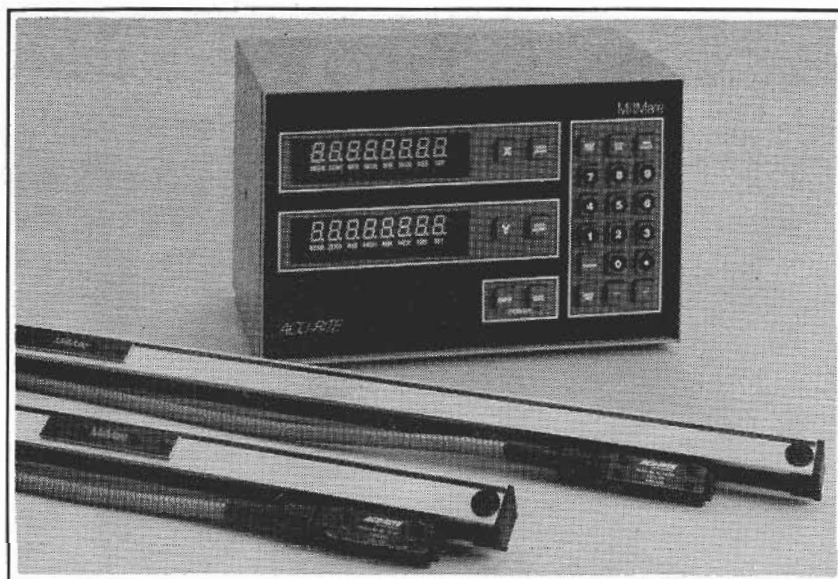


MillMate™

Digital Readout System for Vertical Knee Mills



REFERENCE
MANUAL

ACU-RITE®

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Note: Please compare all items enclosed with items on packing lists, to ensure no parts are missing.

Section 1. Scale Installation

Scale Installation

MillMate scales come preassembled, ready to be mounted on any mill. Scale mounting brackets are required, however, for secure attachment. ACU-RITE has developed kits specific to the most common mills, as well as universal kits for other mills. Bracket kits can be ordered from an ACU-RITE distributor or brackets can be fabricated.

During installation, the following steps should be taken:

- Keep the reading head casting and alignment brackets fastened in position until scale mounting is complete.
- The scales must be mounted so the front surface of the scale is true to the mill's table travel within .010" (.25 mm) TIR over the full length of the scale case, and within .005"/foot (.13 mm/300 mm) TIR. The top surface must be true to the table travel within .005" (.13 mm) TIR at both ends of the scale.
- Mount the scale case with the lip seals facing down or away from the spindle and coolant sprays.
- If the reading head must be removed from the scale assembly, use extreme caution as the glass grating within the assembly could be damaged. The removal procedure should be performed only by a qualified service technician with the proper tools and training.
- For greatest accuracy, the scales should be mounted as close to the table as possible. Deviations in alignment with the table travel should be kept as small as possible.
- Scales over 24" must have additional center support. The 32" and 35" scales have a center support bracket installed by ACU-RITE. All other scales, 24" and over, must be installed with the center support casting provided in the scale hardware bag.

Note: All illustrations referenced for scale installation are on pages 1-6 through 1-9.

1. Position and lock the table in the center of the longitudinal (X-axis) travel, and move the table completely forward in the cross travel (Y-axis).
2. Hold the scale assembly against the front or back edge of the table to determine mounting position. Refer to the mounting information provided in Figures 1-1, 1-2 and 1-3. In most cases, the scale case should be mounted to the table, and the reading head mounted to the saddle.
3. It may be necessary to shift the scale assembly, to the left or right of the center of the saddle, to provide a relatively flat mounting surface for the reading head and any necessary spacers. Check the position of all locking handles, hand wheels, power feeds, and table stops to be sure they will not interfere with the scale case or reading head. Also note the top of the scale must be below the top of the table so it does not interfere with tabletop fixtures or large workpieces.

Mounting the longitudinal scale

Mounting the longitudinal scale (cont.)

4. If conditions permit mounting the scale case and reading head against a machined surface of the table and saddle, proceed to step 6. If not, spacer blocks, standoffs, backup spars, or a combination of these, must be fabricated to provide a flat mounting surface. Scale mounting surfaces must be flat and parallel to machine travel to enable mounting of the scale to within .010" (.25 mm) TIR and .005"/foot (.13 mm/300 mm) TIR.

5. Fabricate parts necessary to obtain a flat mounting surface as referenced in Figure 1-4 and proper machining practices. Due to the end-mounting design of the scale case, single mounting blocks or standoffs, one at each end, should be used instead of a full length spar. This eliminates the need to indicate the full length of the top edge of the spar. The entire length of the **front surface** of the scale case, however, must always be indicated.

Note: If the scale is not mounted directly to a machined surface, it may be necessary to use a backup spar for alignment, to eliminate the natural bow of the scale.

6. Remove round plastic plugs at both ends of scale.

Note: On mid 1985 or later Bridgeport Series I Mills, many of the mounting holes have been predrilled at the factory. It may be necessary to run a tap into the pretapped holes to ensure clean threads. These holes are drilled to fit ACU-RITE bracket kits 385032-01 and 385032-02.

7. Place the scale assembly against the mounting surface and transfer punch one end mounting hole. Drill and tap a 1/4-20 x 1/2" (M6 x 1.0 x 12 mm) hole. Bolt the assembly to the surface at one end using one of the 1/4-20 x 1/2" (M6 x 1.0 x 12 mm) button head cap screws (BHCS) and washers provided.

8. Position the scale parallel to the table top surface within .005" (.25 mm) and transfer punch the hole center for the mounting hole at the other end of the scale. Drill and tap a 1/4-20 x 1/2" (M6 x 1.0 x 12 mm) hole. Attach the scale using a 1/4-20 x 1/2" (M6 x 1.0 x 12 mm) BHCS and washer.

Note: If the longitudinal scale is a 32 or 35 inch scale with a center support bracket installed at the factory, transfer the center mounting hole at this time. Drill and tap a 1/4-20 x 1/2" hole. Secure the center of the scale with one of the 1/4-20 x 1/2" BHCS provided.

If the scale does not have the center support attached:

- a. Use a 1/32" shim (provided in hardware bag) to space the support above the scale. Make sure the support is far enough left or right of center so not to interfere with the scale cover plate (Figure 1-5). With the set screws removed, transfer the two mounting holes.
- b. Drill and tap two #8-32 (M4 x 0.7) holes a minimum of 3/8" (9 mm) deep. Remove the scale during this operation to avoid damage.
- c. Secure the center support using the two #8-32 (M4) screws provided.

Mounting the longitudinal scale (cont.)

- d. Remount the scale and proceed with the alignment procedure in step 9. When alignment is complete, install and tighten the two M4 socket head set screws (SHSS) using the hex wrench provided.
9. Using a depth micrometer or a dial indicator (Figure 1-6), indicate the front surface of the scale case to check for parallelism to table travel to within .010" (.25 mm) TIR overall, and .005"/foot (.13 mm/300 mm) TIR. Indicate the top surface of the scale along 1" (25 mm) sections directly over the scale mounting holes at each end. Align the scale to within .005" (.13 mm) TIR. Securely tighten all mounting screws during the alignment process.
10. Replace the round plastic plugs at both ends of the scale.
Do not move the table before completing the following steps, up to and including, step 17.
11. Remove the reading head cover plate.
12. Make sure that a space of .03" (.8 mm) to .18" (4.6 mm) remains between the reading head casting and its mounting surface. This space is required for proper adjustment of the reading head leveling screws (Figure 1-7).
13. Transfer punch the two mounting holes in the reading head casting (Figures 1-1 and 1-2) on to the mounting surface. Drill and tap two $\frac{3}{8}$ " (10 mm) deep holes for the #8-32 x $\frac{1}{2}$ " (M4 x 0.7 x 12 mm) BHCS provided.
14. There are four leveling jack screws (M3 x 8 HSS) located in the reading head casting (Figure 1-7). With the hex wrench provided in the scale mounting hardware, set the leveling screws to the mounting surface; place a .002" to .005" (.05 mm to .13 mm) thick paper strip or feeler gage behind each leveling screw and tighten until a slight drag can be felt on the paper strip or feeler gage. **Do not overtighten the leveling screws as the reading head casting will be forced out of proper alignment.**
15. Remove the paper strips or feeler gage. Mount the reading head casting with two #8-32 x $\frac{1}{2}$ " (M4 x 0.7 x 12 mm) BHCS.
16. Remove the temporary alignment brackets. Retain these brackets and screws for future use. Peel the protective film from the scale nameplate (provided in hardware) and mount with the **black M3 x 4** phillips head screws provided. **Do not use the silver M3 x 5 screws to install the scale cover plate as damage will occur.**
17. Exit the cable out the end of the casting which provides the best route to the readout, then insert the rubber grommet in the other end. Peel the protective film from the reading head cover plate and mount with **black M3 x 4** phillips head screws provided. Make sure all wires are tucked into the reading head casting before tightening screws.

