



instruments
Innovations in Precision

Digital Readout Manual

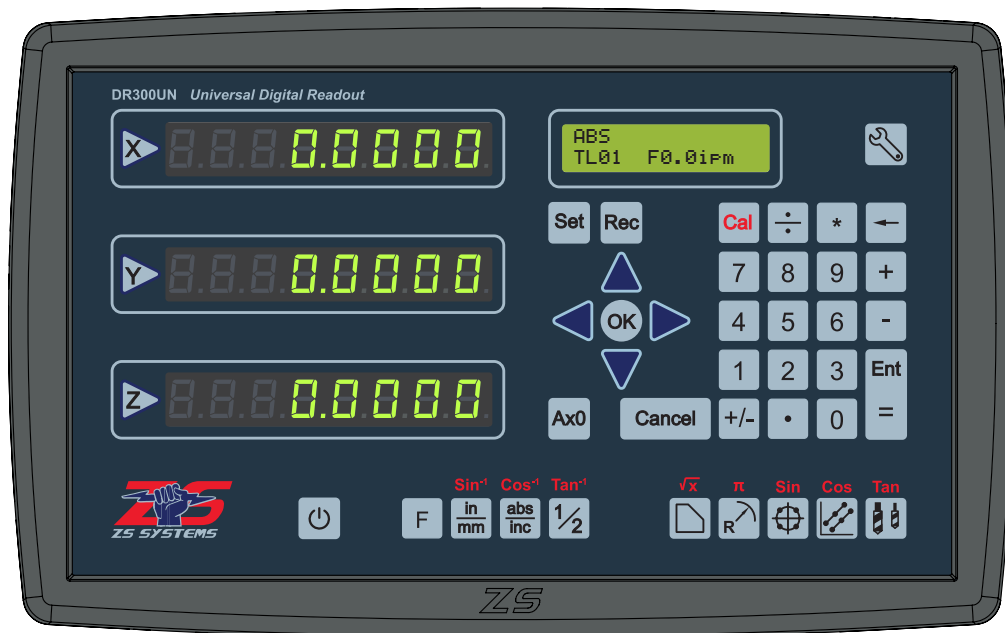


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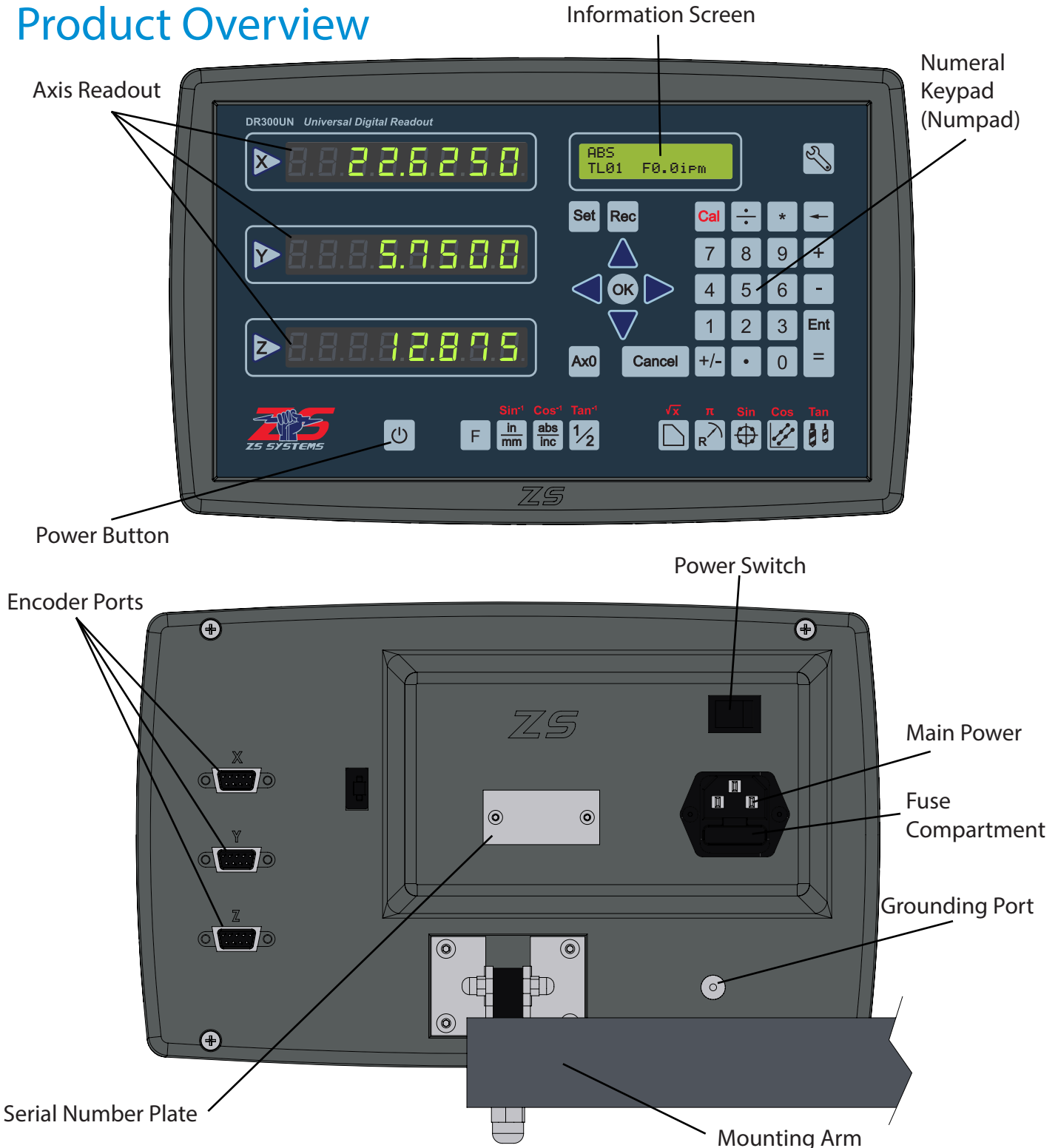
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Introduction


Thank you for purchasing ZS Instruments DR300UN DRO. Your new digital readout is capable of many advanced features that make machining operations fast and easy. This guide will cover the installation and setup of the unit, as well as how to use all of the included features. Please read through this manual in its entirety before beginning installation or using the unit to avoid damage to the DRO, encoders, or your machine. Save this manual for future reference.

Product Overview





Mounting

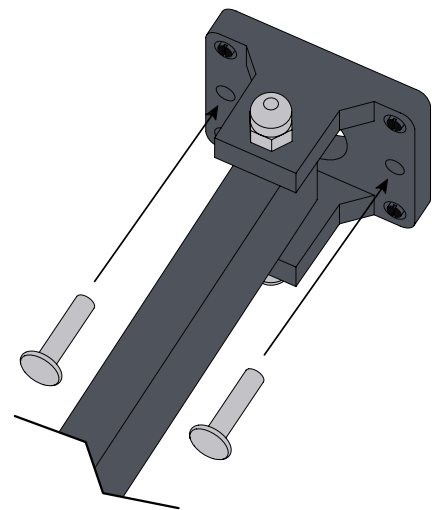
The DRO has different types of arms for mounting to a mill or a lathe. Check that you have the correct type of arm for your machine before attempting to install the DRO.

-  Due to the large number of machines and mounting configurations that are supported by the unit, hardware for securing the mounting arm to the machine is not included. Use two 1/4-20 or M6 screws of an appropriate length for your particular mounting arrangement.


Mill Mounting

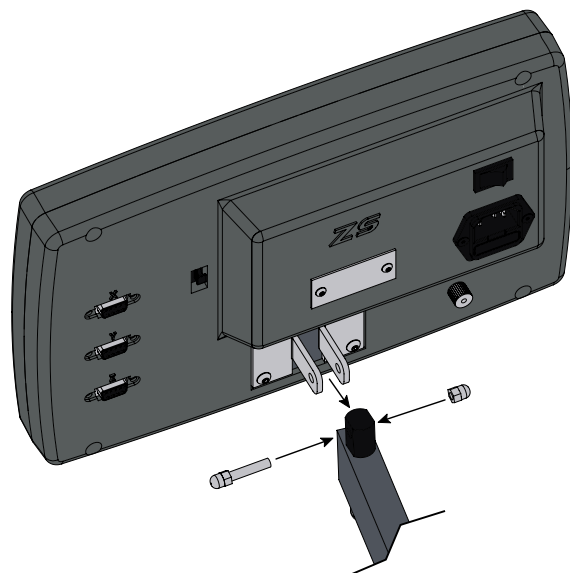
Step 1: Determine the ideal mounting location for your particular machine. Using the mounting base as a guide, center punch, drill, and tap two holes for the 1/4-20 or M6 screws. Attach the arm assembly to the machine as shown. Use the four set screws to level the mounting arm.

-  Make sure that the DRO and cabling will clear all parts of the machine and will be shielded from coolant nozzles, flying chips, or other hazards.
-  Be sure that the mounting arm is securely tightened or damage to the DRO may occur.



Step 2: Attach the DRO to the end of the mounting arm using the included hardware.

