OPTALIGN® PLUS

Operating Instructions and Alignment Handbook

Dear Customer,

If you have any suggestions for improvement or corrections (not only to this manual, but also to software or hardware), please drop us a line! We would be glad to make improvements wherever possible. We look forward to hearing from you!

PRÜFTECHNIK Alignment Systems
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CE

EDITION July 2002
ALI 9.560G, Firmware version 1.2x

Different markets, different OPTALIGNs

Please note that the components and functional capabilities of your particular instrument may vary from those described in this manual. See your original price quotation and packing slip for definitive information regarding your particular system, or ask your local PRÜFTECHNIK dealer for further details.

Depending upon the characteristics of your particular instrument, it may be possible to upgrade to include the latest features. Contact your local PRÜFTECHNIK dealer for more information.

Foreword

Congratulations and thank you for your decision to entrust the shaft alignment of your machines to OPTALIGN PLUS! This all-new system represents over a decade of experience by the pioneers in laser shaft alignment. Thanks to invaluable feedback received over the years from laser alignment customers such as yourself, all components of OPTALIGN PLUS have been designed from the ground up to include the features you want and need, such as:

- Enhanced measurement flexibility thanks to new measuring modes:
  - with minimum shaft rotation
  - with continuous shaft rotation
  - at freely selectable measurement positions
- Elimination of coupling backlash effects
- Graphic indication of compliance with alignment tolerances
- Even easier keyboard operation
- PC/printer interface
- Auxiliary battery for back-up power supply
- Extended battery life management
- Non-volatile measurement storage
- Job set-up, transfer and storage on PC

Of course, the new system also offers the complete range of features that have made OPTALIGN the leading choice of shaft alignment experts around the world. Special situations like 6-feet machines, spacer shaft couplings, vertical machines and thermal growth can all be handled with ease. And the complete range of OPTALIGN accessories remains available to adapt the new system to nearly any machine/coupling configuration you might encounter.

However, alignment needs do continue to change along with machine designs and operating practices, so please share your expertise with us! As in the past, your own experience will most assuredly play a decisive role in the development of future alignment systems.

You can learn quite a great deal by simply taking the equipment out of its case and working your way through this manual. To learn all the capabilities of your new OPTALIGN PLUS and many of the finer points of shaft alignment in general, contact your local PRÜFTECHNIK agent to register for an in-depth alignment training course. If you are like most alignment professionals, you will find it a few days well spent.

Once again, we would like to express our sincere appreciation for your vote of confidence in OPTALIGN PLUS and for joining us in the continued commitment to alignment excellence.

July 2002
PRÜFTECHNIK Alignment Systems
Ismaning, Germany

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Chapter 1: Introduction

This chapter includes general information regarding the OPTALIGN PLUS system and its operation including, in particular, the intended use and safety information.

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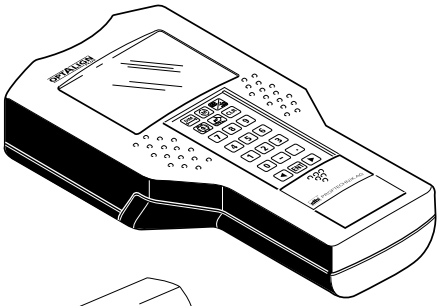
The OPTALIGN PLUS package

ALI 5.000
ALI 5.000 EX

Please check your packing slip to ensure that all parts listed on the slip have been received.

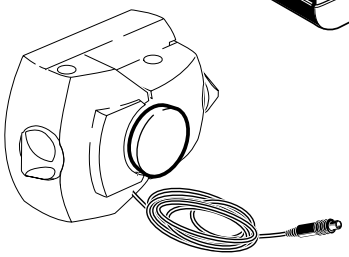
The intrinsically safe version, ALI 5.000 EX contains certain components designated with the 'EX' suffix. See also page 1-10.

ALI 5.010 **OPTALIGN PLUS Case**
(ABS, black), complete with key

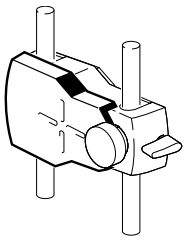


ALI 5.200 **OPTALIGN PLUS Control Unit**
For data entry and display of results and is supplied with both main and auxilliary batteries (page 2-7).

