Laser Doppler Displacement Meter
Laser Measurement System

Title:

Incoming inspection procedure

Document identification: MCV 4000 incoming

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1 Scope

The scope of this document is to define the procedure and methods for tl inspection and acceptation of the product.
The system come with a performance certificate, so it is not necessary test the performances but only the integrity after trasportation.

1.1 Product Description

The Laser Doppler Displacement Meter, referred to herein as LDDM™, an instrument system which measures displacement to an accuracy one part in one million (1 ppm). A laser is positioned on the axis alor which the target moves. The laser beam is returned by a reflectc mounted on the axis along which the target moves. The reflected beam detected near the laser source: the original and reflected beams rı parallel, adjacent paths. After detection the displacement information calculated and sent to a digital display for read-out .

The LDDM™ instrument system consists of four components; a Las Head Module, Retroreflector, Processor Module and a Display Module Notebook omputer as shown in Fig. 2-1, LDDM™ System Blo

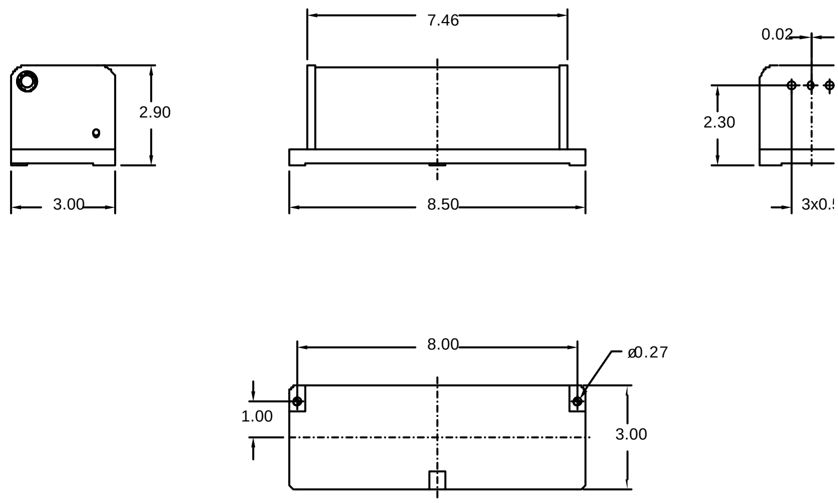


FIG. 2-4 LASER HEAD MODULE
OUTLINE & MOUNTING DIMENSIONS

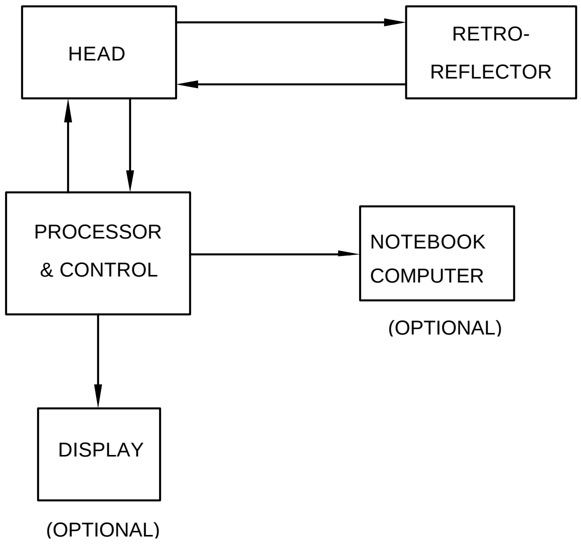


FIG. 2-1 LDDM SYSTEM BLOCK DIAGRAM

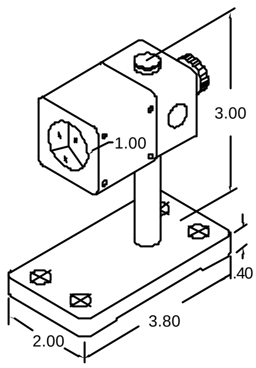


FIG. 2-3 RETROREFLECTOR AND HOLDER

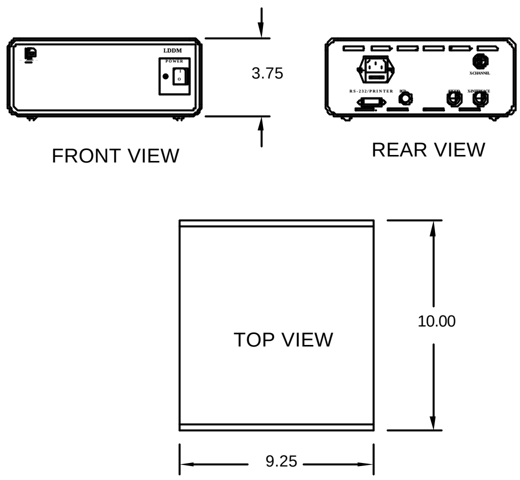


FIG. 2-4 PROCESSOR MODULE
OUTLINE DIMENSIONS

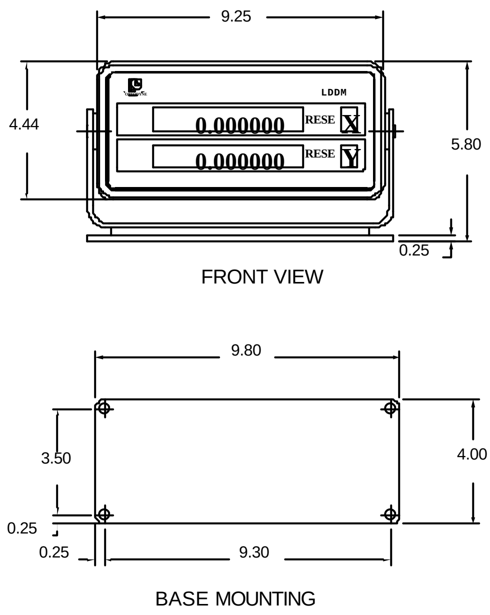


FIG. 2-5 DISPLAY MODULE, PHYSICAL LAYOUT

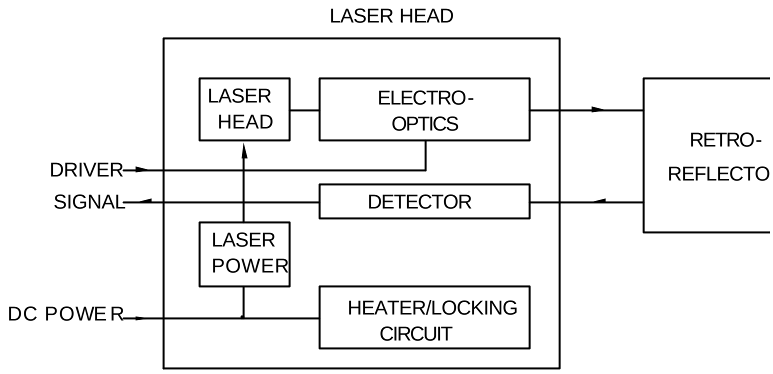


FIG. 2-6 LASER HEAD MODULE, BLOCK DIAGRAM

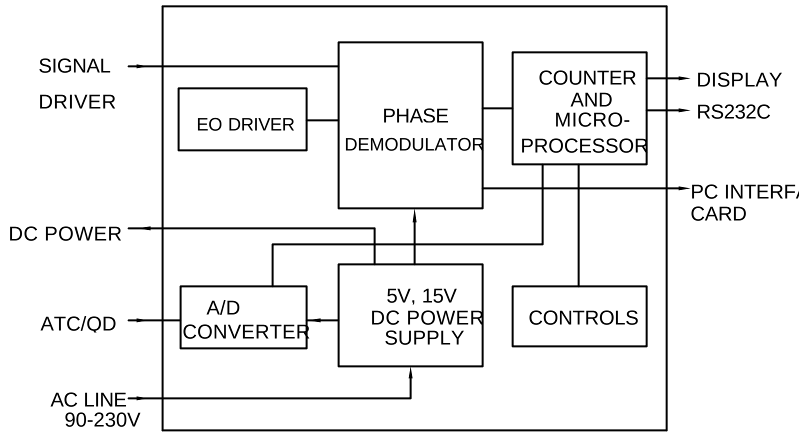


FIG. 2-7 PROCESSOR MODULE, BLOCK DIAGRAM

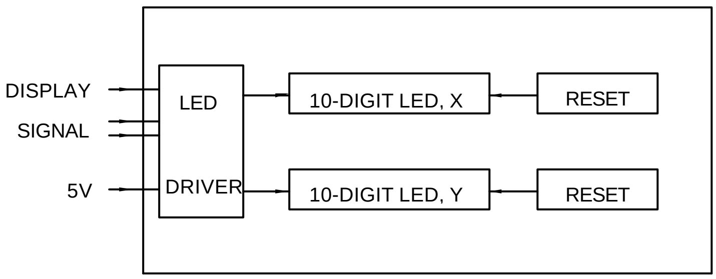


FIG. 2-8 DISPLAY MODULE, BLOCK DIAGRAM

3.0 Warranty and Certification

3.1 Warranty

Optodyne, Inc., warrants that each new instrument which it manufactur and sells is free from defects in material and workmanship unde recommended use and service conditions for 1 year.

3.2 Certification

Optodyne, Inc. certifies that this product meets its published specificati (see section 2.3) at the time of shipment from the factory.

3.3 Calibration

The fundamental accuracy of the LDDM™ is based upon the waveleng stability of the laser used in the system. This wavelength has bee measured to be 632.81994 ±0.0005 nm (24.914171 µin) at ambie conditions defined as follows:

Temperature:	68° Fahrenheit
Pressure:	29.90 inches of mercury
Relative Humidity:	40%

A calibration constant of 80275.60 counts per inch has been programm into the microprocessor within the Processor Module. . A certificate calibration which is traceable to the National Institute of Standards a Technology, NIST, is provided.