Mounting the longitudinal scale (cont.)

18. Move the table in both directions, ensuring that all scale mounting components will not interfere with other machine components and that the table travel does not exceed the travel of the scale. The reading head casting should not come within .88" (22.4 mm) of either end of the scale. **If the total table travel is longer than the travel of the scale, positive table stops must be installed to prevent damage to the scale assembly.**

The longitudinal scale is now ready for use. Route the cable to the approximate area where the readout will be installed. Make sure the cable does not lay on ways, lead screws, or the floor.

Mounting the cross feed scale

1. Determine the mounting position of the cross feed scale. It may be mounted on either side of the mill.
2. Position and lock the saddle in the center of its travel.
3. Refer to the mounting method provided in Figure 1-8.
4. If conditions permit mounting the scale case and reading head against machined surfaces, proceed to step 6. If not, spacer blocks, standoffs, backup spars, or a combination of these, must be fabricated to provide a flat mounting surface. Scale mounting surfaces must be flat and parallel to machine travel to enable mounting of the scale to within .010" (.25 mm) TIR and .005"/foot (.13 mm/300 mm) TIR.

5. Fabricate parts necessary to obtain a flat mounting surface as referenced in Figure 1-4 and proper machining practices. Due to the end-mounting design of the scale case, single mounting blocks or standoffs, one at each end, should be used instead of a full length spar. This eliminates the need to indicate the full length of the top edge of the spar. The entire length of the **front surface** of the scale case, however, must always be indicated.

Note: If the scale is not mounted directly to a machined surface, it may be necessary to use a backup spar for alignment, to eliminate the natural bow of the scale.

6. Remove round plastic plugs at both ends of scale.

Note: On mid 1985 or later Bridgeport Series I Mills, many of the mounting holes have been predrilled at the factory. It may be necessary to run a tap into the pretapped holes to ensure clean threads. These holes are drilled to fit ACU-RITE bracket kits 385032-01 and 385032-02.

7. Place the scale assembly against the mounting surface and transfer punch one end mounting hole. Drill and tap a 1/4-20 x 1/2" (M6 x 1.0 x 12 mm) hole. Bolt the assembly to the surface at one end using one of the 1/4-20 x 1/2" (M6 x 1.0 x 12 mm) BHCS and washers provided.
8. Position the scale parallel to the saddle travel within .010" (.25 mm) and transfer punch the hole center for the mounting hole at the other end of the scale. Drill and tap a 1/4-20 x 1/2" (M6 x 1.0 x 12 mm) hole. Attach the scale using a 1/4-20 x 1/2" (M6 x 1.0 x 12 mm) BHCS and washer.

Mounting the cross feed scale (cont.)

9. Using a depth micrometer or a dial indicator (Figure 1-6), indicate the front surface of the scale case to check for parallelism to saddle travel to within .010" (.25 mm) TIR overall, and .005"/foot (.13 mm/300 mm) TIR. Indicate the top surface of the scale along 1" (25 mm) sections directly over the scale mounting holes at each end. Align the scale to within .005" (.13 mm) TIR. Securely tighten all mounting screws during the alignment process.
10. Replace the round plastic plugs at both ends of the scale.
Do not move the table before completing the following steps, up to and including, step 17.
11. Remove the reading head cover plate.
12. Make sure that a space of .03" (.8 mm) to .18" (4.6 mm) remains between the reading head casting and its mounting surface. This space is required for proper adjustment of the reading head leveling screws (Figure 1-7).
13. Transfer punch the two mounting holes in the reading head casting (Figures 1-1 and 1-2) on to the mounting surface. Drill and tap two $\frac{3}{8}$ " (10 mm) deep holes for the #8-32 x $\frac{1}{2}$ " (M4 x 0.7 x 12 mm) BHCS provided.
14. There are four leveling jack screws (M3 x 8 HSSS) located in the reading head casting (Figure 1-7). With the hex wrench provided in the scale mounting hardware, set the leveling screws to the mounting surface: place a .002" to .005" (.05 mm to .13 mm) thick paper strip or feeler gage behind each leveling screw and tighten until a slight drag can be felt on the paper strip or feeler gage. **Do not overtighten the leveling screws as the reading head casting will be forced out of proper alignment.**
15. Remove the paper strips or feeler gage. Mount the reading head casting with two #8-32 x $\frac{1}{2}$ " (M4 x 0.7 x 12 mm) BHCS.
16. Remove the temporary alignment brackets. Retain these brackets and screws for future use. Peel the protective film from the scale nameplate (provided in hardware) and mount with the **black M3 x 4** phillips head screws provided. **Do not use the silver M3 x 5 screws to install the scale cover plate as damage will occur.**
17. Exit the cable out the end of the casting which provides the best route to the readout, then insert the rubber grommet in the other end. Peel the protective film from the reading head cover plate and mount with **black M3 x 4** phillips head screws provided. Make sure all wires are tucked into the reading head casting before tightening screws.
18. Move the saddle its full travel in both directions, while watching the reading head and scale to make sure that the reading head does not interfere with any other parts of the machine. Make sure the reading head casting does not come within .88" (22.4 mm) of either end of the scale.

The cross feed scale is now ready for use. Route the cable in the same manner as the longitudinal scale.

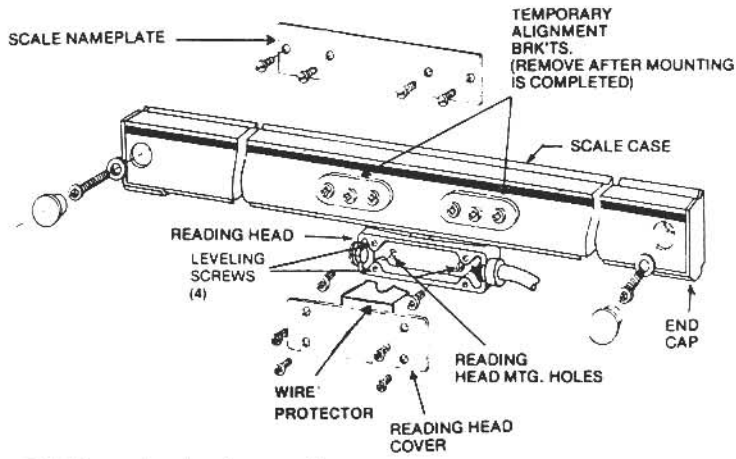


Figure 1-1. MillMate Scale Assembly

NOMINAL SCALE LENGTH	L1	L2
12" (300 mm)	17.437" (442.90 mm)	18.28" (464.2 mm)
13" (330 mm)	*	19.28" (489.7 mm)
14" (350 mm)	19.437" (493.70 mm)	20.28" (515.0 mm)
16" (400 mm)	21.437" (544.50 mm)	22.28" (565.8 mm)
24" (600 mm)	29.437" (747.70 mm)	30.28" (769.0 mm)
30" (750 mm)	35.437" (900.10 mm)	36.28" (921.4 mm)
31.5" (800 mm)	37.155" (943.74 mm)	38.00" (965.2 mm)
32" (813 mm)	37.437" (950.90 mm)	38.28" (972.2 mm)
35" (889 mm)	40.437" (1027.10 mm)	41.28" (1048.5 mm)
36" (900 mm)	41.437" (1052.50 mm)	42.28" (1073.8 mm)

* NOTE: 13" length does not have end mounting holes. It needs to be mounted to a backup spar.

