

Mitutoyo

ProScale Series 950



User Manual for

950-: 404, 405, 406, 407 Systems

with DRO Firmware V2.0 and Higher

Warranty

Mitutoyo America Corporation Inc., (MAC) warrants this product against defective parts and workmanship for one year, commencing from the date of original purchase. Upon notification of a defect, MAC shall have the option to repair or replace any defective part. Such services shall be the customer's sole and exclusive remedy. Expenses incidental to repair, maintenance, or replacement under warranty, including those for labor and material, shall be borne by MAC.

Except as expressly provided in this warranty, MAC., does not make any warranties in respect to the product, either expressed or implied, including implied warranties of merchantability or fitness for a particular purpose, except as expressly provided in this agreement.

MAC shall not be liable for any special, incidental, or consequential damages or for loss, damage or expense directly or indirectly arising from the customer's use of or inability to use the equipment either separately or in combination with other equipment, or for personal injury or loss or destruction of other property, or from any other cause.

SAFETY WARNING

If installing ProScale on machinery, turn off the machine and disconnect it from its power source to avoid injury.

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Introduction

Mitutoyo ProScale Series 950 Linear Measuring Systems are manufactured exclusively for Mitutoyo America by Accurate Technology Inc., Asheville, NC

ProScale digital measuring systems are affordable precision electronic devices for making linear measurements with speed and accuracy. They are ideal for most measuring requirements up to 6m (20ft.) where high accuracy, 10 μm , (approximately .0005") is not needed, but affordable repeatability, (better than a tape measure), or accuracy to 50 μm (.002") is desired. Because ProScale shows the exact measurement on its display, it eliminates the guesswork involved in reading and interpreting tape measures, scales & pointer, or shaft encoders. It is compatible for retrofitting, or as original equipment, on most machinery or for any general purpose measurement application where data is collected (SPC, RS232, RS485) and/or digital accuracy and repeatability is desired.

ProScale consists of a scale, a readhead (or encoder) and a digital display. It uses capacitive encoder technology, the same technology used in Mitutoyo digital calipers.

Because ProScale is a solid-state electronic device there's very little to wear out. The readhead and scale are designed to withstand shop dirt, dust, and other airborne contaminants, and the controls are sealed with a protective cover. With normal care, ProScale will last for years.

For ProScale systems with different measuring lengths, or different DRO's with additional capabilities and accessories please contact your Mitutoyo distributor or Accurate Technology – www.proscale.com .

What This Manual Includes

This manual includes information for:

- **Mitutoyo ProScale Series 950-404, 950-405, 950-406 & 950-407 linear digital measurement systems, supplied with General Purpose LCD Digital Displays with Firmware V2.0 and higher.**

ProScale Terminology

All ProScale systems consist of a **SCALE**, a **READHEAD**, and a **DIGITAL DISPLAY**.

The **SCALE** consists of a series of conductive patterns bonded to an aluminum extrusion.



The **READHEAD**, or encoder, contains a custom computer chip, which transmits and receives signals to and from the scale using capacitive coupling. The received signal is used by the readhead to calculate its position to within 10 microns ($10\mu\text{m}$ / .0004in). This position data is then sent to the digital **DISPLAY**, where it can be displayed in millimeters, centimeters, inches, or fractions and sent to an external data acquisition device via a 10 pin SPC connector.



Readhead



Digital Display (DRO)

Part	Part Number
950-404 Scale only	700-1510-001
950-405 Scale only	700-1518-001
950-406 Scale only	700-2504-001
950-407 Scale only	700-2508-001
Digital Display	701-1006-100
Read head	701-1003-001

Scales

An absolute, (ABS), system measures its actual position by reading a pattern which is unique at any given location over its length. The maximum length of a ProScale absolute pattern is 430mm (16.932 in.). The pattern must then repeat itself.



Consider the illustration above to represent a ProScale [Model 950-406](#). There are three absolute patterns (each pattern is 430mm long), joined together end to end. Within each pattern the system is totally absolute. However, crossing over a pattern joint now presents the readhead with information identical to what it read in the previous pattern. At this point the system must be able to recognize that it has crossed over a pattern joint and therefore must add or subtract the value of 1 pattern offset - 430mm. In fact, each time the readhead passes over a pattern joint it must keep track of how many patterns it has passed, and in which direction. This action is accomplished by the digital display.

What does all this mean? If the readhead remains on the same absolute segment, it can have power removed, its position changed and power restored without loss of position information. However, if power is removed and the readhead passes over a pattern joint, the transition will not be recognized. When power is restored the system knows its absolute position on the new pattern, but does not know how many patterns it has passed, or in which direction!

ProScale displays provide the operator with a method to adjust the pattern offset so the system displays the correct reading at all times without loss of accuracy. See Section 4 All ABS scales have a “zigzag” pattern etched onto the green laminate. **Take care to not damage this etching** or remove the green coating. There should also be a pattern “break” approximately every 430mm (17in.). **Do not attempt to shorten ABS style scales; call Accurate Technology 800-233-0580 for assistance or visit www.proscale.com** .

Readheads

ABS readheads have “**BLACK END OF SCALE**” labels on the cover, and the wire exits from the *corner* of the housing. Extreme care must be taken not to damage the six brass “fingers” inside the readhead housing. ABS style readheads, used in all 950 Series systems, **must** be mounted on ABS scales with a particular orientation. Each readhead has an arrow on the label pointing in the direction of the “**BLACK END OF SCALE**” (each ABS style scale will have one end painted black). This relationship is very important, since the readhead will work, but produce erratic results if incorrectly installed. To insure proper operation, be sure the arrow on the readhead is pointing toward the **BLACK** end of the scale. The standard readhead has 2m (6 ft.) of cable. For special cable lengths, contact Mitutoyo America or Accurate Technology.

Displays

ProScale series 950 systems are supplied with a General Purpose, Battery Operated LCD Digital Display with Firmware v2.0 or greater.

Refer to Section 4 - *Digital Display* - for installation, programming and operation.

NOTE: *Programming Parameters from Pr0 through Pr23 (except Pr15 & Pr 22) are applicable to the Series 950 DRO.*



- Front Panel Programmable with internal programming jumper “lock-out”
- Powered by 2AA Batteries with an approximate life of 8 months
- 10 pin Mitutoyo compatible SPC output
- P/N 701-1006-100

This Digital Display is also backward compatible with the following 950 Series ProScale systems:

950-401, 950-402, 950-403, 950-410, 950-411, 950-414, 950-415, 950-416, 950-417, 950-419, 950-421, 950-422, 950-423

These systems use INCREMENTAL technology and will require internal DRO jumper JP2 to be reset. (See Section 4 *Jumpers*)

Incremental Style Scale Pattern

NOTE: Incremental readheads and scales are not compatible with Absolute (ABS) technology components (950-404, 950-405, 950-406, 950-407) described in this manual.

Product Specifications

ProScale Series 950

Measuring Range*:

950-404	Up to 250mm	(10in)
950-405	Up to 450mm	(18in)
950-406	Up to 1200mm	(4ft)
950-407	Up to 2400mm	(8ft)

Accuracy: $\pm (.025 + .064 \times L / 430)$ mm; max error ± 0.20 mm @ 1.3 to 6m
 $\pm (.001 + .0025 \times L / 17)$ in; max error $\pm .008$ in @ 4 to 20 feet
(L = length of measurement in mm or inches)

Resolution .1mm/.01cm/.01in; .01mm/.001cm/.001in; .01mm/.001cm/.0004in

Repeatability: .01mm or .001cm or .001in

Display Range: ± 9999.99 mm; ± 999.999 cm; ± 999.999 in; $\pm 399 \frac{63}{64}$ in

Operating Temp: 0 to 51°C; 32 to 120°F

Temp Coef: 25ppm/°C; 13ppm/ °F

Max. Slew Rate: 400 mm/sec. (15 inches/sec.)

Accessories: See Section 6

Output Format: Mitutoyo SPC

Readhead: 2m, 10-conductor Mitutoyo 936937 termination.

Dimensions: Available at www.mitutoyo.com.

US Patents: 4420754, 4879508, 4878013, 4959615

Warranty: One year from date of purchase.

All ProScale products are MADE IN USA

* MEASUREMENT lengths are approximately 100mm (4in) *shorter* than PHYSICAL lengths.



ProScale 950-404 and 950-405

General Purpose measuring system with standard measuring ranges of 250mm and 450mm.