4 Hardware, Options and Accessories

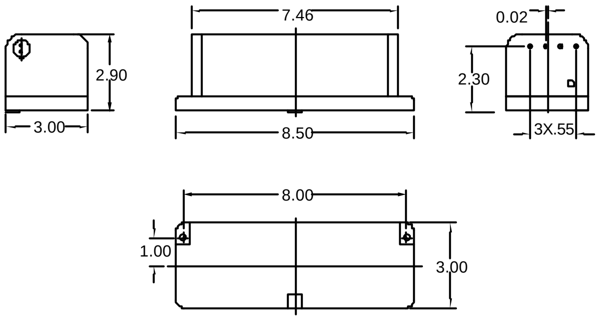


FIG. 6-4 LASER HEAD MODULE OUTLINE (Dual - b
& MOUNTING DIMENSIONS

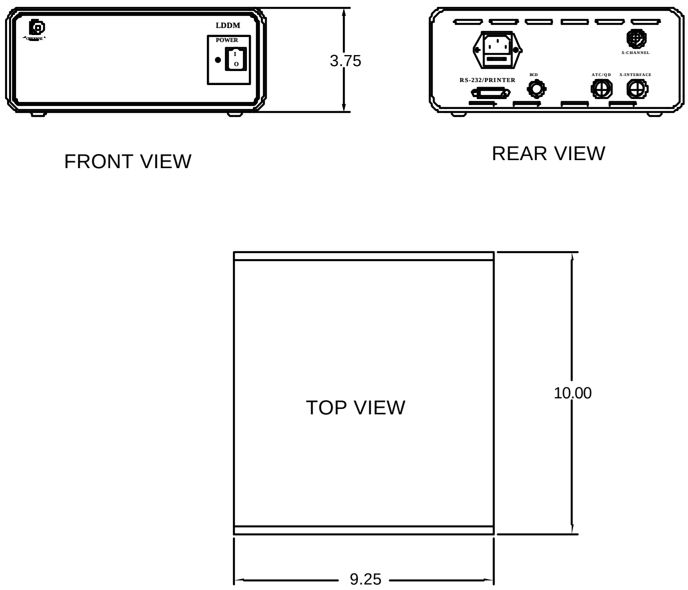
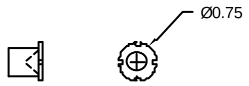
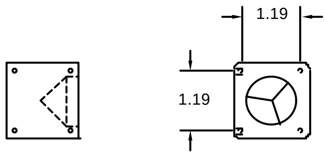


FIG. 6-5 PROCESSOR MODULE
OUTLINE DIMENSIONS

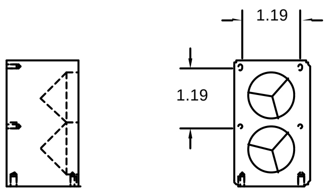
Ø1/4" RETROREFLECTOR



1/2" RETROREFLECTOR



1" RETROREFLECTOR



1" DUAL RETROREFLECTOR

FIG. 6-7 OUTLINE & MOUNTING DIMENSIONS OF RETROREFLECTOR

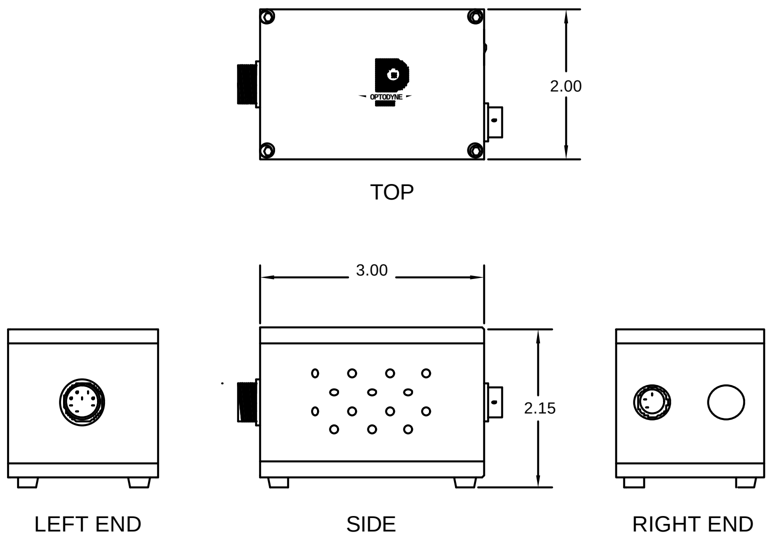


FIG. 6-9 ATC SENSOR

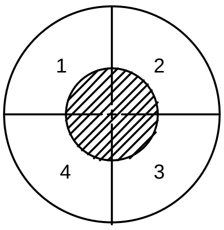


FIG. 6-10 SCHEMATIC
OF QUAD-DETECTOR

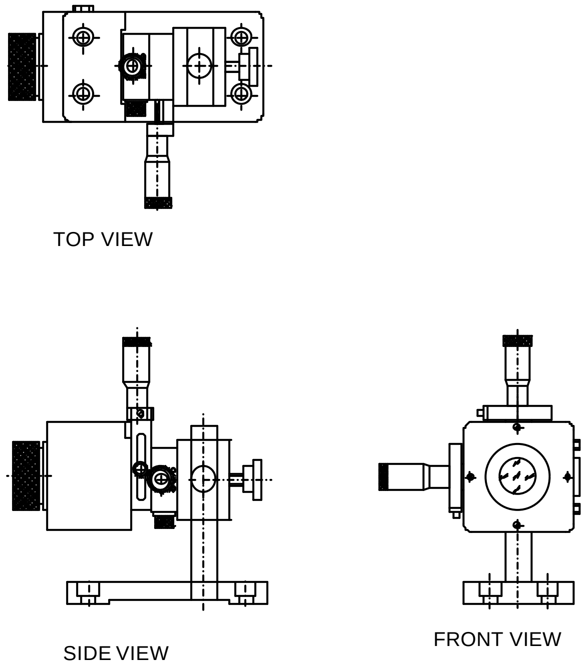


FIG. 6-11 QUAD-DETECTOR
WITH MOUNT

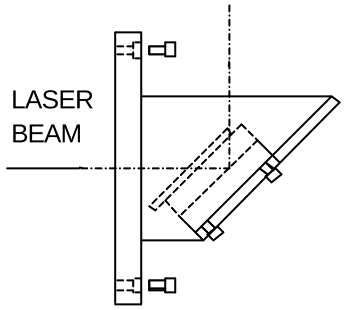


FIG. 6-12 90° BEAM BENDER

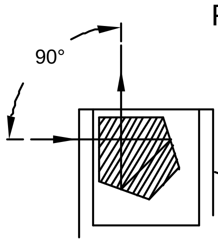


FIG. 6-13 SCHEMATIC OF A PENTA-PRISM

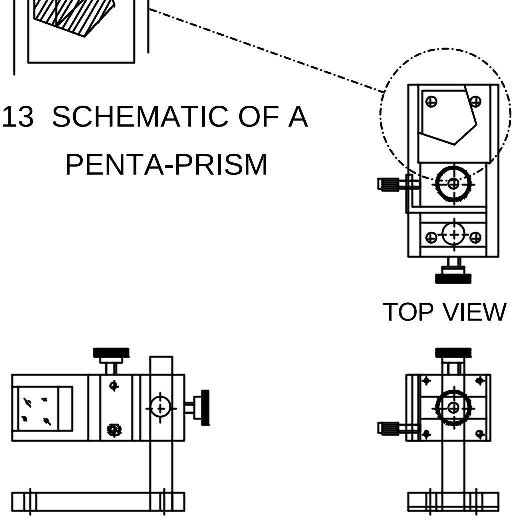


FIG. 6-14 OPTICAL SQUARE WITH MOUNT

5. Checking procedure

5.1 Visual inspection

5.1.1 Check that all the components in the list of purchase a present and are in good condition and not are damage I transportation.

6.0 Displacement and Straightness Measurement

6.1 Introduction

The LDDM™ Flatness and Angle Measurement Package is designed measure pitch or yaw angle, straightness (angular method) and surfac flatness (see section 9). It incorporates a specially designed LDDM™ Dual-beam laser head which measures both the linear and angula displacement of the dual-retroreflector. With a 2-channel processo module, both the linear and angular displacement can be measure simultaneously. The vertical straightness can be obtained by integratin the pitch angle measured along the travel. Similarly, the horizonta straightness can be obtained by integrating the yaw angle measure along the travel. For more discussion on this technique, see Appendix I A notebook computer (or any IBM PC compatible computer) can be used collect data and plot the pitch or yaw angles and vertical or horizont straightness.

6.2 Hardware Required

Dual beam laser head	L-104
Processor module with RS-232 Interface	
(single-channel)	P-111
or (dual-channel)	P-210
Dual retroreflector	R-103
Alignment kit (flatness and angle)	LD-32
Adapter platform for dual-beam head	LD-14DB
Surface flatness kit	LD-24
12 ft cable set	LD-21
Angular measurement program	S-103R
Options:	
Notebook PC Computer	LTC
Automatic Temperature Compensation	IATC
Special straight-edge	LD-43

6.3 Installation and Alignment

6.3.1 Installation mount the system on a lineas stage following tl description

8.5.3. Description

1. Decide which axis of travel you want to measure, which part i moving and which part is stationary for this axis of motion. It is noted that the movable part of the machine may depend on the axi you are measuring. That is, the X-axis movable part may nc necessarily also be the Y-axis or Z-axis movable part (see Fig. 7 10, 7-11, 7-12).

2. Mount the laser head on the stationary part, the retroreflector on th moving part. Move the movable part of the machine to the startin point or the end point, then mount the retroreflector as close to th laser head as possible.

3. Adjust the laser head or the alignment mirror such that the outpu beam is parallel to the direction of travel.

4. Move the retroreflector perpendicular to the laser beam direction s that both return beams enters the respective receiving apertures c the laser head.

5. Move the movable part from the starting point to the end and mak sure that the beam intensity is above the minimum requiremen along the entire measurement path.

6. Now the laser is aligned and ready to do the measurement. If yo are using a computer to collect data, please turn on the compute and load the appropriate software. If you do not use a computer press X-reset on the display module to change the measuremen mode (see Appendix C for detailed description of the variou different modes) and to reset the X-display to zero.

7. If you are using automatic temperature and pressur compensation, locate the air temperature and pressure senso near the laser beam path and the material temperature senso near the lead screw or the machine bed.