-  Be sure that the DRO is in the correct orientation



Lathe Mounting

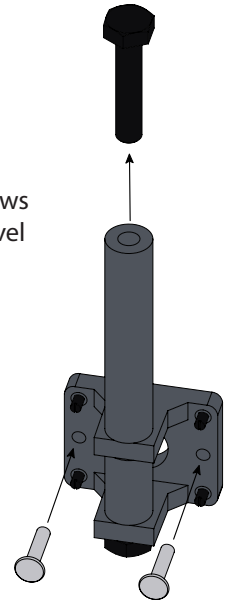
Step 1: Determine the ideal mounting location for your particular machine. Using the mounting base as a guide, center punch, drill, and tap two holes of the same size and thread type as the screws you will be using. Attach the arm assembly to the machine as shown. Use the four set screws to level the mounting arm. Remove the hex screw from the top of the mounting arm base.



Make sure that the DRO and cabling will clear all parts of the machine and will be shielded from coolant nozzles, flying chips, or other hazards.



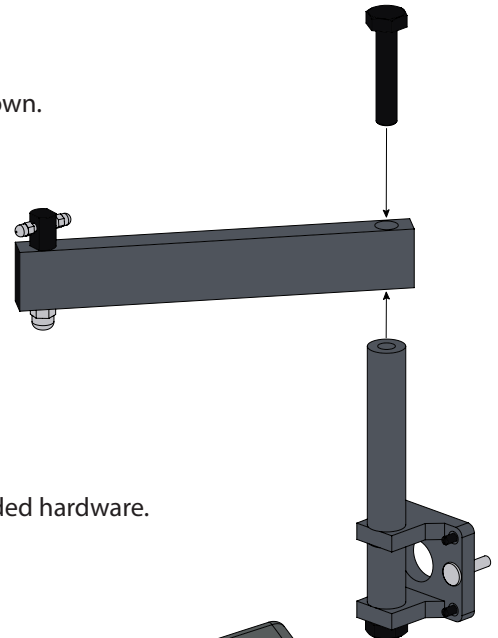
Be sure that the mounting arm is securely tightened or damage to the DRO may occur.



Step 2: Attach the mounting arm to the base using the hex screw as shown.



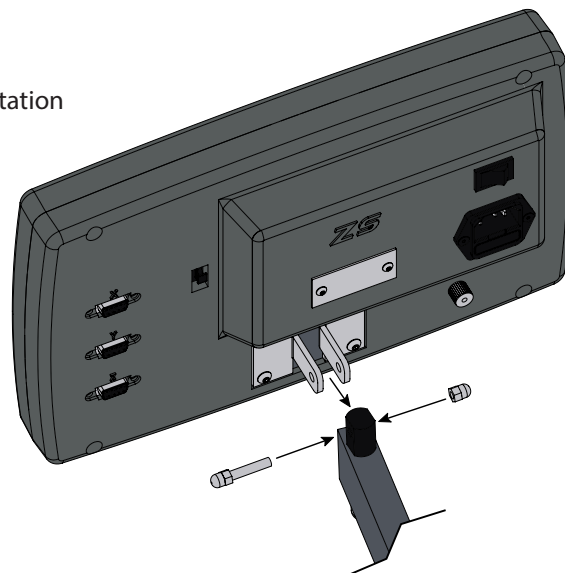
Be sure that the swivel faces upward



Step 3: Attach the DRO to the end of the mounting arm using the included hardware.



Be sure that the DRO is in the correct orientation



Grounding

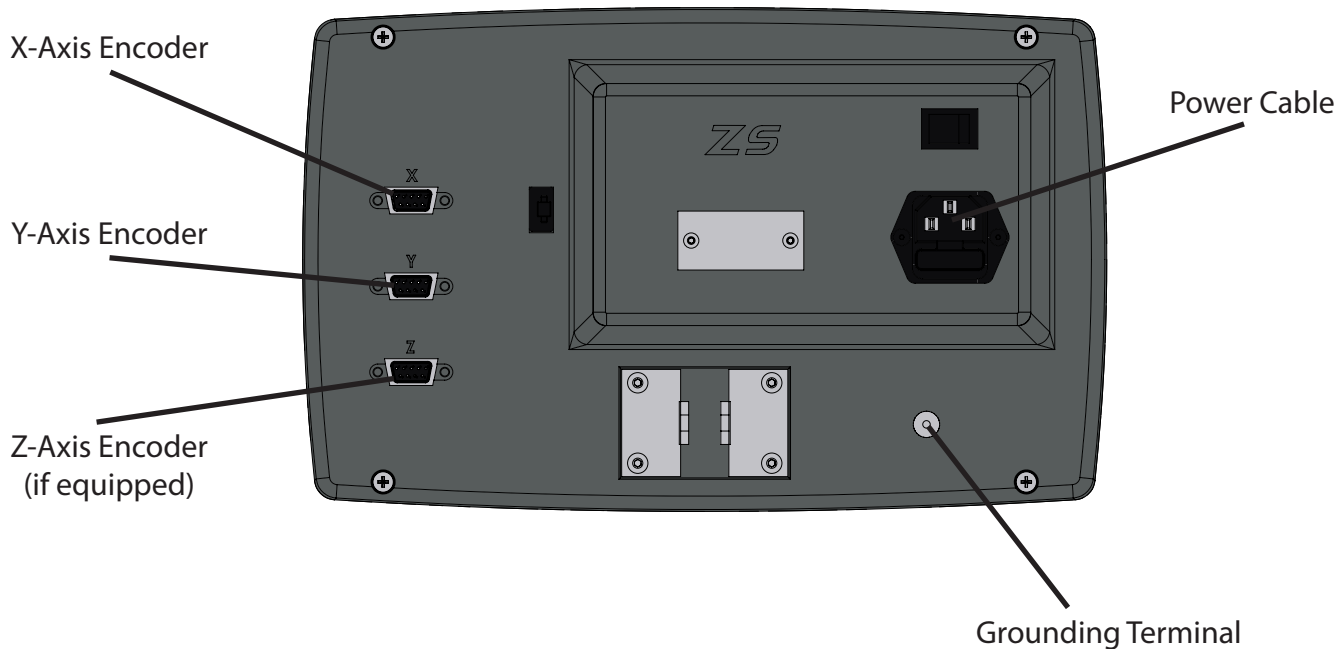
Once the DRO is mounted to the machine, it must be grounded. Using a 3 prong grounded outlet is sufficient; however we also recommend connecting a ground terminal on the back of the DRO unit to the machine ground with AWG 12 wire. It is important to ensure that the machine itself is properly grounded. Note, these are just general guidelines, always follow national and local electric codes! **Failure to ground the unit may cause equipment damage and/or electric shock!**

Cables

Before attempting to connect the encoders to the DRO, ensure that they are properly installed on the machine. Check the encoder manual for the installation procedures. Encoder alignment can drastically affect the accuracy of the DRO system, and severely misaligned encoders will result in premature wear and/or permanent damage.

Once the linear encoders are properly installed, plug the encoder cables into their respective axis inputs on the back of the unit. Switch the DRO power off before connecting the encoders. Move each axis along its full range of motion to ensure that cables are not caught on any parts of the machine and do not rub against sharp edges that may cause damage to the cables. Secure the cables such that they can not fall into the lubricant tray when disconnected from the DRO.

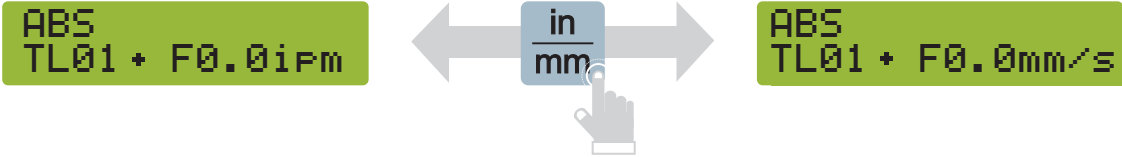
Plug the cables into the following locations:



Units

Your Digital Readout can be set to display position in either imperial or metric units of measure. Imperial units are displayed in inches while metric units are in millimeters. Note that changing units will not affect current position and you may switch the active units at any time.

The current units are indicated on the information screen. The feed-rate will be displayed in inches per minute (ipm) for imperial units and in millimeters per second (mm/s) for metric units.

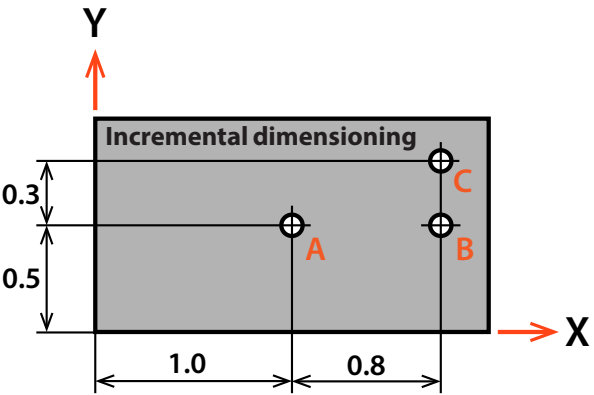
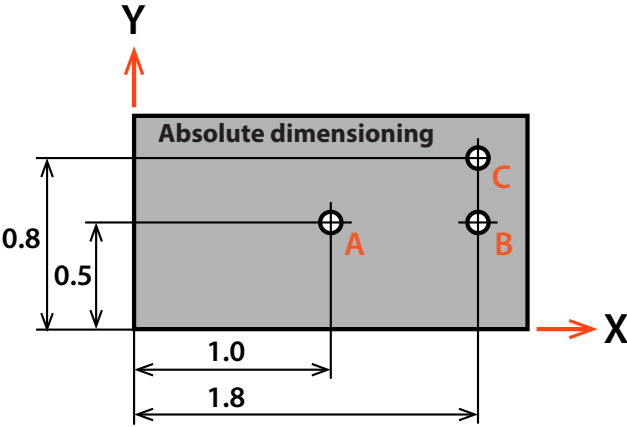


Absolute and Incremental Modes

The use of absolute and incremental modes allows for different methods of referencing measurements. Proper use of these modes allows the machinist to perform operations without the need for manual calculations. The currently active mode is displayed on the information screen ("ABS" for absolute and "INC" for incremental).

