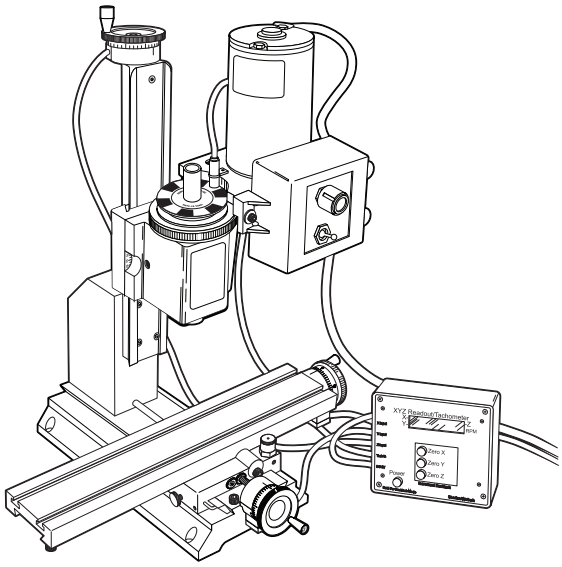


SHERLINE PRODUCTS
INCORPORATED 1974

SHERLINE/WETTROTH

Mill Digital Readout

P/N 8100 (Metric P/N 8160)

The Digital Readout in the Modern Machine Shop

Digital readouts are popular on full-size mills because they make the life of a machinist much simpler. They make it easier to accurately set or change the table position and eliminate errors caused by misreading handwheel increments or losing track of multiple rotations. Now that same convenience is available on tabletop size machines with a DRO (Digital ReadOut) for Sherline mills. John Wettroth designed the compact electronics package and clever backlash compensation feature.

On industrial DROs, a sensor reads a highly accurate external scale. On Sherline's DRO, the sensor reads rotation of the leadscrew. Because of the accuracy of Sherline's precision rolled leadscrew threads and the short travels on a machine of this size, this system makes it possible to provide a DRO with sufficient accuracy while maintaining a price appropriate for a machine of this size and cost.

The kit can be installed on any Sherline mill, regardless of age and is very easy to use. Remember that the directions of movement of the mill are referred to as the X-axis (table side-to-side), Y-axis (table in-out) and Z-axis (spindle up-down). The readout of any axis can be set to zero at any time with the push of a button. As you move the handwheels you can read the table position to three and a half decimal places on the digital readout. It is not necessary to keep track of the number of handwheel rotations to figure the stopping point on larger dimensions. This will be especially appreciated when cranking in "negative" amounts. Backlash is compensated for by setting it into the unit's electronic memory in increments of .0005". As a bonus, the package also includes an electronic readout of spindle RPM at all times.

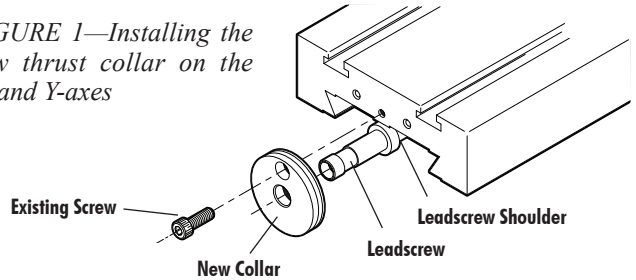
NOTE: The DRO unit itself is accurate to within 1/100 of a revolution of the screw. **Example:** On our 3/8-20 leadscrew, the pitch is .050/rev.; therefore, .050/100 = .0005". The accuracy on a 10 x 1mm leadscrew will be .01mm. On our 10 x 2mm ball screw, the accuracy will be .02mm.

Installing the DRO Components on Your Sherline Mill

The following instructions describe the steps required to remove the existing handwheels and thrust collars and replace them with the DRO encoder/handwheel units. It is suggested that you remove the headstock and motor assembly from the mill to make it easier to install the DRO components. ("Left" and "Right" refer to the operator's left and right sides when facing the mill with the X-axis handwheel on your right.)