ALI 5.201 **Stand for control unit**
(Not shown)

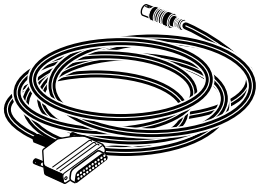


ALI 5.100 **OPTALIGN PLUS Transducer**
incl. dust cap ALI 5.105 and cable ALI 3.528-2
Mounted on stationary machine coupling and connected to the control unit (page 2-11).



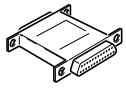
ALI 5.110 **Reflector**
incl. dust cap ALI 5.115
Mounted on coupling to be moved (page 2-12).

ALI 5.106 **Beam Deflector**
Mounts onto the transducer and deflects the beam onto the floor for measuring to the machine feet. (page 2-12)

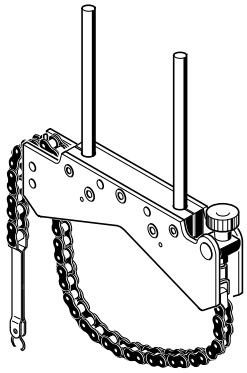


ALI 5.221 **Printer Cable**
(page 2-6)

ALI 5.220 **Serial/parallel Converter**
for parallel printers (page 2-13)

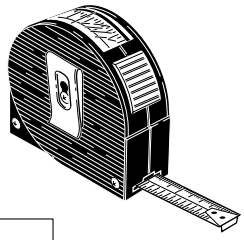


ALI 2.892 SET **Compact Chain-type Bracket Set**
For mounting the components on the machine shaft (page 2-13). The set includes the following.



ALI 2.114	Chains, 2 x 300mm
ALI 2.115	Chains, 2 x 600 mm
ALI 2.170	Bracket Posts, 4 x 115 mm (white)
ALI 2.171	Bracket Posts, 4 x 150 mm (black)
ALI 2.172	Bracket Posts, 4 x 200 mm (gray)
ALI 2.173	Bracket Posts, 4 x 250 mm (green)
ALI 2.174	Bracket Posts, 4 x 300 mm (yellow)

ALI 2.905 **Optics Cleaning Cloth**
(Not shown) (page 2-11, 2-12)



ALI 3.588 **Tape Measure, mm/inch**

ALI 9.561G **OPTALIGN PLUS Short Instructions**
(stored in back panel of the control unit)

ALI 9.560G **OPTALIGN PLUS Operating Instructions**
(This manual)

ALI 9.300 **Laser alignment Product Catalog**
(Not shown)

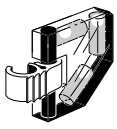
ALI 5.592 CD **OPTALIGN PLUS Explorer CD ROM**
To register the Alignment Explorer and the OPTALIGN PLUS Editor, please use the order form provided with the CD.

Optional accessories:

ALI 5.250 **OPTALIGN PLUS Explorer registration certificate**

ALI 5.260 **OPTALIGN PLUS Editor registration certificate**

ALI 5.020 **External inclinometer**
Used in the static (0369) measurement mode. (page 4-12)



Please see page 6-12 for details of other accessories. Also consult the provided Laser Alignment Product Catalog ALI 9.300.

The contents of this package are subject to change without prior notice more so in the interest of technical development.

Before you start...

Please take a moment to read through these important notices before beginning alignment with OPTALIGN PLUS.

Everyone

Please acquaint yourself first with:

- Safety and Operating Notes, on the following pages.
- Warranty, Service and Care Information in chapter 6.
- Batteries and memory on pages 2-7 to 2-10.

Beginners

Having read the above notes, proceed with the following:

- OPTALIGN PLUS Components in chapter 2.
- What is Alignment? and relevant notes in chapter 6.
- Then try an actual alignment starting page 3-6.

Experts

Even if you have some experience in alignment, e.g. with OPTALIGN, please read the notes listed above for 'Everyone'.

You may then be able to start straight away by following the Short Instructions on page 3-2. Step-by-step alignment for a standard horizontal machine arrangement is described starting on page 3-6. After you have mastered a standard alignment, browse through the sections in chapter 4 to learn about OPTALIGN PLUS's special capabilities.

And finally,

WARNING!

Remember...

Ensure the machine cannot be accidentally started while taking measurements!

Remove all components from the shaft before switching the machine back on!

Do not stare into the laser beam!