When the DRO is in **absolute mode**, the coordinate display is always showing the position from the origin. In the example part below, we set this origin point on the top surface at the front left corner of the part. If we were to move to drill feature "A", the DRO would display X=1.000" and Y=0.500". To drill feature "B", move the X axis until DRO displays X=1.800".

In **incremental mode**, the coordinate display will show the position relative to the last feature. This can be helpful when the working dimensions reference two features from each other. In the example part below, we would zero X and Y after feature "A" is complete, and then move until DRO displays X=0.800" and Y= 0.300" to machine feature "C".



In Absolute Mode:

```
ABS  
TL01 + F0.0ipm
```

In Incremental Mode:

```
INC  
TL01 + F0.0ipm
```

Press the abs/inc button to toggle between absolute and incremental modes.

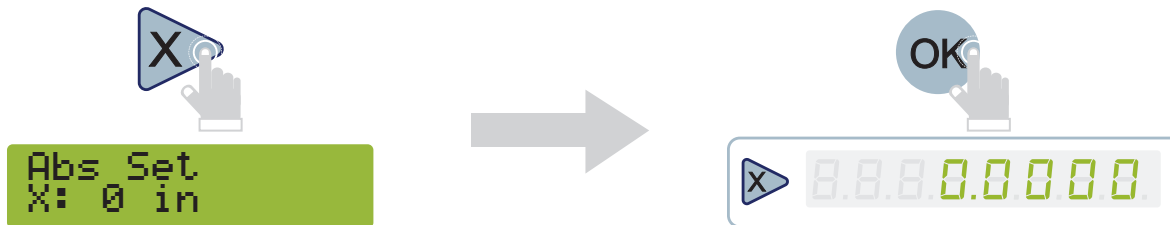


Standard Functions

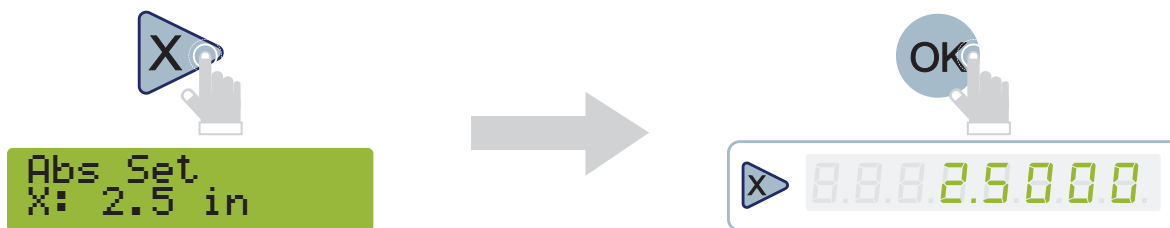
Zeroing or Presetting Axis Position

In either absolute or incremental mode, the current position can be zeroed (setting the origin to the current position) or preset to any number (offsetting the origin from the current position by the specified distance). The value for each axis is set independently.

To zero an axis, press the axis button and then, with the axis reading 0.0000, press the OK button.



To offset zero from the current position in an axis, press the axis button and then type in the desired offset and press the OK button.



In addition, incremental mode supports the All Axis Zero and Recall Last Value functions.

All Axis Zero



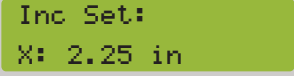


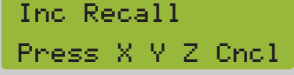
In the incremental mode, to zero all axes at once, press the Ax0 button.



Recall Last Value

In incremental mode the digital readout can recall the last preset value entered for each axis. This function is useful when the same move must be repeated several times.

Example: a part requires a series of holes to be drilled at 2.25 inch intervals along the X axis. The recall function can be used to quickly get the same offset each time

Step	Buttons	Information Screen
1 Move to the position of the first hole and drill to the desired depth		
2 Press X, enter 2.25 on the numpad, and press OK	 	
3 Move the X axis until the X display reads zero and drill the second hole		
4 Press Recall, then press X	 	
5 Move the X axis until the X display reads zero and drill the third hole		
6 Repeat steps 4 and 5 until all of the holes are drilled		

Sub-datum Mode

Up to 200 sub datum points can be added to define the position of features relative to the absolute origin zero point. When a sub-datum is selected the DRO will display the distance to the sub-datum position such that when you are at the correct position the DRO axis displays will read zero. Because all sub-datum features are relative to the absolute mode origin point, when the origin is moved, as in re-zeroing on a new part, all the sub-datum points will move with it.

To enter into the sub-datum mode recall an existing datum using the REC button. To create a new datum use the SET button.



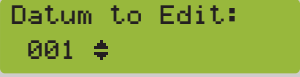

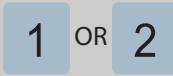
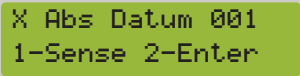
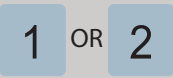
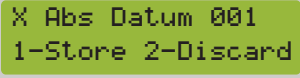


When in sub-datum mode, the current sub-datum is shown on the information screen: "DT001" means Datum 001


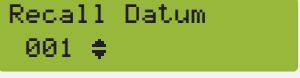


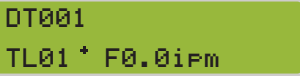
Standard Functions

Set Sub-datum

Setting a sub-datum point assigns an offset to that datum from the absolute zero. Sub-datum points can be set either by sensing the current tool position in relation to the absolute origin or by explicitly entering an offset from the Abs zero. Values for each axis are set independently, so it is possible to choose different methods for different axis. Sub-datums are stored in non-volatile memory, so datum points will not be lost during a loss of power.

Step	Buttons	Information Screen
1 Press the Set button		
2 Use the up and down arrows to select the datum you would like to edit		
3 Press OK to confirm		
4 Press 1 to sense the current position OR Press 2 and enter an offset value using the numpad		
5 Repeat step 4 for the remaining axis		
6 Press 1 if you would like to store this datum OR Press 2 if you would like to discard these settings and select another datum to edit		

To Recall a Previously set Sub-datum:

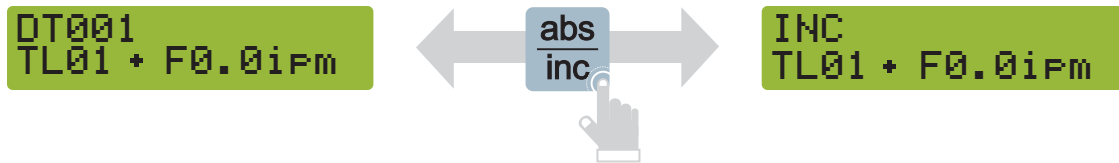
Step	Buttons	Information Screen
1 Press the Rec button		
2 Use the up and down arrows to select the datum you would like to recall		
3 Press OK to confirm		
4 The tool position is now displayed in relation to the selected datum and the information screen shows the selected datum		

Standard Functions

Toggle Between Incremental and Sub-datum Mode

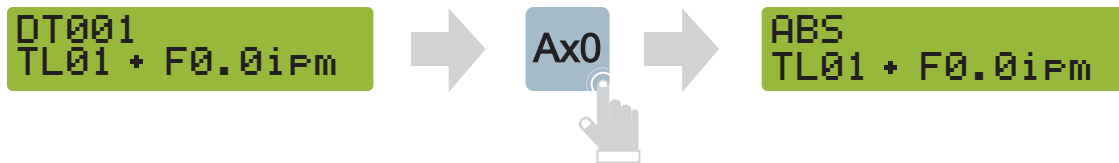
Once a datum has been set and recalled, you can toggle between sub-datum and incremental modes just like between absolute and incremental.

Press the abs/inc button to toggle between sub-datum and incremental modes.



Exit Sub-datum Mode

If you wish to exit the sub-datum mode and return to absolute mode, press the Ax0 button while in sub-datum mode



Feed-rate Display

The feed rate is automatically displayed on the information screen either in inches per minute (ipm) or millimeters per second (mm/s) based on the active units.



Sleep Mode

Sleep mode can be toggled by pressing the power button on the front panel of the DRO. Sleep mode saves power by turning off axis displays and the LCD back-light but continues to track tool position. It is safe to move machine axis while the DRO is in sleep mode, and position loss will not occur.





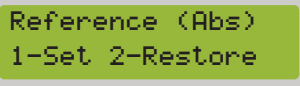

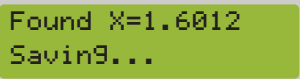
Zero Reference Restore

To allow the user to recover the position of the tool after a power loss, this digital readout is equipped with a zero reference restore function. To enable this feature, a reference zero must be set prior to loss of power. Each axis must be set and recalled independently.



