Model 190 and 160 Family of Optical Micrometers

Maintenance and Adjustment Manual

Instrument Company

Helping the World Measure

Since 1927

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Thank you for purchasing a Brunson Optical Micrometer. Remember that our customer support does not stop after shipment of a product—we are here to help you with any measurement challenges that you may have.

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Model 190 and 160 Family of Optical Micrometers

Introduction

This manual applies to all the different versions of the Brunson Instrument Company **Model 190 single-axis and Model 160 dual-axis optical micrometers**. For the Model 160, simply perform all Model 190 procedures on the front micrometer (closest to the cover glass) first, then repeat them for the rear micrometer. See page 6 for calibrations details on the M160.

In order to be used or calibrated, all of the various optical micrometers we manufacture and sell must be directly mounted on any of our telescope-based instruments (with the exception of our alignment scopes, which require an adapter). In this manual, we refer to the instrument on which you mount the 190 or 160 as the *"Test Instrument"*.

The principles of calibration apply to both the single and dual axis micrometers. Essentially, the M160 consists of two M190's mounted perpendicular to each other.

See page 6 for calibration details on the M160.

Normally, the optical micrometer will need no maintenance beyond cleaning the cover glass on its front. However, if the micrometer is used in environments with heavy airborne dirt and grime, it should be sent back to the factory for complete disassembly, cleaning and recalibration.

Because there are so many traps in the pursuit of accuracy, the tests and adjustments in this manual should be made only by people with proper training and experience in the use and calibration of optical measurement equipment. For the same reason, it is very important that your test results be repeatable. If you can't get the same results every time you repeat a test, the results are invalid. In that case, it is very likely that something is loose or broken somewhere - either in the instrument or in the test setup. You must find and solve that problem before you can accurately calibrate the optical micrometer. It is also important to follow the sequence of calibration checks and adjustments as it is written because the accuracy of each adjustment depends upon the correctness of the one preceding it. If you have a question about a procedure or instrument in this or any other optical tooling manual, please call the factory for over-the-phone assistance.

CAUTION!

Do not over tighten the clamping screw when mounting the micrometer on your Test Instrument. Over tightening can cause the objective lens in the Test Instrument to flex slightly, possibly damaging the instrument and certainly undermining its validity as a calibration reference.

Backlash

In this test, you will be checking backlash in the sector gear. To begin this test, the micrometer can be oriented to measure either horizontal or vertical distances. Because correction of backlash requires complete disassembly of the micrometer, it should not be attempted in the field. If you can't repeat your readings with less than one half of one minor graduation of backlash in either direction, the micrometer cannot be calibrated accurately. Return it to the factory for repair.

1. With the micrometer mounted on the Test Instrument, set the micrometer drum to zero. Place an optical tooling scale (or a similar bifilar target) about three feet away from the Test Instrument.

2. While looking through the Test Instrument, use the tangent screws to bring the reticle image into register on the target. Turn the micrometer drum away from zero at least ten minor graduations, then turn it back until the reticle image is again in register on the target. Check the micrometer reading.

Your reading from this direction should be zero, or the error should be less than one half of one minor graduation on the micrometer drum.

3. Repeat step two, this time turning the micrometer drum away in the other direction.

Your reading from this side should also be zero, or less than one half of one minor graduation in error. Repeat the entire backlash check to confirm the validity of your results. If backlash is not within these tolerances, return the micrometer to the factory for repair.

Zero-Centering

In this test you will prove that when the micrometer reading is zero, the micrometer does not displace the line of sight. Mechanically, you will be checking and correcting the perpendicularity (with the micrometer at zero) of the plano-parallel window to the optical axis of the Test Instrument.

Be careful not to disturb the Test Instrument once the target is *sighted.*

To begin this test, the micrometer can be oriented to measure either vertical or horizontal distances. In step 4 below, be careful not to move the Test Instrument while rotating the micrometer. If the Test Instrument is moved during the test, your results will be unrepeatable. Again, repeatable readings are essential to the validity of calibration test results.

1. With the micrometer mounted, place a bifilar target about three feet away from the Test Instrument and at least nominally perpendicular to its line of sight.