Safety and operating considerations

Please read this section carefully!

OPTALIGN PLUS system may give many users their first contact with laser measurement technology. The following notes will acquaint you with several of the most important aspects of the system.

Symbols used in this manual

The following symbols are used in this manual in order to draw the reader's attention to especially important text, such as that regarding possible sources of danger or useful operating tips.

This symbol denotes information which must be followed in order to avoid personal injury.

WARNING!

This symbol denotes information which must be followed in order to avoid damage to equipment.

ATTENTION

This symbol denotes general information and tips regarding operation of OPTALIGN PLUS.

Note

CE compliance

All versions of OPTALIGN PLUS conform to all applicable CE requirements.

CE

Intended use

OPTALIGN PLUS may be used only for shaft alignment in industrial environments. The device must only be operated by properly trained personnel. No liability may be assumed when components or operating procedures as described in this manual are altered without permission of the manufacturer.

Electromagnetic compatibility (EMC)

All versions of OPTALIGN PLUS conform to the following European Community standards for electromagnetic compatibility: EN 55011 Group 1, Class A and EN 50081-2.

Safety notes

General

Please observe the following points in order to avoid personal injury and damage to equipment:

WARNING!

ATTENTION

- OPTALIGN PLUS must not be operated with the housing open or removed.
- OPTALIGN PLUS must be operated and maintained only by trained personnel.
- Repairs may be performed only by factory-authorized service personnel.
- Only original spare parts and accessories must be used.
- Any unauthorized modifications to OPTALIGN PLUS, its components and the operating procedures described herein shall render all warranty coverage void.
- Ensure that the laser and sensor brackets fit solidly onto their mounting surfaces!
- The specified system accuracy is applicable when the components are mounted with PRÜFTECHNIK-supplied brackets. Do not use self-constructed mounting brackets or modify the original bracket configuration.
- All components must be removed from the shafts or coupling before starting the machines! Otherwise, serious bodily injury may result from flying parts.

Notes for intrinsically safe models

In addition to the general notes described opposite, the following notes must strictly be observed when working in explosive atmospheres.

When equipment to be aligned is located in an explosive environment, the intrinsically safe OPTALIGN PLUS EX (ALI 5.000 EX) must be used. This portable alignment instrument comprises of the control unit (ALI 5.200 EX) and the transducer (ALI 5.100 EX), and is used in the preventive maintenance of rotating machines.

Batteries must be changed only outside the explosive area! Note that only alkali-manganese batteries can be used in explosive atmospheres. With the OPTALIGN PLUS EX version, use 1.5V AA batteries from Philips or Duracell as main supply. As auxilliary supply, use 9V block batteries from Varta, Duracell or Panasonic.

WARNING!

The OPTALIGN PLUS case (ALI 5.010) must not be taken into the hazardous area. Should the case be taken into an explosive atmosphere, appropriate measures must be taken to prevent static electrification.

The transducer conforms to EN 60825, EN 50014:1997 and EN 50020:1994, and was developed, manufactured and tested to the state-of-the-art and in accordance with EN 29001.

The circuit parameters meet the intrinsic safety requirements EEx ib IIC.

The maximum cable length between the control unit terminal and the transducer must not exceed 10 m.

The RS232C interface is not certified for use in explosive environments and therefore its use must take place outside the hazardous zone, and the maximum voltage across the interface must not exceed 25 V_{ac} or 60 V_{dc} respectively.

The installation and operation of OPTALIGN PLUS must be in accordance with the regulations in ElexV and equipment safety law as well as the general recognised rules of the technology. The instructions in this manual must also be observed.

The most current regulations regarding servicing, maintenance and testing, as they appear in ElexV § 13, EN 60079-14 and EN 60079-17 must be observed. The rules of the manufacturer as they appear in this manual must also be observed.

Typical equipment marking include the symbols shown on the right column.