950-404/405 systems use *ABS* style scales, *ABS* style readheads, and general-purpose digital displays. Neither the scale nor readhead are compatible with older Mitutoyo *Incremental* (950-401, 950-402, 950-403, 950-410, 950-411, 950-414, 950-415, 950-416, 950-417, 950-419, 950-421, 950-422, 950-423) ProScale systems.

ProScale Model 404/405 is easy to install. By following the basics of good installation, reliable, error-free operation can be expected. ProScale can be used in many different measurement applications, and with numerous types and brands of equipment. Therefore all installations will be a little different and it is the responsibility of the installer to choose the bolts, screws, or other mounting hardware that guarantee proper installation for optimum operation.

Installation

1. Note the orientation of the readhead on the scale. Be sure the arrow on the readhead points towards the **“BLACK END OF SCALE”**. This orientation is critical for proper operation of ProScale. Be sure the mounting location for the readhead and scale will allow this orientation. Take care when sliding the readhead onto the scale so the brass “fingers” inside the readhead do not get damaged. (A slight “wiggling” motion when installing the readhead on the scale will simplify the process.)

2. Determine an appropriate mounting location for the system. Most applications of the Series 404/405 will have the readhead held stationary while the scale is passed through the readhead. The ProScale will also operate properly if the readhead is moved along the scale (see figures on next page).

3. If the readhead is to be mounted stationary, the scale should be attached to a moving part of the measuring application or machine using the included [Connector Link](#).

Mount the readhead using three screws or bolts. Mount one end of the connector link to the scale using an M5 (or 10-32) screw and the other end to the moving part. Check that the scale is properly aligned with the direction of motion of the moving part. Be sure both connections are secure or inaccurate/erratic readings could result. (The connector link compensates for small misalignments of the installation and acts as a *shear pin*). The connector link must be mounted in the same direction as the scale (see figure below).

Note: Failure to use the connector link could void the warranty.



[Connector Link](#)
[PN 100-1025-005](#)

4. If you choose to hold the scale stationary and move the readhead to measure, you should use the included [Guide Clip](#) to move the readhead along the scale (see figure on next page). The connector link is not necessary in this configuration.

Mount the scale using a M5 (or 10-32) screw. Be sure the scale is properly aligned as the readhead is moved (the Guide Clip will compensate for slight misalignment in one direction only).

Adjust scale alignment if necessary.

For accurate measurements, the guide clip must be mounted perpendicular to the direction of travel of the readhead. The guide clip should exert some pressure over the full range of travel on the readhead so the two move as a single unit.

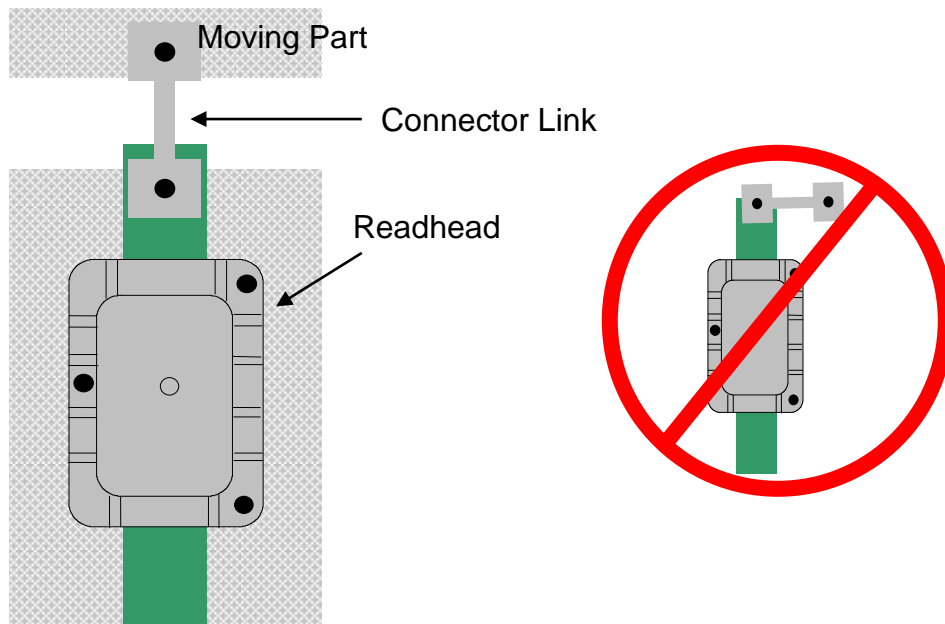
Note: Failure to use the guide clip could void the warranty.



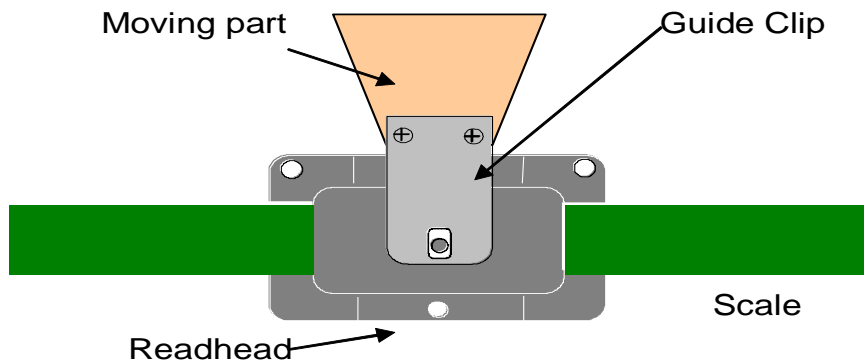
[Guide Clip](#)
[PN 100-1026-005](#)

5. The Digital Display may be mounted in a location which allows for easy viewing by the operator. The location of all parts should also safeguard the cable from possible damage. ProScale wiring should be kept away from electrical wiring and motors. Plug the readhead into the display. See Section 4: *Digital Display Operation*.

Typical ProScale Model 404/405 Installations



Readhead stationary, Scale moves



Scale stationary, Readhead moves

Calibration

Once installed, ProScale can be calibrated easily and quickly. Following is an example for calibrating ProScale on an industrial wide belt sander. Other installations follow the same general procedure.

1. Check to be sure installation of all parts is complete, all fasteners are secure, and the readhead is plugged into the digital display.
2. Set-up the machine to operate as normal. Run a part through the sander.
3. Measure the thickness of the sanded part with the most precise measuring tool available (digital calipers if possible).
4. Press the zero key on the ProScale digital display then press and hold the PLUS key to scroll until the thickness measurement is displayed (The longer the PLUS key is held down, the faster the display will scroll).
5. When the proper reading is reached, lock the display if desired. This prevents accidentally re-zeroing of the display. See Section 4: *Lock Mode*.

If the direction of movement (+ and -) on the digital display is opposite the desired direction, the display programming should be changed.

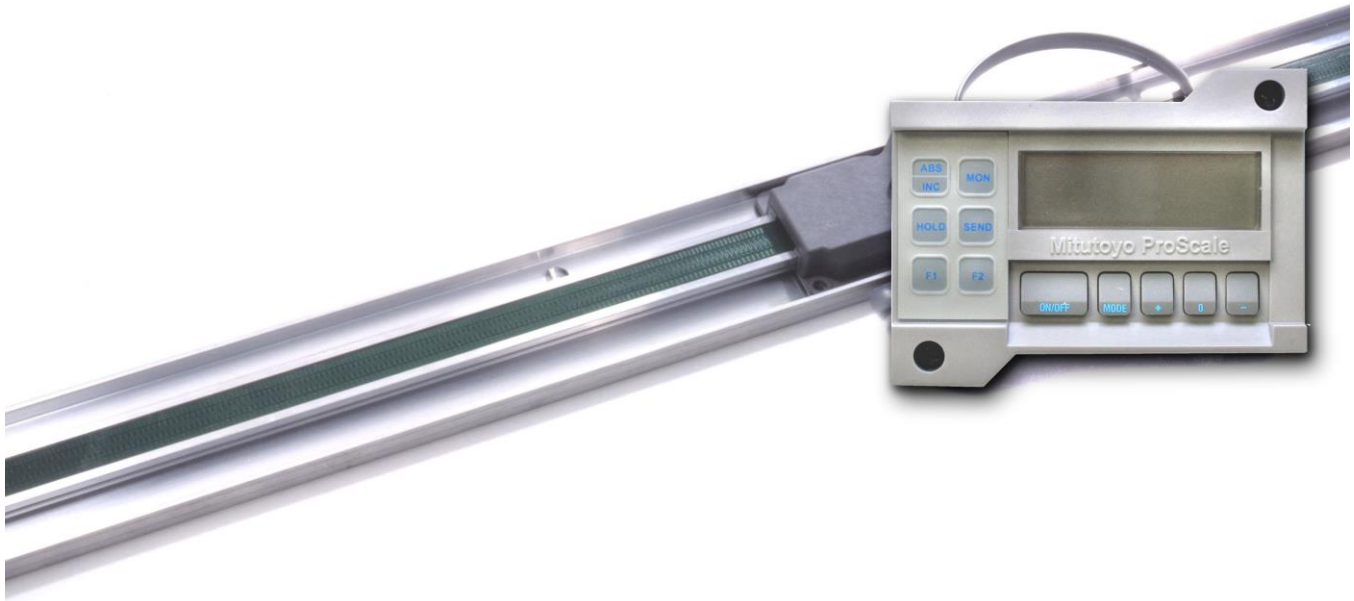
See Section 4: *Programming (Programming Parameter Pr0)*.