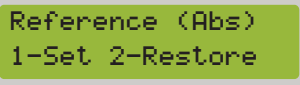

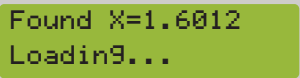
Note: If scales with single/periodic reference marks are used, it is important to always to start from the end of travel and to move the axis in the same direction during both setting and restoring reference

If scales with smart (distance coded) reference marks installed, it will only take about 1" of movement anywhere in either direction along the axis to set or recover the absolute position.

To Set Reference Zero:

Step	Buttons	Information Screen
1 Press F to navigate to the reference function		
2 Press 1 to set a reference		
3 Press the axis button for the axis you would like to set		
4 Move the axis slowly until the information screen shows a brief "found" message and the unit returns to normal operation		

To Restore Reference Zero:

Step	Buttons	Information Screen
1 Press F to navigate to the reference function		
2 Press 2 to restore a reference		
3 Press the axis button for the axis you would like to restore		
4 Move the axis slowly until the information screen shows a brief "found" message and the unit returns to normal operation		

Calculator





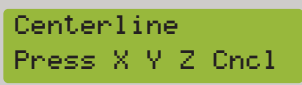
The digital readout comes with a built-in calculator, which can be used to perform simple mathematical and trigonometric functions. Type on the numpad to enter the desired numbers and the various operator buttons (+, -, *, ÷) followed by equals (=) to solve. To use a trigonometric function, first enter the input value, then press the desired function button. The result of the operation will be displayed with one to five places after the decimal (see settings section to choose desired rounding precision).

Press the Cal button to toggle between calculator and normal operation mode.



Centerline

To set the midpoint between zero and the current position as the new zero for the selected axis, use the Centerline function. This function can be used in absolute or incremental mode and is axis-specific, meaning that you must select an axis on which to perform the function. If you would like the midpoint for more than one axis, the function can be performed on each axis individually.

Step	Buttons	Information Screen
1 Press the centerline button		
2 Press the axis on which you would like to find the midpoint	  	
3 The axis display will now show the distance to the midpoint. Move the axis until the display reads zero to put the tool on the centerline		

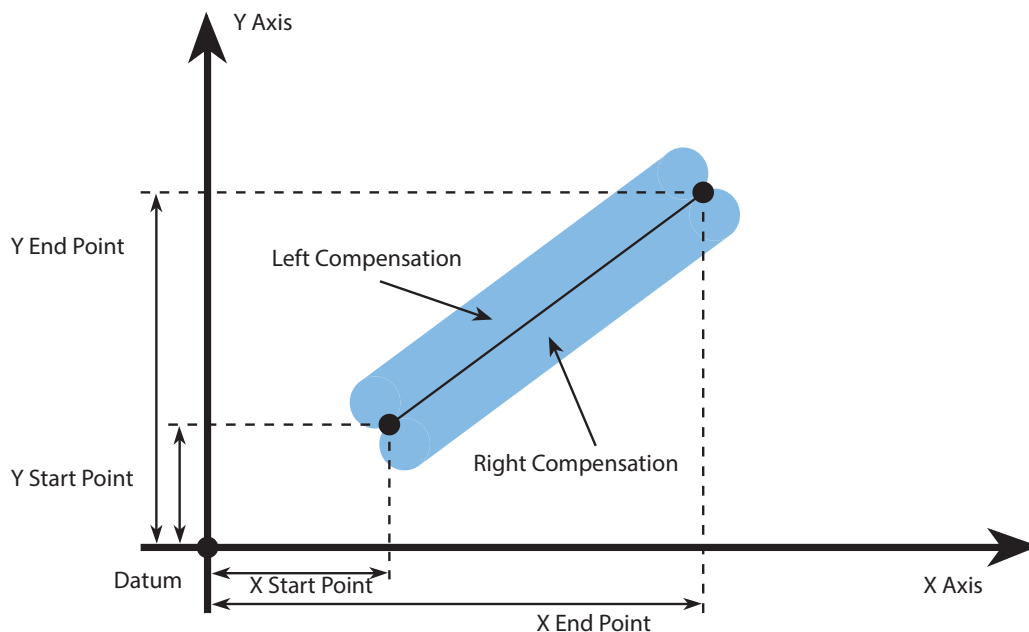
Incline

To machine a surface on a plane that is not parallel to two of the axes of machine travel, use the Incline feature. When machining an incline feature the digital readout will sequentially display the coordinates of the two axes where the tool needs to be positioned to create the incline surface. This program requires the following inputs:






- The cut plane of the incline (XY, YZ, or XZ)
- Whether tool compensation will be applied to the right or left (only for XY cut plane)
- The position of the starting and ending points of the incline
- The maximum cut size (smaller number produces smoother result but requires more machining steps).

The Incline feature can be saved to one of 99 slots or it can be run immediately without saving











Note: A ball end mill MUST be used when milling inclines on the XZ or YZ planes.



To Create a New Incline Feature:

Step	Buttons	Information Screen
1 Press the incline button to access the incline feature		***INCLINE*** 1-New 2-Load
2 Press 1 to setup a new incline program	1	
3 Select a cut plane using the up and down arrows, then press OK to confirm	  OK	Cut Plane 1 ↕ XY
4 If you chose the XY plane: Use the up and down arrows to select whether tool compensation will be applied to the right or left, then press OK to confirm	  OK	Tool Compensation 1 ↕ Right
5 Enter the starting point of the incline for each axis: Press 1 to sense the current position OR Press 2 to enter the position using the numpad Press OK to confirm	1 OR 2 OK	X Start Point 1-Sense 2-Enter
6 Enter the ending point of the incline for each axis: Press 1 to sense the current position OR Press 2 to enter the position using the numpad Press OK to confirm	1 OR 2 OK	X End Point 1-Sense 2-Enter
7 Enter the maximum cut using the numpad, then press OK to confirm	OK	Maximum Cut: 0 in
8 Press 1 to save the program Choose one of the 99 program slots to save it in using the up and down arrows OR Press 2 to run the program without saving	1 OR 2 OK	***INCLINE*** 1-Save 2-Run ***INCLINE*** Save As: #01

To Recall a Saved Incline Feature:

Step	Buttons	Information Screen
1 Press the incline button to access the incline feature		***INCLINE*** 1-New 2-Load
2 Press 2 to load an existing incline program Select the program you would like to load using the up and down arrows, then press OK to confirm	2   	Load Incline 01 ↕
3 The DRO will cycle through all of the setup parameters Press OK for each if the information is correct OR Change the desired values using the numpad or the up and down arrows	  	Cut Plane 1 ↕ XY
4 When the information screen reads INCLINE, the first point is displayed. Move the tool until the axis displays read zero		*** INCLINE *** Pt. 001 of 025 ↕
5 If the cut plane is the XY plane, plunge to the desired depth and leave the tool at that depth for the duration of the program If the cut plane is the XZ or YZ plane, make a pass of the desired length along the remaining axis		
6 Press the up arrow to advance to the next point and move the tool until the axis displays read zero If the cut plane is the XZ or YZ plane, make a pass of the desired length		
7 Repeat step 6 until all points are completed When the program finishes, press cancel to exit the program and 1 to confirm	 	Terminate ? 1-Yes 2-No

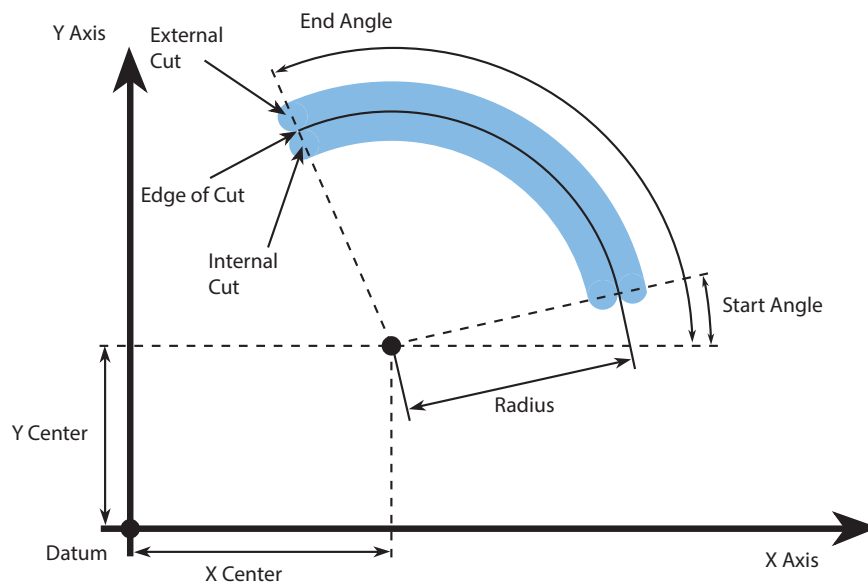
Smooth Radius

To machine a radius or rounded feature in any plane, use the Smooth Radius feature. When machining a Smooth Radius feature the digital readout will sequentially display the coordinates of the two axes where the tool needs to be positioned to create the curved surface. This program requires the following inputs:

- The cut plane of the radius (XY, YZ, or XZ)
- Whether the cut will be external or internal
- The position of the center point of the radius
- The starting and ending angles (counterclockwise from the three o'clock position)
- The radius of the feature
- The maximum cut size (smaller number produces smoother result but requires more machining steps)

The Smooth Radius feature can be saved to one of 99 slots or it can be run immediately without saving

Note: A ball end mill MUST be used when milling radii on the XZ or YZ planes.



