Port Function" field, press the "Computer" menu key.
6) Press the [↓] key to move the highlight bar to the next parameter. The "Output Tail" field only pertains to a printer function and is ignored when the computer function or the external storage function is selected.
7) Press the [↓] key to move the highlight bar to the next parameter. The "LF after CR" (line feed after carriage return) field can be selected ("YES") if the connected computer requires a line feed after a carriage return. If the line feed is not needed, select "NO" by pressing the corresponding menu key.
8) Press the [↓] key to move the highlight bar to the next parameter. The "Printer Size" field only pertains to a printer function and is ignored when the computer function or the external storage function is selected.

Data request function

The data request option allows an external serial device to poll MILLVISION for process control and SPC data. The following items can be requested:

Reset Channel
Keyboard Echo
Full Screen Prints
Incremental Axis Position
Absolute Axis Position
Inch/MM Status
Axis Position
Current Tool Number
Current Readout Mode
Filter Status

Each data request to MILLVISION is terminated by a carriage return. This carriage return marks the end of transmission" and informs the readout to execute the request. In the same manner, after MILLVISION responds to a request, it marks the end of a transmission with a carriage return.

Data requests (cont.)

Invalid data requests or invalid character sequences automatically close communications until a reset command is issued. This prevents and invalid request from causing damage to MILLVISION.

All data requests begin with a question mark ("?") and then one to two additional characters. The following is a list and definition of available requests:

Note: For each request, enter the information *within* the quotes — do not enter the quotes. Commands and responses are followed by a carriage return (<cr>), which signifies the end of a transmission.

An echo string table can be found on page OP17.

Reset Channel ("?*<cr>") - The reset channel request cancels any previous or pending requests and re-initializes the communication buffers.

Keyboard Echo ("?=<cr>") - This request turns on/off the echo mode. Within the echo mode, there are three formats:

echo mode 0: no echo
echo mode 1: echo the exact character (refer to key table on page OP17 for character code)
echo mode 2: echo a descriptive string (refer to key table on page OP17 for string definition)

This feature is necessary for terminals which require a keyboard echo from the host device. The data requests and storage commands, themselves, will not echo. To change the echo mode use the following commands:

Mode	**Command**
echo mode 0:	"?E0<cr>"
echo mode 1:	"?E1<cr>"
echo mode 2:	"?E2<cr>"

Print Screen ("?P<cr>") - This request provides a character by character reproduction of all ASCII characters currently on the screen. This allows the computer to request full screen prints. Output format consists of 16, 32 character strings each terminated by a single carriage return character.

Incremental Position ("?Ix<cr>") Where X = 1, 2, 3 or 4 for axis X, Y, Z and W respectively. This data request provides each incremental axis position. Output is a 19 digit ASCII string of eight numeric digits, sign, decimal point (+1234.6789), measurement units and crossfeed format. Position requests are only valid when the readout is in the DRO Mode.

Example:

Command: ?I2 (incremental positon for axis #2)
Response: Y = -1234.5678 DEG

Data requests (cont.)

Absolute Position ("?Ax<cr>") Where X = 1, 2, 3 or 4 for axis X, Y, Z and W respectively. This data request provides each absolute axis position. Output is a 19 digit ASCII string of eight numeric digits, sign, decimal point (+1234.6789), measurement units and crossfeed format. Position requests are only valid when the readout is in the DRO mode.

Example:

Command: ?A1 (absolute position for axis #1)
Response: X= +1234.5678 IN

Note: Unavailable axes or positions requested outside of the DRO mode will produce the following response:

=******* ** ***

Inch/mm Status ("?U<cr>") - The linear units response is "IN" for inch and "MM" for millimeters, followed by a carriage return.

DEG/DMS Status ("?D<cr>") - This status is indicated as "D" for degrees and "G" for DMS.

Axis List ("?X<cr>") - This request allows the operator to determine displayed axes and their positions. The axes are listed according to their availability and numerical designation. The numerical designations of one through four are X, Y, Z, and W. If an axis is missing, it is represented by asterisks. For example, if X and Y were not available, the output would be "**ZW**".

Current Tool ("?T<cr>") - This request provides the current tool number in use, 1-99.

