

NAVAIR 17-20MD-20

MD-20

TECHNICAL MANUAL
INSTRUMENT CALIBRATION PROCEDURE

OPTICAL COMPARATORS

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SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of Optical Comparators. Instruments that can be calibrated by this procedure include, but are not limited to the models listed in Appendix A. The instrument being calibrated is referred to herein as the TI (Test Instrument).

1.2 All comments concerning this procedure should be directed to Navy Measurement Science Directorate, Naval Warfare Assessment Division, P.O. Box 5000, Corona, CA 91718-5000.

1.3 This procedure includes tests of essential performance parameters only. Any malfunction noticed during calibration, whether specifically tested for or not, should be corrected.

Table 1. Calibration Description

TI Characteristics	Performance Specifications	Test Method
Light beam adjustment	Collimated and centered on screen	Lamp filament projected on screen and adjusted as required
Magnification	5X, 10X, 20X, 31.25X, 50X, 62.5X, 100X, and 125X	Comparison with ball and pin-chart magnification checker
Horizontal micrometer	Range: 0 to 1 inch Tolerance: ± 0.0001 inch	Comparison with gage blocks
Vertical micrometer	Range: 0 to 2.5 inches Tolerance: ± 0.0001 inch	Comparison with gage blocks
Table angular alignment	Within ± 0.000291 inch/inch of lens mount diameter	Measured with a dial indicator
Screen adjustment	Alignment fixture shadow to remain in contact with horizontal screen line	Fixture moved horizontally before the projection lens

SECTION 2

EQUIPMENT REQUIREMENTS

NOTE

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment, which may be used at the discretion of the using laboratory. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

The instruments utilized in this procedure were selected from those known to be available at Navy calibration facilities, and the listing by make or model number carries no implication of preference, recommendation, or approval for use by other agencies. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in this procedure.

Item	Minimum Use Specifications	Calibration Equipment
2.1 Gage block set	Style 2, Grade 2, Class I Range: 0.2 to 3 inches Uncertainty: $\pm 10 \mu$ in.	Pratt & Whitney Co. Set #88; or Webber RS88A1
2.2 Magnification checker	Four precision-ground balls and one pin. Pin 0.0625 inch diameter Balls 0.1875, 0.250, 0.625, and 1.000 inch diameters	Optical Gaging Products, Inc. Magnification checker catalog #20290 or 120290
2.3 Dial indicator	Range: 0 to 0.008 inch Uncertainty: 0.0001 inch	Brown & Sharpe Mfg Co. 599-7032 or 599-7032-3 or 599-7035-3
2.4 Universal surface gage	To hold dial indicator	Starrett 257C; or Brown & Sharpe 599-620-42; or Federal 2400
2.5 Steel parallels	Riser for support of V-block 1 to 1 1/4 inch	Taft-Peirce Mfg Co. Set 9150C
2.6 Steel toolmakers flat	Size: 6 inch diameter X 1 inch thick Flatness: 0.000010 inch	Acme Scientific Co. 6-inch diameter X 1 inch thick; or Van Keuren 23-006IG

SECTION 3

PRELIMINARY OPERATIONS

3.1 PRELIMINARY CONDITIONS

3.1.1 Ensure that the work area is clean, free from drafts, free from excessive humidity, and that the rate of temperature change does not exceed 2°F per hour.

3.1.2 Ensure that the calibration equipment is clean, and that the TI and the applicable calibration equipment have been allowed to stabilize at the ambient temperature.

3.2 PRELIMINARY INSPECTION

3.2.1 Verify that all of the TI surface components are clean and free from damage such as burrs, score marks, etc., that would impair their operation, and take any corrective action, if necessary, before proceeding.

3.2.2 Ensure that the TI glass viewing screen and mirror are clean and free from excessive scratches, chips, fractures, or other damage. If necessary, clean the glass surfaces as follows:

3.2.2.1 Remove all loose foreign material by brushing lightly and carefully with a clean camel's-hair brush or by using air forced from a small rubber syringe.

CAUTION

USE LENS CLEANING FLUID VERY SPARINGLY. IT MAY DETERIORATE COMPONENTS IN CONTACT WITH THE GLASS SURFACES.