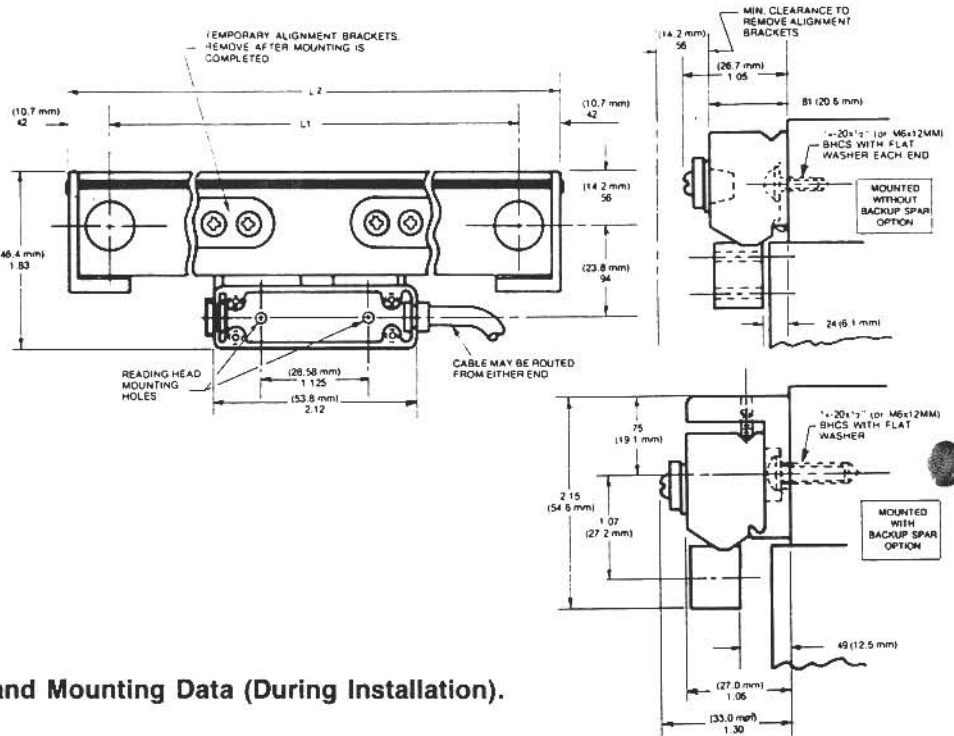


Figure 1-2. Dimensions and Mounting Data (During Installation).

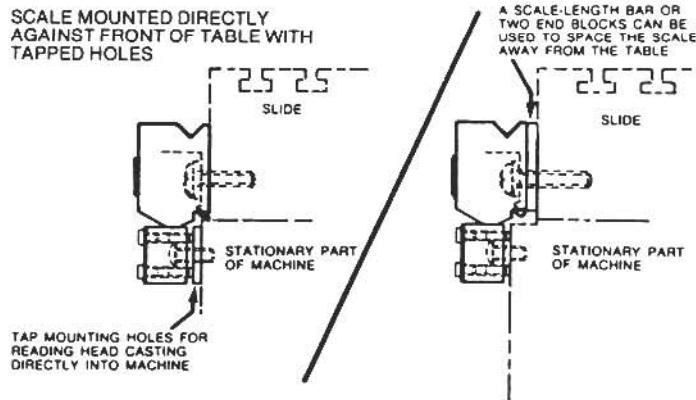
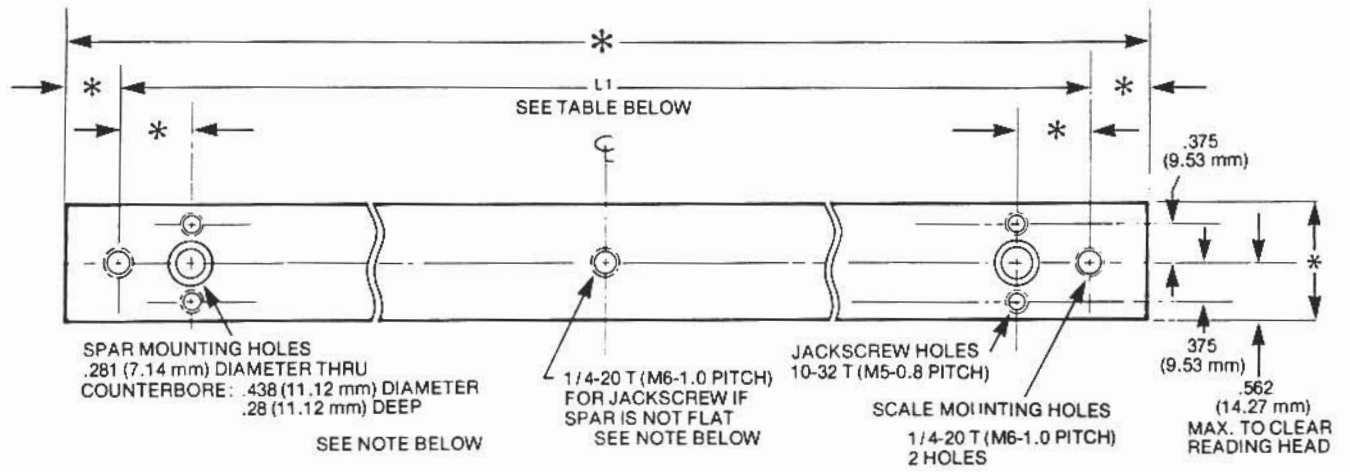


Figure 1-3. Two Basic Methods of Mounting Longitudinal Scale Assembly.



NOMINAL SCALE LENGTH	L1
12" (300 mm)	17.437" (442.90 mm)
14" (350 mm)	19.437" (493.70 mm)
16" (400 mm)	21.437" (544.50 mm)
24" (600 mm)	29.437" (747.70 mm)
30" (750 mm)	35.437" (900.10 mm)
31.5" (800 mm)	37.155" (943.74 mm)
32" (813 mm)	37.437" (950.90 mm)
35" (889 mm)	40.437" (1027.10 mm)
36" (900 mm)	41.437" (1052.50 mm)

- NOTES:
- CHECK SPAR FOR FLATNESS BEFORE MACHINING. IT SHOULD BE FLAT WITHIN .010 (.25 mm) T.I.R. OVER FULL LENGTH, AND .005" (.13 mm) T.I.R. IN ANY ONE FOOT (.13/300 mm). IF SPAR BOWS BEYOND THESE LIMITS, BOW SHOULD BE TOWARD MACHINE. ADD CENTER JACKSCREW FOR STRAIGHTENING WHEN SPAR IS MOUNTED.
 - *THESE DIMENSIONS CAN VARY TO MATCH MACHINE CONFIGURATION OR MOUNTING TECHNIQUE.
 - MATERIAL: LOW CARBON STEEL
 - MACHINING TOLERANCE: $\pm .015$ (.38 mm)

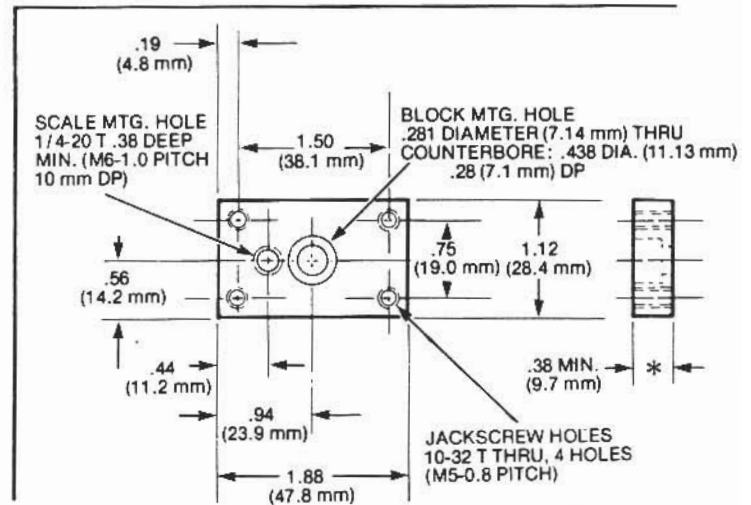


Figure 1-4. Suggested Method of Providing Flat and True Mounting Surface.

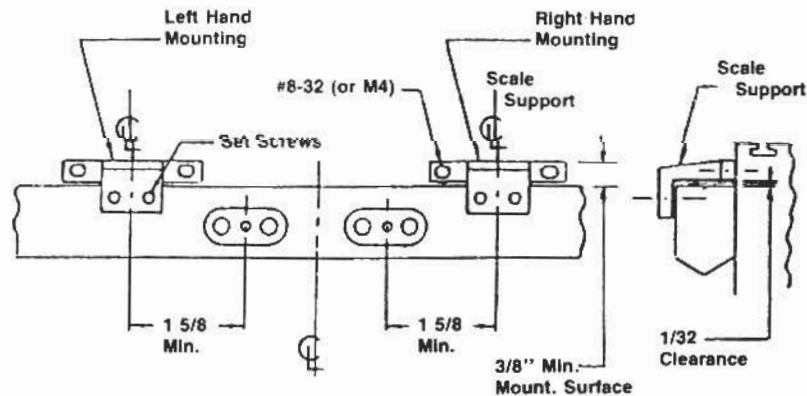


Figure 1-5. Center Support Mounting Options.