Current Readout Mode ("?M<cr>") - This request determines which mode MILLVISION is in. Responses are as follows:

"H" = HELP
"D" = DRO
"P" = PROGRAM
"T" = SET TOOL
"C" = CALCULATOR
"S" = SET SYSTEM

Filter Status ("?F<cr>") - This request allows monitoring of the thermal and filter condition of MILLVISION. If the filter and thermal conditions are good, the response is "0". If the temperature is too high or the filter has been removed the response is "1".

RS232 Error Status ("?Q<CR>") - This request determines if the current port has a parity error, data overrun, or buffer overflow since the last request for RS232 error status. The responses are as follows:

"0" if no errors have occured
"1" if errors have occured

The power up default is "no error".

Keyboard function

The keyboard function allows a computer to simulate MILLVISION's keypad. The MILLVISION keypad has been mapped to a standard ASCII terminal (Zenith Z-19).

The "keypress" mode must be entered to use the keyboard function. The keypress mode is entered by pressing the "%" character. The port will remain in the keypress mode until a carriage return (<cr>) is received. Invalid keypresses are acknowledged with an asterisk and bell characters ("*<ctrl>G").

Note: To terminate the keypress mode, enter a carriage return.

Each character received is interpreted as a simulated keypress. The character-to-key conversion table is on page OP17. MILLVISION provides an echo of the keypress if desired (see page OP17). Depending on the echo mode, MILLVISION can echo the received character, echo a more descriptive string, or echo nothing.

Note: The RS-232 keypress feature has an important restriction: The operator should not access the RS-232 configuration screens (Set System) by using the remote keyboard. Access to these menus will have adverse affects on the port, regardless of whether any values were actually changed.

The character code definitions are as follows:

MILLVISION Keys		**ASCII Keyboard Character**	**Echo String**
Menu keys:	M1	A	(1)
	M2	S	(2)
	M3	D	(3)
	M4	F	(4)
	M5	G	(5)
	M6	H	(6)
Axis keys	X	Q	X_
	Y	W	Y_
	Z	E	Z_
	W	R	W_
Digit keys:	0	0	0
	1	1	1
	2	2	2
	3	3	3
	4	4	4
	5	5	5
	6	6	6
	7	7	7
	8	8	8
	9	9	9
	.	.	.
	–	+/–	–

Preset keys:

ZERO RESET	Y	ZERO RESET
CLEAR	T	CLEAR
EDGE FIND	J	EDGE FIND
PRINT	K	PRINT
AXIS CPLE	L	AXIS CPLE
STEP #	B	STEP #
NEXT STEP	N	NEXT STEP
TOOL #	M	TOOL #

Mode keys:

HELP	1	HELP
DRO	@	DRO
PROG	#	PROG
SET TOOL	$	SET TOOL
CALC	%	CALC
SET SYS	*	SET SYS

Function keys:

REF	U	REF
INCR	I	INCR
ABS	O	ABS
INCH/MM	Z	INCH/MM
DEG/DMS	X	DEG/DMS
HOLE PTRN	C	HOLE PTRN

Arrow keys:

Up	[	<
Down	/	>
Left	;	< –
Right	'	– >

Options appendices

Remote storage device

This appendix contains file format and command information needed if an operator chooses to write a program to support program tansfers.

Each file contains a "GENERAL IDENTIFICATION HEADER". The information format and required bytes of the header is as follows:

MILLVISION ID/	1 byte	"M"
VERSION NUMBER	1 byte	"3"
MODE ID (PROGMODE)	1 byte	"P"
File Type (within mode)	1 byte	"O"
USER SPACE (general use)	(75) bytes	
end of record/line	1 byte	(<cr>)
TOTAL	80 bytes	

The "USER SPACE" is located in the "GENERAL IDENTIFICATION HEADER" and is formatted as follows:

Program Name	8 byte character string
Number of Steps (last step #)	3 byte integer
Axis X Multiplier	10 byte real
Axis Y Multiplier	10 byte real
Axis Z Multiplier	10 byte real
Axis W Multiplier	10 byte real
Reserved info.	7 bytes
Z-Coupling flag 0 = off, 1 = add, 2 = subtract	1 byte
Reserved info.	16 bytes
TOTAL	75 bytes

"PROGRAM STEP RECORD:" (0-999 per program) Each record consists of continuous data followed by a <cr> (carriage return).