1. Move the table all the way to the left. This will limit movement of the leadscrew and help center the new collar.
2. Move the table all the way to the front toward the operator.
3. Raise the headstock all the way to the top of its travel.
4. Using a 3/32" hex wrench, remove all three handwheels by releasing their set screws and sliding them off their leadscrews. (If your mill has resettable "zero" handwheels, loosen the collar locking knob and rotate the collar until the hole lines up with the set screw. Then use the 3/32" hex wrench to loosen the set screw and remove the entire handwheel/collar unit.)
5. Using a 3/32" hex wrench, remove the 5-40 screws holding the thrust collars on the X- and Y-axis leadscrews. Remove the collars.
6. Clean each grooved thrust collar with a solvent like acetone or lacquer thinner to remove any oil from the surface. (You will later lock them in place in relation to the plastic housing with "instant glue" and it will not stick to an oily collar.) Using the existing screws, install new grooved thrust collars on the X- and

FIGURE 1—Installing the new thrust collar on the X- and Y-axes



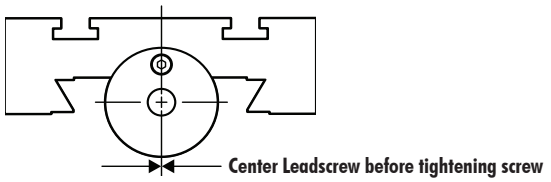


FIGURE 2—Making sure the leadscrew is centered

Y-axes, making sure the leadscrew is centered in the collar. Make sure the screws are secure, but do not overtighten. If a shim washer was present on your existing leadscrew, reinstall it as it was before.

7. Install a new handwheel and encoder ring on the X- and Y-axes. (The encoder ring has been factory installed on the handwheel for easier assembly.) Note that the X and Y handwheels are similar except on the X-axis, the numbers on the handwheel face away from the handwheel. On the Y-axis they face toward the handwheel. Make sure the shoulder at the end of the leadscrew thread is seated against the thrust collar and the handwheel is pushed in tightly to remove end play before tightening the set screw. On the X-axis, push the table AWAY from the handwheel while pushing the handwheel onto the leadscrew shaft. On the Y-axis, hold the table (not the base) with one hand and push the handwheel onto the shaft with the other. Rotate the handwheel so that the set screw tightens on a new part of the shaft. If you don't, it will tend to pick up its old indentation making it difficult to tighten it in a new position.

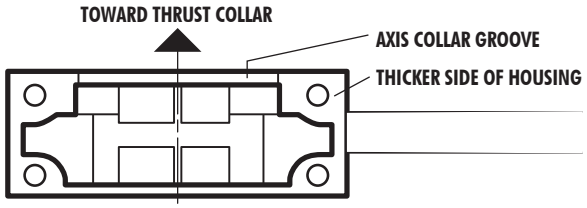


FIGURE 3—(Above) Detail of the encoder housing showing direction of installation

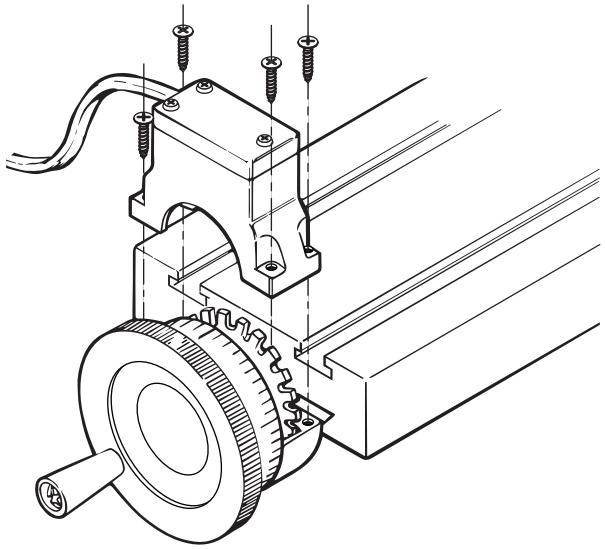


FIGURE 4—Installing the encoder unit over the thrust collar. The unit can be installed upside down to make it easier to put in the screws. It is then rotated into position and tightened to lock it in place.

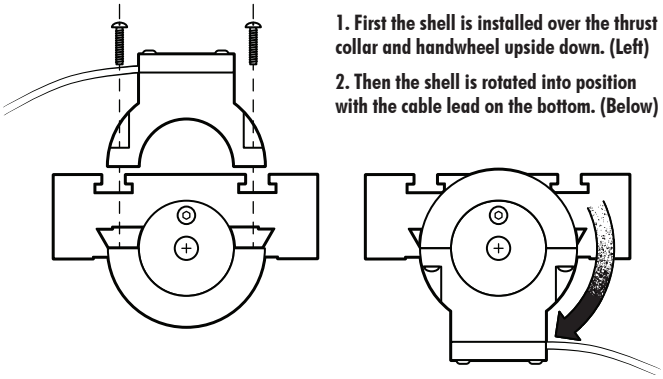


FIGURE 5—Rotating the unit into its proper position. (Note: Handwheel/encoder unit not shown for clarity.)