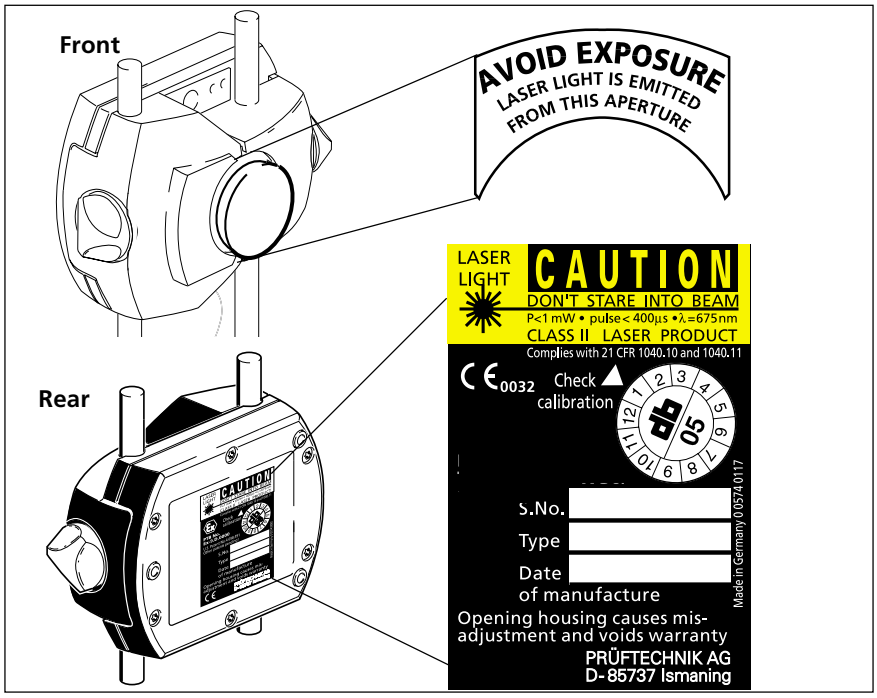
Laser safety

OPTALIGN PLUS system uses a Class II laser beam. Class II lasers comply with the requirements outlined in the USA's FDA specification 21 CFR Ch. 1, Parts 1040.10 and 1040.11 as well as the ANSI standard. OPTALIGN PLUS also fulfills British standard BS 4803 (Part 1 to Part 3) and European Industrial Standard IEC 825. The OPTALIGN PLUS Class II laser operates at a typical wavelength of 675 nm, with a maximum pulse duration of 128 μsec., maximum radiant power of 0.8 mW and maximum radiant energy per pulse of 0.1 μJ. No maintenance is necessary to keep this product in compliance with the above specifications.

WARNING!

- Do not look into the laser beam at any time, including during setup, adjustment or operation.*
- Do not insert any optical devices into the beam path.
- Caution: use of controls or adjustment or performance of procedures other than those specified herein may result in hazardous radiation exposure.
- The red LED on the front of the transducer illuminates whenever the laser beam is emitted.

The diagram below shows all locations of laser safety labels on the OPTALIGN PLUS transducer housing.

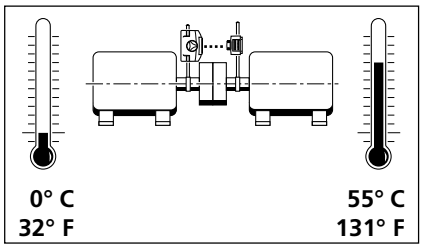


*Since the FDA specification allows maximum exposure of 0.25 seconds, the natural blink reaction of the human eye is normally sufficient to avert any danger, provided that no optical instruments

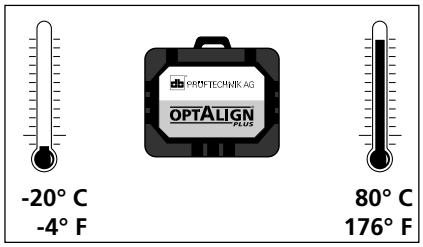
Operating considerations

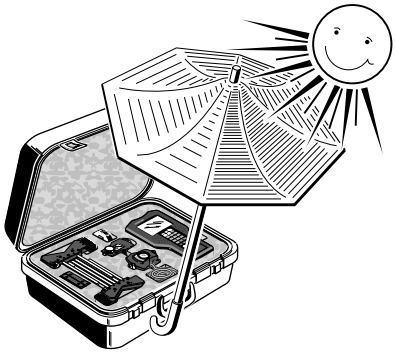
Temperature range

The OPTALIGN PLUS system may be used only at temperatures between 0° and 55° C (32° to 131° F). Outside of this range, the specified accuracy may not be maintained. For further information regarding operating temperature, see page 6-45.