To Create a New Smooth Radius Feature:

Step	Buttons	Information Screen
1 Press the radius button to access the smooth radius feature		*SMOOTH RADIUS* 1-New 2-Load
2 Press 1 to setup a new smooth radius program		
3 Select a cut plane using the up and down arrows, then press OK to confirm		Cut Plane 1 \updownarrow XY
4 Use the up and down arrows to select whether the cut will be internal or external Press OK to confirm		Cut direction 1 \updownarrow External
5 Enter the center point of the radius for each axis: Press 1 to sense the current position OR Press 2 to enter the position using the numpad Press OK to confirm	OR	X Center 1-Sense 2-Enter

Mill Functions

Step	Buttons	Information Screen
6 Enter the starting angle using the numpad Press OK to confirm		Start Angle: 0 De9
7 Enter the ending angle using the numpad Press OK to confirm		End Angle: 90 De9
8 Enter the radius length using the numpad Press OK to confirm		Radius: 1.5 in
9 Enter the maximum cut using the numpad, then press OK to confirm		Maximum Cut: 0.125 in
10 Press 1 to save the program Use the up and down arrows to choose a program slot to save in and press OK OR Press 2 to run the program without saving	 OR 	*SMOOTH RADIUS* 1-Save 2-Run *SMOOTH RADIUS* Save As: 01 ↕

To Recall a Saved Radius Feature:

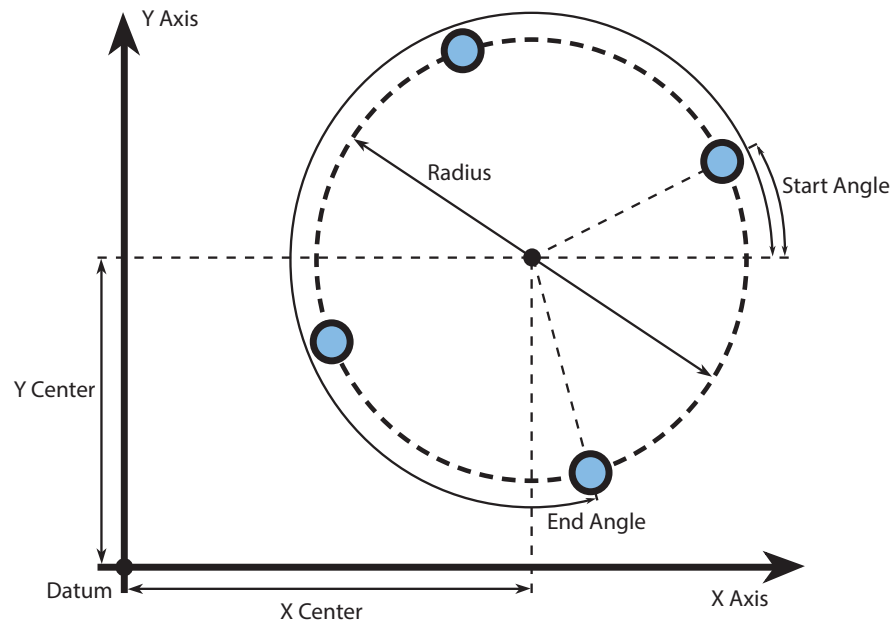
Step	Buttons	Information Screen
1 Press the radius button to access the smooth radius feature		*SMOOTH RADIUS* 1-New 2-Load
2 Press 2 to load an existing smooth radius program Select the program you would like to load using the up and down arrows, then press OK to confirm	 	Load Smooth Rad. 01 ↕
3 The DRO will cycle through all of the setup parameters Press OK for each if the information is correct OR Change the desired values using the numpad or the up and down arrows	 	Cut Plane 1 ↕ XY
4 When the information screen reads SMOOTH RADIUS, the first point is displayed. Move the tool until the axis displays read zero		*SMOOTH RADIUS* Pt. 001 of 025 ↕
5 If the cut plane is the XY plane, plunge to the desired depth and leave the tool at that depth for the duration of the program If the cut plane is the XZ or YZ plane, make a pass of the desired length along the remaining axis		
6 Press the up arrow to advance to the next point and move the tool until the axis displays read zero If the cut plane is the XZ or YZ plane, make a pass of the desired length		
7 Repeat step 6 until all points are completed When the program finishes, press cancel to exit the program and 1 to confirm	 	Terminate ? 1-Yes 2-No

Bolt Circle

To automatically calculate the position of holes in a circular pattern use the Bolt Circle function. It requires the following inputs:

- The position of the center of the circle
- The number of holes to be drilled (up to 999)
- The starting and ending angles (counterclockwise from the three o' clock position)
- The radius of the circle.












The Bolt Circle feature can be saved to one of 99 slots or it can be run immediately without saving












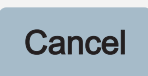

To Create a New Bolt Circle Feature:

Step	Buttons	Information Screen
1 Press the bolt circle button to access the bolt circle feature		**BOLT CIRCLE** 1-New 2-Load
2 Press 1 to setup a new bolt circle program	1	
3 Enter the center point of the circle for each axis: Press 1 to sense the current position OR Press 2 to enter the position using the numpad Press OK to confirm	1 OR 2 OK	X Center 1-Sense 2-Enter
4 If your machine is equipped with a Z axis scale, enter the depth of the holes: Press 1 to sense the current position OR Press 2 to enter the position using the numpad Press OK to confirm	1 OR 2 OK	Z Depth 1-Sense 2-Enter

Mill Functions

Step	Buttons	Information Screen
5 Enter the number of holes using the numpad or the up and down arrows Press OK to confirm	  	Number of Holes: 004 ↕
6 Enter the starting angle using the numpad Press OK to confirm		Start Angle: 0 De9
7 Enter the ending angle using the numpad Press OK to confirm		End Angle: 270 De9
8 Enter the radius of the circle using the numpad Press OK to confirm		Radius: 2 in
9 Press 1 to save the program Use the up and down arrows to choose a program slot to save in and press OK OR Press 2 to run the program without saving	    OR 	**BOLT CIRCLE** 1-Save 2-Run

To Recall a Saved Bolt Circle Feature:

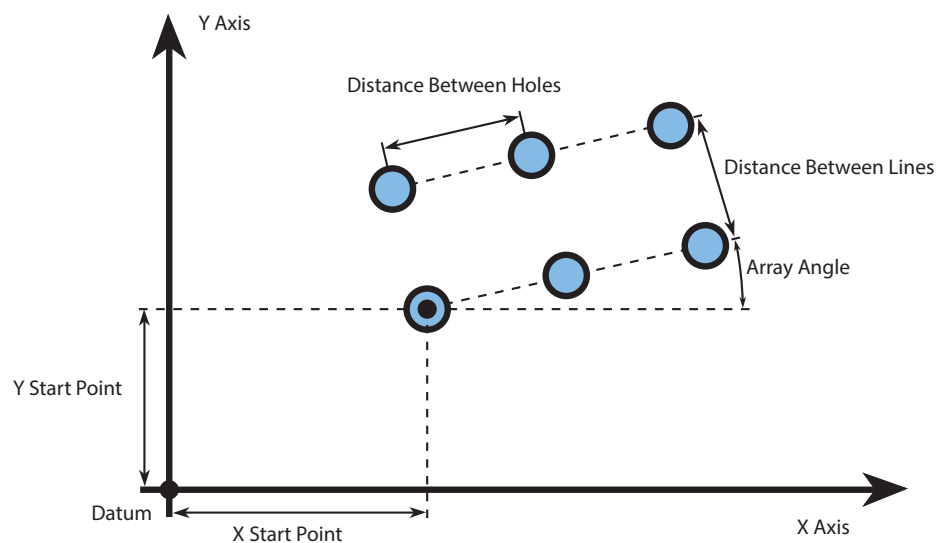
Step	Buttons	Information Screen
1 Press the bolt circle button to access the bolt circle feature		**BOLT CIRCLE* 1-New 2-Load
2 Press 2 to load an existing bolt circle program Select the program you would like to load using the up and down arrows, then press OK to confirm	   	Load Bolt Circle 01 ↕
3 The DRO will cycle through all of the setup parameters Press OK for each if the information is correct OR Change the desired values using the numpad or the up and down arrows	  	X Center (Abs) 0 in
4 When the information screen reads BOLT CIRCLE, the first point is displayed. Move the X and Y axis until the axis displays read zero		**BOLT CIRCLE** Pt. 001 of 025 ↕
5 If your machine is equipped with a Z axis scale, plunge the tool until the Z axis display reads zero If your machine is not equipped with a Z axis scale, plunge the tool to the desired depth In either case, retract the tool above the workpiece once the hole is drilled		
6 Press the up arrow to advance to the next point and move the tool until the X and Y axis displays read zero Repeat step 5		
7 Repeat step 6 until all points are completed When the program finishes, press cancel to exit the program and 1 to confirm	 	Terminate ? 1-Yes 2-No

Bolt Array

To automatically calculate the position of holes in a linear pattern, at any angle, use the Bolt Array function. It requires the following inputs:

- The position of the starting point of the array
- The angle of the array (counterclockwise from the three o'clock position)
- The number of holes to be drilled per line (up to 99)
- The distance between the holes on the lines
- The number of lines (1 to 9 lines are supported)
- The distance between the lines.