See Figure 3 for orientation of the encoder housing. The thicker shoulder inside the encoder should be facing toward the thrust collar. It is easier to tighten the screws if you install the units upside down with the screws coming down from the top. Place the two halves of the shell over the thrust collar and over the encoder ring and install the four #2 x 3/8" self-tapping screws. Draw the screws down until they seat snugly, but DO NOT OVERTIGHTEN or you will strip the threads! Once tightened into position, the unit can be rotated around until the screws and cable are on the bottom.* When finished, the cable from the X-axis encoder should come off to the rear, and the cable from the Y-axis encoder should come off to the right.

***NOTE:** The unit should be tight enough so that it doesn't move accidentally once positioned. If it rotates too easily when the screws are tightened, you can remove the housing shell and sand the mating surfaces on a piece of sandpaper on a flat surface until they grip the collar tightly enough.

8. Using a 1/8" hex wrench, remove the flat head screw that holds the Z-axis thrust collar to the column. Remove the collar by lifting it up and off the Z-axis

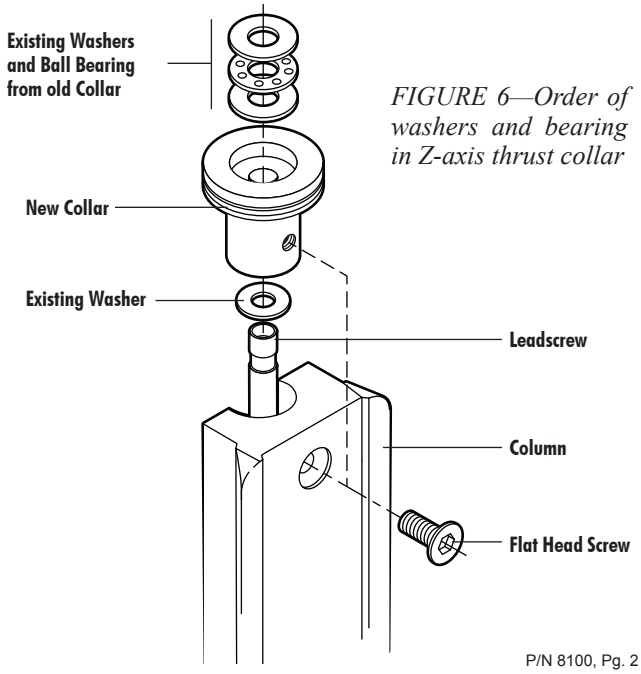


FIGURE 6—Order of washers and bearing in Z-axis thrust collar

leadscrew. If the spacer washer sticks to the bottom of it, remove it and reinstall it on the leadscrew shaft. Then remove the ball bearing thrust and two washers from the collar and reinstall them in the new Z-axis thrust collar in the same order. (See Figure 6.) Install the new collar on the leadscrew shaft and secure it to the bed with the flat head screw.

9. Install the remaining handwheel and encoder unit onto the Z-axis leadscrew. Lift up on the saddle assembly until the washer and shoulder of the leadscrew are all the way up against the bottom of the collar. Then push down on the handwheel and tighten its set screw, being sure to tighten it against a new spot on the shaft. If installed on your machine, reinstall the 5-40 x 3/8" flat head screw through the center of the Z-axis handwheel and into the end of the leadscrew. See "Adjustint the Z-axis handwheel" on page 4 for more details on adjusting this screw. Install the pickup housing over the handwheel unit as shown in Figures 4 and 5. When finished, the cable should exit toward the left when viewed from the front.
10. The sensors that read gear-tooth position as you turn the handwheel are located in the bottom of the handwheel housing. If the housing moves, it is the same as if you moved the handwheel, because it changes the relationship between the sensor and the gear tooth. Therefore, the housing should be anchored in place so that it cannot be inadvertently moved. The screws that hold the two halves together go into plastic, and overtightening them can strip the threads out of the hole. A good solution is to place a drop of "super glue" between the plastic housing and the metal collar once the housing is positioned where you want it. This will keep it in place but can still be broken loose if you need to later.