Axis 1 Name 0 = null, 1 = x, 2 = y, 3 = z, 4 = w	1 byte
Axis 1 Preset	10 byte real (mm/deg)
Axis 1 Function 0 = ref, 1 = incr, 2 = abs, 3 = zero inc	1 byte
Axis 1 Ref. Step #	3 byte integer
Axis 1 RoundOff 0-9, a-f table index (below)	1 byte
Axis 1 FlashPoint	10 byte real (mm/deg)
Axis 2 Name 0 = null, 1 = x, 2 = y, 3 = z, 4 = w	1 byte
Axis 2 Preset	10 byte real (mm/deg)
Axis 2 Function 0 = ref, 1 = incr, 2 = abs, 3 = zero inc	1 byte
Axis 2 Ref. Step #	3 byte integer
Axis 2 RoundOff 0-9, a-f table index (above)	1 byte
Axis 2 FlashPoint	10 byte real (mm/deg)
Hole Pattern Current Hole Number	2 byte integer
Hole Pattern Last Hole Number	2 byte integer
Tool Number	2 byte integer
Tool Axis X offset direction 0 = centered, 1 = "+", 2 = "–"	1 byte
Tool Axis Y offset direction 0 = centered, 1 = "+", 2 = "–"	1 byte
Reserved Must be 0	1 byte
AutoStep flag 0 = no, 1 = yes	1 byte
end of record/line <cr>	1 byte
TOTAL	63 bytes

Round Off Table

Table #	Associated Value	
0	1.0	mm/deg
1	0.5	mm/deg
2	0.2	mm/deg
3	0.1	mm/deg
4	0.05	mm/deg
5	0.02	mm/deg
6	0.01	mm/deg
7	0.005	mm/deg
8	0.002	mm/deg
9	0.001	mm/deg
a	0.0005	mm/deg
b	0.0002	mm/deg
c	0.0001	mm/deg
d	0.00005	mm/deg
e	0.00002	mm/deg
f	0.00001	mm/deg

Figure OP9. Round Off Table.

All "real" numeric entries are to consist of a right justified ASCII signed string, with leading zeros suppressed to spaces. The sign is to be located at the immediate left of the most significant digit; the positive sign suppressed to spaces. For example: "0.012345", " −12.3442", "58.844023", " −7.". In addition, all presets and flashing points are to be described in "mm" or "degree" units only.

All integer values are right justified ASCII unsigned strings, with leading zeros suppressed, except in the units position. For example: "12", "0", "154".

Communication commands

There are seven communication commands that are used when performing transfers between MILLVISION and the remote storage device.

A. IDENTIFICATION COMMAND
B. DIRECTORY COMMAND
C. AVAILABLE SPACE COMMAND
D. GET RECORD (0) of FILE (INDEX#) COMMAND
E. GET RECORDS (ALL) of FILE (INDEX #) COMMAND
F. SEND RECORDS (ALL) of NEWFILE (NAME) COMMAND
G. DELETE FILE COMMAND

During program transfers, between MILLVISION and a remote storage device, MILLVISION is always the **issuer** of commands and the remote storage device is always the **respondent.** A written program will have to interpret the command and issue a response, for a transfer function to work correctly.

Communication commands (cont.)

Note: For each command, enter the information *within* the quotes — do not enter the quotes. Commands and responses are followed by a carriage return (<cr>), which signifies the end of a transmission.

A. Identification command

The identification command contains the MILLVISION ID information. This command is used to confirm and initialize or reset the communications link between MILLVISION and the remote storage device. The RESPONSE must follow within four seconds or a "timeout" will occur, and the remote device will not be available.

COMMAND "AAM3<cr>"

Definition: "AA" is the command type
"M" is MILLVISION
"3" is release number of the firmware

RESPONSE "AAab<cr>"

Definition: "AA" is the response type
"a" is either "I" for IBM-PC, or "B" for Stand-Alone Box
"b" release number of soft/firmware

B. Directory command

The remote storage device is responsible for determining the amount of disk space available and the number of files (programs) in the disk directory. The remote storage device also maintains an alphanumeric list of available program file names and sizes. A numeric INDEX is used to identify a file in a list, where the first file has an index of 01, the second is 02, etc. With this type of index, all necessary file information can be determined without the operator having to supply its name.