Bolt array can be used as a bolt line function if the number of lines is set to one. The Bolt Array feature can be saved to one of 99 slots or it can be run immediately without saving



To Create a New Bolt Array Feature:

Step	Buttons	Information Screen
1 Press the bolt array button to access the bolt array feature		**BOLT CIRCLE** 1-New 2-Load
2 Press 1 to setup a new bolt array program	1	
3 Enter the starting point of the array for each axis: Press 1 to sense the current position OR Press 2 to enter the position using the numpad Press OK to confirm	1 OR 2 OK	X Start Point 1-Sense 2-Enter
4 Enter the array angle using the numpad Press OK to confirm	OK	Array Angle: 0 De9
5 Enter the number of holes per line using the up and down arrows Press OK to confirm	OK	# Of Holes/Line: 05 ↕

Mill Functions

Step	Buttons	Information Screen
6 Enter the distance between holes using the numpad Press OK to confirm		Dist Btwn Holes: 1.25 in
7 Enter the number of lines using the numpad or the up and down arrows Press OK to confirm		Number of Lines: 2 ↕
8 Enter the distance between lines using the numpad Press OK to confirm		Dist Btwn Lines: 0.625 in
9 Press 1 to save the program Use the up and down arrows to choose a program slot to save in and press OK OR Press 2 to run the program without saving	 OR 	***BOLT ARRAY*** 1-Save 2-Run ***BOLT ARRAY*** Save As: 01 ↕

To Recall a Saved Bolt Array Feature:




Step	Buttons	Information Screen
1 Press the array button to access the bolt array feature		**BOLT ARRAY** 1-New 2-Load
2 Press 2 to load an existing bolt array program Select the program you would like to load using the up and down arrows, then press OK to confirm		Load Bolt Array 01 ↕
3 The DRO will cycle through all of the setup parameters Press OK for each if the information is correct OR Change the desired values using the numpad or the up and down arrows		X Start Pt. (Abs) 0 in
4 When the information screen reads BOLT ARRAY, the first point is displayed. Move the X and Y axis until the axis displays read zero		***BOLT ARRAY*** Pt. 001 of 025 ↕
5 Plunge the tool to the desired depth Retract the tool above the workpiece once the hole is drilled		
6 Press the up arrow to advance to the next point and move the tool until the X and Y axis displays read zero Repeat step 5		
7 Repeat step 6 until all points are completed When the program finishes, press cancel to exit the program and 1 to confirm		Terminate ? 1-Yes 2-No

Tool Compensation

When tool compensation is enabled, the digital readout will offset the displayed position by the 1/2 tool diameter from the actual position, Z coordinate will be also adjusted per tool length offset (if any). This feature allows a part to be machined directly using the dimensions from the drawing.

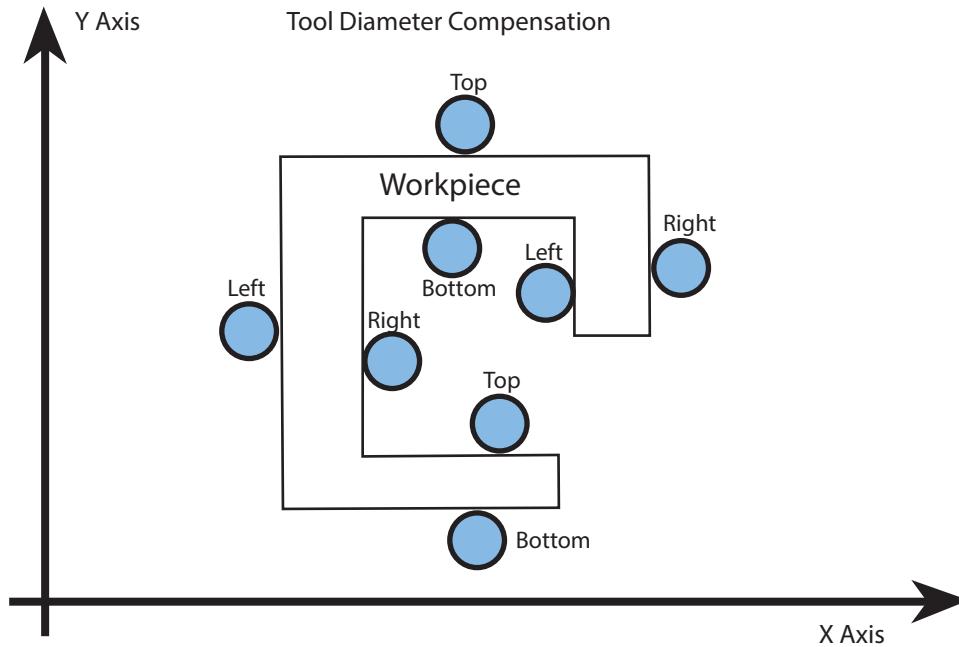
In mill mode, the DRO stores the diameter and length offsets and can save up to 99 unique tools. The current tool is displayed on information screen (e.g. "TL02").

To Edit Tool Offsets:

Step	Buttons	Information Screen
1 Press the tool button to access the tool compensation feature		Tool Compensatn 1-Use 2-Edit
2 Press 2 to edit or create a new tool configuration Select the tool number you would like to edit using the up and down arrows, then press OK to confirm	2   OK	Edit Tool 01 ↕
3 Enter the tool diameter using the numpad Press OK to confirm	OK	Tool Diameter 0.5 in
4 Enter the length offset using the numpad Press OK to confirm	OK	Length Offset 0 in
5 Press 1 to store the tool OR Press 2 to discard any changes	1 OR 2	Tool 01 1-Store 2-Discard

Using Tool Compensation

Once a tool is selected, compensation in the Z direction is automatically applied. The compensation required in the X and Y directions is based on the position of the tool in relation to the part. The +/- button cycles through the possible cut directions, which are displayed on the information screen. Press +/- until the desired cut direction appears



Step	Buttons	Information Screen
1 Press the tool button to access the tool compensation feature		Tool Compensatn 1-Use 2-Edit
2 Press 1 to use an existing tool configuration Select the tool number you would like to apply using the up and down arrows, then press OK to confirm	1	Select Tool 01 ↕
3 Press the +/- button to cycle through cut directions The orientation is shown on the information screen	+/-	TL01* TL01◄ TL01◑ TL01+ TL01◓ TL01◔

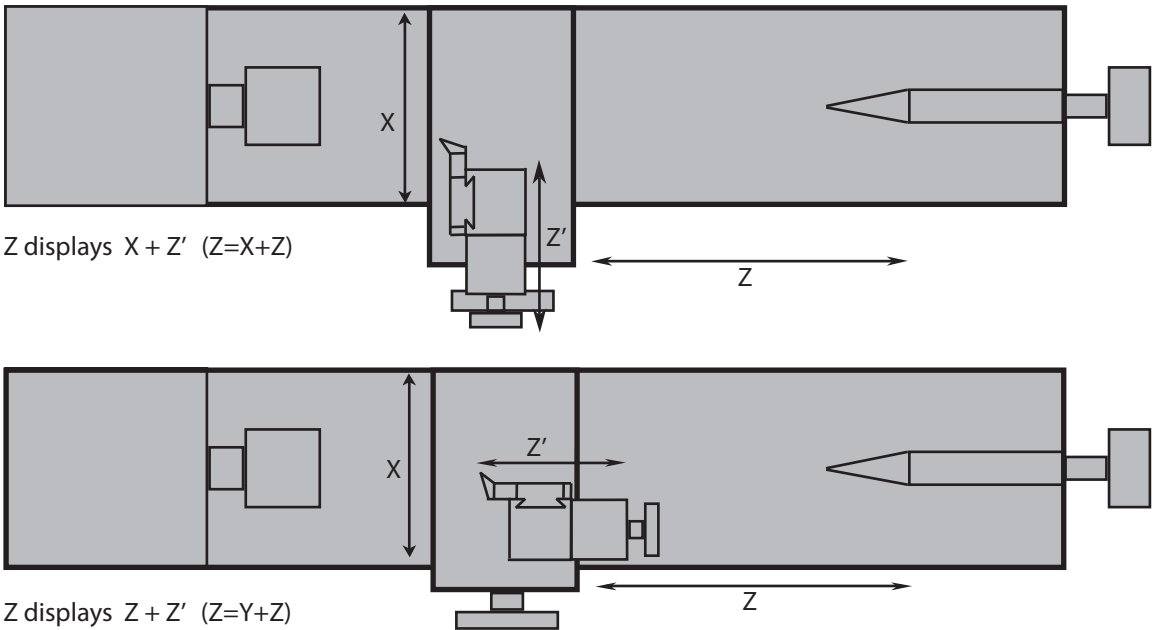
- TL03* Tool 03, No Compensation
- TL03◄ Tool 03 Right Compensation
- TL03◑ Tool 03 Left Compensation
- TL05◑ Tool 05 Bottom Compensation
- TL05◔ Tool 05 Top Compensation

Lathe Functions

The 3 physical DRO axis displays are labeled as X, Y, and Z. When the DRO is installed on a lathe, the cross travel (X) will be shown on the X axis display, the longitudinal travel (Z) will be shown on the Y axis display, and the compound travel (Z') will be shown on the Z axis display.

Axis Summing

When using a lathe, it is often useful to align the compound axis with either the longitudinal or cross axis. The movement from the compound must then be added to the axis with which it is aligned. To perform this addition automatically the DRO provides an axis summing function. The function adds the compound to either one of the two axis and the result is displayed for that axis. If the compound is not aligned with one of the two other axis and is set at a known angle, see the section on vectoring.



Step	Buttons	Information Screen
1 Press F and use the up and down arrows to navigate to the summing function Press OK to confirm	F ▲ ▼ OK	Function 2 ⚙ SummIn9
2 Use the up and down arrows to select the axis you would like to sum or choose "OFF" to turn feature off Press OK to confirm	▲ ▼ OK	SummIn9 2 ⚙ Z=Y+Z

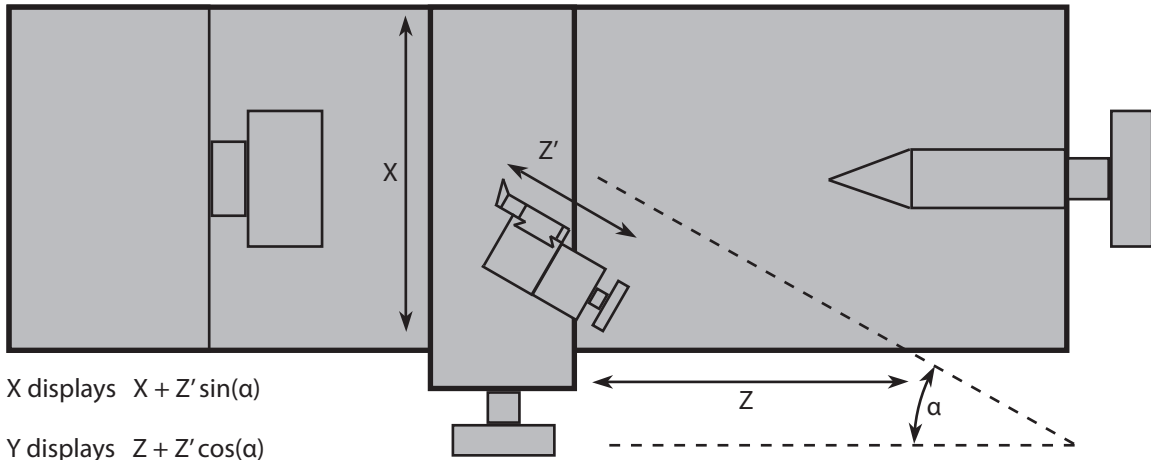
Radius/Diameter Mode

To quickly toggle the X axis display between Radius and Diameter when the machine type is set as a Lathe, press the R key. The "RAD" or "DIA" indicator is shown at the right top corner of the information screen to indicate current setting.

Step	Buttons	Information Screen
1 Press R key to toggle between Radius and Diameter modes	R	ABS DIA TL01+ F0.0iPm

Axis Vectoring

Some lathe operations (e.g. thread cutting, taper machining) require setting the compound axis at an angle. In order to correctly display the position of the tool, the movement from the compound must be broken into its axial components and added to the other two axes. To automatically perform this operation, use the Axis Vectoring function and enter the angle between the compound axis and the axis of rotation of the workpiece.



Step	Buttons	Information Screen
1 Press F and use the up and down arrows to navigate to the vectoring function Press OK to confirm	F ▲ ▼ OK	Function 3 ⇄ Vectoring
2 Use the numpad to enter the angle at which you would like to vector the compound axis Press OK to confirm	OK	Set Compound Ang 60 De9

To turn vectoring off, access the function as before, but set the angle to zero when entering the angle and press OK.

Taper Measurement

To measure the taper angle of the conical workpiece, use the Taper Measurement function. The taper angle is displayed during the movement to the second position

Step	Buttons	Information Screen
1 Press F and use the up and down arrows to navigate to the taper function Press OK to confirm	F ▲ ▼ OK	Function 4 ⇄ Taper
2 Move the tool to the first point Press OK or Enter	OK Ent =	Move to 1st Pnt and Press Enter
3 Move the tool to the second point The taper angle will be displayed on the information screen		Move to 2nd Pnt Taper=-30




Tool Compensation

When tool compensation is enabled in lathe mode, the digital readout will offset the displayed position from the actual position by the difference in tool sizes. This feature allows you to perform operations with multiple tools without re-zeroing every time the quick change tool post or turret is indexed. The DRO can store up to 99 unique lathe tool configurations. All offsets in the tool configuration will be automatically applied when the tool is selected. To measure the tool offsets so they may be entered into the DRO, perform the following steps.




To Measure Lathe Tool Offsets:

- 1 Make sure offsets for TL01 are set to 0 and select TL01
- 2 Using tool #1 touch a cylindrical bar of a known diameter and set X to 0.
- 3 If X axis is in diameter mode, enter bar diameter as a "Tool Offset X" for TL01, otherwise use bar radius
- 4 Select TL02, make sure its offset is set to 0 and touch a cylindrical bar of a known diameter
- 5 Subtract current X axis reading (with sign) from the bar diameter and set resulting value as "Tool Offset X" for TL02
- 6 Repeat steps 4 and 5 for TL03, TL04, etc

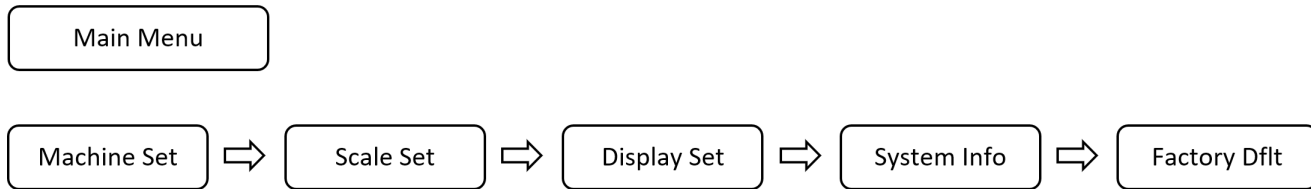
To Enter Known Lathe Tool Offsets:

Step	Buttons	Information Screen
1 Press the tool button to access the tool compensation feature		Tool Compensatn 1-Use 2-Edit
2 Press 2 to edit or create a new tool configuration Select the tool number you would like to edit using the up and down arrows, then press OK to confirm	2   OK	Edit Tool 01 ↕
3 Enter the X offset using the numpad Press OK to confirm	OK	Tool Offset X 1.125 in
4 Enter the Z offset using the numpad Press OK to confirm	OK	Tool Offset Z(Y) 0.0625 in
5 Press 1 to store the tool OR Press 2 to discard any changes	1 OR 2	Tool 01 1-Store 2-Discard

To Use Tool Compensation:









Step	Buttons	Information Screen
1 Press the tool button to access the tool compensation feature		Tool Compensatn 1-Use 2-Edit
2 Press 1 to use an existing tool configuration Select the tool number you would like to apply using the up and down arrows, then press OK to confirm	1   OK	Select Tool 01 ↕
3 The X and Z offsets will now be applied to the tool position		

Your DRO was preprogrammed at the factory with the most popular settings and set to match the supplied linear encoders. All settings, parameters, and custom programs are stored in power-independent memory. When power is interrupted or the DRO is turned off with the switch on the back, no settings or data will be lost. However, if an axis is moved while the unit is without power, the position of that axis will not be tracked. If this occurs, see reference zero restore for recovery



Machine Settings

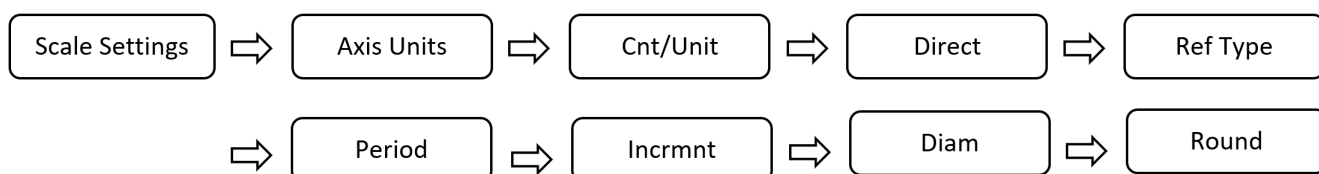
To select between the mill and lathe machine specific functions, select the correct machine type from the Machine Set menu. Mill mode includes functions such as Incline, Radius, Bolt Circle, Bolt Array, and Tool Diameter/Height Compensation. Lathe mode includes Radius/Diameter display, Axis Summing, Vectoring, Taper Measurements function, and tool offsets.

Step	Buttons	Information Screen
1 Press the settings button Use the right and left arrows to navigate to Machine Settings and press OK	  	***MAIN MENU*** -Machine Set
2 Use the up and down arrows to select the desired machine type Press OK to confirm	  	Machine Type Mill ↓
3 Press cancel to exit the settings menu Press 1 to save changes or 2 to discard	 OR 	Save Changes? 1-Yes 2-No

Encoder Settings



























Each encoder setting must be set for each axis independently. Under scale settings select the encoder axis to modify.

- Axis Units - Select the units for the encoder resolution under the Axis Units parameter. The two options are Counts/inch and Counts/mm.
- Counts/Unit - Enter the number of counts per inch or counts per millimeter, depending on the previous setting. This value is determined by the linear encoder. See the table in the end of this section for the most common resolutions and corresponding counts/in.
- Axis Direction - Select the direction of travel so that all axes form a Right-handed Coordinate System. The two options are straight or reversed.
- Reference Mark Type - Select the reference mark type. If the installed scales have distance coded reference marks, select distance coded, otherwise choose single/periodic.
- Period / Increment - If the Reference Mark Type selected is distance coded, Period and Increment settings will be enabled. See the table in the end of this section for the most common grating period/resolution/increment combinations and the corresponding period and increment values.
- Diameter Mode - Select on to enable diameter mode which reports the axis position as a diameter, a useful feature for some turning applications.
- Rounding - Select the number of decimal places to be rounded for the selected axis



Settings

To Change the Encoder Settings:

Step	Buttons	Information Screen
1 Press the settings button Use the right and left arrows to navigate to Scale Settings and press OK	  	***MAIN MENU*** -Scale Set
2 Use the right and left arrows to select the axis to change settings Press OK to confirm	  	SCALE SETTINGS -Y Axis
3 Use the up and down arrows to select the units for the selected axis Press OK to confirm	  	Y Axis Units -Counts/inch ↕
4 Use the up and down arrows to select the number of counts per unit for the selected axis Press OK to confirm	  	Y Axis Cnt/in 0005080 ↕
5 Use the up and down arrows to select the direction for the selected axis Press OK to confirm	  	Y Axis Direct -straight ↕
6 Use the up and down arrows to toggle diameter mode for the selected axis Press OK to confirm	  	Y Axis Diam -Mode is OFF ↕
7 Use the up and down arrows to select the rounding for the selected axis Press OK to confirm	  	Y Axis Round 0.0001"/0.001mm
8 Use the up and down arrows to toggle between single/periodic and smart (distance coded) reference Press OK to confirm	  	Y Axis Reference -single/periodic
9 Press cancel to exit the settings menu Press 1 to save changes or 2 to discard	 OR 	Save Changes? 1-Yes 2-No

Sample Linear Encoder Settings:

Encoder Resolution	Counts/in	Counts/mm
5.0 um (0.005mm)	5,080	200
1.0 um (0.001mm)	25,400	1000
0.5 um (0.0005mm)	50,800	2000
0.0002"	5,000	N/A


















Distance Coded Reference Settings:

Grating Period/ Resolution/Increment	Period, Counts	Increment, Counts
20 um/5.0 um/20 mm	4	4,000
20 um/1.0 um/20 mm	20	20,000
4 um/0.1 um/20 mm	40	200,000

Display Settings

The display settings allow the user some control over the information displayed by the DRO:

- LCD Back-light - Select on or off to enable the LCD back-light.
- Calculator Rounding - Set the number of places after the decimal for the calculator function.
- Number of Axes - Enter the number of axes used by the DRO. This value should match the number of linear encoders installed on the machine.

Step	Buttons	Information Screen
1 Press the settings button Use the right and left arrows to navigate to Display Settings and press OK	  	***MAIN MENU*** -Display Set
2 Use the up and down arrows to toggle the LCD back-light Press OK to confirm	  	LCD Backlight On 
3 Use the up and down arrows to select the rounding for the calculator Press OK to confirm	  	CALC Rounding 4  Digit(s)
4 Use the up and down arrows to select the number of axis to be used by the DRO Press OK to confirm	  	Number of Axis 3  Axis DRO
5 Press cancel to exit the settings menu Press 1 to save changes or 2 to discard	 OR 	Save Changes? 1-Yes 2-No






System Info

Select the system info function to display the DRO's model, hardware revision and installed software version.

Factory Default

Select the factory default function to erase all custom memory in the digital readout and restore it to the original factory settings. This is useful if the digital readout changes owners, is transferred from one machine to another, or behaves abnormally due-to improper settings performed by end user.

Note that this process is **irreversible** and will **permanently erase** all custom programs, tool configurations, and all other user settings.

Step	Buttons	Information Screen
1 Press the settings button Use the right and left arrows to navigate to Factory Default and press OK	  	***MAIN MENU*** -Factory Dflt
2 Press 1 to restore all memory to factory condition or 2 to cancel	 OR 	Reset to Default 1-Yes 2-No

Electrical

Power	100 ~ 240 V AC, 47 ~ 63 Hz, 0.35 A
Fuse	250 V, 1.0 A
Encoder Interface	Meets or exceeds TIA/EIA-422-B and ITU Recommendation V.11
Encoder Supply	5 V \pm 5%, 50 mA max per axis
Maximum input Frequency	5.0 MHz

Physical

Dimensions	11.8 in x 2.7 in x 7.4 in	30 cm x 6.8 cm x 18.8 cm
Weight (excluding mounting arm)	3.9 lbs	1.8 kg

Environmental

Operating Temperature	30 ~ 115 °F	0 ~ 45 °C
Operating Humidity	20% - 90% RH non-condensing	
Storage Temperature	-40 ~ 185 °F	-40 ~ 85 °C
Storage Humidity	10% ~ 95% RH non-condensing	

Input and Resolution

Input	Up to three incremental quadrature encoders (linear or rotary)
Reference Mark Support	Single, Periodic, or Distance Coded
Resolution	2 nm ~ 1 in: user specified counts/in (1 ~ 5,000,000) or counts/mm (1 ~ 500,000)

Disposal

Review local ordinances on the disposal of electronic devices at the end of life of your DRO. The outer casing is recyclable.

Unit does not turn on

1. Ensure that the power cable is installed properly and the switch on the back of the unit is in the “on” position.
2. Ensure that the power outlet has power and is supplying the proper voltage and current.
3. Ensure the fuse is intact. The fuse compartment is located directly below the power plug and can only be accessed with the power cable removed. Replace only with a 1.0 amp 250 volt fuse.

Axis display does not change when axis is moved

1. Ensure the encoder cables are plugged into their appropriate inputs.
2. Check the connectors for bent or missing pins.
3. If the problem persists, swap the unresponsive axis input with another axis. Move both axis and check the displays. If the same display does not change, the DRO may be faulty. If the axis display that you swapped the original encoder to does not change, the problem is most likely with the encoder. See the encoder manual for further troubleshooting.

Axis display “skips,” change intermittently, or display inaccurate position

Most such issues are caused by encoder misalignment or encoder hardware failure. Be sure to follow your encoder’s installation instructions carefully to avoid misalignment. See your encoder manual for further troubleshooting and repair or replacement information.

If an axis display always changes by a constant scale factor of the distance moved (e.g. the display always shows double the distance traveled), it is possible that the DRO has an incorrect value set for the counts per unit for that axis. Determine the proper value for your encoder and adjust accordingly. See “Encoder Settings” in the Settings section of this manual for instructions on changing this value in the DRO.

Some programs, such as Bolt Circle and Taper Measurement, are unavailable

Some programs are specific to the mill or lathe machine type. If the DRO is set to the incorrect machine type, the program you would like to use may be disabled. We strongly recommend leaving your DRO set to the machine type that it is installed on. See the “Machine Type” in the Settings section of this manual to learn how to change the machine type.

Bolt Circles and other features turn out backwards or mirrored

Ensure the linear encoders are set to the proper directions of travel. See “Encoder Settings” for instructions on reversing the direction of travel. The directions should be set such that they obey the right hand rule (form a right-handed coordinate system). Typical this is done so that the positive X axis points right, the positive Y axis points forward, and the positive Z axis points up, all in relation to the operator



Warning: Attempting to repair the equipment will void any and all product warranties. Only qualified factory technicians may perform necessary repairs.

Three-Year Limited Warranty

The DR300 series Digital Readouts come with a three (3) years limited warranty and is guaranteed to be free of manufacturing defects in materials and/or workmanship. If the product is found to be defective within a 3 year period from the date of original purchase, ZS Instruments will replace or repair the product free of charge. See below for limitations.

All defective products must be first returned to ZS Instruments and pass an inspection process for a warranty claim to be approved. ZS Instruments, under its sole discretion, will repair, replace or refund the cost of the defective products. Defects caused by normal wear and tear, improper installation, use for not intended purpose and/or abuse are not covered. Warranty is void if any part of the product was physically damaged, submersed in liquids, subjected to electrostatic discharge or electromagnetic pulse, altered by any way, disassembled, or repaired by unauthorized personnel.

This warranty does not apply to installation and shipping costs. Any expenses occurred as a result of ZS Instruments product failure including but not limited to product installation and defective output are the sole responsibility of the purchaser.

ZS Instruments makes no warranty, express or implied, as to merchantability or fitness for a particular purpose. ZS Instruments shall not be liable for any direct, indirect, punitive, incidental or consequential injury, loss, or damage, including but not limited to lost data, lost savings, production downtime, cancellation of contracts, lost profits, or lost business opportunity arising from the use of ZS Instruments products.

This warranty applies only to the DR300 series of digital readouts. Warranty terms for other categories of products and other models of digital readout may vary.

The liability of ZS Instruments under this warranty may not exceed the original purchase price of the product, regardless of legal theory applied, including but not limited to, contract, warranty, negligence, or strict liability.

ZS Instruments products are not authorized for use in critical applications. Critical applications defined herein as systems in which the failure of a single component could cause a life loss or substantial property damage (life support systems, nuclear, military etc). If you intend to use our products in such applications, you must first obtain a written authorization and have a written agreement with ZS Instruments regarding such a use.



If you have any questions related to ZS Instruments Products, Installation, Warranties, or Returns, please contact us by using one of the methods listed in this manual or on our website:

www.zsinstruments.com

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F/W Ver 1.302