Installing the RPM Sensor

1. Reinstall the headstock/motor/speed control onto the mill.

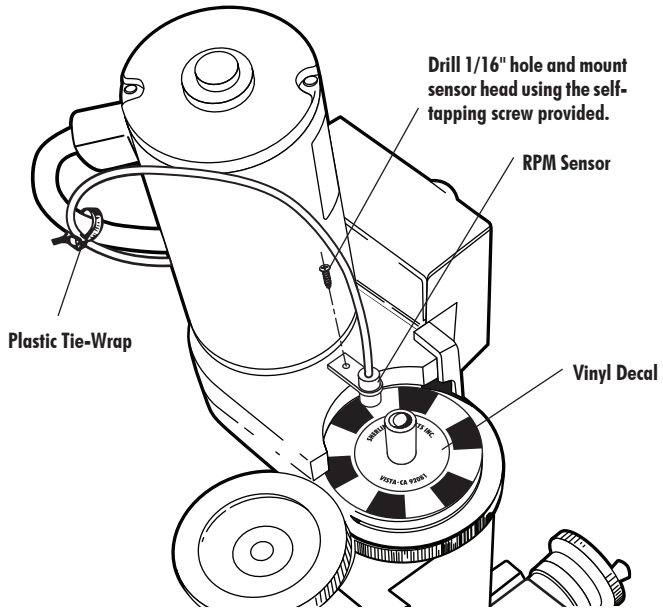


FIGURE 7—Mounting the sensor to the belt housing

2. Peel off the backing and apply the 2-1/2" round decal to the pulley. (HINT: A little liquid window cleaner on the pulley allows the decal to be repositioned and bubbles squeezed out before it sticks. Once the liquid is squeezed out and dries, the adhesive on the sticker will stick fine.)

NOTE: You must make sure you have the correct tach sticker for your machine. Use a 6-pulse (P/N P/N 81510) tach sticker if your machine is a leadscrew machine, or a 5-pulse tach sticker (P/N P/N 87860) if your machine is a ball screw machine.

3. Locate the RPM sensor by holding it in the position shown in Figure 7. Mark the center of the hole on the plastic belt housing and drill a 1/16" hole. Fasten the sensor to the belt housing using the self-tapping screw provided. (Do not overtighten or you can strip the threads.) A plastic tie-wrap is provided to secure the sensor lead to the motor's power cord to keep it out of the way.

NOTE: If you have a mill with an older AC/DC motor that does not have a plastic belt guard, the RPM sensor can be mounted in the proper position over the pulley by attaching it to the motor mounting bracket. Locate and mark where the hole should be drilled. Remove the motor and drill a hole through the bracket. You can use a self-tapping sheet metal screw or a bolt and nut through the hole or you can tap the hole to match the thread of the bolt you use.

Hooking up the Connecting Cables

Plug the cable connector from each encoder unit into is respective port on the display unit. The telephone type cable connectors go in with the locking tab facing up when the unit is lying on its back. The RPM sensor cable goes into the port marked "Tach In".

Plug the power adapter into the bottom hole marked "DC In", and plug the transformer into a 115 VAC (60 Hz.) source. Check to make sure all three axes are functioning. Turn on the motor and check to see that the RPM indicator is functioning.

Initializing Your Display for Inch or Metric Leadscrews

When you press the "Power" button to turn your system on, the upper right corner of the display will read either "inch" or "metric" mode. Normally, the DRO will be set up properly when you receive it, but there is always a possibility it could be set wrong. To set or change the system of measurement your unit displays for DROs that were purchased prior to 8/1/21, follow these steps:

1. With the power off, unplug the power cable from the display unit.
2. **INCH**—Hold down both the "Power" button and the X-axis button while you plug the power cord back into the display unit. After the display comes up, release the buttons. The display should now read in inch dimensions.
3. **METRIC**—To initialize your display unit to read metric dimensions, hold down the "Power" and "Y" buttons while plugging the power cord back into the display

unit. Once initialized, the unit will always read in your chosen system of measurement each time it is turned on unless you change it.

The only difference between the inch and metric packages is the number of divisions engraved into the handwheels. The electronics package is the same for either and can be set to read in either measurement system depending on the leadscrews of the machine on which it is installed.

NOTE: Before you choose a mode, the mode must be for the actual leadscrew or ball screw that is on your machine.

For example, if you have an Inch leadscrew on your machine, you cannot use modes 2,3,5, or 6. You can only use modes 1 or 4. The DRO software calculations (and display) are based on the actual screw that is on your machine.

NOTICE! On DROs sold before 8/1/21, the display does not convert dimensions from inch to metric!

The DRO reads rotary handwheel movement and converts it to a linear dimension based on a formula assuming a certain leadscrew thread pitch. The DRO must be set to agree with the leadscrews installed on your machine to provide accurate measurements.

2021 DRO Mode Settings

We upgraded our DRO chip in 2021 in order to use the DRO with our metric ball screw machines. We also made a few other upgrades based on our customer feedback. This new DRO system will offer the two original settings, Modes 1 and 2.

- **Mode 1** for use on an inch leadscrew machine with an inch display
- Mode 2 for use on a metric machine with a metric display.

Modes 3 through 6 are in addition to the original settings.

- **Mode 3** is used for our ball screw machine with an inch display.
- **Mode 4** is used for an inch Leadscrew machine with a metric display.
- **Mode 5** is used for a metric Leadscrew machine with an inch display.
- **Mode 6** is used for our ball screw machine with a metric display.

The chart in Figure 8 shows all six modes along with the "Key Combinations" to use to activate each mode. The initializing steps to activate Modes #1 and #2 are the same as the original DRO instructions noted above for Inch and Metric. To Initialize modes 3–6, use the same steps of holding down the POWER ON button along with the additional keys shown on the chart. Watch the display screen when the DRO powers on to make sure that the "power up display" that shows on the screen is correct. For example, if you are initializing Mode #5, you hold down the Power button along with the Y and Z buttons. When the display comes on, the display should show "M1INT6," then the DRO display will come on.

NOTE: For more detailed information on setting up the modes for DRO, please see the *DRO Mode Instructions* https://sherline.com/wp-content/uploads/2021/07/dro_mode_inst.pdf

Mode	Key Combination	Leadscrew Pitch	Displayed Units	Example Display	Position Resolution	Backlash Entry Units	Power Up Display	Notes
1	ON + X	.05"/Turn	Inch	+ 1.0055	.0005"	Inch	ININT6	Original Inch Mode for a machine with an inch leadscrew
2	ON + Y	1 mm/Turn	Metric	+ 25.41	.01 mm	mm	M1MMT6	Original Metric Mode for a machine with an metric leadscrew
3	ON + Z	2 mm/Turn	Inch	+ 0.3937	0.0008"	mm	M2INT5	For a Ball Screw machine showing the readout in inches
4	ON + X + Y	.05"/Turn	Metric	+ 1.0055	.01 mm	Inch	INMMT6	For an Inch Leadscrew machine showing the readout in metric
5	ON + Y + Z	1 mm/Turn	Inch	+ 1.0055	0.0004"	mm	M1INT6	For a Metric Leadscrew machine showing the readout in inch
6	ON + X + Z	2 mm/Turn	Metric	+ 25.42	0.02 mm	mm	M2MMT5	For a Ball Screw machine showing the readout in metric

FIGURE 8—See page 6 for a full-size chart.

Setting the Backlash Compensation Values

To set backlash compensation for each axis, you must first measure to determine what the backlash is. Use a dial indicator to determine how far the handwheel on each axis rotates before the table starts to move. (If this amount is excessive, see your instruction manual for instructions on setting backlash. It should ideally be in the .003" to .005" range.) Once the amount is determined, the backlash is compensated for by setting it into the display unit's memory.

To set the measurement system to correspond to your machine's leadscrews, complete the following steps for each axis:

1. Turn the handwheel for each axis one full turn clockwise. This assures that the software starts the backlash compensation at the proper initial point.
2. Hold down the "Power" button for longer than a second until the display changes.
3. Now you can set in the backlash for each axis by pushing the button for that axis. Each time the button is depressed, .0005" (or .01 mm on metric units) is added to the reading. Set in the amount of backlash you measured previously for each axis. Amounts up to .015" (.50 mm) can be set. (Note: You cannot cycle backwards to a lower number. If you go past your desired setting you must continue pushing the button until the reading passes .015" or .50 mm and returns to zero. Then start over.)
4. Once the backlash for all three axes is set, briefly push the "Power" button again to return the display to its normal reading. The backlash setting can be checked or changed at any time by holding the power button until the display changes. The amount can then be reset as described in instruction number 3 above. Once set, backlash settings are held in a special memory chip even if the unit is turned off and unplugged. They remain until you change them.