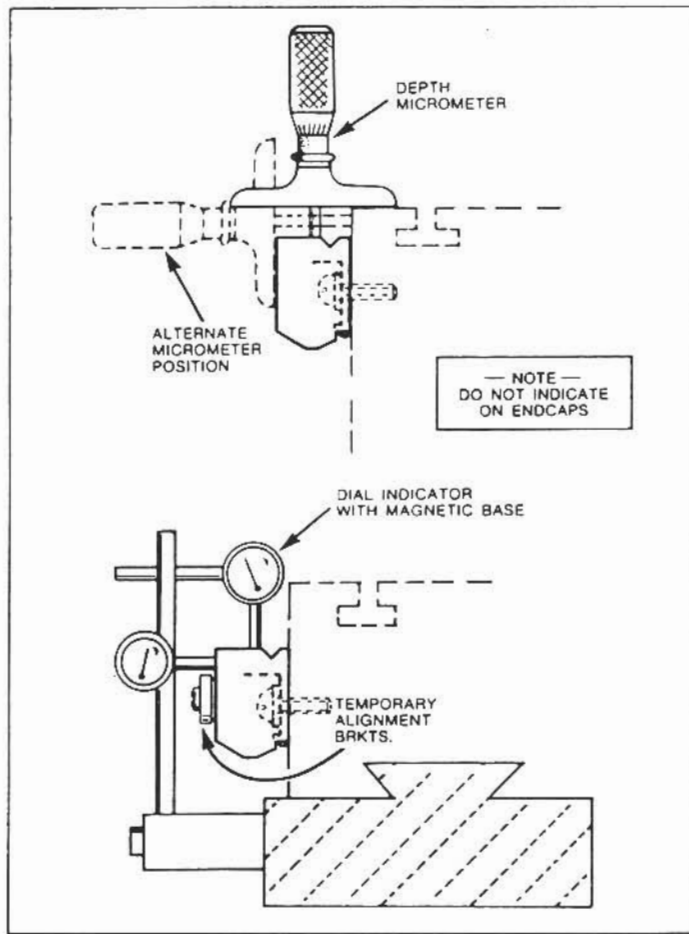


Figure 1-6. Methods of Lining Up Scale Case.

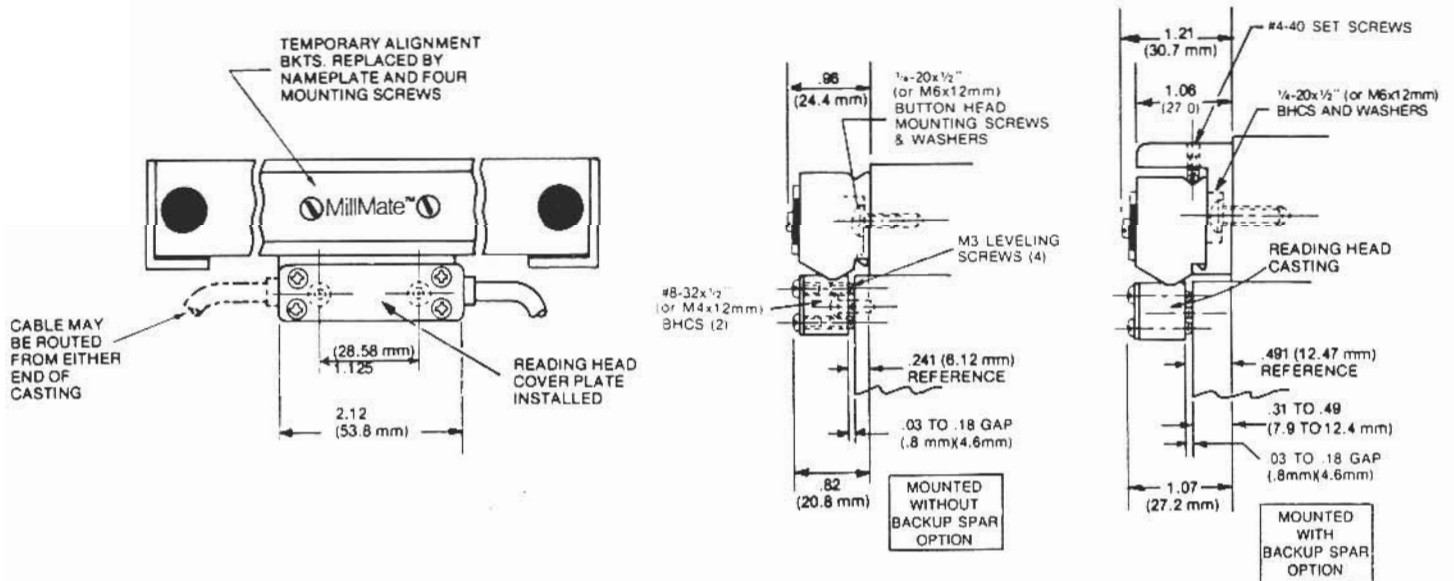


Figure 1-7. Assembly Dimensions and Mounting Data (Completely Installed).

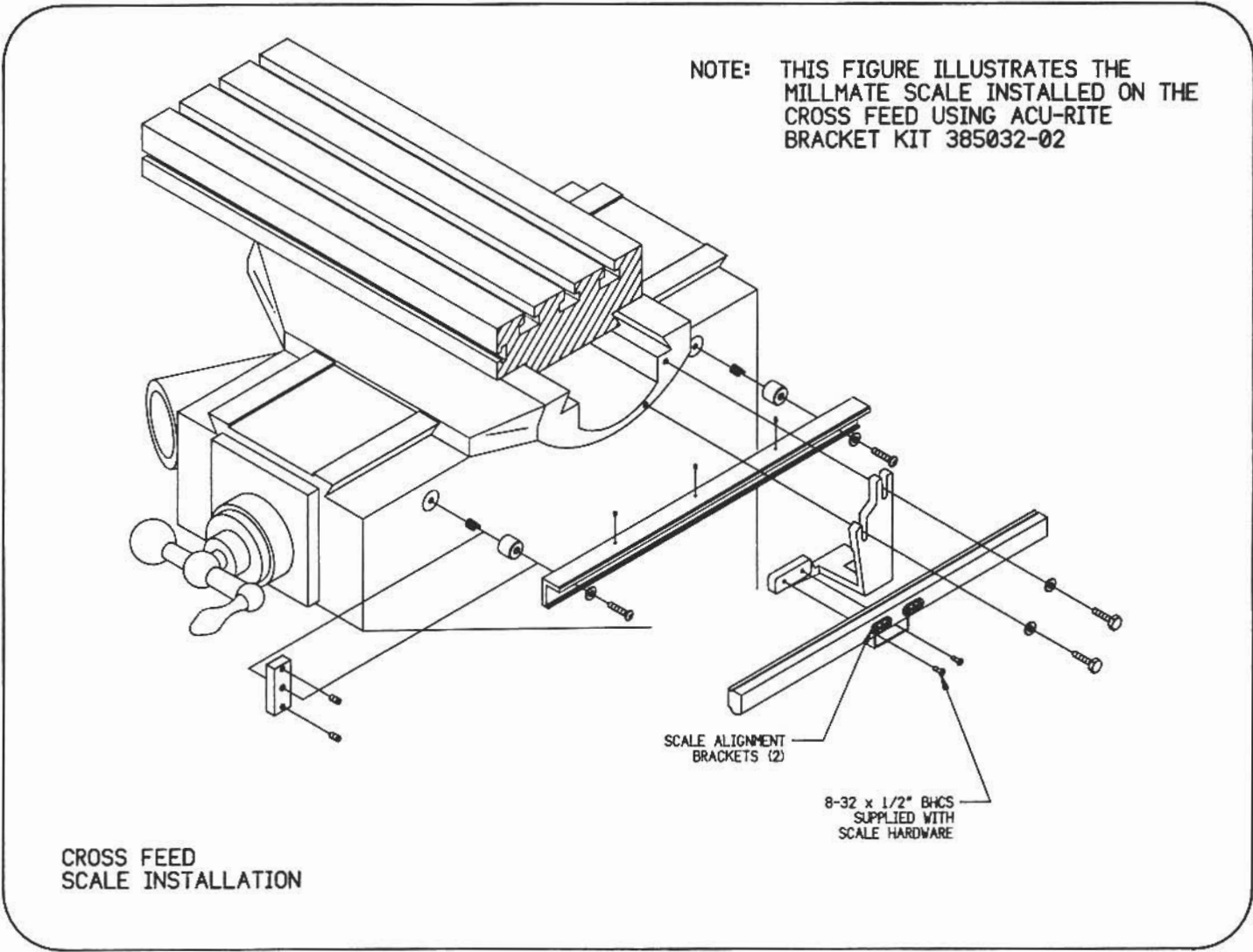


Figure 1-8. Suggested Mounting Method.