2. Loosen the micrometer clamping screw just enough to be able to

rotate the micrometer smoothly about the end of the Test Instrument barrel. If your Test Instrument barrel has an indexing pin, slide the micrometer forward slightly so you can move it easily past the pin.

3. Set the micrometer drum to zero, then use the tangent screws to register the measuring reticle line (the line that moves when you turn the micrometer drum) precisely on the target. The other reticle line should be approximately on target.

4. Rotate the micrometer 180° about the Test Instrument barrel. If necessary, turn the micrometer drum to bring the measuring reticle line back onto the target. Record the micrometer reading.

5. Repeat this entire test to confirm the validity of your results, then leave the micrometer drum in position showing the error and remove the micrometer from the Test Instrument.

Because zero centering affects range accuracy slightly, you should recheck the range after any adjustment to zero centering.

The error indicated on the micrometer drum is twice the actual amount of error. If the actual error (one half the error indicated on the micrometer) is not less than one half of one minor graduation, correct it this way:

1. Rotate the micrometer drum halfway back toward zero from its position at the end of step 5, above.

2. Hold the drum to prevent it moving and loosen the three small screws located near the edge of the top of the micrometer drum. The graduated ring will then rotate freely between the top and bottom pieces of the micrometer drum.

3. Without moving the rest of the drum assembly, carefully rotate the graduated ring the remainder of the distance back to zero.

4. Retighten the three screws and repeat the entire zero centering test to confirm the effects of your adjustment.

Continue the cycle of checking and adjusting until the actual deviation from zero (half the error indicated on the micrometer) is less than one half of one minor graduation on the micrometer drum.

Range Accuracy

In this test, you will be checking the axial position (range symmetry) and operating radius (range length) of the sector pin. Because changing the sector pin geometry affects backlash and zero centering, this calibration can become very complicated. If you make a correction to either dimension of the micrometer range, you must recheck backlash and recalibrate zero centering, in that order, before you can see the results of your adjustment to the range. As always, and particularly in this case, repeat the test to confirm the validity of your results

before you make an adjustment.

For this test, select a reference target with graduations corresponding to the micrometer range on either side of zero. If, for example, the micrometer has a range of plus or minus .100", the target should have graduations .100" apart (though these need not be the only graduations on the target). Place the target about three feet from the Test Instrument and at least nominally perpendicular to its optical axis. To begin this test, the micrometer can be oriented to measure either vertical or horizontal distances.

1. With the micrometer mounted on the Test Instrument, set the micrometer drum to zero. While looking through the Test Instrument, use the tangent screws to bring the reticle image into register on one of the target graduations corresponding to the micrometer range.

2. Turn the micrometer drum to move the measuring reticle line (the line that moves when you turn the drum) to the next target graduation corresponding to the micrometer range. With the reticle line precisely registered on the second target graduation, the micrometer reading should exactly correspond to the interval between the target graduations. If the two numbers do not correspond, record the difference and repeat the test to confirm the validity of your error observation.

Range adjustments are very delicate. About a quarter turn of the screws is enough to change symmetry by half a minor graduation.

3. Repeat steps one and two, only this time turn the micrometer drum the other direction to check the other end of the micrometer range.

The micrometer range should be symmetrical (same reading in either direction) and its length accurate, with less than one half of one minor drum graduation of error in any dimension. If error is found, follow the next sequence of adjustments carefully, in the order it is written.

When range error is greater at one end than it is at the other, the micrometer drum (and thus the sector pin) is not centered over the optical axis of the micrometer. You must correct this asymmetry of the range before you can check range length.

Once you have made the range even on both sides and corrected zero centering, range length should be relatively easy. However, it can be difficult to change range length without putting range symmetry off a little. Try walking them in slowly, adjusting each axis a little at a time.

1. Notice which end of the range shows longer error, then move the drum assembly a little to one side or the other (see Figure 1) using the small Allen screws in the sides of the micrometer body. You may have to loosen the front or back Allen screw a bit to allow the drum assembly to move.