The directory command issued by MILLVISION, contains the INDEX of the ITEM in the directory being requested. The RESPONSE returns the FILENAME and FILESIZE from the directory.

COMMAND "BBaa<cr>"

Definition: "BB" is the command type
"aa" is the INDEX of the file requested. The INDEX is 2 character ASCII numeric unsigned integer, right justified field with left zero suppression to spaces (except units position).

RESPONSE: "BBabbbbbbbb.bbb cccccccc<cr>"

Definition: "BB" is the response type
"a" is the RESPONSE FLAG (see list below)
"bbbbbbbb.bbb" is the name of the file from the directory. The FILENAME is 8 + 3 ALPHA/NUMERIC characters with a POINT separating the EXTENSION from the NAME, and a trailing space for separation from the next field (filesize).

"cccccccc" is the filesize from the directory. The FILESIZE is 8 character ASCII numeric unsigned integer, with left zero suppression to spaces (except units position).

Possible Response Flags:

"0" GOOD, function complete
"1" BAD, INDEX parameter (out of range) (not numeric)
"2" BAD, MEDIA write lockout
"5" BAD, MEDIA read error/verify
"6" File not found
"7" BAD, disk not ready

C. Available space command

This command orders MILLVISION to determine if there is enough space for a particular program to fit on the remote storage device directory.

COMMAND "CC<cr>"

Definition: "CC" is the command type

RESPONSE "CCabbcccccccc<cr>"

Definition: "CC" is the response type
"a" is the RESPONSE FLAG (see list below)
"bb" is the number of FILE ENTRIES AVAILABLE in the remote storage device directory. FILE ENTRIES AVAILABLE is a 2 character ASCII numeric unsigned integer, with left zero suppression to spaces (except units position). 25 file entries maximum per directory.

"cccccccc" is the bytes available from the directory. BYTES AVAILABLE is an 8 character ASCII numeric unsigned integer, with left zero suppression to spaces (except units position.).

Possible Response Flags:

"0" GOOD, function complete
"2" BAD, MEDIA write lockout
"5" BAD, MEDIA read error/verify
"7" BAD, disk not ready

D. Get record (0) of file (index #) command

This command is used to retrieve the "General Identification header" which contains the remote program, number of steps, etc. for use with the LOAD operation.

COMMAND "DDaa<cr>"

Definition: "DD" is the command type
"aa" is the INDEX of the file requested. The INDEX is a 2 character ASCII numeric unsigned integer, right justified field with left zero suppression to spaces (except units position).

RESPONSE "DDaDATA<cr>bb<cr>"

Definition: "DD" is the response type
"a" is the RESPONSE FLAG (see list below)
"DATA<cr>" is the contents of the FIRST line/record of data from the file, terminated by <cr>, end of string.
"bb" is the CHECKSUM value generated by the data.

The checksum is calculated by adding all the DATA bytes (including the trailing <cr>), to an unsigned binary value which is converted to two ASCII-HEX characters and sent, the checksum bytes are followed by a <cr> that terminates the RESPONSE.

Possible Response Flags:

"0" GOOD, function complete
"1" BAD, INDEX parameter (out of range)
"5" BAD, MEDIA read error/verify
"6" BAD, file not found
"7" BAD, disk not ready

E. Get records (all) of file (index #) command

This command is used to send the entire file to MILLVISION from the remote storage device. Hardware *or* software handshaking is required, unless the baud rate is very low.

COMMAND "EEaa<cr>"

Definition: "EE" is the command type
"aa" is the INDEX of the file requested. The INDEX is two character ASCII numeric unsigned integer, right justified field with left zero suppression to spaces (except units position).

RESPONSE "EEaDATA<cr>bbDATA<cr>bb<cr>"

The basic transmission unit is "DATA<cr>bb", sequence (above), repeated twice.