Section 2. Readout Installation

MillMate is shipped with the mounting yoke attached. The yoke is then attached to the mill with the mounting arm provided. This allows the readout to be swiveled and angled for easy viewing.

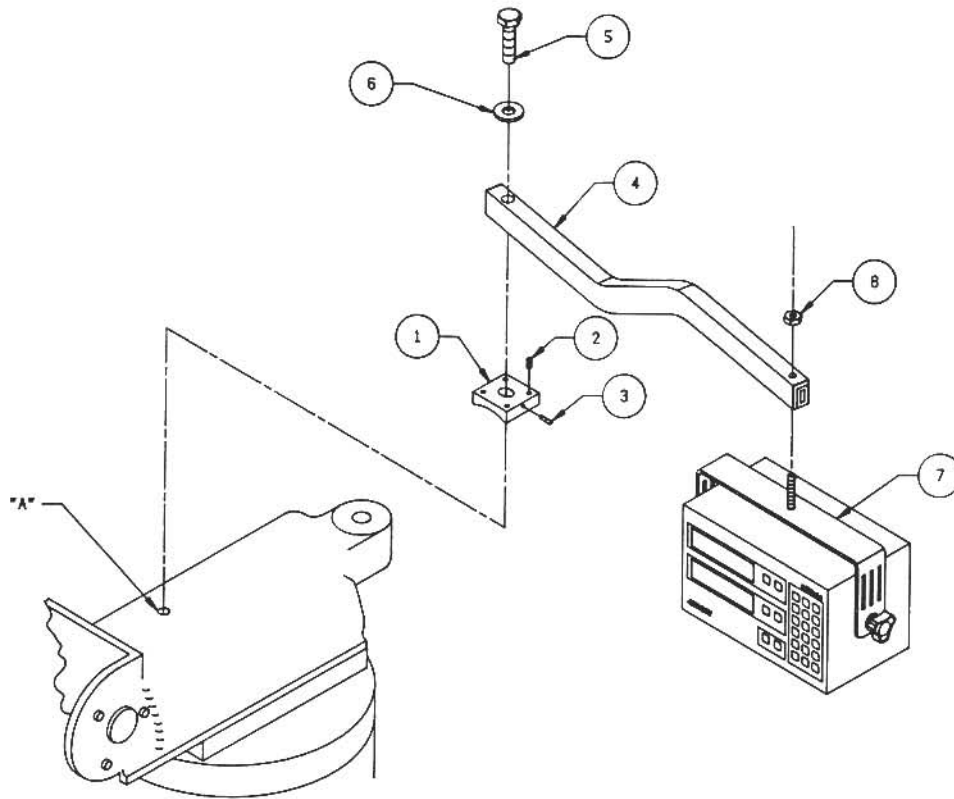
1. The mounting arm is designed to bolt to the top surface of the mill's ram. Many Bridgeport mills (and those similar to Bridgeport) have a $\frac{5}{8}$ -11 hole already drilled and tapped as shown in Figure 2-1. If the mill already has this hole, run a $\frac{5}{8}$ " tap into it to ensure clean threads and proceed to step 3.
2. If the mill does not have the $\frac{5}{8}$ " hole, drill and tap either a $\frac{5}{8}$ -11 hole or a M16 x 65 mm hole. Both sizes of hex head cap screw have been provided. The thread depth must be $\frac{3}{4}$ " (19 mm) minimum. **Note:** The system was designed for use with a $\frac{5}{8}$ " bolt. A smaller bolt is **not** recommended.
3. Thread the four $\frac{1}{4}$ -20 x $\frac{1}{2}$ " socket head set screws (SHSS) into the mounting block until they are flush with the top (flat) side. Thread the 10-24 x $\frac{3}{4}$ " SHSS into the hole on the side of the block until it is flush with the center slot. Do not allow the screw to extend into the center slot.
4. Thread the $\frac{5}{8}$ -11 x $2\frac{1}{2}$ " (or M16 x 1.0 x 65 mm) HHCS into the hole on top of the ram. Hand tighten the screw. From the rear of the mill, check the position of the screw. If the screw is tilted to one side, the mounting block should be installed with the side set screw to the opposite side. Remove the $\frac{5}{8}$ " mounting screw and set the mounting block on the ram with the side set screw on the correct side.
5. With the $\frac{5}{8}$ " washer attached (optional), insert the $\frac{5}{8}$ " (M16) HHCS through the mounting arm and into the mounting hole on the ram. **Do not fully tighten the cap screw at this time.**
6. Place a level on the opposite end of the arm and using the hex wrench provided, adjust the four $\frac{1}{4}$ -20 SHSS in the mounting block until the arm is level. Using the other hex wrench provided, tighten the 10-32 side set screw until it makes contact with the mounting screw, but do not tighten.
7. Tighten the $\frac{5}{8}$ -11 (M16) mounting screw to obtain the desired amount of friction for the swivel movement of the arm. **Note:** The readout assembly must be secure enough so it does not move as keys are pressed.
8. Attach the DRO and yoke assembly to the arm by inserting the $\frac{3}{8}$ -16 stud through the arm and fastening the assembly with the $\frac{3}{8}$ -16 torque type hex nut provided.
9. Tighten the torque nut to obtain the desired amount of friction for the swivel movement of the DRO.

MillMate is now ready for connection to utility power and scale assemblies.

Installing the mounting arm

Attaching MillMate

MillMate™



PARTS LIST

Item No.	Qty.	Description
1	1	MOUNTING BLOCK
2	4	1/4-20 x 1/2" SHSS
3	1	10-24 x 3/4" SHSS
4	1	ARM
5	1	5/8-11 x 2 1/2" HHCS
	1	M16 x 65 HHCS
6	1	5/8" FLAT WASHER
7	1	YOKE AND
	2	HANDLE ASSEMBLY
8	1	3/8" HEX NUT TORQUE TYPE
Also included:	1	1/8" HEX WRENCH
	1	3/32" HEX WRENCH

Figure 2-1. MillMate Column Mount Installation.

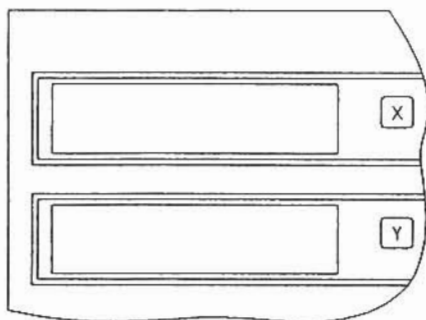
Section 3. Configuration

Parameters that control several readout display options can be set to reflect operator preference. Parameters include near-zero warning boundary value, count direction, and linear error compensation. Descriptions of each parameter are given later in this section.

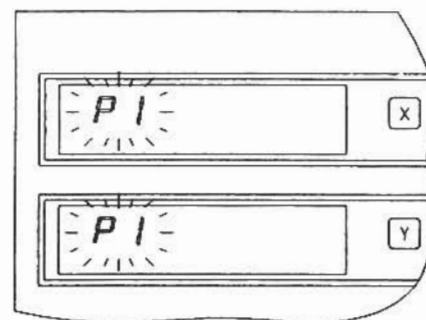
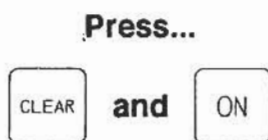
Parameter setting operations

Parameters can be set independently for each axis. Initial values for all parameters have been factory set. To set parameters (refer to Figure 2-4 for locations of front panel keys):

- 1 **Begin setting parameters** by turning the readout OFF (pressing the OFF key). Hold the CLEAR key down and press the ON key; **P1** will flash on both axis displays, showing that the parameter setting mode is active.



Displays turned off

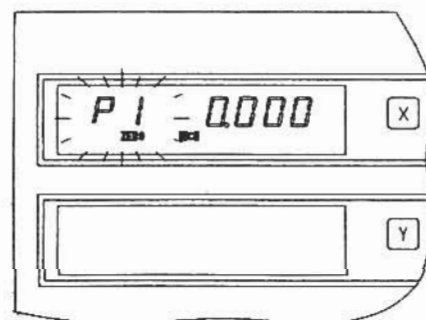


Parameter setting mode display

- 2 Parameters include:
 - P1 - near-zero warning boundary value
 - P2 - count direction
 - P3 - linear error compensation

- 3 **Press an axis key (X or Y) to begin setting parameters for that axis.** P1 and the current setting appears in the axis display; the other axis display is blank.