2. Recheck backlash and recalibrate zero centering (in that order) after each adjustment, then recheck range symmetry.

Continue the cycle of checking and adjusting until range error is within one half of one minor graduation of being equal on both

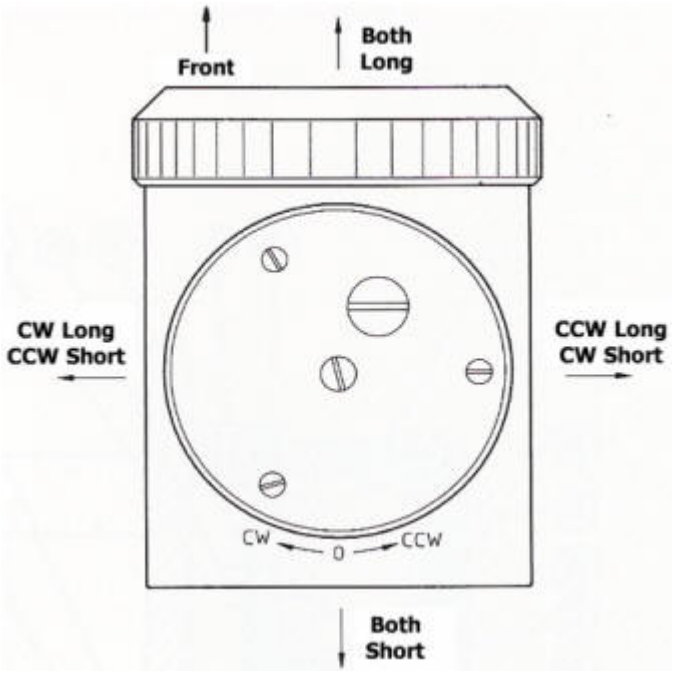


Figure 1

sides, and backlash and zero centering are within the tolerances stated in those sections above. When all these conditions are satisfactory, continue with the steps below.

When the range is symmetrical, but too long or too short, the radius of travel of the sector pin is incorrect. Correct sector radius this way:

1. Notice whether the micrometer reads shorter or longer than the reference target graduations, then move the drum assembly a little to the front or back (see Figure 1) using the small Allen screws in the front and back of the micrometer body. You may have to loosen the side screws a bit to allow the drum assembly to move.

2. After each movement of the drum assembly, recheck backlash and zero centering (in that order). Make any necessary adjustments, then recheck range symmetry. Correct range symmetry (checking backlash and zero centering again) before you recheck range length.

Continue the correction cycle until the range error on both sides of zero is less than one half of one minor drum graduation, with backlash and zero centering also within the tolerances specified in their respective procedures above.

M160 Dual-Axis Micrometer Calibration

The principles of calibration for the Model 190 single-axis micrometer also apply to the Model 160 dual-axis micrometer. Essentially, the M160 consists of two M190's mounted perpendicular to each other. Therefore it is a simple matter to perform all previously described calibration procedures on the front micrometer first, then repeat them for the rear micrometer.

Two additional checks are required on the Model 160. Proper sequence of calibration is detailed below.

The front micrometer is closest to the cover glass and the rear micrometer is nearest the objective end of the telescope.

Front Micrometer

Rear Micrometer

Initially set the rear micrometer to zero in preparation for calibrating the front micrometer.

Front Micrometer Calibration

1. Backlash (see page 2)
2. Zero-Centering (see page 2)
3. Range Accuracy (see page 3)

Note: When all parameters on the front micrometer are set, align the graduated drum to zero to prepare for calibration of the rear micrometer.

Rear Micrometer Calibration

1. Backlash (see page 2)

2. Zero-Centering (see page 2)

3. Range Accuracy (see page 3)

Note: When all parameters on the rear micrometer are set, align the graduated drum to zero and re-check the front micrometer calibration parameters. If adjustments are required on the front micrometer, be sure to re-check the rear micrometer as well. Repeat this iteration until no adjustments are required on the individual micrometers.

Zero-Centering in Two Planes

When both micrometers are calibrated, the Model 160 can be rotated 180° around the barrel of the Test Instrument and remain registered on both axes of the reference target. To check this, simply perform the Zero-Centering check in both planes simultaneously. Allowable error in each direction is ±0.001″ T.I.R*. (±0.0005″ actual error).

** T.I.R. = Total Indicator Runout.*

If excessive error exists in either plane, perform the Zero-Center check on the individual micrometer(s). This is typically a very small adjustment, so the backlash and range parameters may not be affected. However, you should check to confirm.