Store your OPTALIGN PLUS equipment at temperatures between -20° C and 80° C (-4° F to 176° F). Remember that on a hot day, the temperature inside a locked car can easily surpass 80° C (176 °F)!





Sudden changes in temperature and humidity (for example, when OPTALIGN PLUS is stored in an office but used in hot or cold work areas) can cause the optics to fog over with condensation: the computer displays "OFF" and stops measurement.


Note

In that case, give the equipment about 10 minutes to reach the work area temperature.

Operating environment considerations

If the transducer is subjected to strong, uneven heating during measurement (such as when placed in direct sunlight), measurements may be affected by uneven expansion of the transducer housing, which could cause the laser beam to deflect irregularly. In that case, allow several minutes for the OPTALIGN PLUS system to reach ambient temperature before beginning measurement; if in doubt, repeat the readings and compare them to establish repeatability.


Note

Do not allow point light sources to shine directly into the transducer; shade it if necessary during measurement.

Avoid exposing the OPTALIGN PLUS control unit directly to sources of thermal radiation such as direct sunlight.

The LCD display can act as a solar collector (at a rate of 10 watts!) and turn dark (reversibly) if overheated.

Water and contamination resistance

The OPTALIGN PLUS control unit is water and contamination resistant to specification IP65; the transducer and prism are resistant to IP67. This specification requires that each component be able to withstand a water jet spray from any direction (the components are NOT guaranteed to withstand a full submersion). Note: as with most water-resistant products, the resistance must be periodically checked and re-sealed if necessary. This can be carried out during OPTALIGN PLUS service and re-calibration which should be carried out every two years.

Interface connections

OPTALIGN PLUS uses the following interface connections:

1. The plug-in cable ALI 3.581-2 connects the transducer to the control unit sensor socket. This cable normally remains attached to the transducer; in case of damage, it may be replaced according to the instructions given on page 6-29 of this manual.

2. The plug-in printer cable ALI 5.221 connects the 6-pin RS232 socket of the control unit to the serial/parallel converter ALI 5.220 which in turn connects to the PC end of the parallel (Centronics) printer cable (see page 2-6).


Note

Note regarding data storage

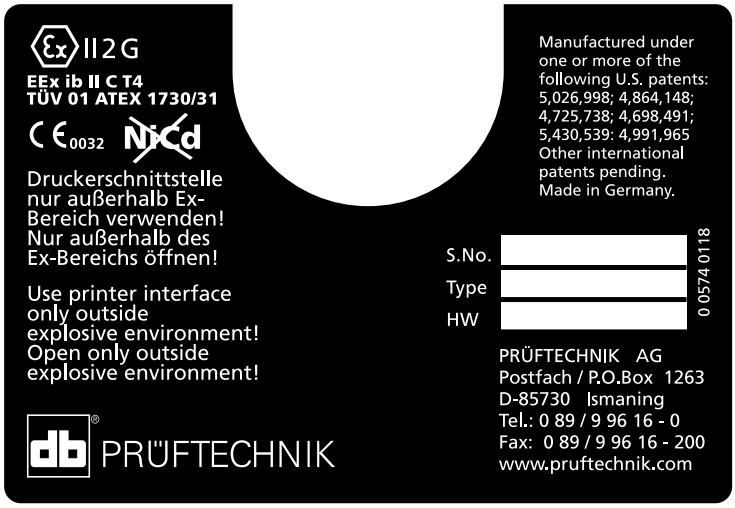
With any data processing software, data may be lost or altered under certain circumstances. PRÜFTECHNIK strongly recommends that you keep separate written or printed records of all important data.

PRÜFTECHNIK assumes no responsibility for data lost or altered as a result of improper use, repairs, defects, battery replacement/failures or any other cause.

PRÜFTECHNIK assumes no responsibility, directly or indirectly, for financial losses or claims from third parties resulting from the use of this product and any of its functions, such as loss or alteration of stored data, etc.

Component labeling

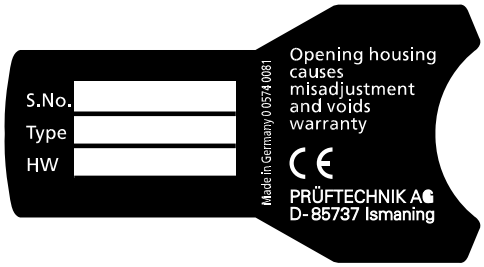
The following identification labels appear on the rear of the OPTALIGN PLUS components.
Note that non-Ex instruments are supplied without Ex labels.