Press...

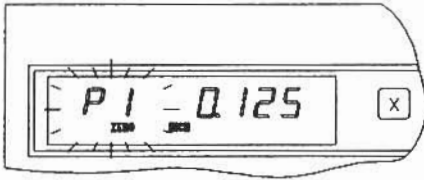


First X-axis parameter, current setting

- 4 **Enter values for P1 and P3 with the numeric keys** (an existing value is cleared when entry begins). P3 can also be set with an automatic routine (refer to "Parameter descriptions"). **Press the ZERO RESET key to change P2.**

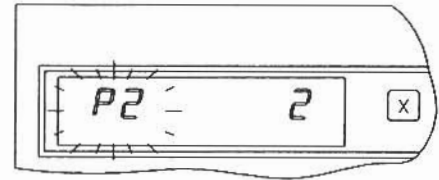
MillMate™

5 Press the same axis key to advance to the next parameter.



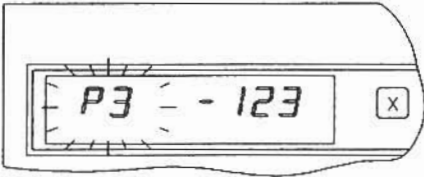
Current setting for near-zero value on the selected axis

Press...



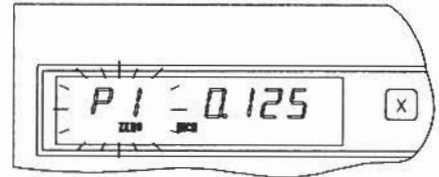
Current setting for count direction on the same axis

6 Press the same axis key again at P3 to return to the first parameter.



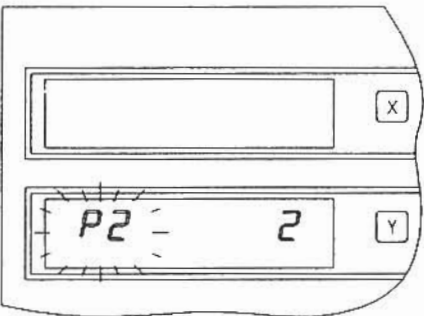
Last parameter for the X-axis, as set

Press...



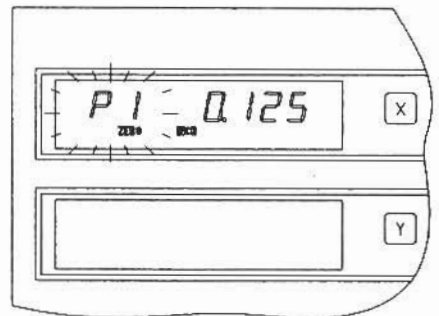
Parameter setting scrolls back to the first parameter on the same axis

7 Press the other axis key to set parameters for the other axis. P1 and the current setting appear in the newly-selected axis. Set parameters in the same manner as for the first axis.



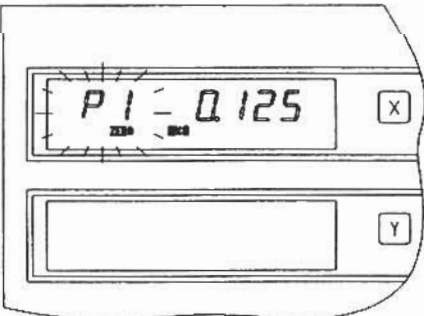
Displays during setting of Y-axis parameters

Press...



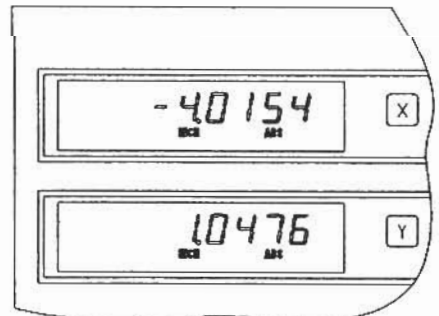
Displays after pressing X axis key

8 Press the ON key to save the new settings. The readout returns to normal DRO operation.



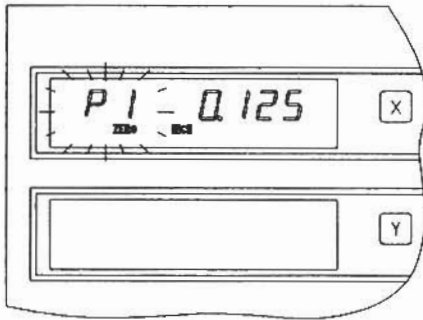
X-axis display, showing a new (but not saved) setting for count direction

Press...



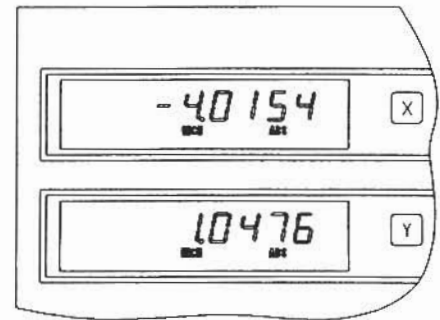
Typical axis display after pressing the ON key. New settings are in effect

- 9 Press the OFF key to exit without saving parameter changes, then press ON to return to normal DRO operation. The old parameter settings will be in effect.



X-axis display, showing a new (but not saved) setting for count direction

Press...



Typical displays after pressing OFF and ON keys. New settings are discarded

The near-zero warning provides a flashing display warning when close to the end of an intended machining operation. When the display measurement is less than the boundary value, the ZERO display message will flash. The message will continue to flash until the measurement reaches zero, or until the measurement is increased again beyond the boundary value.

The boundary value is an absolute value; the message will flash when the display measurement is less than the boundary value, regardless of whether the boundary is reached from the negative or the positive direction. The factory setting for this parameter is **P1 0.000**, which disables the feature.

Set the parameter with the numeric keys and decimal point key. An existing value is cleared as soon as entry is begun. The + and - sign keys are inoperative. Note that the ZERO message flashes, and the currently-selected measuring units (INCH or MM) are shown on the display while setting this parameter. The boundary value is units sensitive: with an entry of 1.000", the ZERO message will flash whenever the display is less than 1.000" or 25.400 mm.

Counting direction defines the counting polarity for encoder movements. For example, movement to the left can be set for positive or negative counting. The count direction parameter should be set to match industry or shop practices.

Change the counting direction setting between 1 and 2 by pressing the ZERO RESET key; selecting the opposite mode will change the counting direction. The factory setting for this parameter is **P2 1**.

Parameter descriptions

P1 - Near-zero warning boundary value

P2 - Count direction

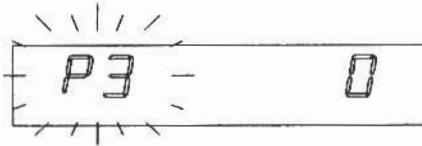
P3 - Linear error compensation

Linear error compensation (LEC) can help overcome errors in the machine table geometry. LEC is given in parts-per-million (PPM). The error compensation factor may be entered with the numeric keys, or can be determined with a built-in automatic routine. The default value is zero, or no compensation.

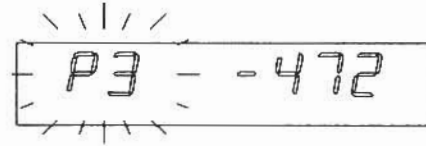
LEC manual entry

Set the LEC with a numeric entry by calculating the LEC and entering the value with the numeric keys.

- 1 Measure the errors across the machine movement and plot the error vs. distance traveled.
- 2 Draw the best-fit line through the data, and pick two points at opposite ends of the line.
- 3 Calculate the linear error compensation factor to be entered in parts-per-million with the formula:
$$\frac{\text{Error}_2 - \text{Error}_1}{\text{Position}_2 - \text{Position}_1} \times 1,000,000 = \text{LEC (PPM)}$$
- 4 Set the compensation factor with the numeric keys. **The sign is important;** use the plus (+) and minus (-) keys to change the sign of the compensation factor. The current setting is cleared when an entry is begun. The decimal point key is inoperative. Entries must be in the range of +/- 9999.



Current setting for linear error compensation (no compensation)



New setting for linear error compensation

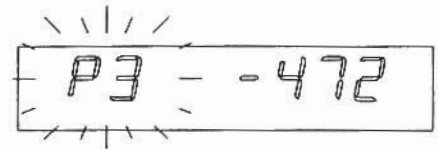
- 5 Press an axis key to set other parameters, the ON key to save changes and return to DRO operations, or the OFF key to abandon changes.