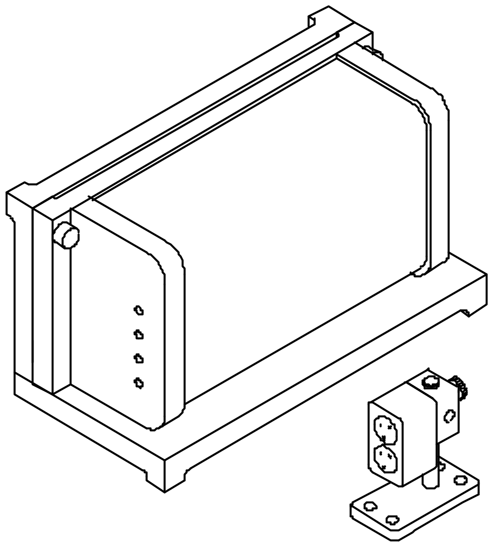


FIG. 8-1 DUAL-BEAM LASER HEAD AND
DUAL-RETROREFLECTOR FOR
PITCH ANGLE MEASUREMENT

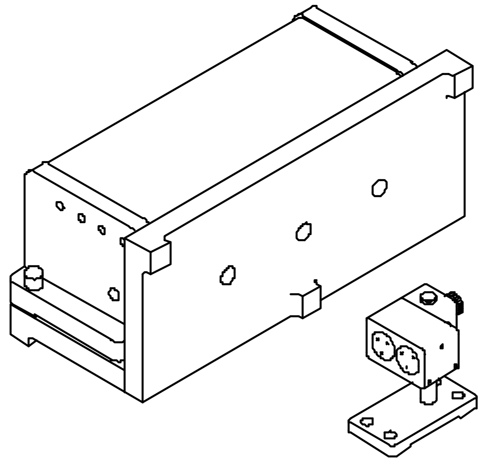
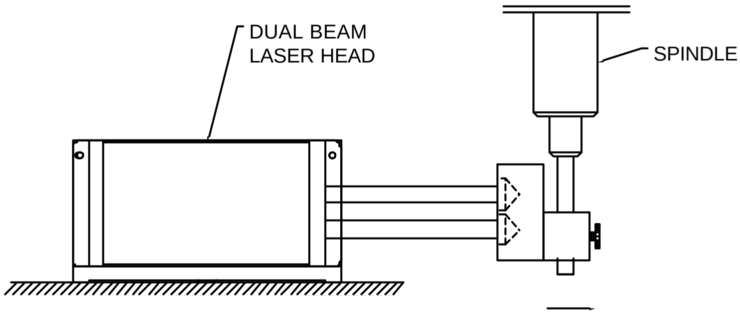
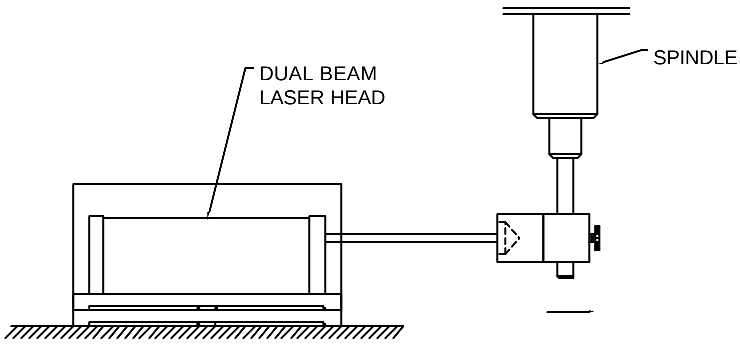


FIG. 8-2 DUAL-BEAM LASER HEAD AND
DUAL-RETROREFLECTOR FOR
YAW ANGLE MEASUREMENT

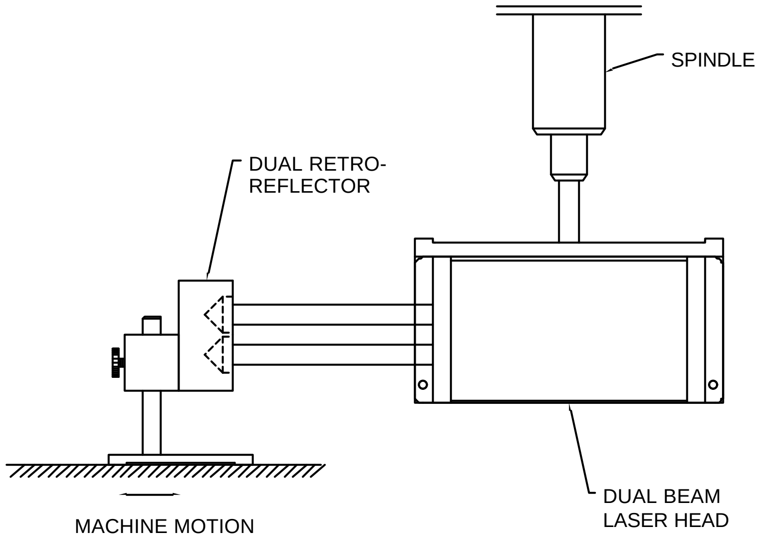


PITCH MEASUREMENT, TABLE MOUNT

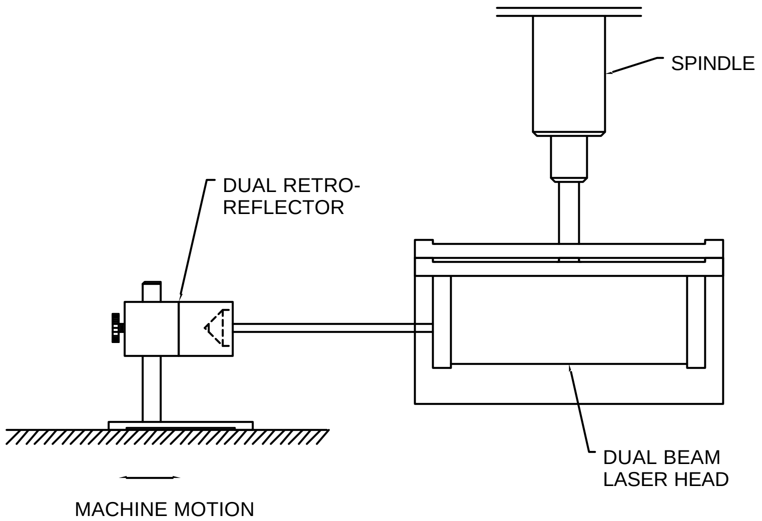


YAW MEASUREMENT, TABLE MOUNT

FIG. 8-3



PITCH MEASUREMENT, SPINDLE MOUNT



YAW MEASUREMENT, SPINDLE MOUNT

FIG. 8-4

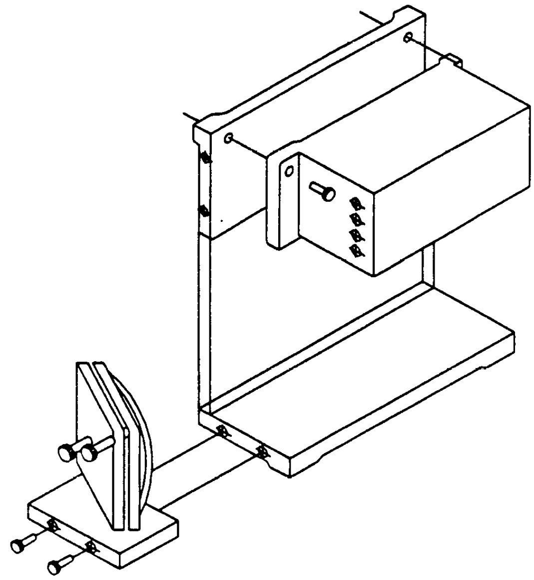


FIG. 8-5a PITCH MEASUREMENT WITH AN ALIGNMENT KIT

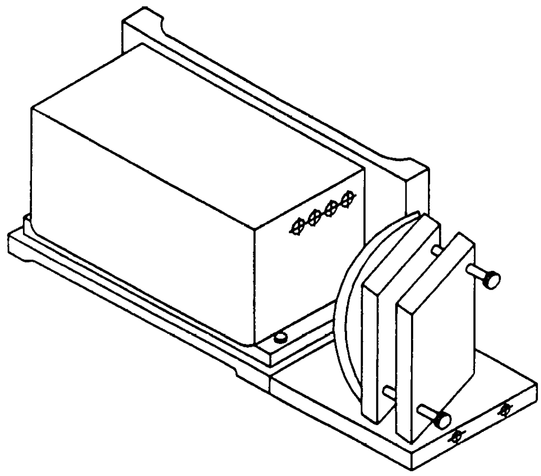


FIG. 8-5b YAW MEASUREMENT WITH AN ALIGNMENT KIT

6.4 Alignment Procedure

1. Make sure the two output laser beams are in the vertical plane fo pitch angle measurement and in the horizontal plane for ya angle measurement.

2. Make sure the Laser beam is parallel to the stage travel by usin magnetic cross or masking tape as a target.

   A) When the target is near the laser head, move the cross t the center of the beam.
   B) When the target is away from the laser head, move the lase beam to the center of cross, by steering the beam.
   C) Repeat A and B until laser beam is parallel to the stag travel.

3. For pitch angle measurement, with table mount, move the dua retroreflector, not the laser beam, so that the top laser beam i returned by the top retroreflector to the center of the top receivin aperture with the intensity reading at maximum. The lower lase beam should be returned by the lower retroreflector to the cente of the lower receiving aperture with the intensity reading a maximum. Otherwise, rotate the laser head or the dua retroreflector slightly. Please note that for standard processo module, when the linear-detector is connected, the Y displa shows the signal intensity of the product of the top laser bea and the lower laser beam. For a 2-channel processor modul when both the linear-detector and angular-detector ar connected, the number of bars on X is proportional to the sign intensity of the top laser beam and the number of bars on the Y display is proportional to the signal intensity of the product of th top and lower laser beam.

4. Move the stage in and out and be sure (check) that the intensit reading is at maximum. (See Section 7.5.4).

6.5 Software Description

The Straightness/Angular Measurement setup is almost the same as th linear measurement, with the difference being the need to define th orientation of the laser head.