Maintenance

Although the ProScale will operate in a dry environment of non-conductive debris such as sawdust, the system should be cleaned of excess debris when necessary. This will prevent premature damage to the scale or readhead. Should the scale become difficult to move, check to see if debris has built up under the readhead and remove if necessary. Find and remove any burrs which may have developed on the aluminum scale. Do not use any liquid lubricants on the scale assembly, as this may impede the readhead's ability to operate properly and will attract other contaminants to the scale.

The Digital Display should be cleaned periodically with compressed air to remove any dust on the lens and keys.

All mounting fasteners should be checked occasionally for tightness.



ProScale 950-406 and 950-407

General Purpose measuring system with standard measuring ranges of 1.2m and 2.4m.

950-406/407 systems use *ABS* style scales, *ABS* style readheads, and general-purpose digital displays. Neither the scale nor readhead are compatible with older Mitutoyo *Incremental* (950-401, 950-402, 950-403, 950-410, 950-411, 950-414, 950-415, 950-416, 950-417, 950-419, 950-421, 950-422, 950-423) ProScale systems.

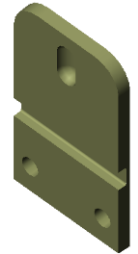
ProScale 950-406/407 is easy to install. By following the basics of good installation, reliable, error-free operation is assured. ProScale can be used in many different measurement applications, and with numerous types and brands of equipment. Therefore all installations will be a little different and it is the responsibility of the installer to choose the bolts, screws, or other mounting hardware that guarantee proper installation for optimum operation

Installation

1. Note the orientation of the readhead on the scale. Be sure the arrow on the readhead points towards the **“BLACK END OF SCALE”**. This orientation is critical for proper operation of ProScale. Be sure the mounting location for the readhead and scale will allow this orientation. Take care when sliding the readhead onto the scale so the brass “fingers” inside the readhead do not get damaged. (A slight “wiggling” motion when installing the readhead on the scale will simplify the process).

- Determine an appropriate mounting location for the system. Most applications of the Series 406/407 will have the scale held stationary while the readhead is moved along the scale. However, the ProScale will read correctly if the readhead is moved along the scale or if the scale is moved through the readhead.
- When the scale is stationary and the readhead moves to measure, you should use the *Guide Clip* to move the readhead along the scale (see figures below). Mount the scale using M4 (or #8) screws. Be sure the screw heads do not protrude above the surface of the extrusion. Check that the scale is properly aligned as the readhead is moved over its length (the Guide Clip will compensate for slight misalignment). Adjust scale alignment if necessary. For accurate measurements, the guide clip must be mounted perpendicular to the direction of travel of the readhead. The guide clip should exert some pressure over the full range of travel on the readhead so the two move as a single unit.

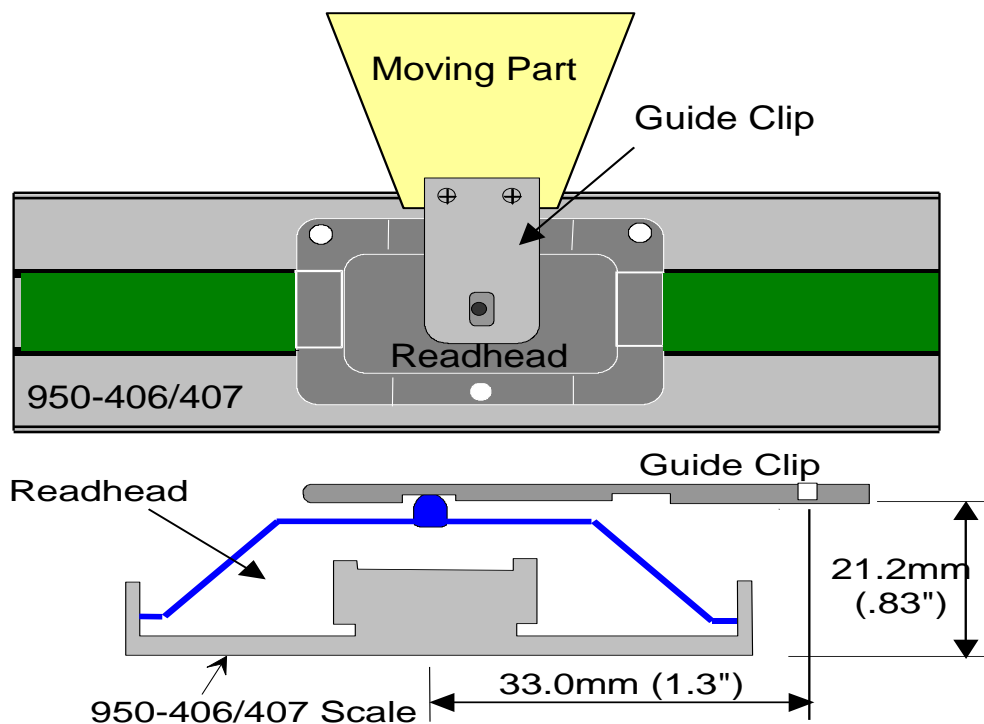
Note: Failure to use the guide clip could void the warranty.



Guide Clip

- The Digital Display may be mounted in a location which allows for easy viewing by the operator. The location of all parts should also safeguard the cable from possible damage. ProScale wiring should be kept away from electrical wiring and motors. Plug the readhead into the display. See Section 4: *Digital Display Operation*.

Typical ProScale 950-406/407 Installation



Guide Clip Pressure/Spacing (End View)

Calibration

Once installed, ProScale can be calibrated easily and quickly. Following is an example for calibrating ProScale on a table saw fence. Other installations follow the same general procedure.

1. Check to be sure installation of all parts is complete, all fasteners are secure, and the readhead is plugged into the digital display.
2. Cut a part using the normal fence operation.
3. Do Not move fence until calibration is completed.
4. Measure the dimension of the part with the most precise measuring tool available (i.e. digital calipers).
5. Press the zero key on the ProScale digital display then press and hold the PLUS key to scroll until the measurement you just made is displayed. (The longer the PLUS key is held down, the faster the display will scroll).
6. When the proper reading is reached, lock the display if desired. This prevents accidentally re-zeroing of the display. See Section 4: *Lock Mode*

If the direction of movement (+ and -) on the digital display is opposite the desired direction, the display programming should be changed. See Section 4: *Programming (Programming Parameter Pr0)*.