Adjusting the Z-axis Handwheel Screw

To adjust tension on the screw, first remove all Z-axis backlash in the conventional manner by lifting the motor/speed control unit by hand while tightening the handwheel

set screw on a "fresh" quadrant of the leadscrew to avoid picking up any previous indentations. Once adjusted, tighten the center screw* only until it is "finger tight". Use a very small amount of Loc-tite® on the end of the screw to keep it in place. (Do not coat the threads or the screw may become impossible to remove.) Overtightening the screw will cause the handwheel to become hard to turn. The purpose of the screw is not to adjust backlash, but rather to keep it from increasing once it is properly adjusted. Do not try to use the screw to pull out additional backlash. The small 5-40 threads are not strong enough for this task.

***NOTE:** If installing the Z-axis DRO handwheel on an older machine that does not have a 5-40 hole in the end of the leadscrew this screw is not used.

Tach Readout

In addition to the mode selections, the tach readout is also different for our leadscrew machines and our ball screw machines.

The leadscrew machines have a tach sticker that goes on the headstock pulley. This is the tach sticker that comes with the DRO. This tach sticker is a 6-pulse tach sticker. If you have a leadscrew machine, use the 6-pulse tach sticker.

The ball screw machines come with the MASSO 5-pulse tach sticker. This 5-pulse tach sticker is what the optical encoder uses with the MASSO controller. Use the 5-pulse tach sticker on the ball screw machine. When you set your DRO to Mode 3 or Mode 6, the software is set up to read the 5-pulse tach sticker.

You can also change the "Tach Pulse Number" on the DRO to match either a 5 or 6-pulse tach sticker on your machine.

To do this, follow the previous instructions to set the DRO to your machine and desired readout setting.

Then follow the instructions below to change the tach pulse setting:

1. Disconnect the DC power from the DRO box.
2. Simultaneously hold down the Power, X, Y, and Z buttons, and reconnect the DC power. This is accomplished easiest by using your forefinger to hold down the X, Y, and Z buttons, and your pointer finger to hold down the Power button.
3. When the DRO display screen comes on the "T6" should change to a "T5" in this case.

NOTE: If you have a ball screw machine, and you are using a controller other than our MASSO controller, you will need to request the 5-pulse tach sticker (P/N 87860) for the DRO tach readout to be correct.

A Few More Tips

When in use, shield the unit from chips so they don't accumulate around the telephone jack connections on the side. Do not use an air hose to clean the unit.

A metal stand is included with your DRO so you can stand the unit up on your workbench. This makes it easier to read while you work. If you wish to secure the box to the stand, a piece of double-sided foam tape or hook-and-loop (Velcro®) tape are good methods.

Reversing the Direction of the Reading on the X-axis

The X-axis readout is designed to read negative numbers when the handwheel is turned in the clockwise direction and positive when turned counter-clockwise. Should you wish to change your readout so that it uses a standard x-y plot, you can do so by switching two of the four wires coming from the encoder for the X-axis.

To do so, unplug the X-axis cable from the readout box. Remove the four screws that secure the lower housing to the upper housing and then remove the encoder halves from the handwheel. On the bottom of the half with the encoder is a cover plate secured by three screws. Remove these screws and the cover plate. This will expose the soldered connections for the four wires coming from the encoder. To reverse the direction of the readout, unsolder the green and black wires. Reverse their position and re-solder to the encoder leads. Reinstall in reverse order. The diagram in Figure 9 shows the factory locations of the wires before the swap is made.

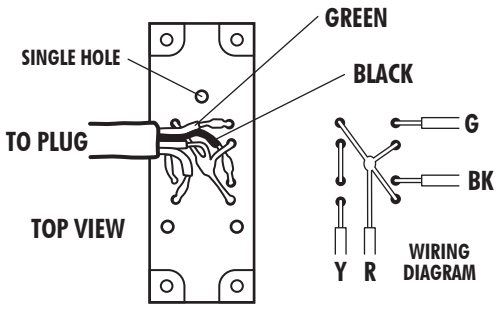


FIGURE 9—The drawing on the left shows the encoder housing and wires coming from the plug. The diagram to the right shows a schematic of where each wire is connected. Swapping the black and green wires will change the + (plus) and – (minus) directions of the readout.