Straightness Measurement Main Display (Fig. 5-1)

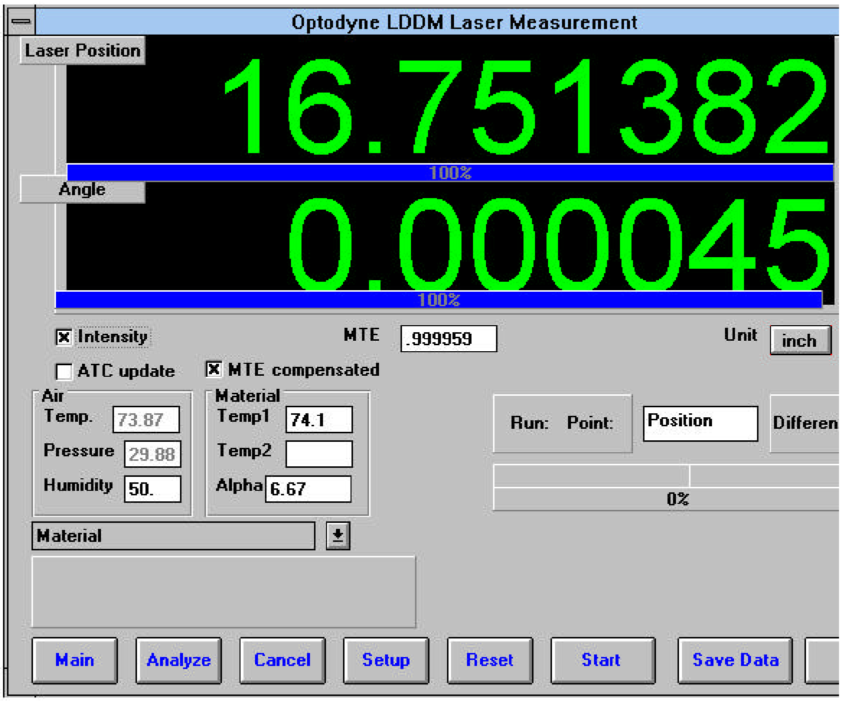


Fig. 5-1 Straightness Measurement Main Display

The display, in the straightness mode, shows the linear distance traveled on the top line, and the difference between LDDM #1 and LDDM #2 for the second line. If this second line value is divided by 1.1 (inches) or 27.94 (mm) then the value is in radians.

Straightness Measurement Setup Screen (Fig. 5-2)

Click the mouse button while the vertical bar is over the box. Use the arrc keys and the delete key to erase the previous information. Then input tl new information.

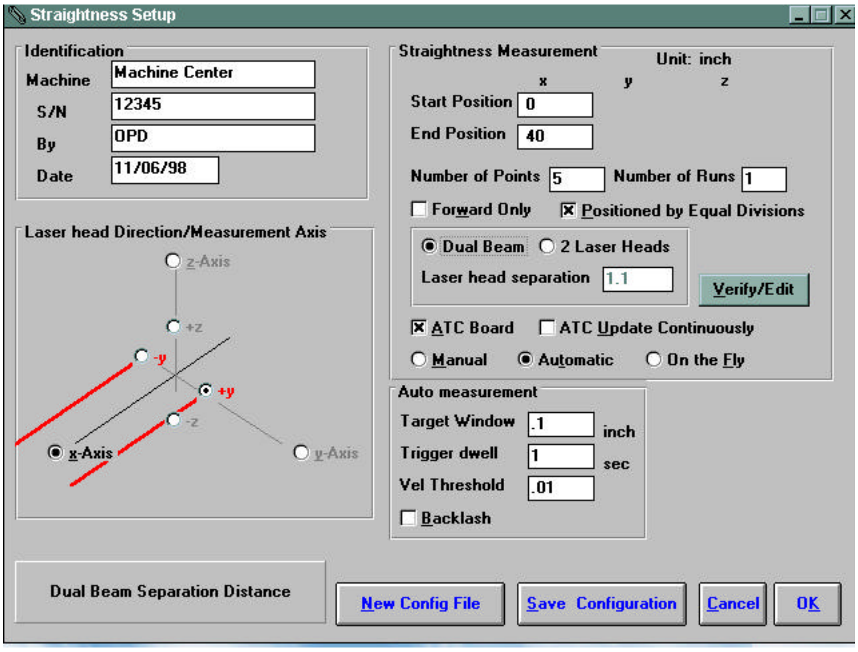


Fig. 5-2 Straightness Measurement Setup Screen

Identification Box:

The identification of the machine, i.e. the machine type, serial number, tl person doing the calibration, and the date, is entered here and is saved the data file. The date is automatically entered using the computer syste date.

Laser head direction/Me asurement Axis Box:

1) Choose which axis the lasers are pointed in (**X**, **Y** or **Z** axis). In Fig. 5- it is the X-axis.

2) Double click the **X-axis**, **Y-axis** or **Z-axis** axis button until the red bear are pointing in the direction that the laser is pointed in referenced to tl machine.
3) Choose the axis of the straightness measurement. The two beams the laser head are in the same plane of the straightness measurement.

Straightness Measurement Box:

Set: Start/End Position, Number of Points, Number of Runs
Verify/Edit: Click on this button to see the data acquisition setup
ATC Board: If you have an ATC board, please click the mouse here ar make a X mark. If you do not have an ATC board, please make sure th there is no X mark there.
Please choose the type of measurement you wish to take:
Manual: The Start ill turn into a "TAKE" button after the measuremer begins. At every collection point, this button will have to be pushed.

Automatic: The software will collect data every time the retroreflect comes within a "Target Window", drops under a certain velocity and sits s for a designated dwell time.

On-the-Fly: The software will automatically take data as soon as it sensed that the retroreflector is within the "Target Window" of the targ position.

Auto Measurement Box:

Target Window (automatic and on-the-fly): For automatic and on-the- measurements, being within this value of the target position allows th software to take data. For on-the-fly measurements, the maximum spee is 10 times the target window.
Trigger dwell (automatic only): For automatic measurements, the settlir time of the machine (typically 3-5 seconds) is entered here. Choose value of at least 2 seconds less than the programmed machine dwell time

Vel Threshold (automatic only): This is the threshold that the retroreflect must drop underneath so that a data point can betaken.

Backlash (automatic only): If the box has an X, backlash at the end ar beginning of each run (other than the first point) will be taken. The distan necessary to remove the backlash and allow the software to re-trigger twice the target window.

6.6 Example of a Straightness Measurement

Straightness Measurement Main Display (See Fig. 5 -1):

Choose your material from the list given. Press the **Down arrow** key ar you will get a list, press the **Down arrow**, or **PgDn** key from there to scr down.

Move your retroreflector to the beginning of your run. Click on **Start**.

If you are running the automatic program, you will see a stoplight appea The red means that the conditions for a measurement have been me (inside the target window, and the velocity is lower than the given one) yellow means that the delay is being counted and the green means that tl data has been collected and the program is waiting for you to move to tl next point (Fig. 5 -3)

On-The-Fly: If you are running the On-The-Fly program, you will also se the stoplight appear. The light will turn red when a data point is taken ar green when it is ready to take another data point. If you move faster tha the target window allows for, you will hear a continuous beeping noise Please move the retroreflector backwards until the beeping stops, the move it forwards again.

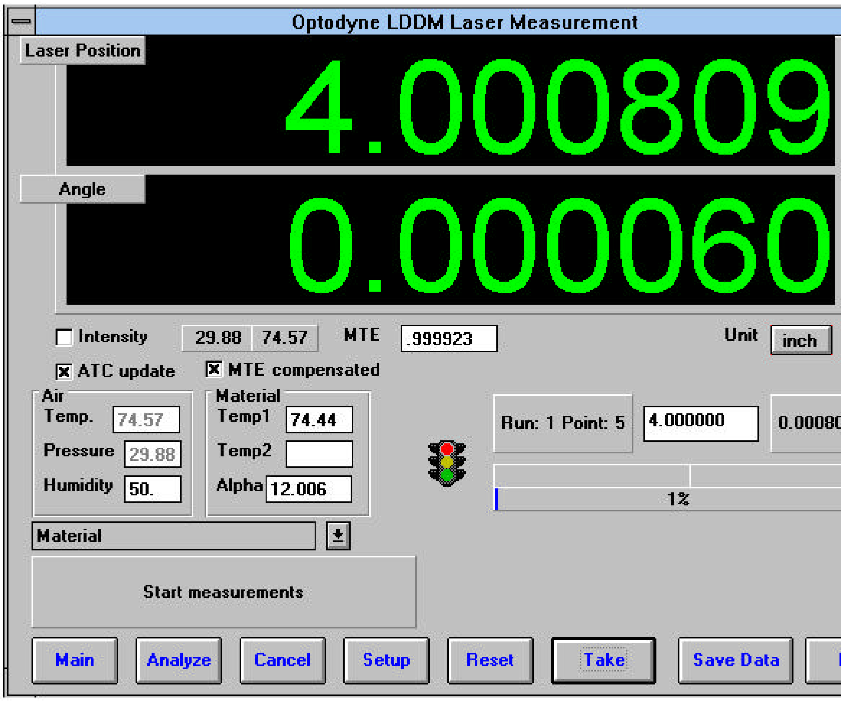


Fig. 5-3 Automatic Straightness/Linear Data Collection

After all the data is taken, press **OK** to save the data, or **Cancel** to not sa the data.

To analyze the data click on the **Analyze button**. When it prompts yo unload the module, unless you are taking a flatness measurement.

6.7 Straightness Data Analysis Menu

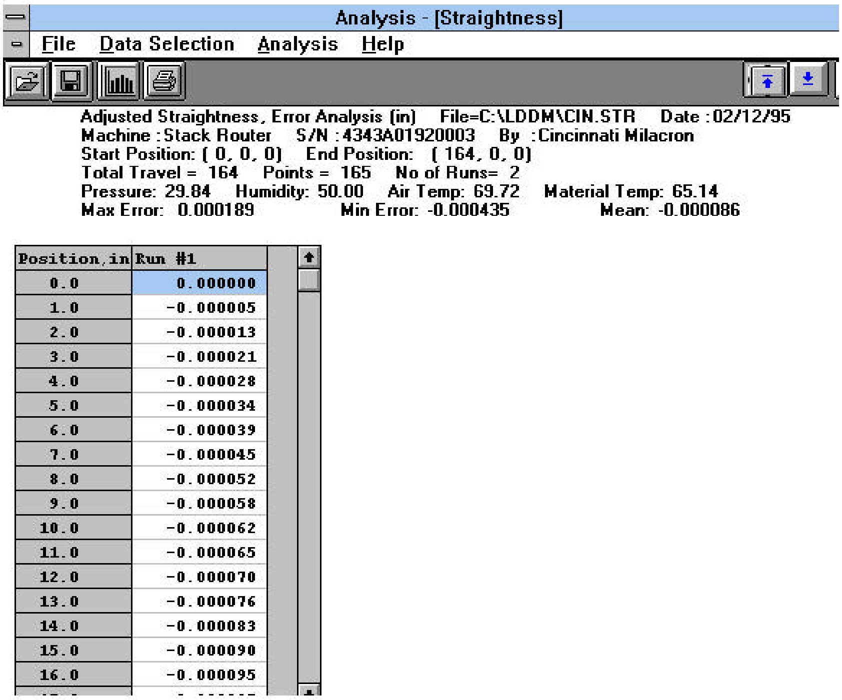


Fig. 5-4 Straightness Measurement Data Analysis Table

Under the **Data Selection** heading, you may choose **displacement** dat **angle** data, **straightness** data, and **adjusted straightness** data when lookii at a straightness (.STR) file.