Maintenance

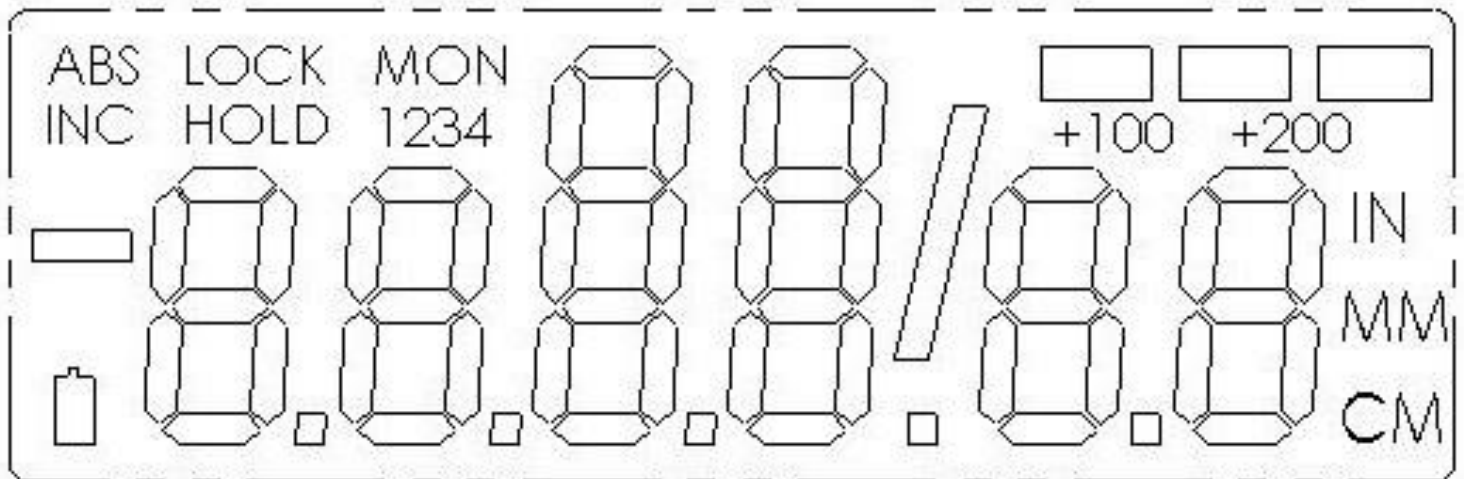
Although the ProScale will operate in a dry environment of non-conductive debris such as sawdust, the system should be cleaned of excess debris when necessary. This will prevent premature damage to the scale or readhead. Should the scale become difficult to move, check to see if debris has built up under the readhead and remove if necessary. Find and remove any burrs which may have developed on the aluminum scale. Do not use any liquid lubricants on the scale assembly, as this may impede the readhead's ability to operate properly and will attract other contaminants to the scale.

The Digital Display should be cleaned periodically with compressed air to remove any dust on the lens and keys.

All mounting fasteners should be checked occasionally for tightness.

This section covers the programming and operation of the [Series 950 LCD DRO](#) (Firmware V2.0 and higher). This display is supplied on all Mitutoyo ProScale 950 Series Digital Measuring Systems.

The LCD



The above figure illustrates all the segments available on the Digital Display.

Display Keys



Key Press Timing

The keys pictured above, found on all Series 950 LCD Digital Displays, have multiple functions. Timing, that is how long a key is depressed, and the combination of the keys pressed is important. This manual uses the term “*momentarily*” to describe a key press of typically less than 1 second. Whereas “*press and hold*” is used imply a key press of typically longer than 1.5 seconds. As an example; when using a PC keyboard to type a capital letter you would “*press and hold*” the SHIFT key and “*momentarily* depress the LETTER key.

In addition the key(s) “*function*” is executed on the key RELEASE, not the key DEPRESS. This is important since some keys execute different functions based on how long they are depressed. These key operations, once tried, quickly become intuitive.

ON/OFF

Momentarily pressing the **ON/OFF** key will cause the display to turn on or off. The Firmware Version is displayed on power-up or when **ON/OFF** key is pressed. While on, if no key presses or positional changes occur within 15 minutes, the Digital Display will automatically turn itself off to conserve battery life. While off, if a position change is detected (.05mm or .002in) or the **ON/OFF** button is pressed, the display will automatically turn itself on with no loss of measurement information.

(Programming Parameter Pr8. Factory default set to 15 minutes.)

Battery voltage is displayed by pressing and holding the **ON/OFF** key for 5 seconds while display is turned on.

CAUTION: Pressing and holding the ON/OFF and MODE key for 10 seconds while the display is turned off will perform a full segment LCD test AND re-set all programming parameters to factory defaults.

MODE

The digital display can show measurement information in Imperial or Metric. To change the current display mode, momentarily press the **MODE** key. With each key press the display will cycle through decimal inches, fractional inches (1/16), (1/32), (1/64) (if enabled by **Programming Parameter Pr6**) and metric (mm or cm based on setting of **Programming Parameter Pr5**).

When the display is in a decimal mode (mm, cm or in) it will auto-range to the next resolution if the value is displayable in the next range. This allows the display to be used with other Mitutoyo products in inch mode or different resolutions other than 2 decimal places.

When the display is in 1/16 or 1/32 inch fraction mode, a series of “bars” in the upper right corner of the LCD each represent an additional 1/64th of an inch measurement. ie. When in 1/16 inch mode and three bars are showing, the measurement displayed is rounded *down* to closest 1/16 inch and each illuminated bar indicates an additional 1/64 of an inch (“heavy”) measurement. For better resolution switch to 1/32 or 1/64 fraction mode. For the best resolution switch to a decimal mode.

When the measurement is greater than $\pm 99 \frac{63}{64}$ inches, a **+100** or **+200** will show in the upper right portion of the LCD to indicate this amount must be added to the displayed reading. ie: if the measurement is $154 \frac{5}{8}$ inches, $54 \frac{5}{8}$ and **+100** will be displayed on the LCD. If the measurement is $-307 \frac{23}{64}$ inches - $7 \frac{23}{64}$, **+100** and **+200** will be displayed on the LCD.

The **Resolution** of the display can be set for *Normal*; (.01mm or .001in), *Reduced*; (.1mm or .01in) or *Increased*; (.01mm or .0005in) (**Programming Parameter Pr4**.)

+ , 0, and – Keys

The **+** (plus), **0** (zero) and **–** (minus) keys are used to change the currently displayed position to a different value. The **0** key forces the unit to display 0. Momentarily depressing the **+** key increments the current position by one unit of measurement. Momentarily depressing the **–** key decrements the current position by one unit. Pressing and holding the **+** or **–** keys will cause the displayed position to change continuously. Holding down the key will cause the amount of change to speed up. This allows for quick adjustments over a range of large values. These keys can be “locked out” to prevent accidental offset or zero entries. **(See Programming Parameter Pr3)**

Digital Display Functions

Lock Mode

The user can “lock-out” the position offset adjustment functions (**+**, **-**, **0** keys) to prevent accidental changes of the current displayed position. To activate the lock mode, press and hold the **ON/OFF** key and then momentarily press the **MODE** key. The word LOCK on the LCD display will turn on or off with each lock/unlock operation. When the LOCK symbol is displayed, the **+**, **-** and **0** keys will not change the displayed position. On Displays with an auxiliary keypad: ABS and INC modes have independent lock operations. **(See Programming Parameter Pr3. Factory default is Enabled.)**

Segment Offset Adjustment

For scales that are longer than 430mm (17 inches), multiple scale pattern segments are installed end-to-end on the aluminum extrusion. This provides a quasi-absolute measurement capability in which the readhead can calculate its position on any individual scale segment but cannot determine which particular segment it is on. To solve this problem, the Digital Display tracks which scale segment the readhead is on by detecting the “splice” between one segment and adjacent segments.

In certain situations, the crossing from one segment to another may not be detected by the display. This may occur if the readhead is disconnected from the digital display and then moved along the scale to another segment. It may also occur if the readhead is moved too quickly between two segments. (Maximum slew rate is 400mm/sec, 15in/sec)

If the segment tracking count is incorrect because of one of the above situations, the user can re-adjust the display to correct the error. This adjustment is referred to as the *Segment Offset Adjustment*.

To add one segment value (430.08mm) to the displayed value, hold the **MODE** key and then momentarily press the **+** key. The displayed position will increase by 430.08mm (16.933 inches). To subtract one encoder segment from the displayed value, press and hold the **MODE** key and then momentarily press the **-** key. The displayed position will decrease by 430.08mm.

(See Programming Parameter Pr1 and **SCALES in Section 1 of this manual for additional information. Factory Default is set to Enable this function.)**

Offset Addition

Offset addition allows the user to preset up to 3 different distances that are then added to the Digital Displays position when selected. This allows the user to quickly switch measurement modes from one reference point to another. To utilize the offset addition feature, programming parameter Pr10 must be set to 1. The display will then flash one of “offset” numerals 1, 2, 3 or 4 located in the upper left corner of the LCD. Offset 1 is the ABS position with no offset addition. Offset 2 is the ABS position with parameter Pr11 (Offset Addition 1) added to it. Offsets 3 and 4 have similar functions with parameters Pr12 and Pr13 added to the ABS position respectively.

To move from “Offset” 1 to 2, momentarily press the F1 key. Each depression of the F1 key advances to the next offset. After offset 4, the display will move back to offset 1.

(See Programming Parameters 9, 10, 11, 12 and 13. Factory default is *Disabled*.)