LEC automatic setting

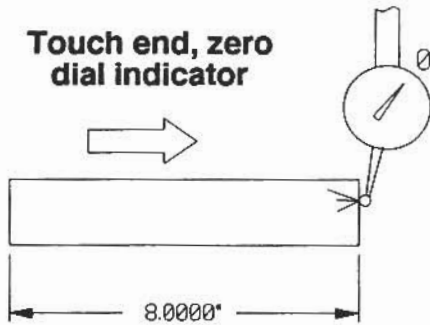
Set the LEC with the automatic routine by installing a measuring standard on the machine table, zeroing on the first edge, moving to the opposite side of the standard, and entering the standard length. Make sure that the readout's measuring units are set to match the measuring standard before beginning this procedure. If necessary, quit the setup mode by pressing the ON key, change the units with the INCH/MM key, then again enter the setup mode and move to display P3.

- 1 Install the measurement standard (essentially a bar of known length) on the machine table. For this example, an 8" long measuring standard is used. Make sure that the standard is aligned with the table movement.

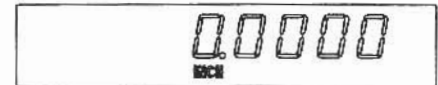
- 2 Install a measurement device in the tool holder or other fixed reference position. The device may be a dial indicator or other contact-sensing indicator.
- 3 This example begins with the previous manual error compensation setting of -472 ppm. Move the machine tables so that the indicator's probe touches one end of the measurement standard. Zero the indicator. With the current setting for LEC shown, press the ZERO RESET key. The axis display zeros, and the measuring units annunciator indicates the selected units.



Starting display for LEC setting with automatic routine

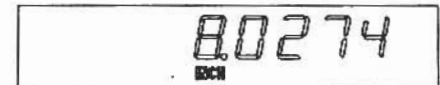
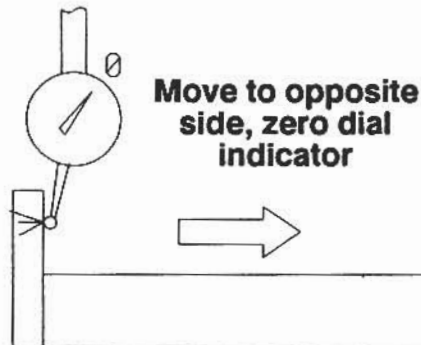


Press...



Display zeroed to start automatic LEC routine

- 4 Move the machine tables so that the indicator's probe touches the opposite end of the measurement standard. Move the table to zero the indicator's dial. The readout's axis display indicates the total movement, which will usually be slightly different from the length of the standard.



Display shows perceived movement

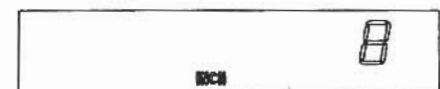
- 5 Press the ZERO RESET key. The axis display shows the last entry made for standard length. Use the numeric keys to enter the standard's length.

Press...



Last entry for standard length

Enter actual length..



New standard length entered

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- 6 Press the ZERO RESET key. The axis display shows the calculated linear error compensation factor in PPM.

Press...



A rectangular digital display showing the value "-3409".

Calculated LEC

Sometimes a flashing "E4" message appears, indicating the calculated LEC factor was outside the acceptable range of -9999 to +9999. This is usually the result of an incorrect entry during the automatic error compensation routine. Press the ZERO RESET key to return to step 4 (total movement is again displayed); or press an axis key to **void changes to this axis' LEC** and to set other parameters, the ON key to **save changes other than this LEC**, or the OFF key to abandon all changes.

- 7 Press an axis key to set other parameters, the ON key to save changes, or the OFF key to abandon changes.

Press...



A rectangular digital display showing "P1 - 0.125". The display has a scale-like background with tick marks.

Display again shows first parameter

Section 4. System Operation

Press the **ON** key. The displays will light up with **000's**, or a measurement if the table has been moved (provided there has not been a power interruption).

Note: The MillMate system tracks table movement even when the readout is turned off, as long as AC power was not interrupted. This allows the operator to turn the unit off in the middle of machining a part without losing the workpiece's position relative to the tool. If a power interruption does occur, the readout will display the E1 error code. It will not display an incorrect position.

Operating the system

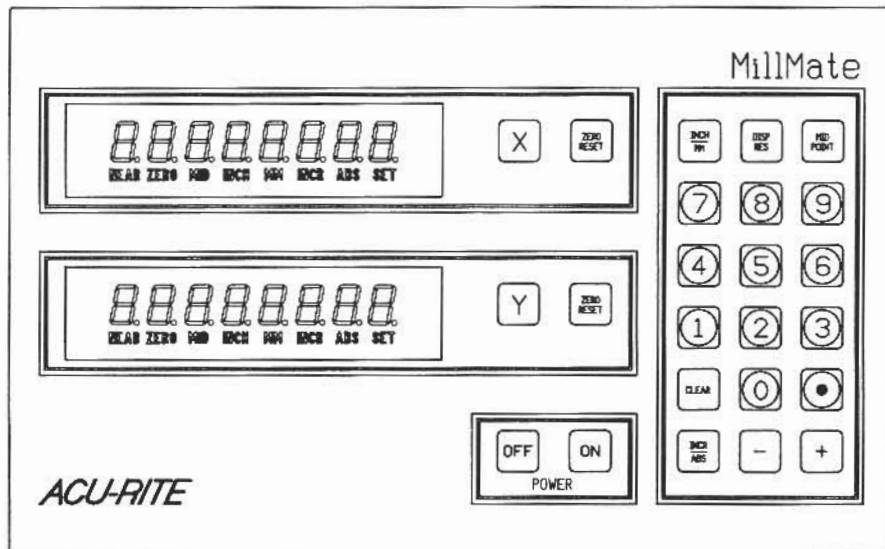


Figure 4-1. Front of Readout.

Inch to Metric Conversion

Axis positions, both incremental and absolute, may be displayed in either inches or millimeters. The current unit of measurement is shown by the status indicator on the display (INCH or MM). To change the units, press the **INCH/MM** key. The status indicator lights will toggle with each press of the key.

Display Resolution

MillMate features three display resolutions. The **DISP RES** key toggles the display resolution between 0.0002" (.005 mm), 0.0005" (.010 mm), and 0.001" (.020 mm). The operator can choose a coarse display resolution for rough machining and a fine display resolution for finish machining.

Special function keys

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Midpoint

The **MIDPOINT** key provides the operator with the means to determine the midpoint or center of a particular part, or the centerline of two holes. In simple terms, it presets the selected axis to one half of its current displayed value.

The **MIDPOINT** feature may be used to perform two forms of center presetting, incremental and absolute. With *incremental* midpoints, only the incremental display is affected. An *absolute* midpoint however, affects 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 use the midpoint feature, proceed as follows:

- 1) Press the **MIDPOINT** key. The midpoint indicator will begin flashing.
- 2) Press the desired axis key. MillMate will immediately preset the readout with one half of the current axis display.

Clear

The **CLEAR** key is used to clear an operator entry (such as a preset) and start over. The **CLEAR** key is also used to clear error codes from the display. The error must be corrected first, however, before it can be cleared.

Absolute and Incremental Displays

MillMate has absolute and incremental displays for both axes of movement. The current mode (ABS or INCR) is shown by the status indicator below the digits in the display window. To switch from one mode to the other, simply press the **INCR/ABS** key. The status indicator toggles with each INCR/ABS key press.

The **absolute display** is used to measure the distance from workpiece zero (a fixed datum point) to the current tool position.

The **incremental display** is used to measure the distance from the current tool position to a desired tool position (point to point) such as a hole pattern. Incremental moves comprise the absolute measurement (parts make up the whole).

Both the absolute and incremental displays can be zero reset and preset as explained below.

Zero resetting

The absolute display is normally zero reset when the tool is at workpiece zero. Zero resetting the absolute display, zeros **both** the incremental and absolute display. To zero reset the absolute display, make sure MillMate is in the absolute mode ("**ABS**" status indicator should be lit). If the ABS status is not lit, toggle the display by pressing the "**INCR/ABS**" key. Press the **ZERO reset** key to the right of the desired axis.

Zero resetting the incremental display, zeros only the incremental display; the absolute display is not affected. To zero reset the incremental display, make sure MillMate is in the incremental mode ("**INCR**" status indicator should be lit). If the INCR status is not lit, toggle the display by pressing the **INCR/ABS** key. Press the **ZERO RESET** key to the right of the desired axis.