NOTE: The wires and solder joints are small and delicate. If you don't have a suitable soldering iron and a little expertise along these lines you may return your encoder housing to the factory and we will make the change for you at no charge. Call first for a return authorization number and instructions on how to return your housing.

Getting the Most out of Your DRO

When using a machine equipped with a digital readout, we find it is best to use either the readout or the handwheels, but not both. If the displayed accuracy of .0005" (.01mm) is satisfactory for the job you are doing, use just the digital readout and disregard the handwheel settings. In cases where you might want to interpolate to a higher degree of accuracy, the markings on the handwheels will allow you to do this.

An example of this would be where you have located the center of a bored hole and then changed the table position. To return the spindle exactly to the hole's center again using the digital readout could leave you a few ten-thousandths

off, which may not be acceptable. In this case, you should write down your handwheel settings and direction the handwheel was last turned before moving from the desired location. This will allow you to return to the same spot with great accuracy. The handwheel marks are .001" or .01mm apart. By reading the space between the marks on the handwheel and interpolating your position, you can achieve a high degree of accuracy. Knowing your machine is an important part of achieving this kind of accuracy, and as you get more familiar with your machine, your accuracy will continue to improve.

Sherline's DRO brings modern machine shop technology down to tabletop size and makes your Sherline tools easier and more fun to use. We think you will find the digital readout to be a great addition to your Sherline machine shop.

Thank you,
Sherline Products Inc.