Limit Mode

The digital display will show either “ **LL** “ for Low Limit or ” **UL**” for Upper Limit if a pre-programmed upper or lower reading is encountered. Upper and Lower limits are set with programming parameters **Pr16** and **Pr17** but are only active if **Pr14** is set to 1. Display toggles between current position display and "LL" or "UL". The position is shown for 2 seconds and the "LL" or "UL" is shown for 2 seconds. This continues as long as a limit has been exceeded. Limit monitoring is always active, even in programming mode.

Numerous Programming parameters, including [Offset Addition](#) and [Limit mode](#) indicate a ‘factory default set in inches’. The equivalent offset/limit value in mm or cm is applied if you switch the [MODE](#) of display to mm or cm. ie These parameter values take on the unit of measurement [MODE](#) (mm, cm or inches) active when programming is entered.

Scaling

All Series 950 Digital Displays have the ability to “scale” the actual measurement.

This function is useful when the actual measurement must be multiplied or divided before being displayed. **Care should be taken when using this function since invoking it will cause the unit to display a reading different than the actual measured or traversed value.**

This function is set using **Programming Parameter Pr7. The Factory Default is set to 1.000 - No Scaling**

Changing the Batteries

A low battery indicator will appear in the lower left corner of the LCD display when new batteries are needed.

To change batteries remove the screws in the upper right and lower left corners. Pull the cover off. Remove the old batteries. Reinstall new AA Alkaline batteries, noting the proper orientation. Replace the cover and tighten the screws.

CAUTION: DO NOT BEND BATTERY CLIPS!

THESE CLIPS ARE DESIGNED TO BE LOOSE WHEN THE CASE IS OPEN AND WILL COMPRESS AND SECURE THE BATTERIES IN PLACE WHEN THE CASES ARE SCREWED TOGETHER.

Auxiliary Keypad



ABS - INC

The Digital Display has two measurement “indexes”. One is referred to as **ABS** and the other is **INC**. The **ABS** measurement setting is designed to allow the user to set a current position on the display referenced from a fixed or known position such as a saw blade, or stop. The **INC** measurement setting is designed to take relative distance measurements from one arbitrary point to another. The systems operate independently allowing separate position offsets to be programmed. The **ABS** position of the measuring system is not lost when using the **INC** settings.

ABS Mode – The ProScale automatically enters ABS mode when power is first applied. This is indicated by the ABS symbol in the upper left corner of the display. While in the ABS mode, all position measurements are related to the current system reference point. To enter the INC mode, momentarily press the **ABS/INC** button.

INC Mode – While in the INC mode, the INC symbol is shown in the upper left corner of the display. When the INC mode is initially entered, the displayed position will change to reflect a new reference point at the current position of the readhead. This is typically a position of zero (0) but may be changed by using the **+** or **-** keys to provide an offset. Moving the readhead in either direction will display the distance moved from the initial INC starting point (plus any offset). To complete another incremental measurement from the new position, momentarily press the **ABS/INC** key. The display will again change to 0 (or the previously programmed offset). To return to the ABS mode, press and hold the **ABS/INC** key for approximately 3-4 seconds.

HOLD

The Digital Display provides a feature that allows the displayed position to be “frozen” in time while the readhead is moved from its measuring position. This allows measurements to be captured on the display and held for later viewing regardless of the current readhead position. To activate the **HOLD** mode, momentarily press the **HOLD** key. The **HOLD** symbol will be shown in the upper left corner of the display. The currently displayed position and selected key presses will be frozen at this point. To release the **HOLD** feature, momentarily press the **HOLD** key again.

MONitor

The Digital Display has the ability to monitor a position to detect position drift or measurement variance. To activate the monitoring mode, position the readhead to the desired location and momentarily press the **MON** key. The MON symbol will flash on the display to indicate that the position monitor mode is active.

If the readhead moves outside the programmed tolerance the displayed reading flashes, indicating a drift condition. When the readhead is moved back within the programmed tolerance, the displayed reading will stop flashing.

To exit the monitor mode, momentarily press the **MON** key. The MON symbol will stop flashing and the currently displayed position will also stop flashing.

NOTE: Position monitor mode can only be activated while in the ABS measuring mode. If the ABS/INC key is depressed while monitoring, the position-monitoring mode is automatically exited.

The display can be programmed to automatically enter or exit the MONitor mode based on elapsed time or movement of the encoder.

If the programmable **auto monitor** is enabled (Programming parameter Pr19 set to 1), the Digital Display will automatically enter monitor mode after either 30 or 60 seconds of no encoder motion. If the programmable auto monitor is disabled, the ProScale will automatically exit monitor mode if the encoder is moved beyond a programmable distance from the monitored position. This option, in conjunction with auto monitor activation, allows the ProScale to be kept in monitor mode without manually pressing the monitor key.

(See Programming Parameters 19,20, 21. Factory default is OFF.)

SEND

The Digital Display provides an output port that can be used to send measurement information to a compatible SPC device such as a printer or data acquisition unit. After connecting the SPC device to the 10 pin connector on the display, the user may initiate the data transmission by momentarily pressing the **SEND** key. This signals the SPC device to acquire the data from the digital display.

Pressing the **SEND** key displays “ **Snd** ” on the display for 1 second to show activation of the send function (even if no SPC device is attached to the ProScale).

The data format and connector style of the ProScale SPC output is the same as other Mitutoyo SPC enabled products and can be interfaced with most available SPC products including multiplexers, RS232 converters and PC plug-in boards. Data from the ProScale is sent to the SPC connector in either millimeters or decimal inches, whichever is currently displayed on the LCD.

If no SPC device is attached to the display, the SEND key has no other function.

See *Section 6 Accessories* for interface and data acquisition products descriptions.

F1 / F2

These keys are used for special features and/or Custom programming functions.

Programming

Several functions of the digital display are user programmable. The following instructions describe what features are available and how to change the system's factory defaults to customize the display for your application.

The keys pictured have multiple functions. Timing, which is how long a key is depressed, and the combination of the keys pressed is important. This manual uses the term "*momentarily*" to describe a key press of typically less than 1 second. Whereas "*press and hold*" is used imply a key press of typically longer than 1.5 seconds. As an example; when using a PC keyboard to type a CAPITAL letter you would "*press and hold*" the SHIFT key and "*momentarily* depress the appropriate letter key.

The "*function*" associated with the key(s) pressed is executed on the key *RELEASE*, not the key *DEPRESS*. This is important since some keys execute different functions based on how long they are depressed. These key operations, once tried, quickly become intuitive.



To enter programming mode, *press and hold* the **MODE** key and then *momentarily* press the **0** (zero) key. The **MODE** key must be held for approximately 1 second before the depression of the **0** (zero) key.

Once you are in the Programming Mode, *momentarily* pressing the **MODE** key will advance through the Programming Parameter list.

To step backwards in the Programming Parameter list *press and hold* the **ON/OFF** key and *momentarily* press the **MODE** key.

Momentarily pressing the **+** (plus) key while displaying a Programming Parameter will increase the parameter setting.

Momentarily pressing the **-** (minus) key while displaying a Programming Parameter will decrease the parameter setting.

Momentarily pressing the **0** (zero) key while displaying a Programming Parameter will revert the parameter to its factory default setting.

To exit programming mode, *press and hold* the **MODE** key and then *momentarily* press the **0** (zero) key.

NOTE: The display will automatically exit programming mode after 60 seconds of no key activity.

Programming Parameters are listed below. Values in [] are the available range of values that can be programmed for that entry. **Series 950** settings are shown in **bold**. Factory defaults are shown on pg 28: *Programming Summary*. Functions not available on Series 950 DRO's are shown **SHADED**

Pr0 – Encoder Direction [0,1]

Change value to reverse the direction of measurement readings.

Pr1 – Enable/Disable Segment Offset [0, 1]

0 = For ABSOLUTE scales shorter than 430mm, (16.9in). ALL Incremental scales

1 = For All ABSOLUTE scales longer than 430mm, (16.9in).

Pr2 – High Speed Readhead [0, 1]

0 = Normal Readhead

1 = High Speed Readhead

Use this setting *only* if instructed by special instructions included with High Speed Readheads. A setting of 1 will impact battery life.

Pr3 – Enable/Disable the +, - and ZERO keys [0,1]

0 = Disables operation of Zero, + and – keys (Display will be in Lock Mode).

1 = Enables operation of Zero, + and – keys.

Pr4 – Display Resolution [0, 1, or 2]

Sets the displayed resolution in *decimal* mode. (No change in fractions mode.)

0 = Reduced resolution Inch = xxx.xx MM = xx.x

1 = Normal resolution Inch = xxx.xxx MM = xx.xx

2 = Increased resolution Inch = xx.xxxx MM = xx.xx (Inch mode only)

Auto scaling will allow measurements of over 100 inches when in high resolution.