Under **Analysis**, you can choose **Error**, **NMTBA**, **NMTBA with Zero Shift**, **V 3441**, **ISO ASME B5.54** or **ASME B5.57** for different types of da manipulation. After choosing **Error**, you will be given a choice on what yo wish to see, **Runs #1-7**, and **forward** or **backward**. Click with the mous button on which runs you wish to see.

The following icons have the following function in Analysis:

 Open a new data file.

Save a data file.

Graph a data file (After graphing, you may also change the scaling the graph by checking X on adjust grid).

Print a data graph (for printing data tables, use the Print option und the “File” heading)

Moves to the previous screen.

Moves to the next screen.

Exits the program.

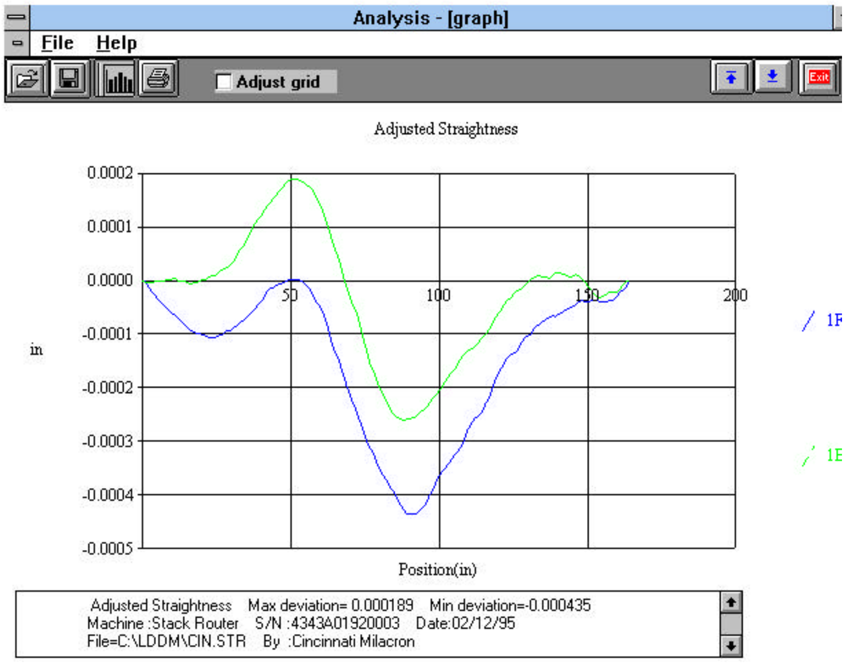


Fig. 5-5 Adjusted Straightness Measurement Data Plot

6.8 Taking a Measurement

1. Decide which axis you are going to measure, from which startin point to which end point, and what the increment per stop is. Key i all this information into the computer.

2. For manual data collection, you need to program your machine controller with the specific increment per stop, total number of stop (or total travel) and the speed. Minimum dwelling time at each sto should be 3 seconds.

3. For on-the-fly data collection, you need a dual-channel processo module. Program your machine controller with speed no more tha 1 ips.

4. Set up the LDDM™ by following the instructions in Section 8.5.

5. Set up the computer and load the appropriate software by followin the instructions in Section 7.6 or the software manual.

6. All of the software are menu-driven, just follow the instructions o the monitor.

7. Move the machine to the starting point.

8. Reset the LDDM™ reading, press the start key, then move the machine to the first stop (for on-the-fly measurement, move the machine continuously to the end point).

9. Move the machine to the next stop and repeat step 8.

10. Repeat step 9 until the end point.

11. After all the data have been collected, if a printer is connected, yo may print the data in table format or plot in graphic form.

12. You may plot the data in angle (pitch or yaw) with the units in µrad c arcsec, or integrate the angular data to plot as straightness in unit of inches. Here, the straightness plot assumes the initial angle o slope is equal to zero.

13. The adjusted straightness is defined as rotating the straightnes measured in step 12 by an angle, such that the deviation at both th starting point and end point is zero.

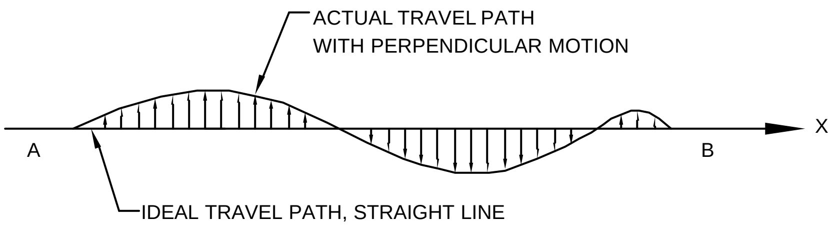
14. Typical plots of pitch angle in µrad, pitch angle in arcsec straightness and adjusted straightness are shown in Figs. 8.7, 8.8 8.9 and 8.10 respectively, and their data is shown in Table 8.1.

Squareness, Parallelism and Straightness Measurement

9.1 Introduction

In determining machine geometry, a laser beam is used to produce a ultra precision equivalent to the straight-edge. An optical square is us to bend the laser beam precisely at a 90° angle, and a quad-detector used to determine the centroid of the laser beam.

A straightness measurement is the measurement of perpendicul motion along a travel path as shown in Fig. 10-1.



DEFINITION OF STRAIGHTNESS
FIG. 10-1

The ideal travel path is a straight line. Any deviation from the straight li in the horizontal direction is called horizontal straightness. In the vertic direction it is called vertical straightness.

Attach a target with a cross in the center to the travel mechanism and ali the cross to the center of the laser beam, as shown in Fig. 10-2. Assun the laser beam travels from A to B and follows the ideal path. The cent of the cross should follow the actual travel path. By measuring how far t cross is deviated from the center of the laser beam along the travel pat we can determine the straightness.

For more accurate measurement, the centroid of the laser beam can b measured by using a quad-detector which is a large area photodetect cut into four quadrants, as shown in Fig. 10-3.

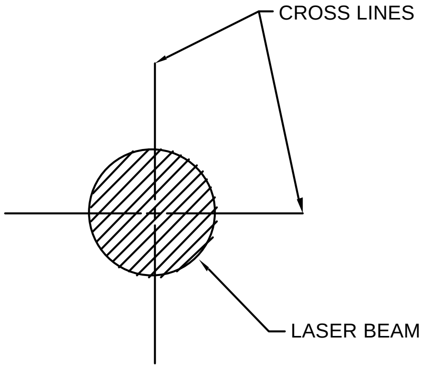


FIG. 10-2 LASER BEAM AND CROSS-LINE TARGET

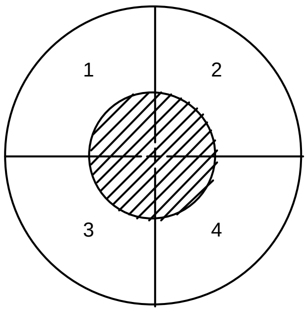


FIG. 10-3 QUAD-DETECTOR AND LASER BEAM

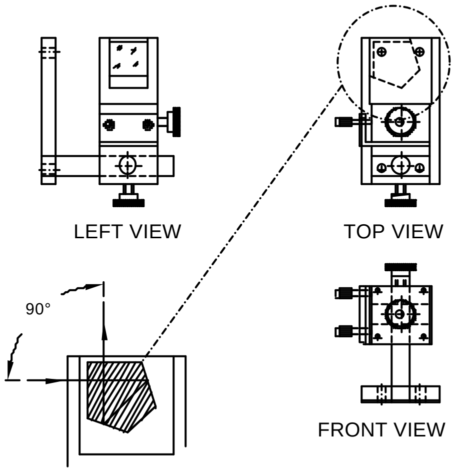


FIG. 10-4 SCHEMATIC OF A PENTA-PRISM

9.2 Hardware Required

The basic hardware and software required for linear calibration are the following:

a.	Dual Aperture Laser Head	L-101
b.	Processor Module with RS-232 Interface	P-111
d.	Ø1" Retroreflector	R-106
e.	Quad-Detector	LD-42
f.	Optical Square	LD-16
g.	90° Beam Bender (Ø1")	LD-15
h.	Magnetic Base	LD-03
i.	Adapter Platform	LD-14
j.	12 ft. cable set	LD-21
k.	Notebook Computer	LTC