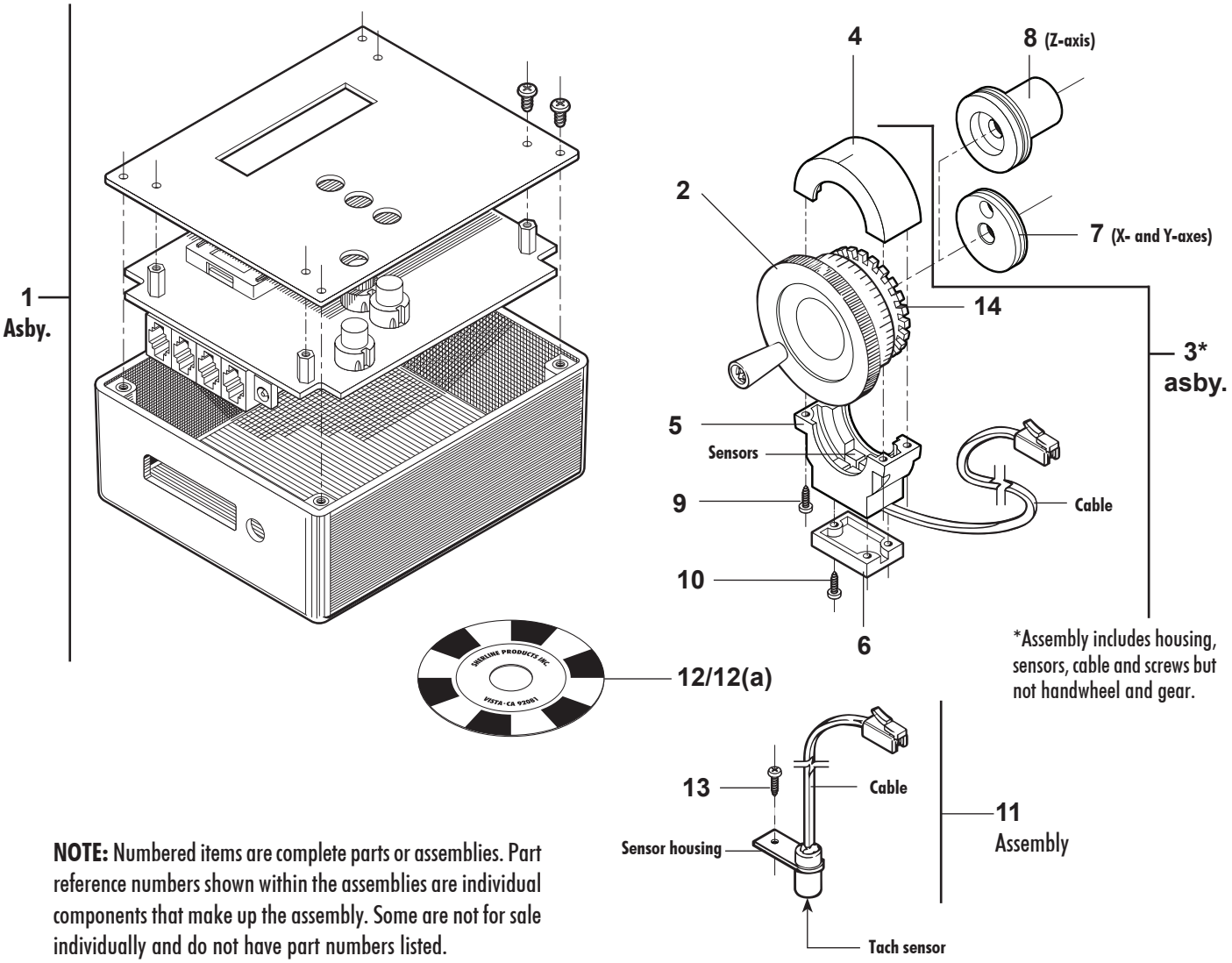
2021 DRO Mode Settings

Mode	Key Combination	Leadscrew Pitch	Displayed Units	Example Display	Position Resolution	Backlash Entry Units	Power Up Display	Notes
1	ON + X	.05"/Turn	Inch	+ 1.0055	.0005"	Inch	ININT6	Original Inch Mode for a machine with an inch leadscrew
2	ON + Y	1 mm/Turn	Metric	+ 25.41	.01 mm	mm	M1MMT6	Original Metric Mode for a machine with an metric leadscrew
3	ON + Z	2 mm/Turn	Inch	+ 0.3937	0.0008"	mm	M2INT5	For a Ball Screw machine showing the readout in inches
4	ON + X + Y	.05"/Turn	Metric	+ 1.0055	.01 mm	Inch	INMMT6	For an Inch Leadscrew machine showing the readout in metric
5	ON + Y + Z	1 mm/Turn	Inch	+ 1.0055	0.0004"	mm	M1INT6	For a Metric Leadscrew machine showing the readout in inch
6	ON + X + Z	2 mm/Turn	Metric	+ 25.42	0.02 mm	mm	M2MMT5	For a Ball Screw machine showing the readout in metric

NOTE: For more detailed information on setting up the modes for DRO, please see the *DRO Mode Instructions* https://sherline.com/wp-content/uploads/2021/07/dro_mode_inst.pdf

P/N 8100 Mill Digital Readout

Exploded View and Parts Listing



NOTE: Numbered items are complete parts or assemblies. Part reference numbers shown within the assemblies are individual components that make up the assembly. Some are not for sale individually and do not have part numbers listed.

REF. NO.	PART NO.	DESCRIPTION	REF. NO.	PART NO.	DESCRIPTION
1	81010	3-axis DRO box and electronics (complete)	10	81270	2-56 x 3/8" pan head Phillips screw
2	81320	2" X-axis handwheel, inch (Metric 81322)	11	81500	Tachometer encoder & cable asby.
	81330	2" Y-axis handwheel, inch (Metric 81332)	12	81510	6-pulse Tachometer pickup decal (standard leadscrews)
	81340	2.5" Z-axis handwheel, inch (Metric 81342)	12a	87860	5-pulse Tachometer pickup decal (ball screws)
3	81100	Encoder housing w/ wheel and cable	13	40440	#2 x 1/4" Self-tapping pan head screw
4	81110	Encoder housing upper cap	14	81310	Encoder star gear
5	81120	Encoder housing body	--	81080	Black tie-wrap (not shown)
6	81130	Encoder housing lower cap	--	81050	115 VAC Power supply/transformer(not shown)
7	81300	X- and Y-axis thrust collar	--	81150	Stand for readout display box (not shown)
8	81350	Z-axis thrust collar	--	45013	Z-axis handwheel support screw (not shown)
9	81280	#2 x 3/8" Self-tapping pan head screw			

* **NOTE:** The Z-axis handwheel has a hole through the center and comes with a 5-40 x 3/8" flat head screw that goes into the end of the Z-axis leadscrew. The screw is P/N 45013.