Measurements over 100 inches will automatically be reduced to 3 decimal places.

Pr5 – Metric Display Units [0, 1]

Controls whether the measured value is displayed in millimeters or centimeters when in metric mode.

0 = millimeters

1 = centimeters

Pr6 – Disable Fractions/Inches [0, 1, 2]

0 = All measurement modes (millimeters or centimeters, inches and fractions)

1 = No Fractions. Only decimal inches and metric units* will be displayed.

2 = Only Metric. No Imperial (decimal inches or fractions) will be displayed.

* Pr5 will determine if mm or cm are displayed for metric units.

Pr7 – Scaling Factor [.001 .. 99.999] **Default = 1.000** (No Scaling.)

The multiplier applied to the measurement. Scaling factors less than 1.000 will make the displayed measurement less than the actual measurement. Scaling factors greater than 1.000 will make the displayed measurement greater than the actual measurement.

Pr8 – Automatic Power Off [0 to 60] **Default = 15.**

Sets the amount of time in ‘minutes without activity’ before the display automatically turns off.

0 = Disables Auto Off.

Encoder motion or ON/OFF key “wake-ups” the display and resets the timer.

Pr9 – Auxiliary Keys Enable/Disable [0..7]

0 = ABS/INC, MON and HOLD Disabled

1 = ABS/INC Key Enabled

2 = MON Key Enabled

4 = HOLD Key Enabled

7 = All Keys Enabled

To enable keys, add up combination of key values. A value of 2 enables only the MON key. A value of 7 enables all 3 Keys.

Pr10 – Offset Addition Enable [0, 1]

0 = Offset Addition Disabled

1 = Offset Addition Enabled.

SEE ALSO Pr11, Pr12, Pr13

Pr11 – Offset Addition 1 [-999.999 to 999.999in] or [-9999.99 to 9999.99mm]

When offset 1 is selected (see section 4 -*Offset Addition*), this value is added to the current ABS position. **Default = 1.000IN**

Only active if Pr10 is set to 1. Note: Default is set in Inches

Pr12 – Offset Addition 2 [-999.999 to 999.999in] or [-9999.99 to 9999.99mm]

When offset 2 is selected (see section 4 -*Offset Addition*), this value is added to the current ABS position. **Default: 1.500IN**

Only active if Pr10 is set to 1. Note: Default is set in Inches

Pr13 – Offset Addition 3 [-999.999 to 999.999in] or [-9999.99 to 9999.99mm]

When offset 3 is selected (see section 4 -*Offset Addition*), this value is added to the current ABS position and displayed. **Default: 2.000IN**

Only active if Pr10 is set to 1. Note: Default is set in Inches

Pr14 – Output Signal Mode [0, 1]

Set to 1 to enable *LIMIT MODE* function on Series 950 DROs

Pr15 – Output Polarity [0, 1].

This function is not available on Series 950 DROs

Pr16 – Lower Limit [-999.999 to 999.999in] or [-9999.99 to 9999.99mm]

Sets the lower limit alarm value. **Default = 0.000IN.**

Active only when parameter Pr14 = 1. Note: Default is set in Inches

Pr17 – Upper Limit [-999.999 to 999.999in] or [-9999.99 to 9999.99mm]

Sets the upper limit alarm value. **Default = 5.000IN.**

Active only when parameter Pr14 = 1. Note: Default is set in Inches

Pr18 – Drift Tolerance [.01 to 9999.99mm] or [.001 to 999.999in].

Range of motion allowed (+ or -) while in MONitor mode. **Default = .01IN.**

Note: Default is set in Inches

Pr19 – Automatic Monitor ON Time [0, 1 or 2]

Configures display to automatically activate MONitor mode after 30 or 60 seconds of encoder inactivity.

0 = disabled. 1 = 30 seconds. 2 = 60 seconds.

Pr20 – Automatic Monitor OFF Enable[0, 1]

Configures display to automatically exit MONitor mode after a programmed distance (**Pr21**) has been exceeded from the drift tolerance position (**Pr18**).

0 = disabled 1 = enabled.

Pr21 – Automatic Monitor OFF Distance [0.001 to 999.999in] or [0.01 to 9999.99mm].

The distance that must be exceeded from the drift tolerance position (**Pr18**) to activate auto monitor off. **Default = 0.500in**

This parameter is relevant only when **Pr20=1**. **Note: Default set in Inches**

Pr22 – Backlight ON time [0, 1, 2, 3 or 4]

The ON time of the LCD backlighting (24VDC displays only).

0 = always off. 1 = 3 seconds. 2 = 7 seconds. 3 = 15 seconds. 4 = always on.

Backlighting is activated when a key is pressed.

Pr23 – Future Enhancement DO NOT CHANGE [0,1,2] **Default =1**

Pr24 – Future Enhancement DO NOT CHANGE [0..63] **Default =0**

Pr25 – Future Enhancement DO NOT CHANGE [0..31] **Default =0**

CAUTION: Pressing and holding the ON/OFF and MODE key for 10 seconds while the display is turned off will perform a full segment LCD test AND re-set all programming parameters to factory defaults

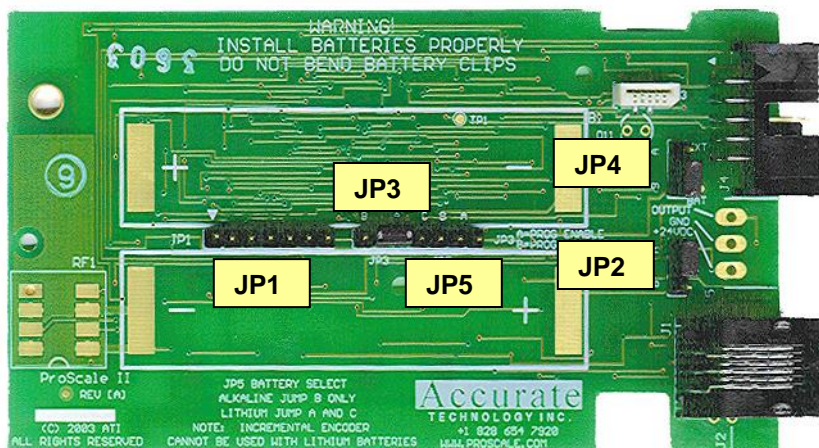
Jumpers

Although the ProScale display uses a keyboard-programming mode to enable and configure features in the unit, several selection jumpers are located on the circuit board for additional system configuration.

User configurable jumpers consist of three pins and a 'shorting block'.

The center of these pins is 'Common'. One end pin is labeled 'A' and the other end pin is labeled 'B'.

DRO Circuit Board



JP1 FOR FACTORY USE ONLY

JP2 Absolute/Incremental Encoder Selection

The Digital Display supports both Incremental and Absolute technology measuring systems making it backward compatible with older Mitutoyo 950 Series systems. The display is configured for use with absolute type encoders (shorting jumper in position A). For older incremental 950 Series systems, install the shorting jumper in position B.

NOTE: This functionality is not related to the ABS / INC measurement modes described in Section 4: *Auxiliary Keypad*.

JP3 Programming Enable/Disable

Entry to the programming mode of the ProScale display can be enabled or disabled based on this jumper setting. To enable keyboard programming (default), install the shorting jumper in position A. **To disable keyboard programming, install the shorting jumper in position B.** When programming mode is disabled, the user cannot access the programming functions via the **Mode + 0** keys as described in the Section 4: *Programming*. This provides the user with a method of configuring the display with specific parameters and prevents unauthorized configuration changes.

JP4 Display Power

This jumper configures the Digital Display to operate on either Battery or 24VDC. This jumper will be set at the factory based on the type of display you have ordered. All Mitutoyo 950 Series DRO's are battery powered.