Tracking

Tracking confirms the front and rear micrometers travel perpendicular to each other.

If the Tracking check is out of tolerance, determine if the accuracy is good enough for your application or return it to Brunson for repair or replacement.

1. Initially set both micrometers to zero.

2. Orient the Model 160 on a telescope so the front micrometer tracks parallel to the horizontal crosshair on a reference target.

3. Re-set the front micrometer to zero, then use the tangent screws to register both crosshairs precisely on the target.

4. Now rotate the rear micrometer to translate the instrument reticle vertically. The reticle should stay in register with the vertical target line over the entire range of travel. Allowable error for this test is ±0.0005″.

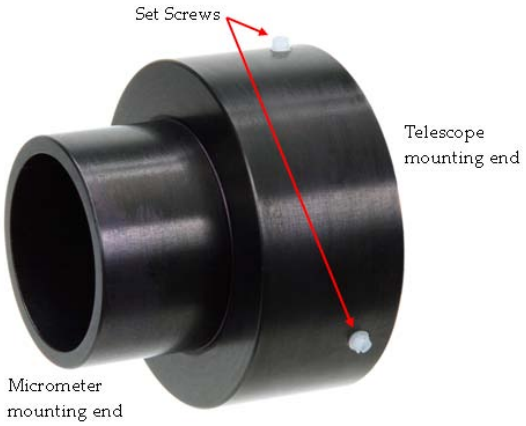
This parameter is not adjustable. If excessive error exists, determine if the accuracy is appropriate for your application or return it to Brunson for repair or replacement.

Adapter for 2.250″ Barrels

Micrometers may be mounted on various alignment telescopes and collimators. The 15206 Adapter connects the M190 and M160 micrometers to any 2.250″ diameter barrel.

Three set screws (two are shown below) attach the adapter to the instrument barrel. Notice the adapter set screws are nylon to avoid distorting the instrument barrel due to excessive torque.

When securing the adapter to the telescope barrel, do not over tighten the set screws as barrel distortion may occur.



Orient Micrometer on the Barrel

The M190 or M160 must be oriented to track the micrometers parallel to the instrument reticle.

1. Mount the adapter to the objective end of the telescope, then mount the micrometer on the adapter approximately parallel to the instrument reticle.