Definition: "EE" is the response type
"a" is the RESPONSE FLAG, see list.
"DATA<cr>" is the contents of one line/record of data from the file, terminated by <cr>, end of string. Approximately 80 data bytes can be expected, but it is not fixed. 1 to 250 bytes are possible.
"bb" is the CHECKSUM value generated for the data. The checksum is calculated by adding all the DATA bytes (including the trailing <cr>), to an unsigned binary accumulator, and performing a modulo 256 to obtain an 8 bit value. This value is converted to two ASCII-HEX characters and sent. The last checksum byte is followed by a <cr> that terminates the RESPONSE.

Possible Response Flags:

"0" GOOD, function complete
"1" BAD, INDEX parameter (out of range)
"2" BAD, MEDIA read error/verify
"5" BAD, file not found
"7" BAD, disk not ready

F. Send records (all) of newfile (name) command

This command sends the entire file from MILLVISION to the remote storage device. Hardware *or* software handshaking is necessary, unless the baud rate is low. The response to the command returns the new file (INDEX #) after re-sorting the directory.

COMMAND "FFaaaaaaaa<cr>DATA<cr>bbDATA<cr>b-bDATA<cr>bbDATA<cr>bb<cr>"

The basic transmission unit is the "DATA<cr>bb" sequence (above) repeated four times.

Definition: "FF" is the command type
"aaaaaaaa<cr>" is the name of the file to save, *without* the DOS extension.
"DATA<cr>" is the contents of continuous lines/records of data from the file, terminated by <cr>, end of string.
"bb" is the CHECKSUM value generated for the data. The checksum is calculated by adding all the DATA bytes (including the trailing <cr>), to an unsigned binary accumulator, and performing a modulo 256 to obtain an 8 bit value. This value is converted to two ASCII-HEX characters and sent. The last checksum byte is followed by a <cr> that terminates the COMMAND. The end of the file is recognized by noting that the last <cr> had no data before it.

RESPONSE "FFabb<cr>"

Definition: "FF" is the response type
"a" is the RESPONSE FLAG (see list below)
"bb" is the INDEX of the stored file. The INDEX is a two character ASCII numeric unsigned integer, right justified field with left zero suppression to spaces (except units position).

Possible Response Flags:

"0" GOOD, function complete
"1" BAD, INDEX parameter (out of range)
"2" BAD, MEDIA write lockout
"3" BAD, MEDIA insufficient space
"4" BAD, CHECKSUM
"5" BAD, MEDIA read error/verify
"7" BAD, disk not ready

G. Delete file command

This command deletes files by the FILENAME

COMMAND "GGaaaaaaaa.aaa<cr>"

Definition: "GG" is the command type
"aaaaaaaa.aaa" is the name of the file from the directory. The FILENAME is eight plus three ALPHA/NUMERIC characters with a decimal point separating the NAME from the EXTENSION.

RESPONSE "GGa<cr>"

Definition: "GG" is the response type
"a" is the RESPONSE FLAG (see list below)

Possible Response Flags:

"0" GOOD, function complete
"2" BAD, MEDIA write lockout
"5" BAD, MEDIA read error/verify
"6" BAD, file not found
"7" BAD, disk not ready

Connector specifications

Footswitch
⅛ inch (3.5mm) phono jack

Edge Finder
⅛ inch (3.5mm) phono jack

Centronics Parallel Printer
Female 16-pin SDL connector:

pin	1 - strobe (active low)	(out)
	2 - data 1	(out)
	3 - data 2	(out)
	4 - data 3	(out)
	5 - data 4	(out)
	6 - data 5	(out)
	7 - data 6	(out)
	8 - data 7	(out)
	9 - data 8	(out)
	10 - acknowledge (active low)	(in)
	11 - busy	(in)
	12 - paper empty	(in)
	13 - select	(in)
	14 - auto feed	(out)
	15 - N.C.	
	16 - GND	

External Video Monitor
Female phone jack

RS-232 Communications

Male 9-pin D-subminiature connector

Pin	I/O	Description
2	I	Incoming Data
3	O	Out going data
4	O	When active (logical "0", +12V), it informs the other device that MILLVISION is available to communicate.
5		Signal ground
6	I	When active (logic "0", +12V), it indicates that the other device is available to communicate.
7	O	When active (logical "0", +12V), it indicates that MILLVISION is ready to receive data.
8	I	When active (logical "0", +12V), it indicates the device is available to receive data.

Troubleshooting

NOTE: THE MILLVISION CHASSIS COVER SHOULD NEVER BE REMOVED FROM THE UNIT — THERE IS NOTHING WITHIN THE CHASSIS THAT CAN BE FIELD SERVICED.

Ventilation system

MILLVISION is equipped with an electrically powered exhaust fan for the dissipation of internally generated heat, and features a passive, filtered, fresh air intake. Adequate airflow to the intake should be allowed for, as well as accessibility to replace the filter assembly, if necessary.

If MILLVISION's internal temperature rises above a preset limit, a message will appear on the screen (when in the DRO mode). This message will direct the operator to select the HELP screen for remedial action.

> **WARNING - Whatever the reason for the diagnostic filter message, it is imperative that the unit be shut down and the fault rectified as soon as possible (the immediate machining operation may be completed).**

"Check Filter" Faults and Remedies

1) **Inadequate airflow to the filtered intake** - Make sure paper, wipes, or debris are not restricting air circulation around and under the unit.

2) **Plugged Filter** - The fan filter is easily removed for cleaning or replacement. Simply unsnap the protective outer guard from the main fan assembly. Clean the filter with soap & water (let dry before reinstalling). Replacement filters are available from ACU-RITE Factory Service (1-800-632-3222).

3) **Work area temperature too high** - MILLVISION is designed to function in a temperature range of 0° to 40° C (32° to 104° F) with 25-85% relative humidity, non condensing. If the work area temperature is too high, it is recommended that MILLVISION be shut down until temperatures return to the normal operating range.

4) **Exhaust fan does not operate at high temperatures** - The exhaust fan only runs when internal temperatures are high. If the "Check Filter" warning is present, indicating high internal temperatures, and the fan is not turning do not continue to operate MILLVISION. Excessive internal temperatures can damage the electronic components. Contact your ACU-RITE Distributor/OEM or the Factory Service Department (1-800-632-3222) for repair or replacement information. for repair or replacement information.

MILLVISION fuses

Unit Line Fuse

If there is power to MILLVISION, but it does not power up, check the line fuse on the back of the chassis. If the fuse is bad, replace it with an equivalent 1.5 AMP 250V, 1¼" length fuse.

Troubleshooting software errors

Hardware Identification

CPU Module number and Axis Module numbers can be found as follows:

1) Press the SET SYS mode key.
2) Press the "MISCELLANEOUS" menu key.
3) Press the "TESTS" menu key.
4) Press the "HARDWARE IDENTIFICATION" menu key.

The module revision numbers will be useful when discussing a problem with the ACU-RITE Service Department.

If a problem arises within MILLVISION, error messages and help to recover from the error appear on the screen.

Possible errors in data transmission from one module to another and encoder performance include:

ERR T1 - Module (axis) transmitting invalid data
ERR T2 - CPU Module transmitting invalid data
ERR T3 - Previously identified module fails to communicate
ERR T4 - Invalid data request
ERR C1 - Invalid pulse counting
ERR C2 - Encoder output signal is out of spec
ERR C3 - Invalid encoder input signal, for those axes with differential input option

"T" Errors are self-correcting (up to a certain level). The system will attempt to remedy the condition several times before prompting the operator.

ERR T1 and ERR T2 trap errors from partial communication hardware breakdowns and from certain communication software errors. If a bit gets dropped during a data transfer, or if an axis board fails to recognize a data request code, the error message results.

ERR T3 appears if the module is removed while the unit is operating or if there is a communication hardware failure. This error will also appear if the software fails to interface with the communication hardware.

"C" Errors involve the axis board encoder pulse circuitry and software. These errors are *not* self-correcting and must be remedied by the operator (through an error recovery routine) or an ACU-RITE serviceman.

ERR C1 is a software error "trap". It occurs if the axis board microprocessor is unable to access the pulse counting circuitry (keeping current encoder position), or if the circuitry fails to count correctly. This error may be corrected by resetting the axis board in question. It should, however, be interpreted as a serious error and the axis board serviced or replaced.

ERR C2 is a hardware error generated by the axis board encoder input circuitry. This electronic circuit constantly monitors the integrity of the encoder signal for slew speeds greater than the unit can accommodate. Incorrect pulse train sequence or electro-magnetic interference (noise) will make the unit count incorrectly. These problems are outside the readout and require the operator to first correct the external problem and then reset the axis board.