JP5 FOR FACTORY USE ONLY

Programming Summary for Series 950 DROs

Programming Parameter	Function	Factory Default	950 Setting
Pr0	Encoder Direction	0	0
Pr1	Segment Offset	1 - On	1
Pr2	High Speed ReadHead	0 - Off	0
Pr3	Zero, Offset Entry	1 - Enable	1
Pr4	Display Resolution	1 - Normal	2
Pr5	mm or cm	0 - mm	0
Pr6	Fractions, mm, in	0 - all	0
Pr7	Scaling	1.000 (none)	1.000
Pr8	Auto off	15 - 15 min.	15
Pr9	Auxiliary Keypad	7 - all keys	7
Pr10	Offset Addition	0 - disabled	0
Pr11	Offset Addition 1	1.000 Inch	1.000
Pr12	Offset Addition 2	1.500 Inch	1.500
Pr13	Offset Addition 3	2.000 Inch	2.000
Pr14	Output Mode	0	0
Pr15	Output Polarity	0	N/A
Pr16	Lower Limit	0.000	0.000
Pr17	Upper Limit	5.000 Inch	5.000
Pr18	Drift Tolerance	.01 Inch	.01
Pr19	Auto Monitor ON	0 - disabled	0
Pr20	Auto Monitor OFF	0 - disabled	0
Pr21	Auto Monitor Distance	.500 Inch	.500
Pr22	Backlight On	1	N/A
Pr23	FUTURE FEATURE	1	1
Pr24	FUTURE FEATURE	0	0
Pr25	FUTURE FEATURE	0	0

Functions not available on Mitutoyo 950 Series DRO's are shown **SHADED**. These functions are available on select ProScale systems available from Accurate Technology. For additional information contact your Mitutoyo distributor, Accurate Technology or visit www.proscale.com.

Jumpers and Key Press Summary

Circuit Board Jumpers

JP1	Internal Use Only
JP2	Position A for 950-404, 405, 406 & 407 Position B for 950-401, 402, 403, 410, 411, 414, 415, 416, 417, 419, 421, 422, 423
JP3	Programming Enable/Disable
JP4	Position B for all 950 series dros
JP5	Internal Use Only

Key Press Functions:

ON/OFF (*Press & Hold*) + **MODE** (*Momentarily*)
Enable/Disable LOCK mode ('0', '+' & '-' keys).

MODE (*Press & Hold*) + '0' (*Momentarily*)
Enter or Exit Programming Mode

While in Programming mode:

MODE (*Momentarily*)
Advances through the Programming Parameter list.

ON/OFF (*Press & Hold*) + **MODE** (*Momentarily*)
Steps backwards in Programming Parameter list

+ (*Momentarily*) while displaying a Programming Parameter
Increases the Parameter setting.

- (*Momentarily*) while displaying a Programming Parameter
Decreases the parameter setting.

0 (*Momentarily*) while displaying a Programming Parameter
Reverts the parameter to its Factory Default setting.

MODE (*Press & Hold* + '+' or '-' (*Momentarily*)
Apply Segment Offset Adjustment

ON/OFF (*Momentarily*)
Turn Display power on or off

ON/OFF (*Press & Hold*) for 5 seconds
Display Battery Voltage

ON/OFF (*Press & Hold*) + **MODE** (*Press & Hold*) both for 10 seconds
LCD Segment Test & sets ALL Programming parameters to factory defaults

How long a key is depressed, and the combination of the keys pressed is important. The term (*Momentarily*) describes a key press of typically less than 1 second. Whereas (*Press & Hold*) is used imply a key press of typically longer than 1.5 seconds.

For example: When using a PC keyboard to type a CAPITAL letter you would “*press and hold*” the SHIFT key and “*momentarily*” depress the LETTER key.

In addition, a key(s) “*function*” is executed on the key RELEASE, not the key DEPRESS of that key(s). This is important since some keys execute different functions based on how long they are depressed. These key operations, once tried, quickly become intuitive.

Frequently Asked Questions**What does “no Enc” mean?**

If the readhead is off the scale, or the readhead cable is unplugged from the digital display, an “no Enc” will appear on the display. To clear error:

1. Be sure the readhead is on the scale.
2. Unplug the connector from the display for one second.
3. Reconnect the readhead cable to the digital display.

The battery clips seem to be very loose. Is this normal?

Yes. DO NOT attempt to bend these clips or wedge anything between them and the case. These clips are designed to expand when the two case halves are screwed together.

Can I mount the scale/readhead without the flex link/guide clip?

The flex link and guide clip serve to provide an accurate method of transferring the movement of the moving part to the readhead or scale, while also absorbing any stresses that may occur. If they are not used, the warranty could be voided.

The display reads numbers but they seem to be random.

Be sure the readhead is oriented correctly on the scale. One end of the scale is black. Be sure that the arrow on the readhead is pointed in the correct direction.

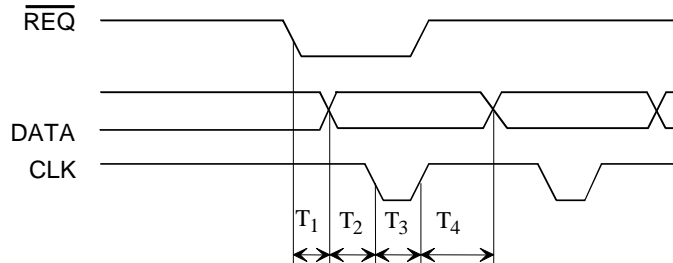
The display does not change as the scale/readhead moves.

The display is in the HOLD mode. Press & release the Hold button.

Communicating With Other Equipment

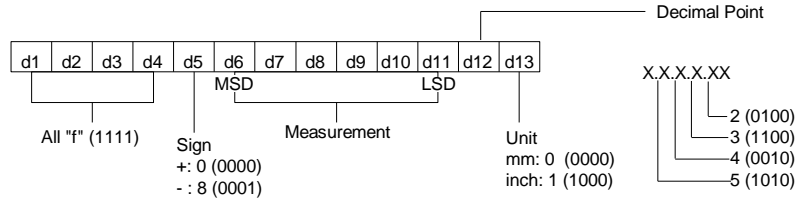
ProScale's electrical interface allows the read head position to be read by a computer or other instrument. Refer to the following diagrams:

Read Head Output

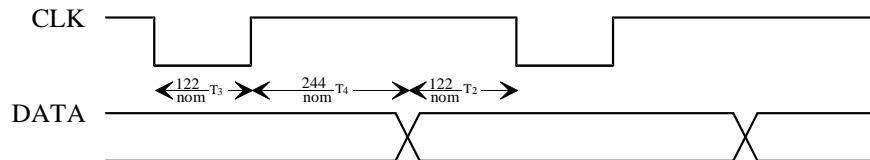


- $0.0\text{ms} \leq T_1 \leq 93.75\text{ms}$
- $110\mu\text{S} \leq T_2 \leq 140\mu\text{S}$ (TYP: $122\mu\text{S}$)
- $110\mu\text{S} \leq T_3 \leq 140\mu\text{S}$ (TYP: $122\mu\text{S}$)
- $230\mu\text{S} \leq T_4 \leq 260\mu\text{S}$ (TYP: $244\mu\text{S}$)

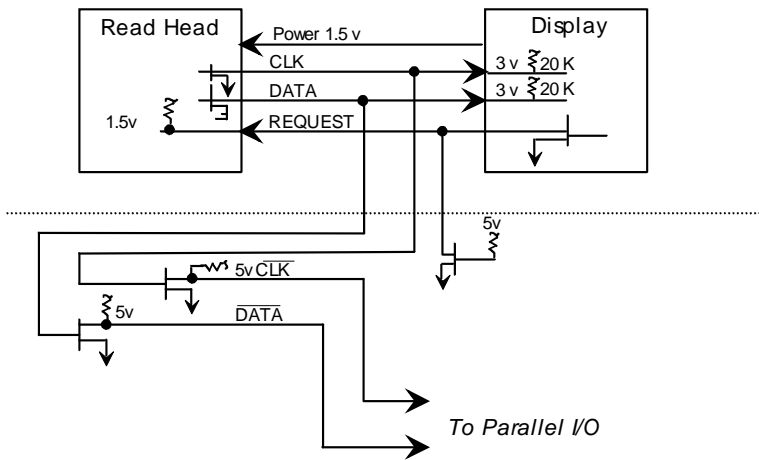
Timing Chart



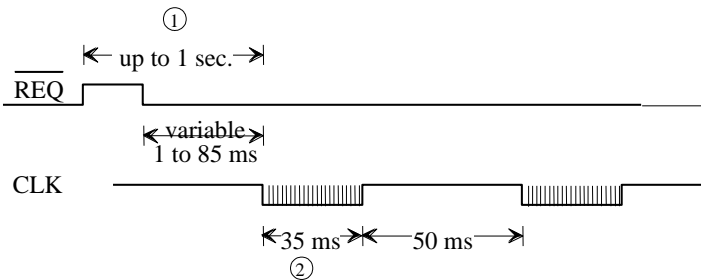
Data Format



Timing of CLK and DATA



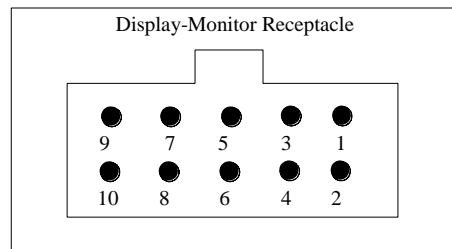
Typical computer interface. Computer must monitor CLK and DATA lines.