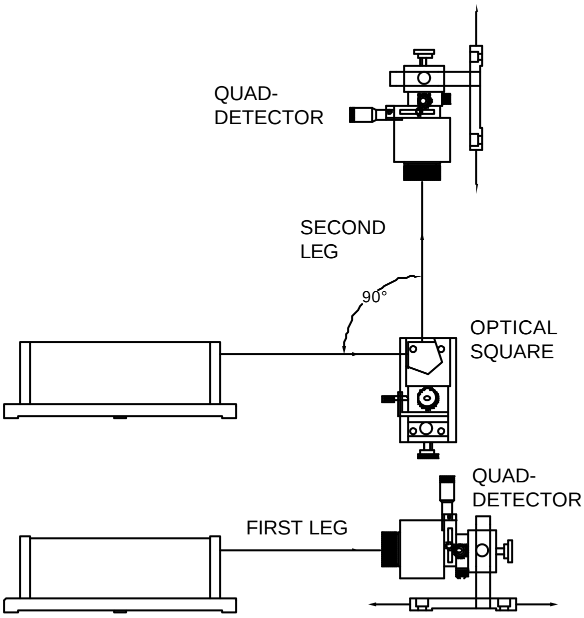


FIG. 10-5 SQUARENESS MEASUREMENT SETUP

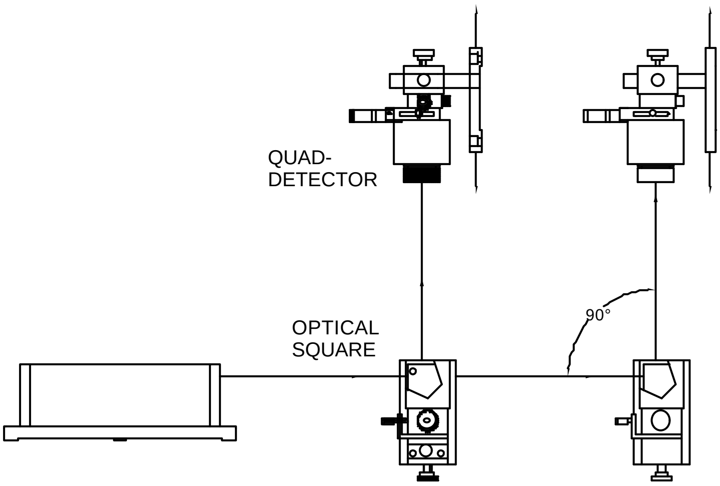
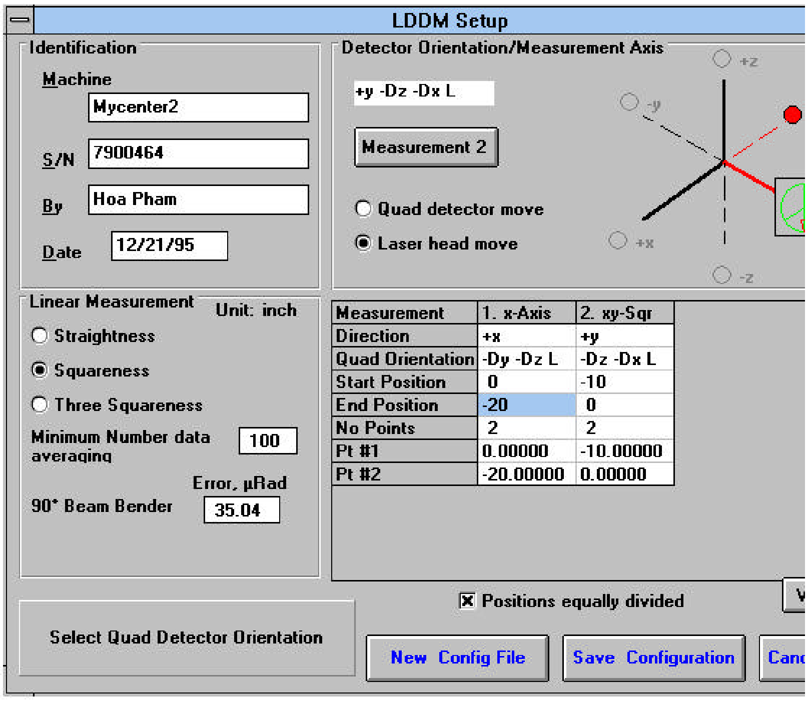


FIG. 10-6 PARALLELISM MEASUREMENT SETUP

Example of a Squareness Measurement

Go to the setup screen (Click on **Setup** at the bottom of the screen)

Enter the type of measurement, **Straightness**, **Squareness** (1 optic square), **or Three-Squareness** (2 optical squares).Enter your **machi information** and



Determine which piece is fixed, the **quad detector** or the **laser head**.

Rotate the quad detector icon so that the arrows are pointed in the corre MACHINE axes. To rotate, click the left mouse button on the **quad detect square** icon.

Edit the **measurement setup**, enter the start/end MACHINE coordinates ar the number of points.

Press **View/Edit** to check your increments.

After completing the first axis, press the **Measurement 1** button.

Setup your system in the second axis. Repeat steps 10-14. Repeat up to times (if you have chosen 3 squareness).

After you are finished setting up the measurement, a setup complete message will appear
Press **OK** to exit the setup screen. You are now ready to tal measurements.

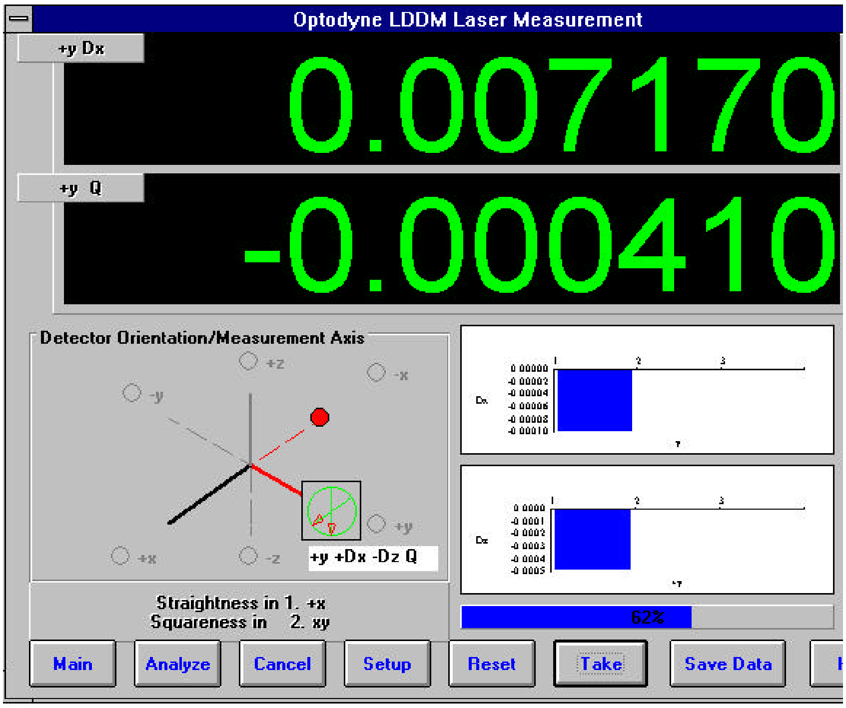


fig. 7-4 Manual Squareness Data Collection

Taking Data Points for a Squareness Measurement

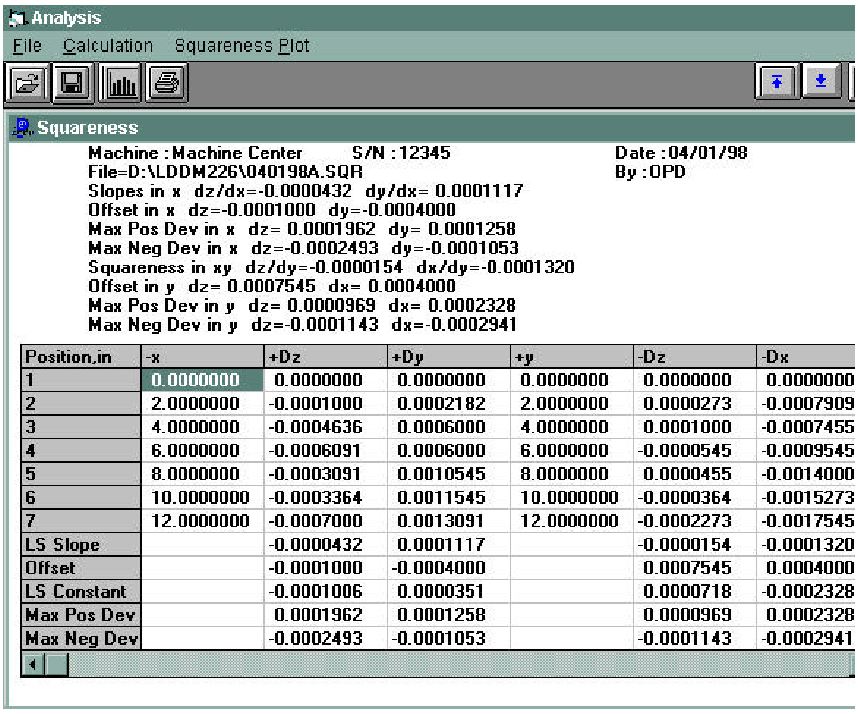
Align the quad detector according to your setup and the procedure in th User's Guide. Last minute changes may be made in the bottom left har graph of the measurements.
Press **Start**. Move to each point along the first axis and press the **Tal** button. A countdown of data points being averaged is shown. When yc are done with your first axis, the Take button will change into **Start Axis 2**.

Setup your second axis and press the **Start Axis 2** button, repeat 19.

After finishing all of your data points, a save file message will appeai Press **Yes** and type in your **filename** to save your data (the extension .SQR is automatically added).

Check your results by clicking on the **Analysis** button and opening your fi for squareness.

7.4 Squareness Data Analysis (Fig. 7-5, 7-6)



Position,in	-x	+Dz	+Dy	+y	-Dz	-Dx
1	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
2	2.0000000	-0.0001000	0.0002182	2.0000000	0.0000273	-0.0007909
3	4.0000000	-0.0004636	0.0006000	4.0000000	0.0001000	-0.0007455
4	6.0000000	-0.0006091	0.0006000	6.0000000	-0.0000545	-0.0009545
5	8.0000000	-0.0003091	0.0010545	8.0000000	0.0000455	-0.0014000
6	10.0000000	-0.0003364	0.0011545	10.0000000	-0.0000364	-0.0015273
7	12.0000000	-0.0007000	0.0013091	12.0000000	-0.0002273	-0.0017545
LS Slope		-0.0000432	0.0001117		-0.0000154	-0.0001320
Offset		-0.0001000	-0.0004000		0.0007545	0.0004000
LS Constant		-0.0001006	0.0000351		0.0000718	-0.0002328
Max Pos Dev		0.0001962	0.0001258		0.0000969	0.0002328
Max Neg Dev		-0.0002493	-0.0001053		-0.0001143	-0.0002941

Fig. 7-5 Squareness Measurement Data Table

Under the **File Menu**, you can open a **new** data file, **save** a data file, set yo **printer type**, set your **printer style**, or return to the **main menu**. Whe loading a file, choose the files with the extension of .SQR for squarenes You can only **print data** tables using the print function under this heading..

Squareness Plot: This will show the angle between the POSITIVE X, Y ar Z axes of yo ur machine (depending on which axes were measured). Not This angle MAY or MAY NOT be the one you measured, but the angle ha been calculated out to the machine's positive axes.