Error messages note the error type, the slot location of the deviant module, and the particular axis the error has occurred.

Resetting error codes

Most error codes can be reset by restarting the axis board in question. This is done through the "ERROR RECOVERY" menu key which becomes active in the DRO display once an error has occurred.

Press the "ERROR RECOVERY" menu key to restart an axis board. A screen indicating the axis board and encoder connection in error, possible reasons the error occurred, steps to recover from the error, and requirements are displayed.

Press the "FIX AXIS" menu key to restart the axis in question. A note will appear indicating if the error was removed successfully or unsuccessfuly. If the error was removed successfully, the axis board is reset and the problem is no longer present. If the error was *not* removed successfully, the problem is still present and further troubleshooting must continue. The problem may be a faulty module or in the linear encoders.

Note: If a home reference point is used (FTO or Absolute Zero scales), "C" type errors require that it be found again.

If a hardware fault is suspected (axis board, CPU board or power supply board), please contact your ACU-RITE distributor for further information.

Warranty

ACU-RITE products and accessories are under a one-year (from date of purchase) warranty for defects in material and workmanship. ACU-RITE will, at its option and expense, repair or replace any parts of the ACU-RITE Product which fail to meet this warranty. However, ACU-RITE must have received notice of the claimed defect from the consumer during the warranty period.

This warranty applies only to products and accessories which have been installed and operated in accordance with instructions in ACU-RITE reference manuals. ACU-RITE shall have no obligation, with respect to any defect or other condition, caused in whole or part by the consumer's incorrect use; improper maintenance or modification of the equipment, or by the repair or maintenance of such product by any person except persons deemed by ACU-RITE to be qualified.

Loss in operating performance due to environmental conditions, such as humidity, dust, corrosive chemicals, deposition of oil or other foreign matter, spillage or other conditions beyond ACU-RITE's control cannot be accepted by ACU-RITE.

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

Before returning the unit to your local ACU-RITE Distributor or Original Equipment Manufacturer, be sure that all efforts to correct a problem have been exhausted.

Specifications

Dimensions	14" W x 14.5" D x 7.5" H
Weight	Approximately 25 lbs.
Power Input Requirements	95-130, 180-250 VAC, 1.5 amp, 47-63
Number of Display Axes	1, 2, 3, or 4 (user configurable)
Electronics	Multiple Microprocessor
Display	7" diagonal CRT
Scale Resolutions	Standard resolutions (user specified) 10 µm (.0005") 5 µm (.00025") 2 µm (.0001") 1 µm (.00005")
Linear and Rotary Encoder Input	Channel A & B TTL Square Wave signal in quadrature (90°) nominal phase relationship with Fiducial Trigger Output signal (when provided)
UL & CSA Compliance	Pending

FCC Compliance Statement for USA Users

This equipment uses, generates, and can radiate, radio frequency energy. If this product is not installed and used in accordance with the operator's manual, interference to radio communications may result. This product has been tested and is in compliance with the limits in effect at the time of manufacture for a Class A computing device pursuant to Subpart J of Part 15 FCC Rules. These limits provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference, in which case the user will be required to take whatever measures necessary to correct the interference at the user's expense.

Glossary

BATTERY # 387800587

ABSOLUTE - The measurement of total distance moved along an axis from a fixed datum point (zero, zero reference or workpiece zero) on, or fixed with reference to, the workpiece.

AUTO STEP - An optional feature in the PROG mode which combines the current program step with the next step and displays both at the same time. This feature allows the operator to view up to 4 axes at one time (the axes must be 4 different axes).

BATTERY BACKUP - One of two self-contained DC auxiliary power sources. One power source is a standard feature that maintains axis parameters and programs if AC power is interrupted or lost. The second power source is an option that supplies complete power to the unit (optional AC backup).

CRT - Acronym for Cathode Ray Tube; main viewing screen of the unit.

CPU (CENTRAL PROCESSING UNIT) - The integrated circuit which provides control of memory and computational functions.

CARTESIAN COORDINATES - A system of rectangular coordinates for identifying the axis of motion and the direction of motion. MILLVISION automatically calculates coordinates in the hole pattern routine.

CHECKSUM VALUE - A summation of bits or digits. Primarily used for checking ROM (Read Only Memory) computer memory to ensure it has not been altered.

CURSOR - The movable "pointer" which indicates where entries or actions will take place.

DIRECTION POLARITY - The assignment of a + or − value to a direction of motion along an axis. This assignment is based on shop standards or operator's choice.

DMS - Degrees, Minutes, Seconds. One form of displaying angularity. The other form is decimal degrees (DEG).

FIDUCIAL TRIGGER OUTPUT (FTO) - A pulse generated when a fiducial (reference) mark on a glass scale is sensed by the scale reading head. The FTO signal is used to relocate workpiece zero after a power interruption and it is used to define the interval locations when using Multiple Error Compensation.

FREEZE - To hold an axis display with its current value, not allowing it to be changed by incoming scale information.

HOME REFERENCE POINT - (See FTO). Used to reset axis position relative to a workpiece after a power interruption.

INCREMENTAL - A measurement indicating a distance from the current tool position to a desired tool position (point to point). Incremental moves comprise the absolute measurement (parts make up the whole).

MICROPROCESSOR - The control and processing portion of a small computer.

MULTIPLE SCALE COUPLING (MSC) - The capability of mathematically combining the signals from two parallel linear encoders. The screen will indicate the coupled axes and display the combined resultant motion of the two scales.

MULTIPLIER - A parameter in a program that can be used to alter axis displays using shrinkage or expansion factors for mold or die work, or when machining a part to scale. A multiplier of − 1 can be used to machine mirror images.

RAM - Acronym for Random Access Memory. This memory holds information and programs during processing "temporary" memory.

REFERENCE PRESET - Sets the incremental display to the distance and direction required to move to a desired position which is referenced from the axis absolute zero point.

RESOLUTION - The smallest (or least count) unit of motion that a readout system is capable of measuring and displaying.

ROM - Acronym for Read-Only Memory. A storage arrangement for information retrieval only. This memory contains operational instructions ("permanent" memory).

RS-232C - A type of serial communication. When this capability is supplied with the readout, it allows communications in both directions, between the readout and computer or other peripheral device.

SOFTWARE - Programs, routines, codes, and other written information which communicate commands to a computer.

TACTILE - A type of key, that when pressed, can be felt to "snap". The snap indicates to the user that the input was accepted.

THAW - The menu key which will cancel a frozen display. See FREEZE.

TOOL OFFSET - Values generated from tool dimension information to correct the display when tool changes are made. Tool offsets alter the readout display to indicate the true position of tool cutting surfaces.

TTL - Acronym for Transistor-Transistor Logic. Family of logic circuit designs found within digital electronics.

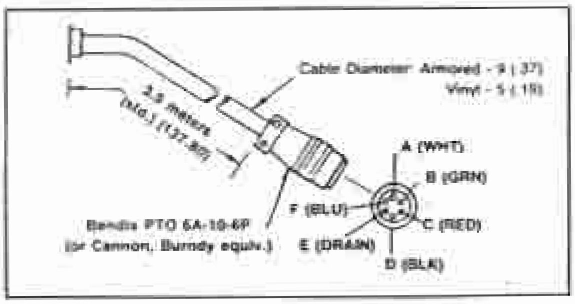
Standard linear encoder specifications

REPEATABILITY	Within one resolution count
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 (−40°F to 149°F) 20% to 95% relative humidity (non-condensing)

ELECTRICAL CHARACTERISTICS

- TTL compatible transistor collector output with internal pull-up resistor.
- Logic "1" level:
  pull-up to Vcc (5.1 ± .1 Vdc through a resistor.
  pull-up resistor = 450 ± 10% ohms)
- Logic "O" level:
  0.5 Vdc maximum
  −7ma maximum (current sinking limit)
- Required Input Connector:
  Bendix PTO 6A-10-6P or equivalent

STANDARD CABLE CONNECTOR



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, current, 200mA max
D	Common (power supply and signal return)
E	Shield, reading head case ground
F	Fiducial trigger output signal (when provided)

MILLVISION™

ACU-RITE Readout Systems are manufactured in the USA

ACU-RITE®

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387820-10002 Edition E 8/95

PRINTED IN U.S.A