Incremental presetting is used to indicate a distance from the current tool position to a desired tool position, or to offset tool diameters. The preset value is added to, or subtracted from (depending on the sign), the current displayed incremental value.

To make an incremental preset, proceed as follows:

- 1) Make sure MillMate is in the incremental mode ("INCR" status indicator should be lit). If the INCR status is not lit, toggle the display by pressing the **INCR/ABS** key.
- 2) Choose the desired axis by pressing the appropriate axis key. The "SET" status indicator will appear.
- 3) Enter the number to be preset and the correct sign (+ or -). If a mistake is entered, the preset function can be started again by pressing the **CLEAR** key. Figure 4-2 illustrates an example of dimensioning where incremental presetting would be used. Figure 4-2 indicates the preset signs (+ or -), relative to the axis signs.

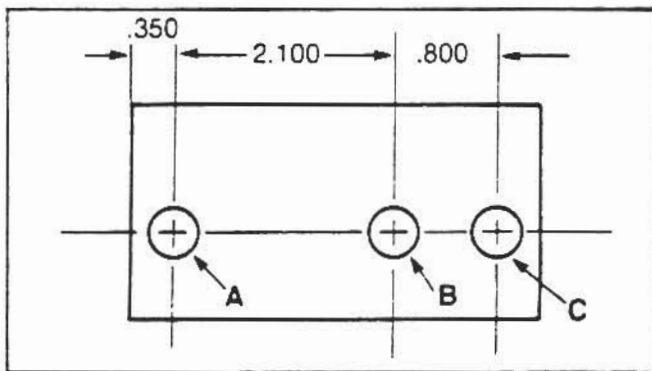


Figure 4-2. Incremental Preset Example.

Absolute presetting specifies the distance from the current tool position, to workpiece zero. Absolute presets are used to shift workpiece zero or home reference points. The preset is added to, or subtracted from (depending on the sign), the current absolute value. The incremental display is zeroed. In standard machining, most operations are performed relative to workpiece zero. Therefore, if it is changed and not indicated on the workprint, it may create confusion for the operator.

To make an absolute preset, proceed as follows:

- 1) Make sure MillMate is in the absolute mode ("ABS" status indicator should be lit). If the ABS status is not lit, toggle the display by pressing the **INCR/ABS** key.
- 2) Choose the desired axis by pressing the appropriate axis key. The "SET" status indicator will appear.
- 3) Enter the number to be preset and the correct sign (+ or -).

Presetting

Incremental presetting

- 1) Locate and drill hole A.
- 2) Press the ZERO RESET key on the X-axis.
- 3) Press the PRESET key on the X-axis. The X-axis "SET" indicator will light.
- 4) Press the digit keys for the value being entered into the preset memory: 2, decimal point, and 1.
- 5) Press the minus key. The display will read -2.100 and the "SET" indicator will go out.
- 6) Move the table to the left until the display reads 0.0000, and drill hole B.
- 7) Press the PRESET key. The X-axis "SET" indicator will light.
- 8) Press the digit keys for the new preset value: decimal point and 8.
- 9) Press the minus key. The display will read -0.8000, and the "SET" indicator will go out.
- 10) Move the table to the left until the display reads +0.0000, and drill hole C.

Absolute presetting

Setting operator options

Near zero warning (P1)

Count direction (P2)

There are three setup options in the MillMate readout which may be entered by the operator through the unit's software: Near Zero Warning (P1), Count Direction (P2), and Linear Error Compensation (P3).

The Setup Mode

To access the setup mode, turn the readout off by pressing the **OFF** key. Hold the **CLEAR** key down and press the **ON** key. MillMate will flash **P1** codes on both displays. The options can now be set according to the information in the following paragraphs. Note: It is easiest to set all three options for one axis and then set all three for the second axis.

The near zero feature gives the operator a visible indication of approaching zero. When the encoder moves into the programmed near zero region, the status indicator flashes "**NEAR ZERO**" until the display reaches zero or the encoder leaves the near zero region.

To set the near zero warning, proceed as follows:

- 1) Select the axis by pressing the corresponding axis key.
- 2) Use the numeric keys to enter the beginning of the desired near zero boundary. **The boundary must be entered as a 5 digit number between 00.000 and 99.999.**

Press the same axis key to advance to the next setup option for that axis.

This feature is used to assign a positive or negative value to axis motion (polarity). 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 check the polarity:

- 1) Press the **ON** key to exit the setup mode.
- 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. Re-enter the setup mode and press the axis key three times to set linear error compensation (see page 4-5 Linear error compensation P3).

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

- 3) Turn MillMate off, then while pressing the **CLEAR** key, press the **ON** key to re-enter the setup mode.
- 4) Press the axis key twice — **P2** should be flashing.
- 5) On the right hand side of the display, there is a number 1 or 2. These numbers represent a count direction (the factory setting for this option is 1).

If a number 1 appears, press the 2 numeric key to change the count direction. If a number 2 appears, press the 1 numeric key.

Press the same axis key to advance to the next setup option for that axis.

Errors due to wear of the machine may be compensated for by the MillMate system. First, measure the error of the mill using gage blocks or a step gage. Calculate the error in parts per million by the following calculation:

$$\frac{\text{Error measured}}{\text{Distance traveled}} \times 1,000,000 = \text{ERROR (PPM)}$$

Enter the error in parts per million for the axis to be compensated. Any whole number between -9999 and +9999 may be entered.

Note: Setup options are set in the same manner as above for the second axis.

After all setup options have been entered, press the ON key. If the ON key is not pressed, the system will revert to the old setup values. To exit the setup mode without saving your changes, press the **OFF** key.

If normal operation of the system is interrupted, one of the following error codes will appear on the readout.

E1

The E1 error code indicates that AC power to the system has been interrupted. Once AC power has been returned to the system, press the **CLEAR** key to remove the error code. Operator options are retained during power losses.

E2

The E2 error code generally indicates that the scale has been moved at a rate (slew rate) faster than the system is specified for. This error is axis specific, therefore, the error code will appear on the axis display which created the error. Press the **CLEAR** key to remove the error code. The CLEAR key zero resets both the incremental and absolute displays of the affected axis (axes).

E3

The E3 error code indicates a weak output signal from a scale. It is axis specific, therefore, the error code will appear on the axis display which created the problem. Clean the scale's glass by gently rubbing a cotton swab saturated with isopropyl (rubbing) alcohol over its entire length. Press the **CLEAR** key to remove the error code. If the problem persists call your ACURITE distributor for service.

E4

The E4 error code indicates display overflow. This means the count value exceeds the number of digits available on the display. Internally, the axis retains correct position information. When the position information returns to the acceptable number of digits, E4 will stop flashing. During an E4 error, there is no loss of position information.

Linear error compensation (P3)

System error codes

Section 5. Appendices

System specifications

INPUT VOLTAGE REQUIREMENTS	100 VAC setting	90-110 VAC
	120 VAC setting	108-132 VAC
	220 VAC setting	198-242 VAC
	240 VAC setting	216-250 VAC
INPUT FREQUENCY	47 - 63 Hz	
INPUT CURRENT	0.15 AMPS continuous	
OPERATING CONDITIONS	0° C to 40° C (32° F to 104° F) 25% to 85% relative humidity (non-condensing)	
STORAGE CONDITIONS	-40° C to 60° C (-40° F to 140° F) 20% to 95% relative humidity (non-condensing)	
ELECTRONICS	Microprocessor/Custom LSI	
DISPLAY	Aqua Vacuum Fluorescent	
SCALE RESOLUTION	5 Micron (.0002 inch)	
REPEATABILITY	5 Micron (.0002 inch)	
ACCURACY	10 Micron/meter (.0005 inch/40 inches) @ 20° C (68° F)	
SLEW RATE	800 mm/sec (31.5 in/sec) maximum @ 10° C to 30° C (50° F to 86° F) 530 mm/sec (21 in/sec) maximum @ 0° C to 40° C (32° F to 104° F)	
MEMORY RETENTION	non-volatile (Readout operating software/customer setup)	
UL & CSA COMPLIANCE	Pending	

For future ordering reference or warranty service, record the following information:

System catalog number (from shipping carton) **381000-** _____

Readout serial number _____

Scale Serial numbers _____

Date of Purchase _____ ACU-RITE Distributor _____

ACU-RITE products and accessories are warranted against defects in material and workmanship for a period of one year from date of purchase. ACU-RITE will, at its option and expense, repair or replace any part of the ACU-RITE product which fails to meet this warranty. Notice of the claimed defect must be received by ACU-RITE within the warranty period.

Warranty

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

Responsibility for 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.

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

FCC compliance statement

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