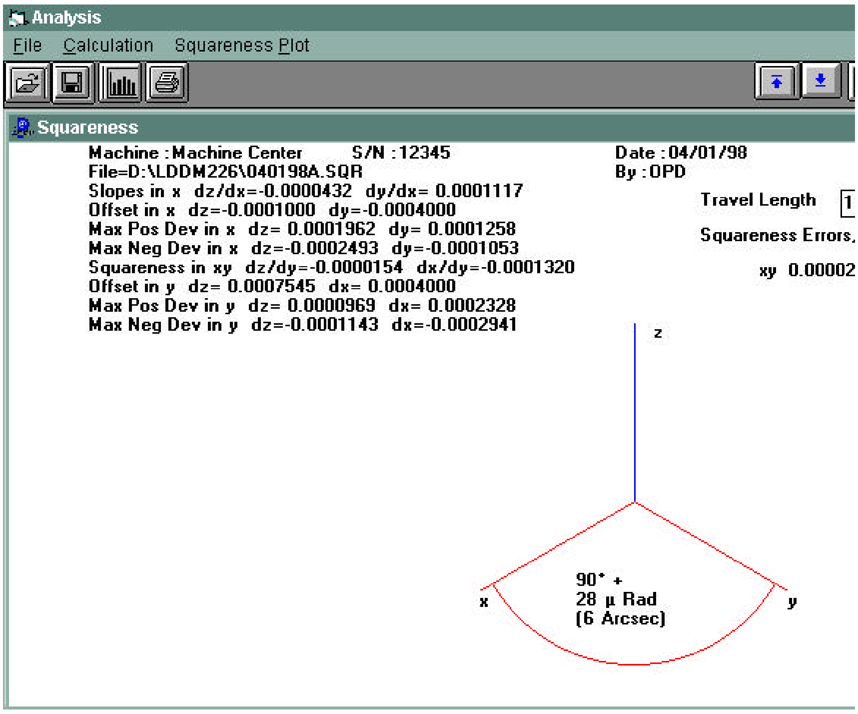


Fig. 7-6 Squareness Measurement Data Plot

10 Calibration of Rotary Tables

12.1 Rotary Table Calibration

The dual-beam LDDM™ system can measure both linear displaceme and the rotational angle of a dual-retroreflector up to ±10°. With a sm turntable , the angular measurement range can be extended to 360° Hence it can be used to calibrate rotary tables or stages.

Because of the large alignment tolerance of the LDDM™ system and th simultaneous measurement of 2 channels, the angular measurement

FIG. 10-10 SPINDLE MOUNT

not effected by the runout, wobble, parallelism, and co-axial alignment the rotary tables. The set up and alignment are not critical. The accurac of the measurement is determined by the LDDM™ system.

Briefly, a dual-retroreflector is placed on top of a small turntable supplie by Optodyne, which is in turn mounted on the test device, a rotary table stage. The test device is programmed (or manually) to move incremental steps of any angle. At the end of each step, press th space-bar of the notebook computer to record the data, rotate the sma turntable in the opposite direction to near initial position, and press "R" the notebook computer key to record the residual value. Hence th rotational angle of the test device and the rotational angle (in the opposi direction) of the small turntable are all recorded. The software wi calculate the difference (error) data from both the forward and revers angular measurements and linear measurements and will provide fu data storage, analysis and plots.

Please note that, the above method is different from the convention comparative method. That is, the test device is compared to the knov inaccuracies in a master rotary calibrator which is very expensive.

10.2 Hardware Required

Dual beam laser head	L-104
Processor module with R-232 Interface	P-210
Dual retroreflector	R-103
Small turntable	LD-52
Adjustable mount	LD-46A
Rotary table calibration accessories	LD-54
12 ft cable set	LD-21
Carrying case	LD-20
Rotary table calibration program	S-102RS
Notebook PC Computer	LTC

10.3 Installation and Alignment

12.5.1 Important Considerations

1 The output laser beam and the retroreflector must be aligne properly so that the beam intensity is above the minimur requirement (4 or 5 bars) along the entire measurement range.

2. The centers of rotation of the test device and the small turntabl should coincide to within 0.002 in (0.05 mm).

3. The dual-retroreflector should be seated at the center of the sma turntable and parallel to the surface.

4. Initially, the laser beam should be perpendicular to the retroreflecto to within 30 arc minutes.

5. Align the laser beams to be parallel to the s urface of the rotary tabl

10.3.1 Installation

Attach the adapter plate (LD-14DB) to the adjustable mount (LD-54) a mount the dual-beam laser head to the adapter as shown in Fig. 8 -2. F vertical rotary table, mount the laser head as shown in Fig. 8-1. Mount t dual-retroreflector on the small turntable (LD-52), as shown in Fig. 12- and place the small turntable on top of the test device as shown in Fi 12-2. The stand off distance between the laser head and the retroreflec should be as close as possible from a few inches to 10 inches. For le accurate measurements, longer stand-off distances of up to 40 inches w be acceptable. Screw the return-rod on the turntable and set the stoppi post near the return-rod. Position the stopping pos t such that when t return-rod touches the stopping post, the retroreflector is perpendicular the laser beam.

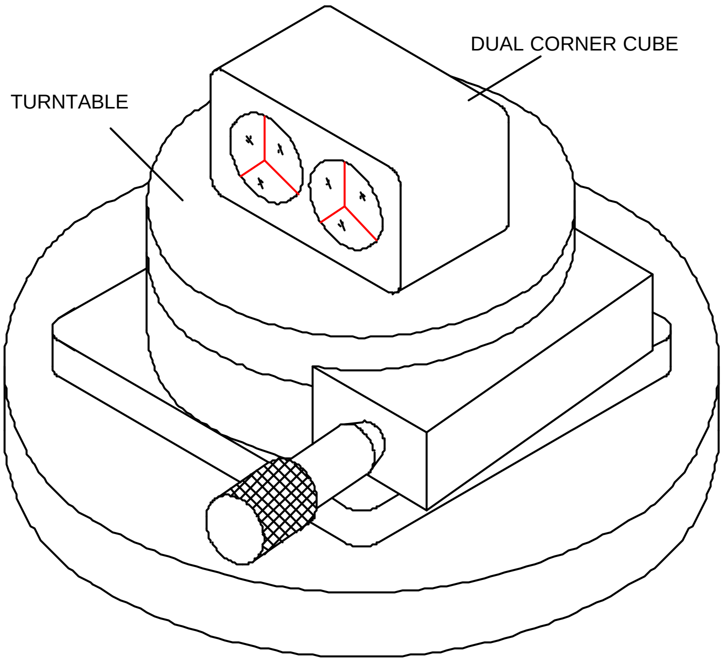


FIG. 12.1 SMALL TURNTABLE WITH
DUAL RETROREFLECTOR

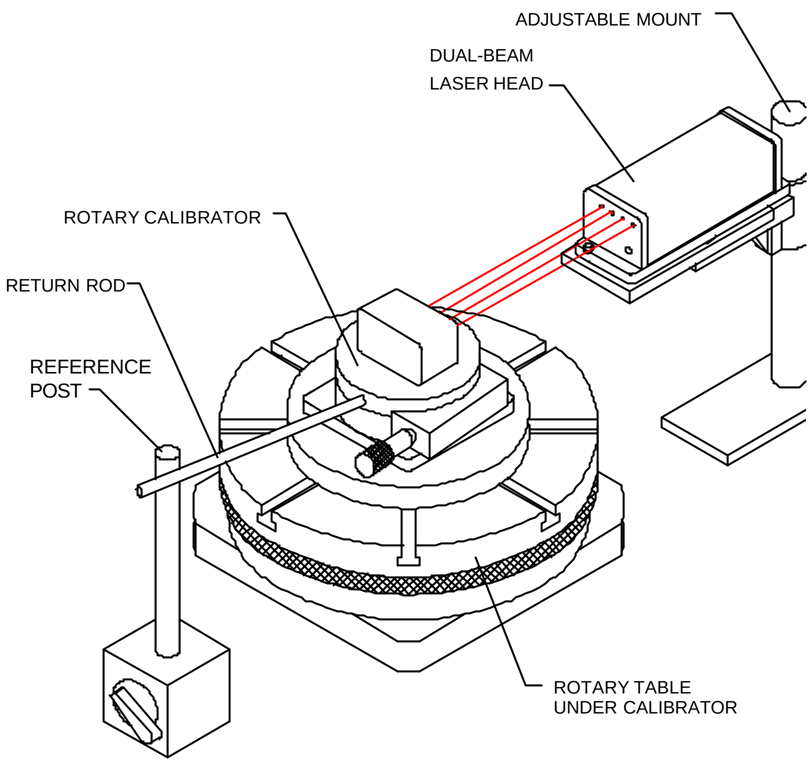


FIG. 12.2 SCHEMATIC OF THE BASIC SETUP

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12.5.4 Alignment Procedure

1. Mount the laser head on the adjustable mount, making sure th laser beams are parallel to the surface of the test device and th rotation is at the center between the two laser beams.
2. Place the small turntable on top of the test device. Center the sma turntable with the center of the test device. Make sure the centers rotation of the two rotary tables coincide to within 0.002 inches (0.0 mm).

3. Place the dual-retroreflector at the center of the small turntable ar tighten the clamping screw.

4. Move the laser head up and down by the adjustment screw such th the laser beams reached the center of the retroreflectors and th reflected beams entered the receiving aperture. Then tighten th locking screw.

5. Set the rotary table at the zero position and with backlash remove Set the turntable at the initial position, return-rod pressed against t stopping post. Reset the display and follow the instructions on th monitor or the software manual in the menu to take data.

Rotary Table Measurements

The rotary measurement setup is similar to the Straight / Angular measurement, exce the starting position is always zero. The least increment is 1 degree with an increme of 1 degree up to 10 degree. Briefly, a dual-retroreflector is placed on top of a small rotary table supplied by Optodyne, which is in turn mounted on the test device, a rotary table or stage. The test device is programmed to move in incremental steps of to 10 degrees. At the end of each step, the data will be recorded. Then rotate the sm rotary table in the opposite direction to prevent laser beam break. At the end of the rotation the residual value will be recorded. Hence the rotational angle of the test device and the rotational angle (in the opposite direction) of the small rotary able are all recorded. The software will calculate the difference (error) data from both the forward and reverse angular measurements and will provide full data storage, analysis and plots. For more detailed setup, see user's guide section 12.

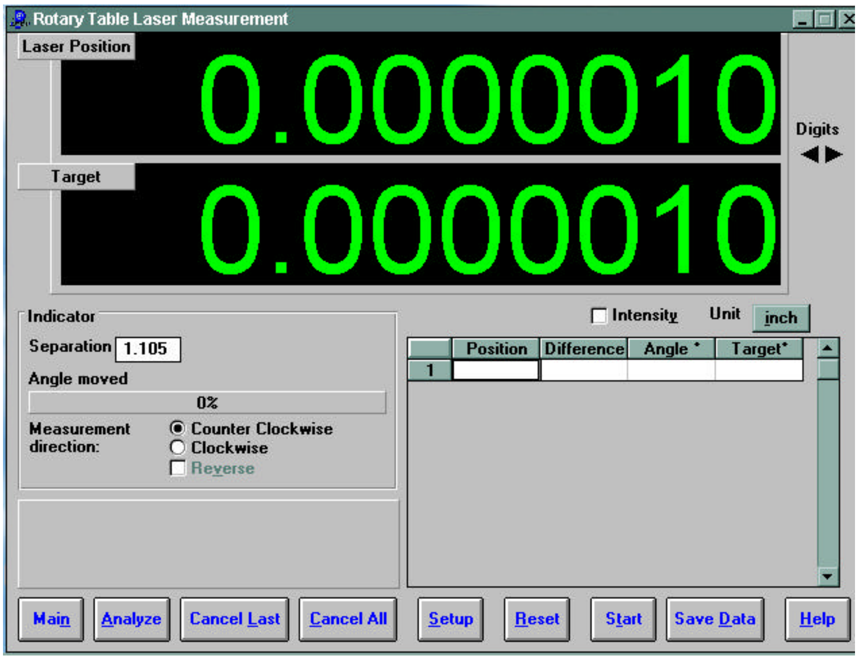


Fig. 8-1 Rotary Table Measurement Main Display

The display shows the linear distance traveled on the top line, and th difference between LDDM #1 and LDDM #2 for the second line. If th second line value is twice of the top line value, the center of rotation exactly between the centers of the two retroreflector.

Choices on the Main Display are

Separation : This is the separation of the dual-retroreflector. Typical valu is 1.105 in or 28 mm. More accurate value could be obtained by calibratio

Angle moved : This box show the angular movement of the rotary tabl 50% is about 10 degree and 100% is about 20 degree.
Measurement direction : If you want counter clockwise rotation to b positive, click counter clockwise. Otherwise click clockwise. For l directional measurement, after you reached 360 degree and taken th data, click the “Reverse” button

Example of a Rotary Table Measurement

Click on the setup box, the screen will show the setup menu.

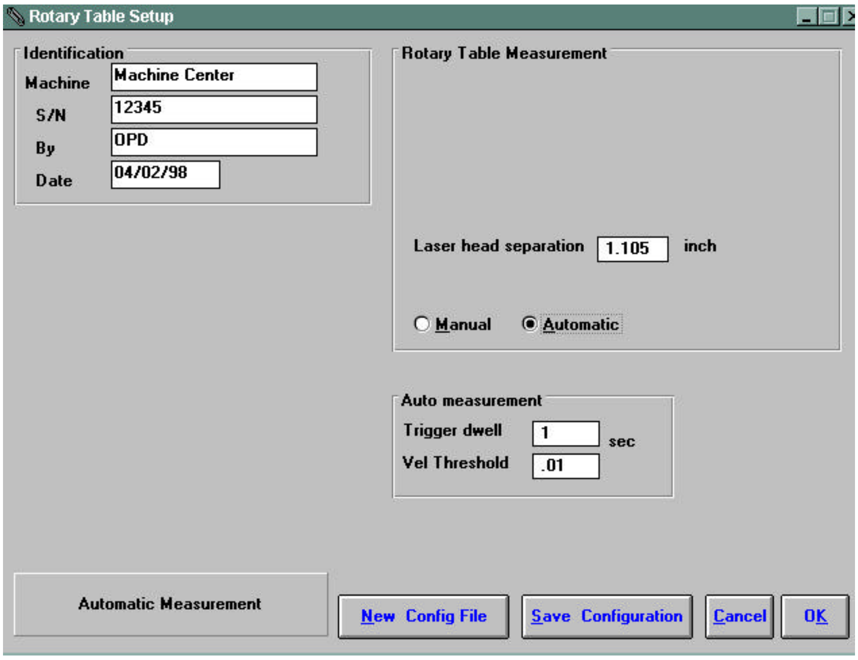


Fig. 8-2 Rotary Measurement Setup Screen

set up automatic data collection or manual data collection.

'Dwell time" is the time delay between stage stopped and data collection. may be zero or up to a few seconds.

"Velocity threshold" is the maximum vibration motion of the stage
Set the beam separation value to ------ (default 1.105).

For automatic data collection, click reset, then click start. The initial positio will be recorded.

Move the stage to be calibrated to the first position (at least 1 degree, no more than 10 degree) then stop. The data will automatically be recorded after the dwell time.

Move the second stage in the opposite direction to zero. The data will automatically be recorded.

Continue steps until reading 360 degrees.

Select “save data” to save data file with extension .ROT .

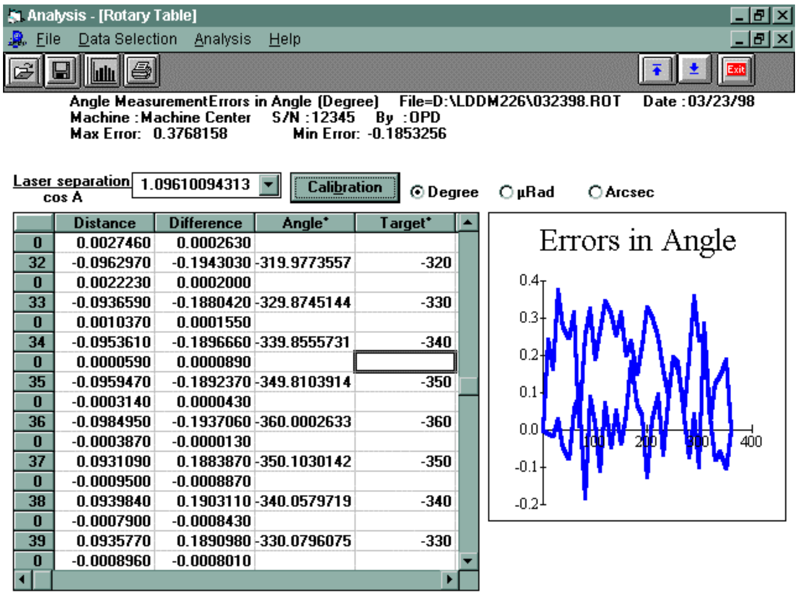
To analyze data, click on “Analyze” in the bottom or in the main menu.

12, Click on the “calibration” button. New data files will be calculated, ar the new beam separation number will be calculated

8.2 Rotary Data Analysis Menu

Click on the calibration, new data files will be calculated, and the new bea separation value will be calculated The graph on the right-hand-side will be replotted as shown in Fig. 8-4 .

Fig. 8-5 Rotary Data Analysis Show Error Table



	Distance	Difference	Angle*	Target*
0	0.0027460	0.0002630		
32	-0.0962970	-0.1943030	-319.9773557	-320
0	0.0022230	0.0002000		
33	-0.0936590	-0.1880420	-329.8745144	-330
0	0.0010370	0.0001550		
34	-0.0953610	-0.1896660	-339.8555731	-340
0	0.0000590	0.0000890		
35	-0.0959470	-0.1892370	-349.8103914	-350
0	-0.0003140	0.0000430		
36	-0.0984950	-0.1937060	-360.0002633	-360
0	-0.0003870	-0.0000130		
37	0.0931090	0.1883870	-350.1030142	-350
0	-0.0009500	-0.0008870		
38	0.0939840	0.1903110	-340.0579719	-340
0	-0.0007900	-0.0008430		
39	0.0935770	0.1890980	-330.0796075	-330
0	-0.0008960	-0.0008010		

To print error table or error plot, move the cursor to “Analysis” and click on “error”. The error table is shown below:

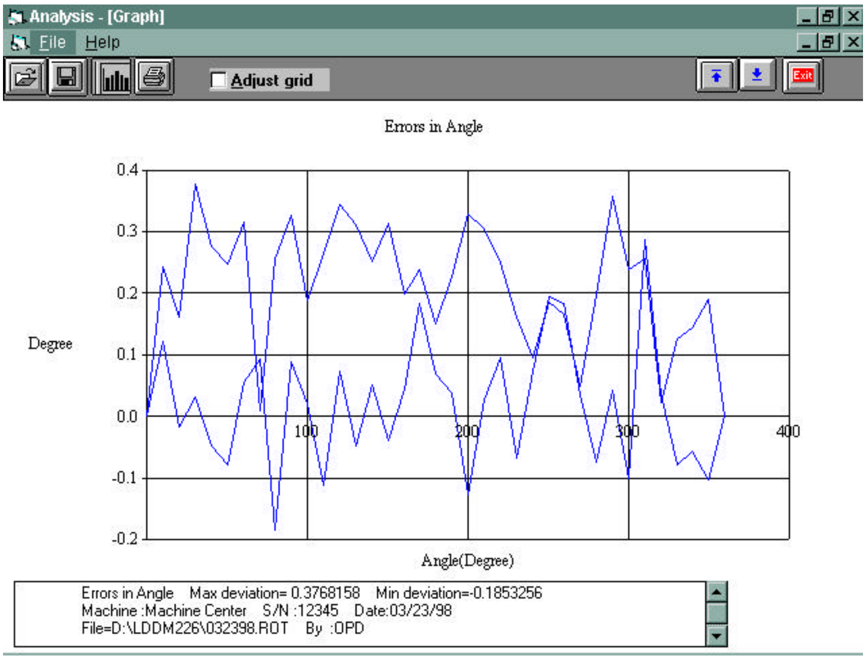


Fig. 8-6 Rotary Measurement Error Plot in Degree

To get a line plot, click on the graph icon. To print the graph, click on the printer icon. An error plot is shown in Fig. 8-6 .

11 System acceptation and Reporting

11.1 For each item will be reported if the system is working correctly or some defect is found.

11.2 The failure of a single components that is not affecting the total performance of the system will not affect the acceptation of the system.

11.3 The failure of the component will be reported in detail and the component will be rejected and repaired or substituted as for warranty rules.