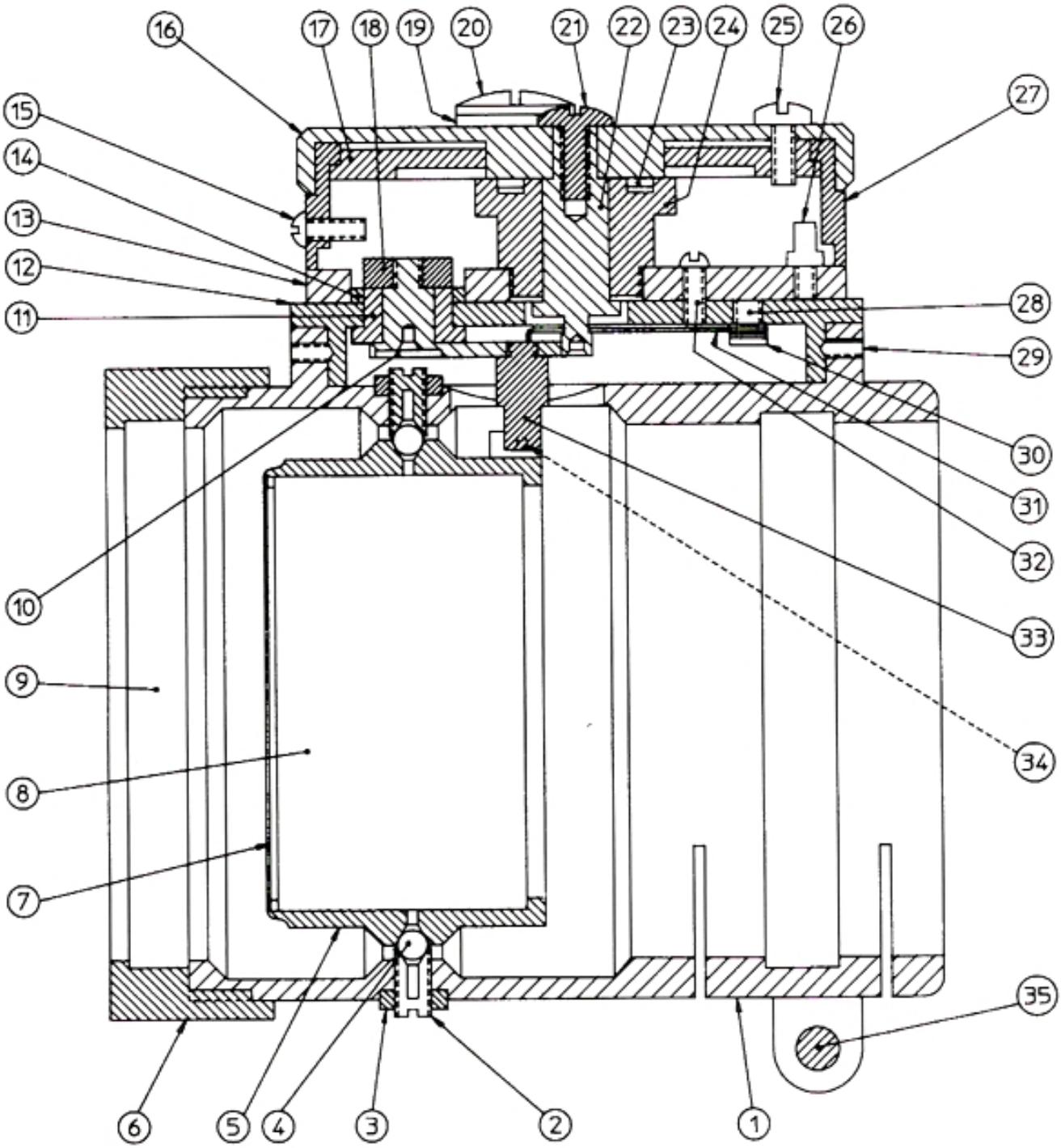
2. Focus the instrument on a finite reference target and precisely register the instrument reticle on the target.

3. Rotate the micrometer drum to track the instrument crosshair across a reference target. If the instrument reticle stays in register with the target, the adjustment is complete. If not, determine which way to clock the micrometer around the barrel to correct the tracking:

4. Make the appropriate clocking adjustment and check the tracking again. Repeat until the instrument reticle tracks parallel to the reference target.

Exploded Parts Diagram (see parts list on next page)

Note: The Model 190 is shown below. See parts listing on the next page for alternate parts specific to the Model 160.



Parts List

	Description	Part No.		Description	Part No.
1	Main Body Tube*	2557-1 (2560)	19	Adj. Screw Washer	2550
2	Window Pivot Screw**	2509-1	20	Adj. Screw Cap	5995
3	Window Screw Nut	2510	21	Pinion Screw	2513
4	Ball Bearing	1113-2	22	Pinion	2511
5	Window Mount*	2507-1	23	Brake Spring	2525
6	Glass Retainer*	2521	24	Pinion Bearing	2512
7	Window Retainer*	2522-1	25	Drum Clamp Screw*	F42E00256012
8	Window*	2520-1	26	Stationary Stop	F24E00172012
9	Cover Glass	2523	27	Graduated Drum*	2504-1
10	Sector Gear	2514	28	Retainer Screw	2534
11	Sector Bearing	2515	29	Screw: 2-56 x 1/8 SHSS, cone pt.	COMM
12	Drum Support	2558	30	Spring Retainer	2530
13	Index Disk	2506	31	Anti-Backlash Spring	2529
14	Sector Bearing Nut	2516	32	Index Disk Screw	2532
15	Movable Stop	2519	33	Crank Pin	2508
16	Knurled Drum	2503	34	Bar Spring	2535
17	Clamp Disk	2505	35	Thumb Screw	11301 (F22E00640040)
18	Sector Retainer Nut	2517			

* Specify model number when ordering
** Specify "top" or "bottom" when ordering

Part Numbers in parentheses ( ) are specific to the M160 dual plane micrometer