3.2.2.2 If additional cleaning is required, lightly and gently wipe the glass surfaces with a clean lens tissue moistened with an approved lens-cleaning fluid, then dry by lightly patting with a clean, dry lens tissue.

NOTE

When wiping a window, prism, or mirror surface, always wipe from the center to the outer edge when the surface is horizontal, or from the top to the bottom when the surface is vertical. To minimize the possibility of scratching the surface with any foreign material that may be picked up on the lens tissue, constantly change the working portion of the tissue.

3.2.2.3 If necessary, rinse the lens-cleaning fluid from the glass surfaces by repeating step 3.2.2.2, substituting distilled water for the cleaning fluid, until all of the cleaning fluid is removed.

SECTION 4
CALIBRATION PROCESS

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met, before proceeding.

4.1 LIGHT BEAM ADJUSTMENT

4.1.1 Remove the TI magnification lens and install the TI light aligning diaphragm in the lens bushing.

4.1.2 Turn the TI line switch on.

4.1.3 Turn the TI projection lamp switch on. An image of the lamp filament or arc will appear on the screen.

4.1.4 Adjust the condensing lens assembly to obtain an image that is focused as sharply as possible.

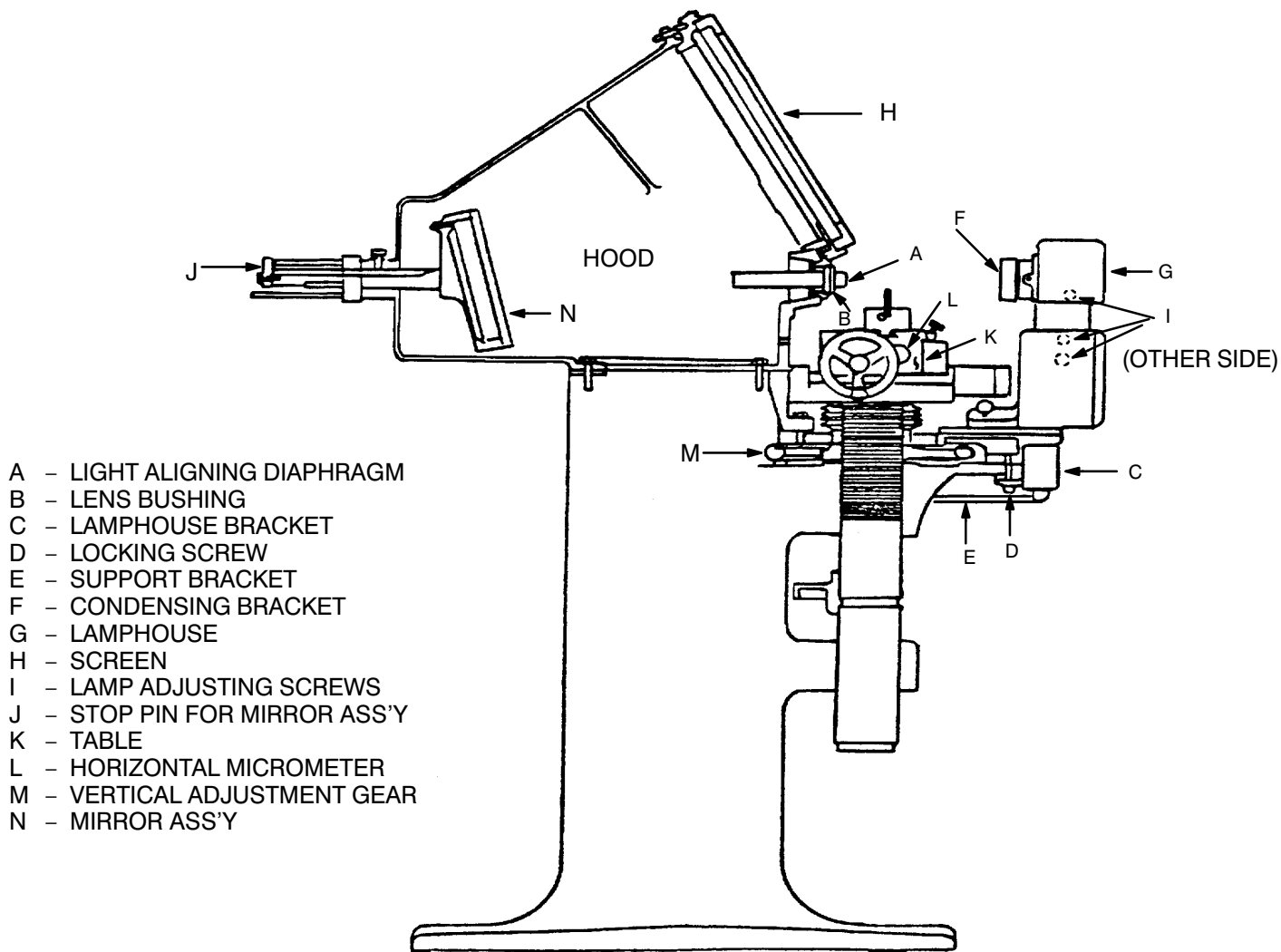


Figure 1. Typical TI Component Location and Identification

4.1.5 Verify that the lamp filament or arc image is centered on the screen both vertically and horizontally. If necessary, adjust the TI lamp adjusting screws on the lamp-house assembly.

4.1.6 Open the TI iris diaphragm fully. (This is located in the condensing lens assembly).

4.1.7 Verify that the TI light beam is collimated from the condensing lens to the light aligning diaphragm. To test the beam, place a white card directly in front of the condensing lens. Measure the diameter of the lighted area of the card. Move the card to place it against the lens bushing. Verify that the lighted area diameter is still the same. If not, move the condensing lens assembly as necessary so that the lighted area in both positions is equal.

4.1.8 Remove the TI light aligning diaphragm from the lens bushing.

4.2 TABLE ANGULAR ALIGNMENT TEST

4.2.1 Remove the TI projection lens from the lens mount.

4.2.2 Attach the dial indicator to the universal surface gage.

4.2.3 Adjust the TI table angle vernier to indicate zero.

4.2.4 Place the surface gage on the TI table and indicate from one side of the lens mount to the other side across the flat surface by moving the table from side to side. Verify that the dial indicator indication is within the tolerance limits.

4.3 MAGNIFICATION TESTS

4.3.1 Position the TI 10X magnification lens into the lens housing and rotate the TI stop pin spool as required to position the 10X stop pin.

4.3.2 Place the MAGNIFICATION CHECKER on the TI work table so that the applicable ball or pin may be observed on the screen.

4.3.3 Adjust the TI vertical, horizontal, and focusing controls so that a sharp outline (shadow) of the 1.000 inch steel ball is centered on the screen.

4.3.4 Position the MAGNIFICATION CHECK SCALE over the outline on the TI screen and verify that the outline is within the SCALE markings.

4.3.5 Repeat steps 4.3.1 through 4.3.4 except using the remaining magnification lens systems and stop pin spools and an appropriate size ball or pin to verify that the outline on the TI screen is within the scale markings for each lens.

4.4 HORIZONTAL MICROMETER TESTS

4.4.1 Set the TI horizontal micrometer to 0.0000.

4.4.2 Place a 1.000 inch gage block on the TI table with the gage block length parallel to the table length.

4.4.3 Adjust the TI vertical handwheel so that the gage block is centered vertically on the screen.

4.4.4 Adjust the TI focus control to obtain a sharply defined shadow outline of the gage block.

4.4.5 Adjust the TI lateral handwheel so that the right edge of the gage block is tangent to the vertical center line of the screen.

4.4.6 Move the TI adjustable anvil into contact with the micrometer and clamp the anvil to the table.

4.4.7 Push the TI table away from the micrometer spindle and insert a combination of gage blocks in the “V” trough between the anvil and micrometer to obtain the values in the following table. Allow the table to return so that the TI anvil clamps the gage blocks to the micrometer.

NOTE

The gage blocks used as a combination must be wrung together. Do not use more than three gage blocks in any combination.

4.4.8 Adjust the TI micrometer so that the right edge of the gage block is tangent to the vertical center line of the screen. Verify that each TI micrometer indication is within the tolerance limits.

TI Micrometer Setting and Gage Block Combination (inch)	Tolerance Limits (inch)		
0.2050	0.2049	to	0.2051
0.4100	0.4099	to	0.4101
0.6150	0.6149	to	0.6151
0.8200	0.8199	to	0.8201
1.0000	0.9999	to	1.0001

4.5 VERTICAL MICROMETER TESTS

4.5.1 Place the toolmakers flat on the TI table.

4.5.2 Wring the 0.500 inch gage block to the toolmakers flat, and position the gage block so that its shadow will occupy one-half of the screen.

4.5.3 Adjust the TI lateral handwheel to obtain a sharply defined image on the screen.

4.5.4 Adjust the TI vertical handwheel to place the top of the 0.5 inch gage block image tangent to the horizontal line of the screen.

4.5.5 Loosen the screw on the TI vertical graduated ring, adjust the ring to align the zero mark with the fixed pointer, and tighten the screw.

4.5.6 Position each of the gage blocks, in turn, listed in the following table beside the 0.500 inch gage block and wring the gage block to the toolmakers flat. Ensure that the gage block is positioned so that a sharply defined image is displayed on the screen.

4.5.7 Adjust the TI vertical handwheel to place the top of the gage block image tangent to the same horizontal line of the screen referenced in step 4.5.4. Verify that the vertical handwheel graduations are within the tolerance limits.

TI Vertical Handwheel Graduations	Gage Blocks (inch)	Tolerance Limits (inch)
0.5000	1.000	0.4999 to 0.5001
1.5000	2.000	1.4999 to 1.5001
2.5000	3.000	2.4999 to 2.5001

4.6 SCREEN ADJUSTMENT

4.6.1 Place alignment fixture on table top with its tongue in the table groove.

4.6.2 Move table vertically until the top of the vertical pin is approximately in the axis of the lens system.

4.6.3 Use focus control to project sharpest image of the fixture on screen.

4.6.4 Zero the graduated chart ring on the vernier.

4.6.5 Rotate the chart within the ring until the projected radius pin image remains tangent to the horizontal centerline when the test pin is moved laterally in front of lens.

4.6.6 When the alignment is complete, secure screen with clamp if equipped.

CALIBRATION CHECKLIST

TEST INST (S) Jones & Lamson PC-14, PC-14A, or TC-10D Optical Comparators

PROC. NO.	NA 17-20MD-20	MFG.	MODEL		SER. NO.	
PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES		OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
			FIRST RUN (4)	SECOND RUN (5)		
3.2	Preliminary Inspection					
3.2.1	Clean and undamaged	—	ck ()			
3.2.2	Screen and mirror	—	ck ()			
4.1	Light Beam Adjustment					
4.1.5	Vert & horiz center	—	ck ()			
4.1.8	Parallel test	—	ck ()			
4.2	Table Alignment Test					
4.2.4	Indicator	0.000 in.				±0.000291 inch
4.3	Magnification Tests					
4.3.5	5 X (PC 14A & TC10)	—	ck ()			
"	10 X	—	ck ()			
"	20 X	—	ck ()			
"	31.25 X	—	ck ()			
"	50 X	—	ck ()			
"	62.5 X	—	ck ()			
"	100 X	—	ck ()			
"	125 X (PC 14A & TC10)	—	ck ()			
4.4	Horizontal Micrometer Tests					
4.4.8	Micrometer reading 0.2050 in.			0.2049	to	0.2051 inch
"	" "	0.4100 in.				0.4099 to 0.4101 inch
"	" "	0.6150 in.				0.6149 to 0.6151 inch
"	" "	0.8200 in.				0.8199 to 0.8201 inch
"	" "	1.0000 in.				0.9999 to 1.0001 inch
4.5	Vertical Micrometer Tests					
4.5.7	Displacement Ring	0.5000				0.4999 to 0.5001 inch
4.5.8	" "	1.5000				1.4999 to 1.5001 inch
"	" "	2.5000				2.4999 to 2.5001 inch

APPENDIX A

REPRESENTATIVE TEST INSTRUMENTS

A.1 TIs that can be calibrated by this procedure include, but are not limited to, the following:

Manufacturer	Model	Nomenclature
Jones & Lamson	FC-14	Optical Comparator
”	FC-30	”
”	PC-14	”
”	PC-14A	”
”	TC-10A	”
”	TC-10D	”
”	TC-14	”
”	TOPIC-14	”
”	E-114	”