- ① May be some recovery time after REQ goes high of about before clocks and data are output when REQ goes low.
- ② Contains 52 clock pulses for 13 4-bit words.

Request Line Timing

1	GND	Braid
2	DATA	Black
3	CLK	Red
4	No Connect	Green
5	REQ	White
6, 7, 8	No Connect	
9	VCC (1.5v)	Orange
10	No Connect	

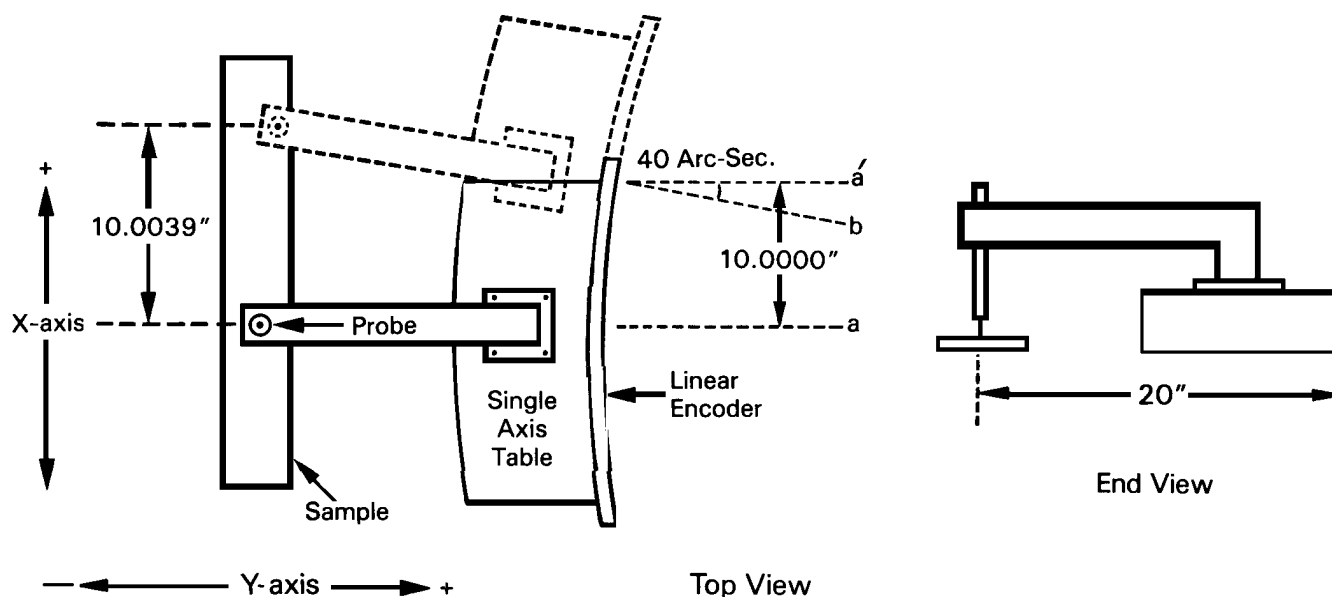


Connector Pinout Diagram

Abbe Error

Abbe error is a condition that may not be visible to the human eye, but will affect linear measurements. Be sure to take precautions when installing ProScale in order to eliminate the possibility for Abbe error.

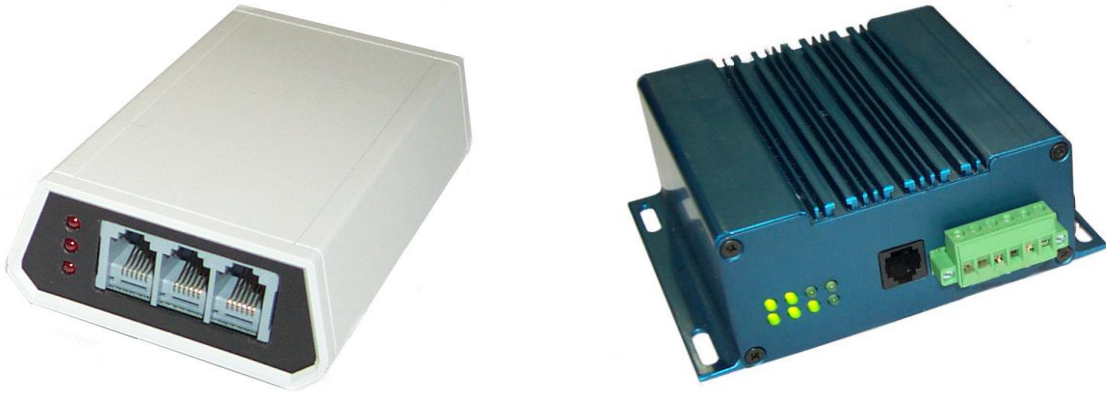
Abbe error refers to a linear error caused by the combination of an angular error and a



dimensional offset between the sample and the measuring system. It is important to understand that the information the encoder is providing is **only the position of the readhead on the scale**. To illustrate this, see the figure, which shows a linear measuring device. (The apparent distortion in the measuring device is intentional - for this example - to show the measuring device with a curvature in its mounting.)

Suppose the curvature in the figure is sufficient to produce an angle of 40 arc-seconds. If the measuring device moves 10 inches, the probe will be found to have moved 10.0039 inches, resulting in an error of +0.0039 inches. Abbe error could be lessened by moving the measuring system closer to the sample. This effectively solves one half of the Abbe error problem (offset) and leaves only the angular mounting problem to be solved. Angular error can best be countered through proper design and placement of the linear scale. Sources of angular error include:

1. Mounting the linear scale to an imperfectly flat surface.
2. Mounting the linear scale to an imperfectly straight surface.
3. Curvature of ways (or linear bearings) used to measure the sample.
4. Contaminants between the probe and item being measured.
5. Friction in any part(s) of the measuring device.



ProMux-3™

The **ProMux 3** is an easy to use hardware interface device providing communication and control of one to three ProScale ABS linear encoders from a user provided PC or PLC. Supplied are two separate components. First is the ProMux 3 interface unit and second is a low voltage plug-in power supply. The user must provide the host PC or PLC and a standard DB-9 serial cable (male to female).

Uses for the ProMux 3 include axis position measurement on XY or XYZ quality control measurement tables, machinery position control (NON-CNC), tooling measurement devices and the like.

ProMux-4™ & ProMux-8™

The **ProMux-4** and **ProMux-8** series of linear encoder multiplexers are designed for OEM and system integrators for use in acquiring setup positional information (non-CNC) on industrial production machinery.

The multiplexers interface directly with ProScale absolute linear measurement encoders. These systems provide linear measurement ranges from 100mm to 6 meters depending on the model.

ProMux 4/8 multiplexers communicate with a host PC or PLC via RS-232 or RS-422 serial interface. Various baud rates are supported from 9600 to 115200. Up to 15 multiplexers can be connected to the same communications bus when utilizing the RS-422 serial interface.



Pro RF

The Pro-RF™ system consists of a base module and a remote module that communicate over a bi-directional RF interface.

The Remote module provides the data acquisition functions.

It accepts 1 ProScale (Mitutoyo) SPC output as input and relays the information via RF link to the Base module.

The Base module communicates to a host PC via RS-232 operating at 57,600 Baud.

The system can support up to 32 remote modules up to 100 meters away for each base module.

Analog Interface Unit

The Analog Interface Unit (AIU) is designed to provide an analog signal output that is proportional to the current position being displayed on a ProScale linear measurement system. The interface provides a DC signal range from 0 to 5 volts or 0 to 10 volts depending on configuration. This offers a simple integration between a ProScale™ linear measurement system and a PLC or other process control system.

The interface incorporates a 12-bit Digital-to-Analog converter to generate the analog output. This provides 4096 discrete steps of resolution over the configured measuring range. This can offer a measurement displacement resolution of .001" over a 4-inch range of motion.

PRODUCT REGISTRATION

Fill out for your records **and**

FAX to 1.828.654.8824 or

Register on line at <http://www.proscale.com/registration.htm>

Name _____

E-Mail _____

Company _____

Address _____

Address _____

City _____

State/Region _____

Zip/Postal Code _____

Country _____

Purchased From: _____

Purchased Date: _____

ProScale 950 Serial Number: