Get Going!

EXPRESS ALIGNMENT BY FIXTURLASER

TRAINING MANUAL

Vibralign

EXPRESS ALIGNMENT BY FIXTURLASER

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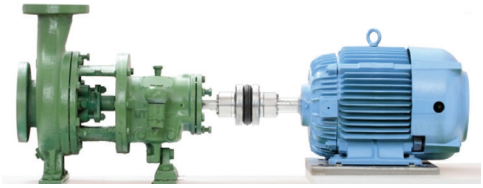
INTRODUCTION TO ALIGNMENT

ALIGNMENT BASICS

The machines we align:

Basic

The most basic machines to align consist of a driver and driven element. The driven unit is usually considered to be stationary and the driver movable. The movable unit is repositioned in relation to the stationary unit.



Stationary *Movable*

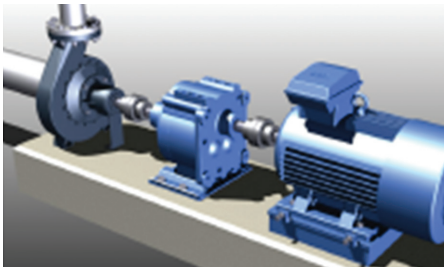
Machine Trains

Sometimes a machine train will include a driver, and more than one driven element. When aligning a machine train, there is more than one alignment to be made.

Typical Drivers: Electric Motor, Steam Turbine, Gas Turbine, Engine, Wind Turbine, Hydraulic Motor

Typical Driven Elements: Pump, Fan, Generator

Intermediate Devices: Gearbox, Clutch, Fluid Coupling

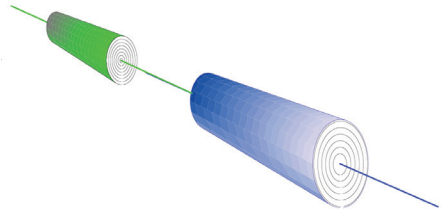


Rotational axes

All shafts, straight or bent, rotate on an axis which forms a straight line.

Shaft Alignment Defined

Shaft alignment is the act of measuring the relative position of two machines that are coupled and repositioning them so that the rotational axes of the two shafts form a straight line (collinear) when the machines are at normal operating temperatures.



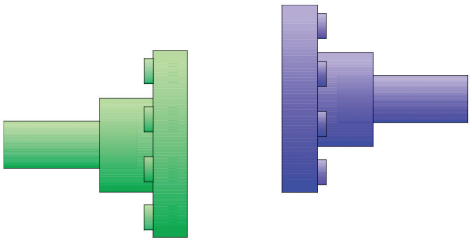
Types of Misalignment

Offset Misalignment

Offset Misalignment is the actual radial position of the movable rotational center relative to the stationary center. If the shafts are not parallel, the offset misalignment is different at every axial position.

Offset misalignment is expressed in mils.

- 0.001" = 1 mil



Offset Misalignment VS Dial Readings

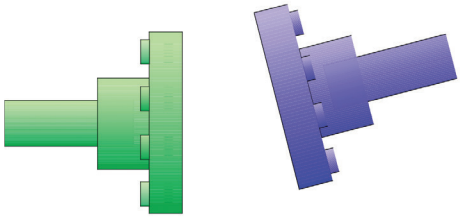
If a dial indicator measuring on the rim is set to zero and then rotated 180 degrees the dial reading (TIR) will be 2X the offset misalignment.

- Offset misalignment = ½ TIR

Angular Misalignment

Angular Misalignment is the slope relationship of the two shafts. The slope has a positive value if the offset values are more positive at the rear feet than at the coupling.

Angular misalignment is expressed in mils per inch.

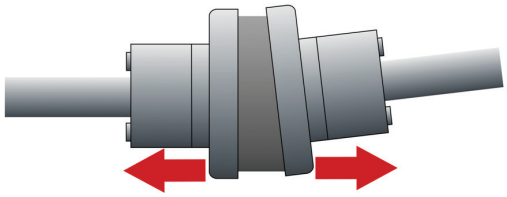


INTRODUCTION TO ALIGNMENT

Angular Misalignment VS Gap Difference

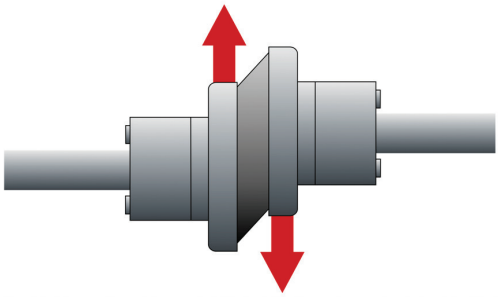
If you use calipers, inside micrometers, or a dial indicator to measure face to face misalignment, the result you get is the gap difference top to bottom or side to side in mils. Angles cannot be expressed as a distance alone. Divide the gap difference by the diameter at which you measure the gap to express the gap difference as angular misalignment.

Gap difference/diameter = angular misalignment



TOLERANCES

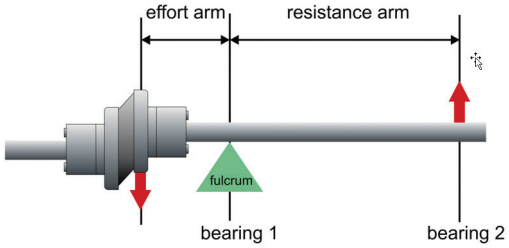
	Angular Misalignment Mils per inch .001/1"		Offset Misalignment Mils .001"	
RPM	Excellent	Acceptable	Excellent	Acceptable
3600	0.3/1"	0.5/1"	1.0	2.0
1800	0.5/1"	0.7/1"	2.0	4.0
1200	0.7/1"	1.0/1"	3.0	6.0
900	1.0/1"	1.5/1"	4.0	8.0



MISALIGNMENT FORCES

Misalignment creates forces at the coupling which are exerted on the shafts. This results in reduced bearing and seal life.

The force effects of misalignment can be simplified by considering the misalignment as a simple lever. Misalignment at the coupling creates a moment of force acting on an effort arm. This will create a first class or second class lever with either the inboard or outboard bearing acting as a fulcrum. The length of the motor shaft between its bearings is the resistance arm. The objective of shaft alignment is to minimize coupling forces by making two rotational axes form a single line while the machine operates.



About making precise alignments:

Fast and accurate alignment should be simple. In fact, most alignments can be accomplished in one or two corrective moves.

- It is helpful to understand some alignment basics.
- Pre-alignment steps are mandatory.
- You must know when you are finished.
- Rigid couplings present unique challenges and final alignment must be near perfect.
- Alignment data can be obtained with the couplings assembled or disassembled.
- When it is humanly possible, both shafts should be rotated when obtaining alignment data

CHAPTER 1

Pre-Alignment Considerations

PRE-ALIGNMENT CONSIDERATIONS

Pre-alignment checks and corrections are performed to either improve machinery reliability or to facilitate the alignment process. In either case, pre-alignment is a very important phase of the alignment process.

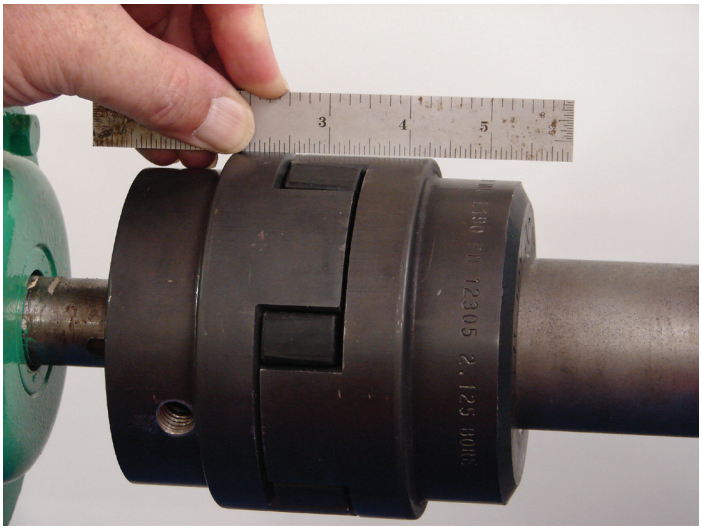
The pre-alignment process could include all of the following checks: (1) Clean up around and under machinery feet. (2) Consolidation of small shims with fewer thicker pieces. (3) Checking run out. (4) Checking pipe strain. (5) Performing a lift check to check bearing clearances. (6) Rough alignment. (7) Checking hub separation on spacer couplings. (8) Recording and tightening bolts in a known sequence. (9) Checking final soft foot.

We will limit the scope of this chapter to what we term "the pre-alignment essentials." You will demonstrate understanding of the following terms and procedures: rough alignment, correct obvious soft foot, tightening bolts in a known sequence, and correcting final soft foot.

ROUGH ALIGNMENT

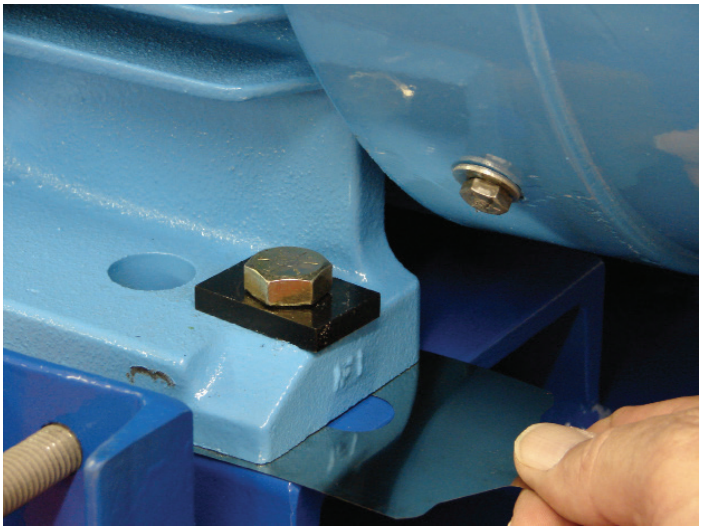
Rough alignment is performed to expedite the precision alignment process. It is intended to **quickly** get the machines "in the ball park." On close-coupled machines (those with no spacer coupling), rough alignment can be performed with a scale or any straight edge to remove vertical and horizontal offset misalignment. On machines with spacer couplings, we recommend that you correct both the angular and offset misalignment vertically and then the angular and offset misalignment horizontally.

Using a scale or straight edge, correct rough vertical misalignment by referencing the highest hub. Place scale firmly on the highest hub and raise or lower the movable shaft to within 20 mils (0.020") of the stationary hub.



Using a scale or straight edge, correct rough horizontal misalignment by referencing the hub closest to you. Place scale firmly on the hub and adjust the movable shaft to within 20 mils (0.020") of the stationary hub.

OBVIOUS SOFT FOOT



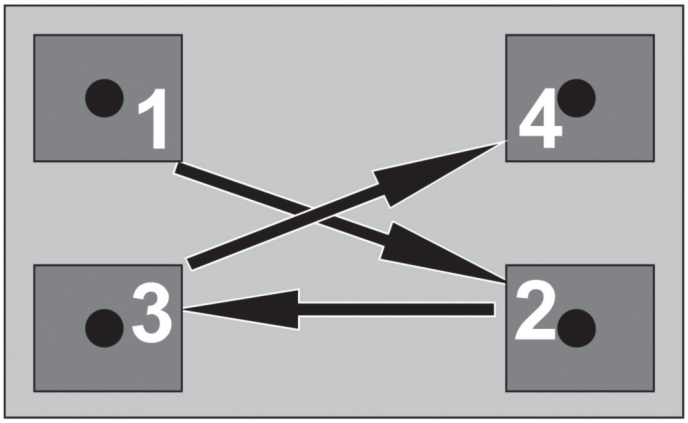
Soft foot occurs when the machine feet do not rest flatly on the machine base. Soft foot is caused by deformed machine base plates or by deformed machine feet. In either case, the effect when tightening the bolts is that the bearings become misaligned, bearing clearances change and the machine

rotational center is moved. Machinery performance is adversely affected by a soft foot's effect on bearings. Precision alignment is nearly impossible to perform unless soft foot is corrected.

Correcting gross soft foot can be accomplished by loosening all the mounting bolts and finding any obviously loose shim packs. Add shims as needed to make a snug fit.

TIGHTENING SEQUENCE

You will find that specifying, recording and maintaining a tightening sequence will result in a better and quicker alignment. The fact is that the machine will move (both vertically and horizontally) as we tighten down the bolts. This is true even after we correct soft foot. If you follow a known sequence you will minimize and make this movement predictable during the alignment process.

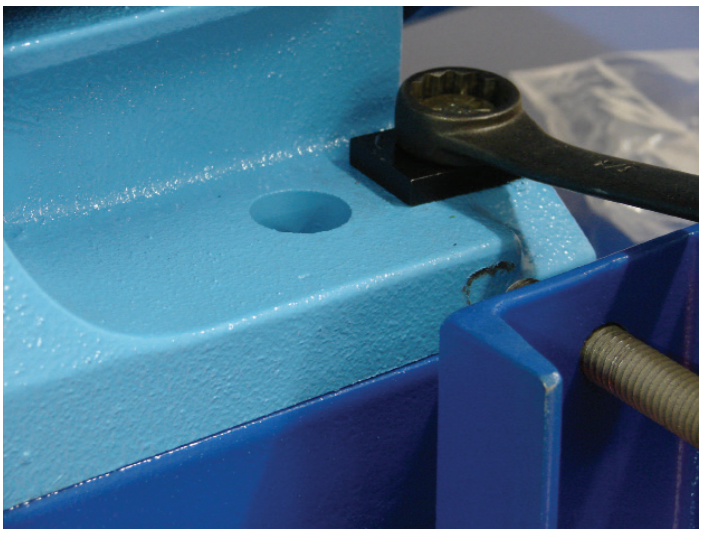


Often when making vertical corrections, people will only loosen two bolts at a time to try to hold horizontal position. This practice is acceptable, but some horizontal movement will likely occur anyway. Therefore, you should re-loosen all bolts and retighten in the recorded sequence after all vertical adjustments are complete.

In practice, make at least three passes around the bolts: Snug on the first pass, ~50% on the second pass and completely tight the third pass. Follow the same sequence throughout the alignment.

FINAL SOFT FOOT

Soft foot issues account for most alignment repeatability issues. For that reason, we address it twice. Now that the obvious soft foot issues are resolved and all feet are tight, we'll make one final check on soft foot. Loosen **one bolt at a time** and check with a 2 mil (0.002") shim or feeler gage at that foot. Correct any foot with 2 mils or more softness. Re-tighten the bolt and proceed to the next foot.



If the foot has an angular relationship to the base, you can correct this by cutting a partial shim to make up the angular correction. When cutting partial shims from pre-cut stock, always leave the shim "tab" intact. The tab can be used to make each shim pile organized and the partial shim will return to the original position. Never "feather" or step shims out to fix an angled foot. It is unlikely the angular correction will be duplicated when the shim piles are changed during the alignment.

CHAPTER 2

Using the GO

CHAPTER TWO GOALS

At the conclusion of this chapter you will see how to:

- Perform all prealignment steps
- Setup GO lasers correctly
- Enter dimensions correctly
- Select tolerances for 1800 rpm
- Measure misalignment
- Correct vertical and horizontal misalignment with compound move
- Remeasure
- Make corrections if necessary and remeasure
- Save results
- Unmount and stow laser in storage case

USING THE FIXTURLASER GO

1. SET UP THE FIXTURLASER GO

1.1 Mount the "S" sensor on the stationary shaft.

- The sensors may be mounted on the shafts or on the coupling hubs.
- Place the bracket on the shaft and pull the chain under the shaft and hook it over the pin.
- Hand tighten the nut, then ½ turn more with the wrench.

1.2 Mount the "M" sensor on the movable shaft.

- Place the bracket on the shaft and pull the chain under the shaft and hook it over the pin.
- Hand tighten the nut.
- Visually align the sensors (side to side), then tighten the nut ½ turn more with the wrench.

1.3 Connect the cables into either connector on the display unit.

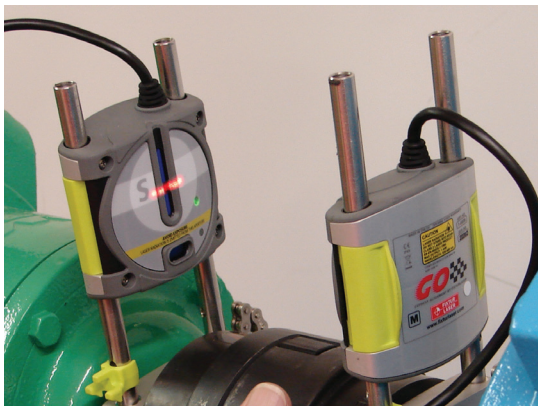
1.4 Turn the unit on by pressing the RED button at the center bottom of the display.

1.5 The Horizontal Shaft Alignment coupling icon will be highlighted in black. Press the "OK" button on the right hand key pad to enter the Horizontal Shaft Alignment program.

- Use the up/down & left/right arrow buttons on the right hand key pad to move the black highlight to the different icons as needed. Press the "OK" button to select.

1.6 Rotate the sensors to 12:00.

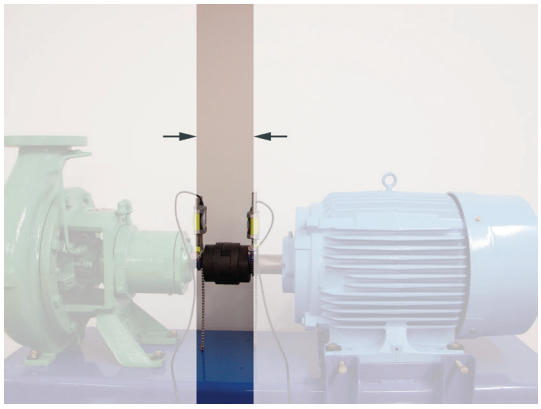
1.7 Aim the lasers.



- The sensors will be on different elevations.
- Open the green latches on either sensor and slide up or down to aim the laser into the light grey band on the opposite sensor. Adjusting one sensor will adjust both.
- You should see both "S" and "M" values in the boxes at the top of the display.
- If you do not, then the lasers are not within the sensors.
- Lock the green latches.

2. ENTER DIMENSIONS

2.1 Measure the distance between the "S" and "M" sensors to the nearest ⅛".



- Center of post to center of post.

2.2 Enter this dimension into the display unit.

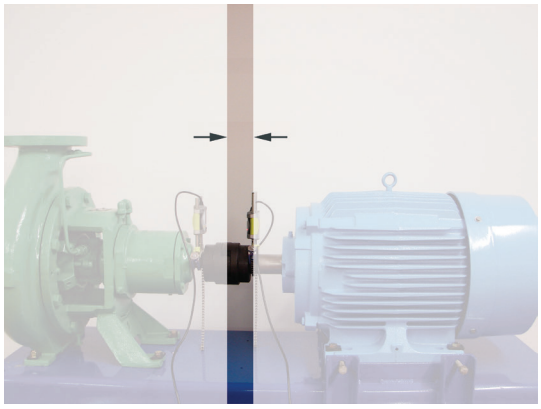
- Left most black highlighted box with ? mark.
- Use left hand keypad to enter the value as a decimal.
- Use the “C” button on right-hand key pad to clear errors.

2.3 Press the “OK” button on right-hand key pad to accept the dimension.

- Black highlight will move to the next box with ? mark.

2.4 Measure the distance from the coupling center to the “M” sensor to the nearest ⅛".

- Center of coupling to center of “M” sensor post.



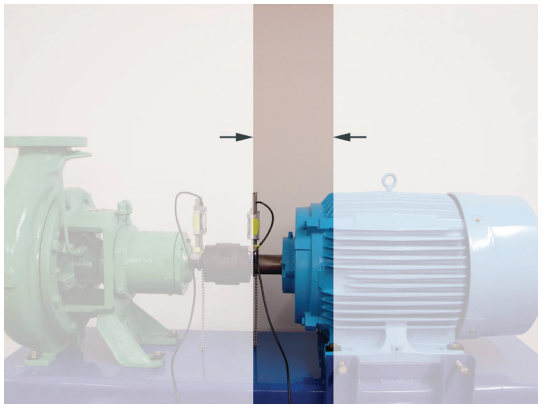
2.5 Enter this dimension into the display unit if different from the value displayed.

- Second black highlighted box.

2.6 Press the “OK” button on the right-hand key pad to accept the value.

- Black highlight will move to the next box with ? mark.

2.7 Measure the distance from the “M” sensor to the movable machine front foot to the nearest ⅛".



- The line parallel to the shaft from the center of the “M” sensor post to the center of the front foot bolt.

2.8 Enter this dimension into the display unit.

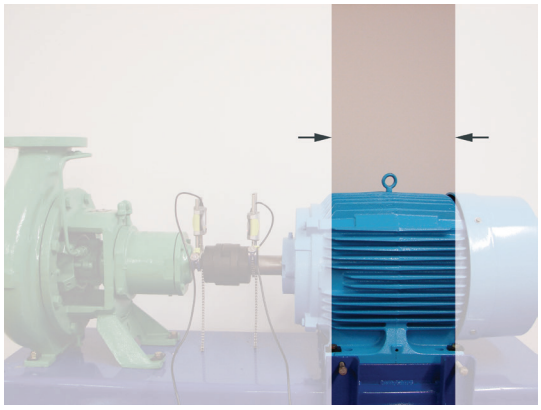
- Third black highlighted box with ? mark.

2.9 Press the "OK" button on the right-hand key pad to accept the value.

- Black highlight will move to the next box with ? mark.

2.10 Measure the distance from the movable front feet to rear feet to the nearest ⅛".

- Center of bolt to center of bolt.



2.11 Enter this dimension into the display unit.

- Fourth black highlighted box with ? mark.

2.12 Press the "OK" button on the right-hand keypad to accept the value.

- Black highlight will move to the Measure icon in the lower right corner of the display.

3. SET MACHINE RPM IN TOLERANCE TABLE

3.1 Use the left arrow button on the right hand key pad to move the black highlight to the Tools icon. Press the "OK" button to select.

3.2. Use the up arrow button to move the black highlight to the tolerance table. Press the "OK" button to select.

3.3. Select the machine RPM using up/down arrow buttons to highlight the correct RPM. Press the "OK" button to select.

- Use next highest RPM setting if machine RPM is in between values listed.

3.4 Use the down arrow button to move the black

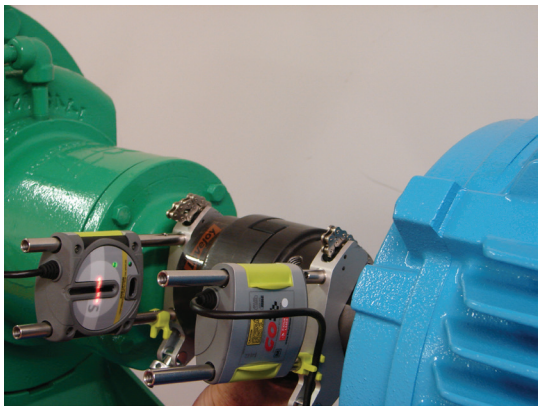
highlight to the Exit Door icon. Press the "OK" button to select.

3.5 Use the right arrow button to move the black highlight to the Measure icon.

4. MEASURE MISALIGNMENT

- The sensors can be at ANY clock position to start.
- The starting measurement is registered by pressing the "OK" button.
- The sensors are then rotated out of the black zone from the starting point.
- The "OK" button registers the second and third measurements.
- The system will give results for the both Vertical and Horizontal misalignment.
- After you get some experience you can try different starting positions.
- To begin, use the orientation shown below.

4.1 Rotate the sensors to 9:00.



- Use the animated rotation guide on the display unit screen.
- You should see both "S" and "M" values in the boxes at the top of the display.
- If you do not, then the lasers are not within the sensors.

4.2 Press the "OK" button to register the 1st measurement.

- The "S" and "M" values are zeroed.
- The values are displayed in mils.
- Do not rotate shafts while the Measuring icon is displayed.

4.3 Rotate the sensors to approx. 12:00.

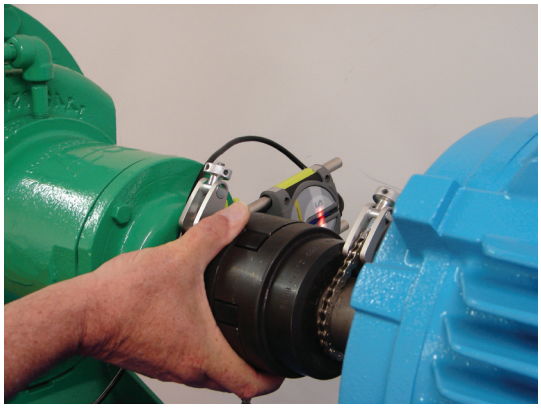
- Use the animated rotation guide on the screen.
- You should see both "S" and "M" values in the boxes at the top of the display.

4.4 Press the "OK" button to register the 2nd measurement.

- The "S" and "M" values will not change.
- Do not rotate shafts while the Measuring icon is displayed.

4.5 Rotate the sensors to 3:00.

CHAPTER 2



- Use the animated rotation guide on the screen.
- You should see both "S" and "M" values in the boxes at the top of the display.

4.6 Press the "OK" button to register the 3rd measurement.

- The "S" and "M" values will not change.
- Do not rotate shafts while the Measuring icon is displayed.

5. ALIGNMENT RESULTS

- Both the vertical and horizontal misalignment values are displayed.

- Displayed values are not live.
- The angle and offset values ONLY determine the alignment condition.

	Angular Misalignment Mils per inch .001/1"		Offset Misalignment Mils .001"	
RPM	Excellent	Acceptable	Excellent	Acceptable
3600	0.3/1"	0.5/1"	1.0	2.0
1800	0.5/1"	0.7/1"	2.0	4.0
1200	0.7/1"	1.0/1"	3.0	6.0
900	1.0/1"	1.5/1"	4.0	8.0

- The three LED lights on the display unit indicate whether the couplings are within tolerance (green light), within twice the tolerance (orange light), or more than twice the tolerance (red).

- Displayed foot values are for making corrections.

6. CORRECTING VERTICAL MISALIGNMENT

6.1 Correct the vertical alignment from the results screen.

6.2 Positive foot values: the movable is high, remove shims.

6.3 Negative foot values: the movable is low, add shims.

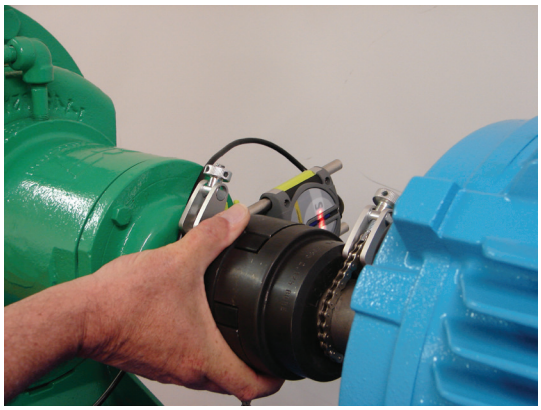
6.4 Leave the bolts loose after adjusting shims.

7. CORRECTING HORIZONTAL MISALIGNMENT

7.1 Using the right arrow button move the black highlight to the Shim icon.

7.2 Press the "OK" button to select.

- The GO is now "live" and will display the values in whatever orientation the sensors are pointing.
- To correct horizontal misalignment be sure the sensors are in the horizontal plane.



- Use the on screen guidance to rotate sensors to horizontal if needed.

7.3 Adjust the feet in the direction of the arrows.

- The Angle and Offset values will change as the feet are adjusted.
- The LED will change from Red to Orange to Green as the angular and offset values are brought into tolerance.
- Green LED indicates alignment in tolerance. It's not necessary to adjust the foot values to zero.

- Tighten the bolts using torque pattern.

8. RE-MEASURE

8.1 Move the black highlight to the Re-measure icon if needed.

8.2 Press the "OK" button to select. OK

- Verify selection.

8.3 Rotate sensors back to the starting measuring position and repeat the process.

9. VERIFY RESULTS & DOCUMENT FINAL ALIGNMENT

- Both the vertical and horizontal misalignment values are displayed.
- Verify the angle and offset values meet or are less than the tolerances.

- Green LED should be on.

9.1 Use the left/right arrow buttons to move the black highlight to the Save icon if needed.

9.2 Press the "OK" button to Select. OK

9.3 Enter the name of the saved alignment.

- Use the left hand key pad to enter up to 17 alphanumeric characters.
- Use the "C" button on the right hand key pad to clear errors.

9.4 Press the "OK" button to save.

- Orange & Green LEDs will flash as alignment is saved.
- Saved alignment will display for approximately 5 seconds.

10. EXIT THE PROGRAM AND TURN OFF

10.1 Move the black highlight to the Exit icon.

10.2 Press the "OK" button to select. OK

10.3 Verify selection and press the "OK" button. OK

10.4 Move the black highlight to the Off icon.

10.5 Press the "OK" button to select. OK

CHAPTER 3

Assisted Practice

CHAPTER THREE GOALS

At the conclusion of this chapter, with a little help, you will be able to:

- Perform all prealignment steps
- Setup GO lasers correctly
- Enter dimensions correctly
- Select tolerances for 1800 rpm
- Measure misalignment
- Correct vertical and horizontal misalignment with compound move
- Remeasure
- Make corrections if necessary and remeasure
- Save results
- Unmount and stow laser in storage case

CHAPTER 4

Student Practice
Aligning to 1800 rpm Tolerances

CHAPTER FOUR GOALS

At the conclusion of this chapter, on your own, you will be able to:

- Perform all prealignment steps
- Setup GO lasers correctly
- Enter dimensions correctly
- Select tolerances for 1800 rpm
- Measure misalignment
- Correct vertical and horizontal misalignment with compound move
- Remeasure
- Make corrections if necessary and remeasure
- Save results
- Unmount and stow laser in storage case

CHAPTER 5

Student Practice
Aligning to 3600 rpm Tolerances

CHAPTER FIVE GOALS

At the conclusion of this chapter you will be able to:

- Perform all prealignment steps
- Setup GO lasers correctly
- Enter dimensions correctly
- Select tolerances for 3600 rpm
- Measure misalignment
- Correct vertical and horizontal misalignment with compound move
- Remeasure
- Make corrections if necessary and remeasure
- Save results
- Unmount and stow laser in storage case

CHAPTER 6

What Are Tolerances?

CHAPTER SIX GOALS

At the conclusion of this chapter, you will understand the:

- Difference between targets and tolerances
- Relationship of speed to tolerances
- 'Zone of Good Alignment'

WHAT ARE TOLERANCES?

TOLERANCES

Tolerances are the allowable deviations from the target values. So far our goal has been to make the movable shaft colinear with the stationary shaft. We have had a target of zero offset with zero angularity between the shafts. The allowable deviation from zero, or tolerance, for 1800 rpm is from positive four mils to negative four mils, or 0±4.0 mils. That allows an eight mil window around our target. The angularity portion is treated similarly--0±0.7 mils/in.

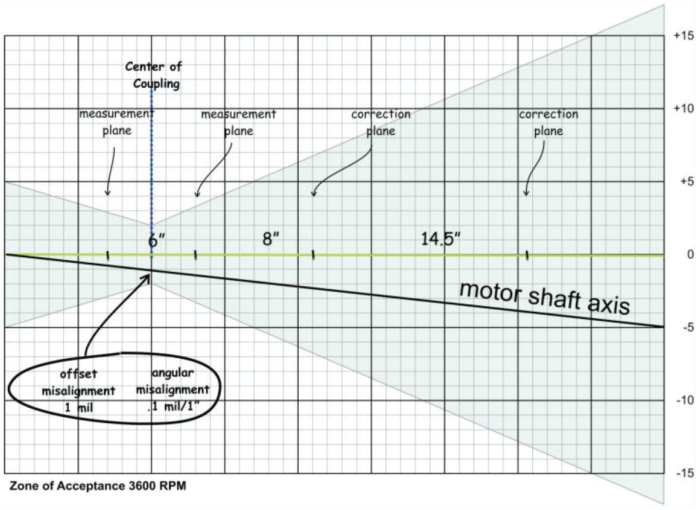
It is very unlikely that perfect alignment is achievable—or is really that important. The objective of shaft alignment is to minimize radial forces by minimizing the offset at the coupling where power is transmitted. We minimize axial forces by minimizing the slope relationship of the two shafts. The coupling tolerances we recommend are based on widely accepted angle and offset values. You can choose to be more or less permissive. The GO allows us to input our own tolerance if the values in the table do not fit our particular job.

You can see from the table below that as the speed increases, the tolerances become tighter. This is because as the speed increases, so do the forces generated by misalignment. It's these forces that decrease the life of couplings, seals, bearings, etc.

	Angular Misalignment Mils per inch .001/1"		Offset Misalignment Mils .001"	
RPM	Excellent	Acceptable	Excellent	Acceptable
3600	0.3/1"	0.5/1"	1.0	2.0
1800	0.5/1"	0.7/1"	2.0	4.0
1200	0.7/1"	1.0/1"	3.0	6.0
900	1.0/1"	1.5/1"	4.0	8.0

ZONE OF GOOD ALIGNMENT

The graph below shows a zone of acceptance for a 3600 RPM machine using angular and offset tolerances. When the movable shaft axis falls completely within the shaded "bowtie," acceptable alignment is achieved. There is a large range of foot values that are acceptable.



The plotted line represents a shaft with offset misalignment of 1.0 mil (0.001") at the coupling center. The slope is 0.1 mil/1". This is a very good alignment!

A few important things to remember about working within the tolerances:

- Keep the back foot value larger than the front foot
- Keep the sign of both values the same

CHAPTER 7

GO Settings

CHAPTER SEVEN GOALS

At the conclusion of this chapter you will be able to:

- Change the date and time on the GO system
- Select the measurement units
- Select the battery type
- Open the Memory Manager
- Open/Delete existing files
- Transfer saved data to a PC

GO SETTINGS

SETTINGS

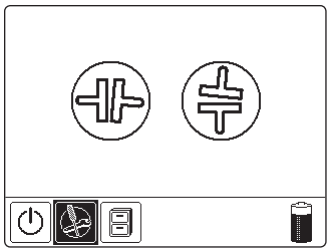
There are a few global and application-specific settings that will be discussed in this chapter.

1. GLOBAL SETTINGS FIXTURLASER GO

- Global settings are accessed from the start screen

1.1 Press the down arrow to move the black highlight to the bottom row of icons, the file cabinet will be highlighted.

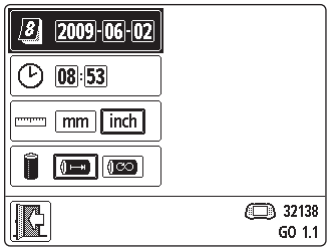
1.2 Press the Left arrow to move the black highlight to the Global Setting icon.



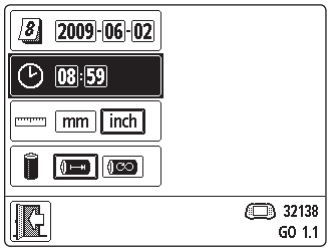
1.3 Press the "OK" button.

1.4 Press the up arrow to move the black highlight over the desired setting

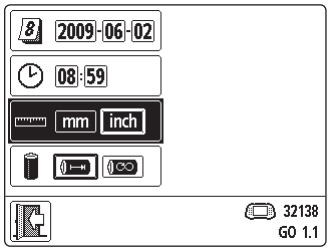
- From top to bottom:



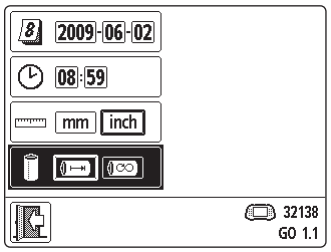
- Date
  - YYYY-MM-DD
  - To select, press "OK" when highlighted
  - To change highlighted value, use up/down arrows, then press "OK"
  - To change field, use left/right arrows as needed
  - To exit, press "OK" (entire Date setting highlighted)



- Time
  - HH-MM, 24 hr clock
  - To select, press "OK" when highlighted
  - To change highlighted value, use up/down arrows, then press "OK"
  - To change field, use left/right arrows as needed
  - To exit, press "OK" (entire Time setting highlighted)



- Measurement Units
  - MM or INCH
  - To select, press "OK" when highlighted
  - To change setting, use left/right arrows as needed
  - To exit, press "OK", (entire setting field will be highlighted)

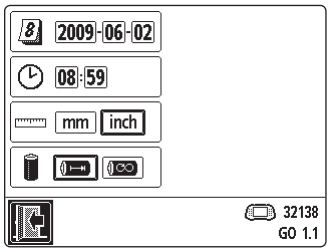


- Battery Type
  - Standard Batteries or Rechargeable

Batteries

- To select, press “OK” when highlighted
- To change setting, use left/right arrows as needed
- To exit, press “OK”, (entire setting field will be highlighted)

1.5 Press Down arrow to highlight exit door icon.



1.6 Press “OK” to exit back to start screen

2. HORIZONTAL ALIGNMENT APPLICATION SETTINGS FIXTURLASER GO

- Application settings are accessed after entering the horizontal shaft alignment program.

2.1 Press the down arrow to move the black highlight to the bottom row of icons.

2.2 Press the left/right arrow to move the black highlight to the Application Setting icon.

2.3 Press the “OK” button.

2.4 Press the up arrow to move the black highlight over the desired setting

- From top to bottom:

Sampling Time

- Normal or Long
- To select, press “OK” when highlighted
- To change setting, use left/right arrows as needed
- To exit, press “OK”

Tolerance Table

- Machine RPM
- To select, press “OK” when highlighted
- To change highlighted value, use up/down arrows, then press “OK”. Also exits tolerance table.

2.5 Press down arrow to highlight exit.

2.6 Press “OK” to exit back to start screen.

3. MEMORY MANAGER FIXTURLASER GO

- The memory management application is accessed from the start screen.

- From this application, previously saved files can be viewed or deleted.

3.1 Press the down arrow to move the black highlight to the bottom row of icons, the file cabinet will be highlighted.

3.2 Press the "OK" button.

3.3 Press the up/down arrows to highlight the desired file.

- Saved files are listed in order of newest to oldest.
- Use the left/right arrow to move black highlight at bottom of screen over the Open File icon to open a file or the Trash Can icon to delete a file.

3.4 To Open a saved file highlight the Open File icon then press the "OK" button to open the selected file.

3.5 Once a saved file is opened:

- Use up/down arrows to view the next saved file
- Use left/right, or OK button to go back to the saved file list
- Use "C" to delete a file

3.6 To Delete a saved file highlight the Delete File icon then press the "OK" button to delete the selected file.

- Use the left/right arrow to move black highlight over the Trash Can
- Press "OK" button to delete selected file
- Press "OK" again to confirm delete
- OR
- Press left arrow to highlight the Do Not Delete icon

3.7 To Exit the Memory Manager

- Close alignment file if open
- Press left/right arrow until exit door is highlighted black
- Press "OK"

4. TRANSFERRING DATA TO PC, FIXTURLASER GO

- Saved files in .BMP format may be transferred to a PC via provided USB cable
- The GO must be at the start screen to transfer data

4.1 Connect USB cable to GO display unit

4.2 Connect USB cable to PC

- The PC will recognize the connection as an external flash memory drive
- A folder will automatically open

4.3 Cut and paste, or copy and paste desired files to PC

4.4 Unplug USB cable after files have been transferred

- It is recommended that files be deleted off the Display Unit once the files are safely transferred to PC; this will prevent filling up the on board memory

CHAPTER 8

Student Practice
Checking for Softfoot Using the GO

CHAPTER EIGHT GOALS

At the conclusion of this chapter you will be able to:

Use the SoftCheck™ function to measure and correct softfoot

CHECKING FOR SOFTFOOT

SoftCheck™

Softfoot was discussed previously in the pre-alignment chapter. Again, softfoot occurs when all the machine feet do not rest flatly on the machine base at the same time. The bad effects of softfoot are that bearings become misaligned, bearing clearances change and the machine rotational center is moved. Precision alignment is nearly impossible to perform unless softfoot is corrected.

The GO has a softfoot function, SoftCheck™, that calculates the approximate lift at the feet as bolts are loosened and then retightened. This process is done by checking one foot at a time. Gross softfoot should always be corrected before using SoftCheck™.

If the foot has an angular relationship to the base, you can correct this by cutting a partial shim to make up the angular correction. When cutting partial shims from pre-cut stock, always leave the shim 'tab' intact. The tab can be used to make each shim pile organized and the partial shim will return to the original position. Never 'feather' shims out to fix an angled foot. It is unlikely the angular correction will be duplicated when shim piles are changed out during the alignment.

Using The Fixturlaser GO To Check Softfoot (Softcheck™)

1. SET UP THE FIXTURLASER GO

1.1 Mount the "S" sensor on the stationary shaft.

- The sensors may be mounted on the shafts or on the coupling hubs.
- Place the bracket on the shaft and pull the chain under the shaft and hook it over the pin.
- Hand tighten the nut, then ½ turn more with the wrench.

1.2 Mount the "M" sensor on the movable shaft.

- Place the bracket on the shaft and pull the chain under the shaft and hook it over the pin.
- Hand tighten the nut.
- Visually align the sensors (side to side), then tighten the nut ½ turn more with the wrench.

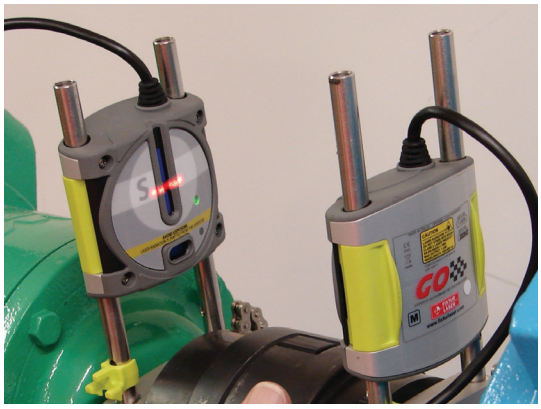
1.3 Connect the cables into either connector on the display unit.

1.4 Turn the unit on by pressing the red button at the center bottom of the display.

1.5 The Horizontal Shaft Alignment coupling icon will be highlighted in black. Press the "OK" button on the right hand key pad to enter the Horizontal Shaft Alignment Program.

- Use the up/down & left/right arrow buttons on the right hand key pad to move the black highlight to the different icons as needed. Press the "OK" button to select.

1.6 Rotate the sensors to 12:00.

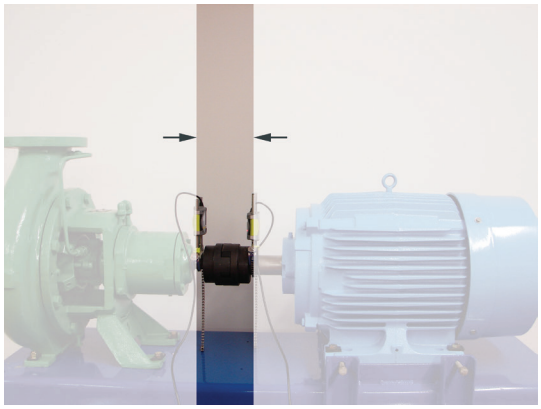


1.7 Aim the lasers.

- The sensors will be on different elevations.
- Open the green latches on either sensor and slide up or down to aim the laser into the light grey band on the opposite sensor. Adjusting one sensor will adjust both.
- You should see both "S" and "M" values in the boxes at the top of the display.
- If you do not, then the lasers are not within the sensors.
- Lock the green latches.

2. ENTER DIMENSIONS

2.1 Measure the distance between the "S" and "M" sensors to the nearest ⅛".



- Center of post to center of post.

2.2 Enter this dimension into the display unit. The dimension will appear in the left most black highlighted box.

- Use left hand keypad to enter the value as a decimal.

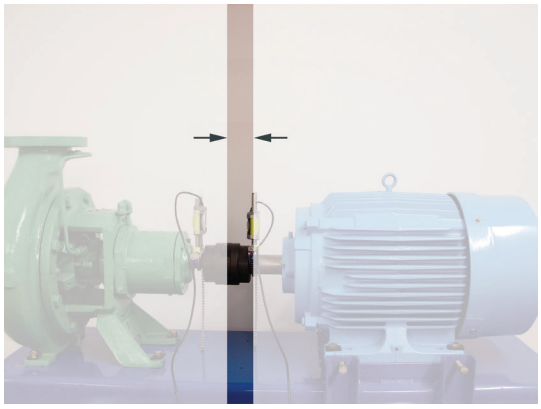
- Use the "C" button on right-hand key pad to clear errors.

2.3 Press the "OK" button on right-hand key pad to accept the dimension. OK

- Black highlight will move to the next box with ? mark.

2.4 Measure the distance from the coupling center to the "M" sensor to the nearest ⅛".

- Center of coupling to center of "M" sensor post.



2.5 Enter this dimension into the display unit if different from the value displayed.

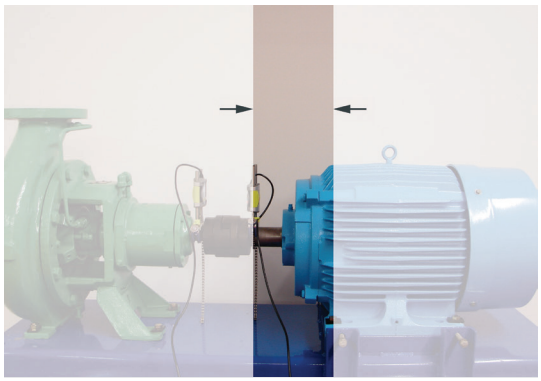
CHECKING FOR SOFTFOOT

- Second black highlighted box.
- To change dimension press "C" button on right hand key pad to clear.
- Use left hand key pad to enter correct value as a decimal.

2.6 Press the "OK" button on the right-hand key pad to accept the value.

- Black highlight will move to the next box with ? mark.

2.7 Measure the distance from the "M" sensor to the movable machine front foot to the nearest ⅛".



- The line parallel to the shaft from the center of the "M" sensor post to the center of the front foot bolt.

2.8 Enter this dimension into the display unit.

- Third black highlighted box with ? mark.
- Use left hand keypad to enter the value as a decimal.

2.9 Press the "OK" button on the right-hand key pad to accept the value.

- Black highlight will move to the next box with ? mark.

2.10 Measure the distance from the movable front feet to rear feet to the nearest ⅛".

- Center of bolt to center of bolt.

2.11 Enter this dimension into the display unit.

- Fourth black highlighted box with ? mark.
- Use left hand keypad to enter the value as a decimal.

2.12 Press the "OK" button on the right-hand keypad to accept the value.

- Black highlight will move to the Measure icon in the lower right corner of the display.

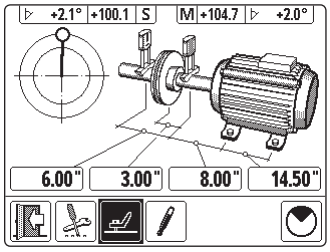
3. MEASURING SOFTFOOT (SoftCheck™ Function)

- Check that all foot bolts are firmly tightened.
- Check that all jack bolts are backed off from all feet.

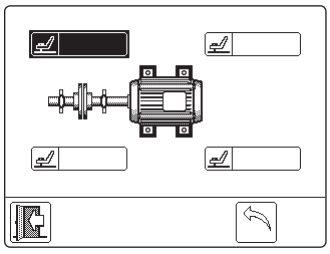
CHECKING FOR SOFTFOOT

- A warning icon will appear if the sensors are not at the 12 o'clock position.

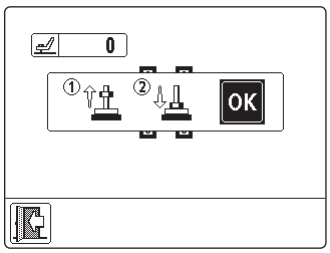
3.1 Use the left arrow button on the right hand key pad to move the black highlight to the SoftCheck™ icon. Press the "OK" button to select.



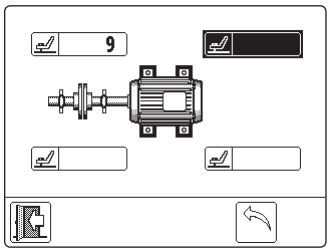
- Rotate the sensors to 12 o'clock if needed.
- Use on screen guidance.
- One foot will be highlighted.
- Press the "OK" button to select the black highlighted foot.



3.4 Wait for the foot value to zero. Then, 1) Loosen foot fully; 2) Tighten foot firmly; 3) Press "OK".

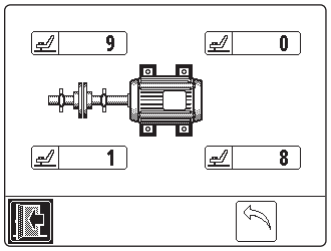


3.5 Check the remaining feet.



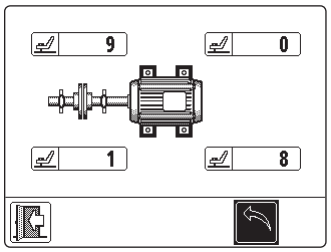
- Black highlight automatically moves to next foot.
- Values displayed are the approximate soft foot at each foot.

3.6 Correct softfoot as needed (if any foot is more than 2-3 mils).



- Re-check each foot if corrections are made.
- Re-measure icon resets foot values.

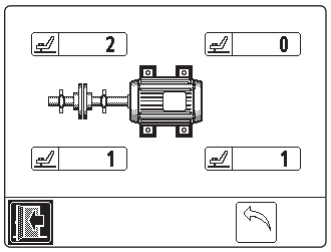
3.7 Use the right arrow button to move the black highlight to the Re-measure icon.



3.8 Press the "OK" button to select.

3.9 Repeat SoftCheck™ until all feet meet tolerance.

3.10 Use the left/right or up/down arrow buttons on the right hand key pad to move the black highlight to the Exit icon.



3.11 Press the "OK" button to select to return to shaft alignment.

CHAPTER 9

Student Practice
Using Thermal Targets

CHAPTER NINE GOALS

At the conclusion of this chapter you will be able to:

- Understand why some machines are intentionally misaligned
- Understand the difference between growth and targets
- Determine target values given growth data

USING THERMAL TARGETS

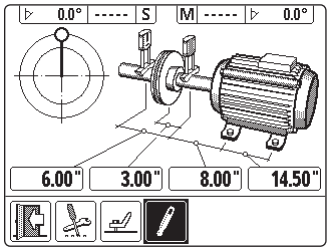
TARGETS

Some equipment moves from its off-line (cold) position when it is on-line and operating (hot). The most common cause of this dynamic movement is thermal growth. For example, a 10-inch long piece of carbon steel grows about 6.3 mils when heated 100°F above ambient conditions. (The coefficient of expansion for carbon steel is 6.31X10e-6"/°F/in; 0.00000631" x 10" x 100°F = 6.31 mils). So most machines which get hot (or cold) will grow in length. They grow away from fixed points. You should be concerned mostly about vertical changes; however, machines will move horizontally, vertically and axially.

TARGET VALUES IN THE GO

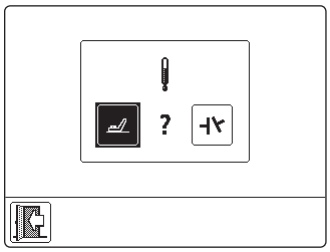
Most machines experience dynamic movement while operating. The moveable and stationary components may grow due to heat generated within the equipment, pipe strain may affect movement, etc. In some applications it is necessary to deliberately misalign the equipment when it is cold so it will 'grow' into proper alignment after reaching operating load and temperature.

We can input target values in either of two ways: feet values or coupling values (angle and offset). The Target Values program is started from the alignment program by selecting the Target Values icon and pressing OK. The Target Values program can only be started after the dimensions are entered.



1. ENTERING FEET TARGET VALUES

1.1 Select the foot icon and press OK.

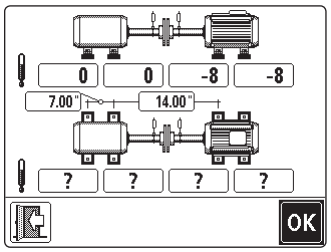


1.2 Select the smaller boxes to enter the foot dimensions. All dimensions must be entered.

1.3 Select the larger boxes under the feet to enter target values for the stationary and/or moveable feet.

If the machine grows vertically (a positive amount), the machine should be set lower (a negative amount). That is, if the moveable front feet are expected to grow +8 mils, enter -8 mils in the box as the target value. Setting the feet 8 mils low ensures a proper alignment at operating load and temperature.

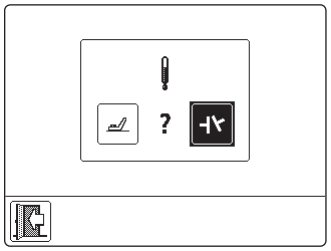
1.4 Select OK to go the alignment job.



1.5 Proceed with the alignment as usual.

2. ENTERING COUPLING TARGET VALUES

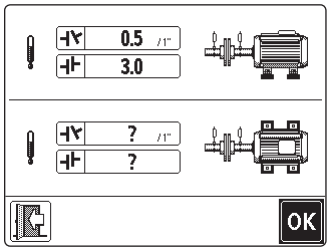
2.1 Select the coupling icon.



2.2 Select the input boxes to enter the angularity (mils/in) and offset (mils) target values.

Make sure you have the correct sign on the values by looking at the coupling icons. Positive angularity values mean the coupling gap is larger at the bottom. Positive offset values mean the moveable machine will be left higher than the stationary machine.

2.3 Select OK to go the alignment job.



CHAPTER 10

Student Practice
Using the Clock Method

CHAPTER TEN GOALS

At the conclusion of this chapter you will be able to:

- Describe difference between the Tripoint and Clock methods
- Identify when you should use the clock method

CHAPTER 10

Clock Method

The built-in guidance of the Tripoint method may not allow you to measure misalignment if the sensors are less than 8" apart and the shafts cannot rotate more than 90° total. The Tripoint method uses the inclinometer angles to make calculations and guide you in making the best measurement possible. In contrast, the Clock method only uses the inclinometer for the operator to reference clock positions. The Clock method bypasses this guidance and allows the user to take readings wherever possible. A typical use of the Clock method would be on a smaller machine with something obstructing the rotation of the shafts.

The purpose of the clock method is to define the maximum rotation allowed in the first two readings (9 o'clock and 3 o'clock) and take the last measurement half-way between those. In the Clock method, measurements are registered at 9 oclock, 3 o'clock and 12 o'clock – in that order – regardless of where the readings are actually taken. The inclinometers and the display will guide you through the positions. Remember, it is best to rotate the shafts as much as possible. Rotation of less than 60° may make for a difficult alignment.

The steps below will walk us through a standard Clock method alignment, taking readings at 9 o'clock, 3 o'clock and 12 o'clock.

Using The Fixturlaser GO Clock Method

1. SET UP THE FIXTURLASER GO

1.1 Mount the "S" sensor on the stationary shaft.

- The sensors may be mounted on the shafts or on the coupling hubs.
- Place the bracket on the shaft and pull the chain under the shaft and hook it over the pin.
- Hand tighten the nut, then ½ turn more with the wrench.

1.2 Mount the "M" sensor on the movable shaft.

- Place the bracket on the shaft and pull the chain under the shaft and hook it over the pin.
- Hand tighten the nut.
- Visually align the sensors (side to side), then tighten the nut ½ turn more with the wrench.

1.3 Connect the cables into either connector on the display unit.

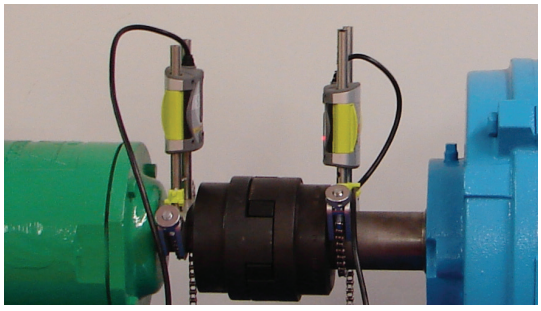
1.4 Turn the unit on by pressing the red button at the center bottom of the display.

1.5 The Horizontal Shaft Alignment coupling icon will be highlighted in black. Press the "OK" button on the right hand key pad to enter the Horizontal Shaft Alignment program.

- Use the up/down & left/right arrow buttons on the right hand key pad to move the black highlight to the different icons as needed. Press the "OK" button to select.

1.6 Rotate the sensors to 12:00.

1.7 Aim the lasers.



The sensors will be on different elevations.

- Open the green latches on either sensor and slide up or down to aim the laser into the light grey band on the opposite sensor. Adjusting one sensor will adjust both.
- You should see both "S" and "M" values in the boxes at the top of the display.
- If you do not, then the lasers are not within the sensors.
- Lock the green latches.

2. ENTER DIMENSIONS

2.1 Measure the distance between the "S" and "M" sensors to the nearest ⅛".

- Center of post to center of post.

2.2 Enter this dimension into the display unit.

- Left most black highlighted box with ? mark.
- Use left hand keypad to enter the value as a decimal.
- Use the "C" button on right-hand key pad to clear errors.

2.3 Press the "OK" button on right-hand key pad to accept the dimension.

- Black highlight will move to the next box with ? mark.

2.4 Measure the distance from the coupling center to the "M" sensor to the nearest ⅛".

- Center of coupling to center of "M" sensor post.

2.5 Enter this dimension into the display unit if different from the value displayed.

- Second black highlighted box.

2.6 Press the "OK" button on the right-hand key pad to accept the value.

- Black highlight will move to the next box with ? mark.

2.7 Measure the distance from the "M" sensor to the movable machine front foot to the nearest ⅛".

- The line parallel to the shaft from the center of the "M" sensor post to the center of the front foot bolt.

2.8 Enter this dimension into the display unit.

- Third black highlighted box with ? mark.

2.9 Press the "OK" button on the right-hand key pad to accept the value.

- Black highlight will move to the next box with ? mark.

2.10 Measure the distance from the movable front feet to rear feet to the nearest ⅛".

- Center of bolt to center of bolt.

2.11 Enter this dimension into the display unit.

- Fourth black highlighted box with ? mark.

2.12 Press the "OK" button on the right-hand keypad to accept the value.

- Black highlight will move to the Measure icon in the lower right corner of the display.

3. SET MACHINE RPM IN TOLERANCE TABLE & SELECT CLOCK MEASUREMENT METHOD

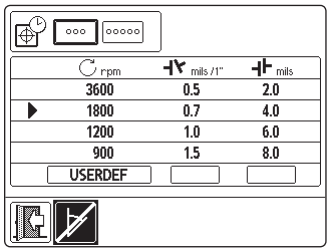
3.1 Use the left arrow button on the right hand key pad to move the black highlight to the Tools icon. Press the "OK" button to select.

3.2. Use the up arrow button to move the black highlight to the tolerance table. Press the "OK" button to select.

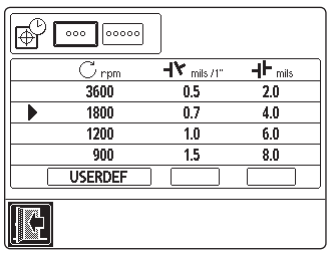
3.3. Select the machine RPM using up/down arrow buttons to highlight the correct RPM. Press the "OK" button to select.

- Use next highest RPM setting if machine RPM is in between values listed.

3.4 Use down arrow button to move the black highlight down (the Exit Door icon will be highlighted), use right arrow button to move black highlight to "disable inclinometer" icon. Press "OK" button.



will disappear.



- Exit door icon will be highlighted
- This step enables "clock" measurement method

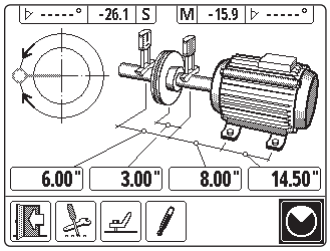
3.5 Press the "OK" button to exit tools menu.

4. MEASURE MISALIGNMENT

- The sensors should begin at or near the 9:00 position.
- Absolute precision to attain each clock position is not necessary, however care should be taken to square the "S" and "M" sensors to one another if shafts are uncoupled.

USING THE CLOCK METHOD

4.1 Rotate the sensors to 9:00.

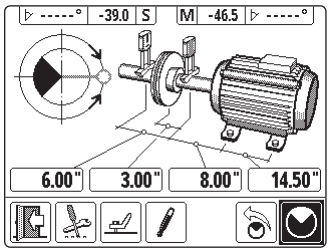


- 9:00 is shown graphically on the screen, but it will not be animated as the sensors rotate. Remember, in the clock method the inclinometers are turned off.
- Standing behind the Movable Machine looking at the coupling, 9:00 is located on the left.
- You should see both "S" and "M" values in the boxes at the top of the display.
- If you do not, then the lasers are not within the sensors.

4.2 Press the "OK" button to register the 1st measurement.

- The "S" and "M" values will change to near zero.
- The values are displayed in mils.
- Do not rotate shafts while the Measuring icon is displayed.

4.3 Rotate the sensors to approx. 3:00.

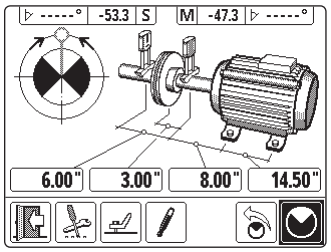


- 3:00 is shown graphically on the screen, but it will not be animated as the sensors rotate. Remember, in the clock method the inclinometers are turned off.
- Care should be taken to square the "S" and "M" sensors to one another if shafts are uncoupled.
- You should see both "S" and "M" values in the boxes at the top of the display.
- If you do not, then the lasers are not within the detectors.

4.4 Press the "OK" button to register the 2nd measurement.

- The "S" and "M" values will not change.
- Do not rotate shafts while the Measuring icon is displayed.

4.5 Rotate the sensors to 12:00.



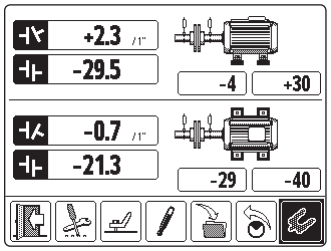
- 12:00 is shown graphically on the screen, but it will not be animated as the sensors rotate. Remember, in the clock method the inclinometers are turned off.
- Care should be taken to square the "S" and "M" sensors to one another if shafts are uncoupled.
- You should see both "S" and "M" values in the boxes at the top of the display.
- If you do not, then the lasers are not within the sensors.

4.6 Press the "OK" button to register the 3rd measurement.

- The "S" and "M" values will not change.
- Do not rotate shafts while the Measuring icon is displayed.

5. ALIGNMENT RESULTS

- Both the Vertical and Horizontal misalignment values are displayed.



- Displayed values are not live.
- The angle and offset values ONLY determine the alignment condition.

	Angular Misalignment		Offset Misalignment	
	Mils per inch .001/1"		Mils .001"	
RPM	Excellent	Acceptable	Excellent	Acceptable
3600	0.3/1"	0.5/1"	1.0	2.0
1800	0.5/1"	0.7/1"	2.0	4.0
1200	0.7/1"	1.0/1"	3.0	6.0
900	1.0/1"	1.5/1"	4.0	8.0

- The RPM you select in the tolerance table determines how accurate the alignment must be and therefore at what results values you will see the green LED indicating a successful alignment.
- The three LED lights on the display unit indicate whether the couplings are within tolerance (green light), within double tolerance (orange light), or out of double tolerance (red).
- Displayed foot values are for making corrections.

6. CORRECTING VERTICAL MISALIGNMENT

6.1 Correct the vertical alignment from the results screen.

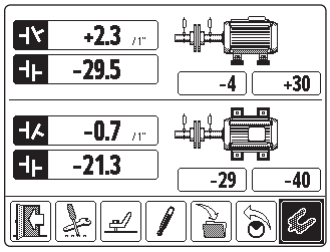
6.2 Positive foot values: the movable is high, remove shims.

6.3 Negative foot values: the movable is low, add shims.

6.4 Leave the bolts loose after adjusting shims.

7. CORRECTING HORIZONTAL MISALIGNMENT

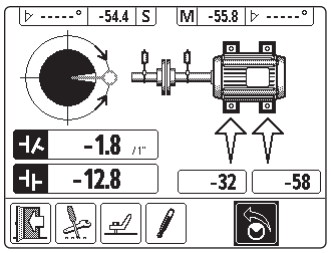
7.1 Using the right arrow button move the black highlight to the Shim icon.



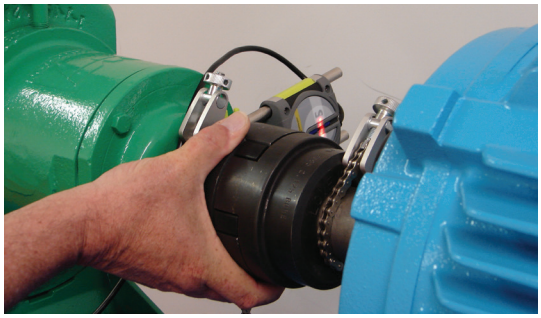
7.2 Press the "OK" button to select.

- The GO is now "live" and will display the values in whatever orientation the sensors are pointing.

7.3 Press the down arrow to switch the view to horizontal

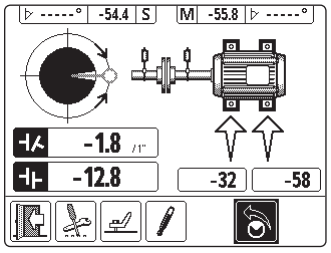


- Rotate the sensors to the 3:00 position

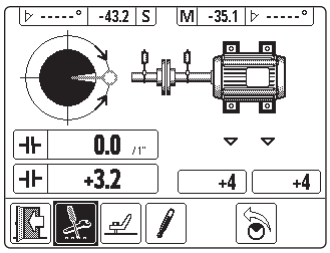


- 3:00 is shown graphically on the screen, but it will not be animated as the sensors rotate. Remember, in the clock method the inclinometers are turned off.
- Care should be taken to square the "S" and "M" sensors to one another if shafts are uncoupled.

7.5 Adjust the feet in the direction of the arrows.



- The Angle & Offset values will change as the feet are adjusted.
- The LED will change from Red to Orange to Green as the angular and offset values are brought into tolerance.
- Green LED indicated alignment in tolerance. It's not necessary to adjust the foot values to zero.



- Tighten the bolts using torque pattern.

8. RE-MEASURE

8.1 Move the black highlight to the Re-measure icon if needed.

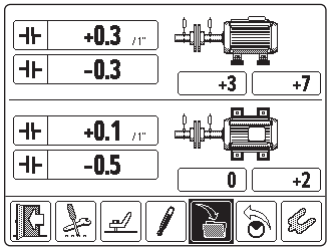
8.2 Press the "OK" button to select. OK

- Verify selection.

8.3 Rotate sensors back to the starting measuring position and repeat the process.

9. VERIFY RESULTS & DOCUMENT FINAL ALIGNMENT

- Both the vertical and horizontal misalignment values are displayed.
- Verify the angle & offset values meet or are less than the tolerances.



- Green LED should be on.

9.1 Use the left/right arrow buttons to move the black highlight to the Save icon if needed.

9.2 Press the "OK" button to select.

9.3 Enter the name of the saved alignment.

- Use the left hand key pad to enter up to 17 alphanumeric characters.
- Use the C button on the right hand key pad to clear errors.

9.4 Press the "OK" button to save.

- Orange & Green LEDs will flash as alignment is saved.
- Saved alignment will display for approximately 5 seconds.

10. EXIT THE PROGRAM AND TURN OFF

10.1 Move the black highlight to the Exit icon.

10.2 Press the "OK" button to select.

10.3 Verify selection and press the "OK" button. OK

10.4 Move the black highlight to the Off icon.

10.5 Press the "OK" button to select.

EXPRESS ALIGNMENT BY FIXTURLASER

TRAINING MANUAL

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