Control unit

Transducer

Reflector



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Chapter 2: Description

This chapter includes a description of OPTALIGN PLUS and its components.

Chapter 1 Introduction ..... 1-1 to 1-12

Chapter 2: Description 2-1
OPTALIGN PLUS overview 2-2
OPTALIGN PLUS components 2-3
The OPTALIGN PLUS Control unit 2-3
The OPTALIGN PLUS keyboard at a glance 2-4
The OPTALIGN PLUS screen 2-5
The OPTALIGN PLUS control unit (top view) 2-6
Transducer connection & RS232/printer interface 2-6
Batteries 2-7
Transducer ALI 5.100 2-11
Reflector ALI 5.110 2-12
Compact chain-type bracket ALI 2.892 SET 2-13
Beam deflector ALI 5.106 2-13
Serial/parallel converter ALI 5.220 2-14
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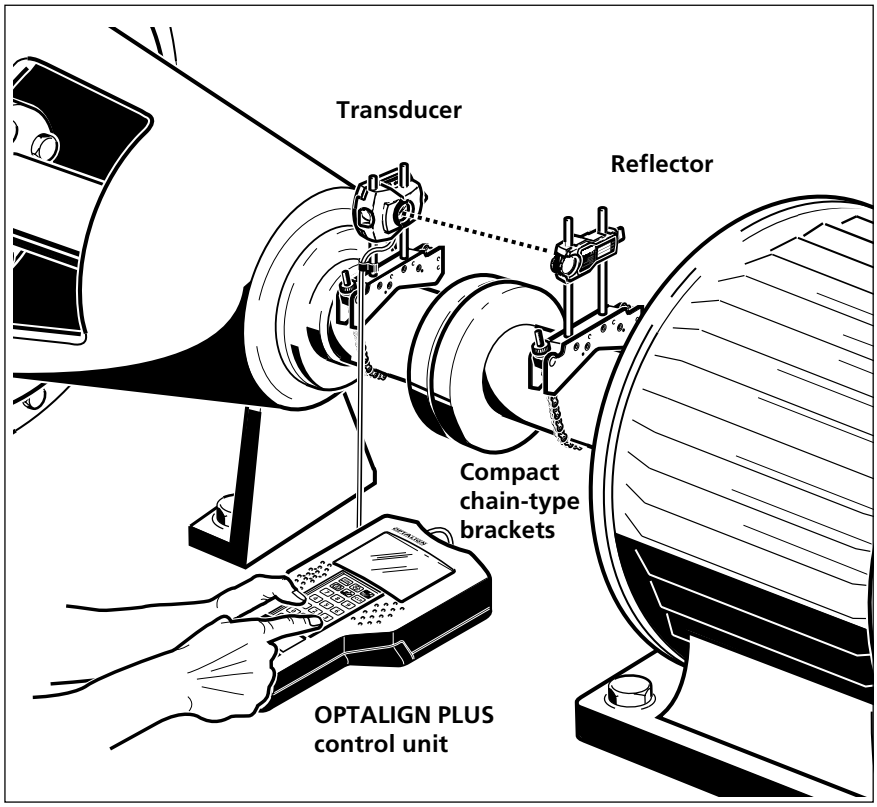
Chapter 3 Horizontal alignment ..... 3-1 to 3-38
Chapter 4 Further functions ..... 4-1 to 4-36
Chapter 5 Vertical alignment ..... 5-1 to 5-18
Chapter 6 Appendix ..... 6-1 to 6-50

OPTALIGN PLUS overview



The complete OPTALIGN PLUS package is shown on page 1-2.

OPTALIGN PLUS control unit ..... page 2-3
connects to the transducer; displays the machine alignment from data collected from the transducer during shaft rotation. The machines can then be aligned with aid of a "live" graphical display. Battery replacement is described on page 2-7. The unit can also be connected to a PC with the OPTALIGN PLUS Explorer software (see chapter 6).

Transducer ..... page 2-11
fits onto the machine shaft on one side of the machine coupling, emits its beam across the coupling and measures the precise position of the beam reflected back into its housing. The beam has no sag and is extremely straight.

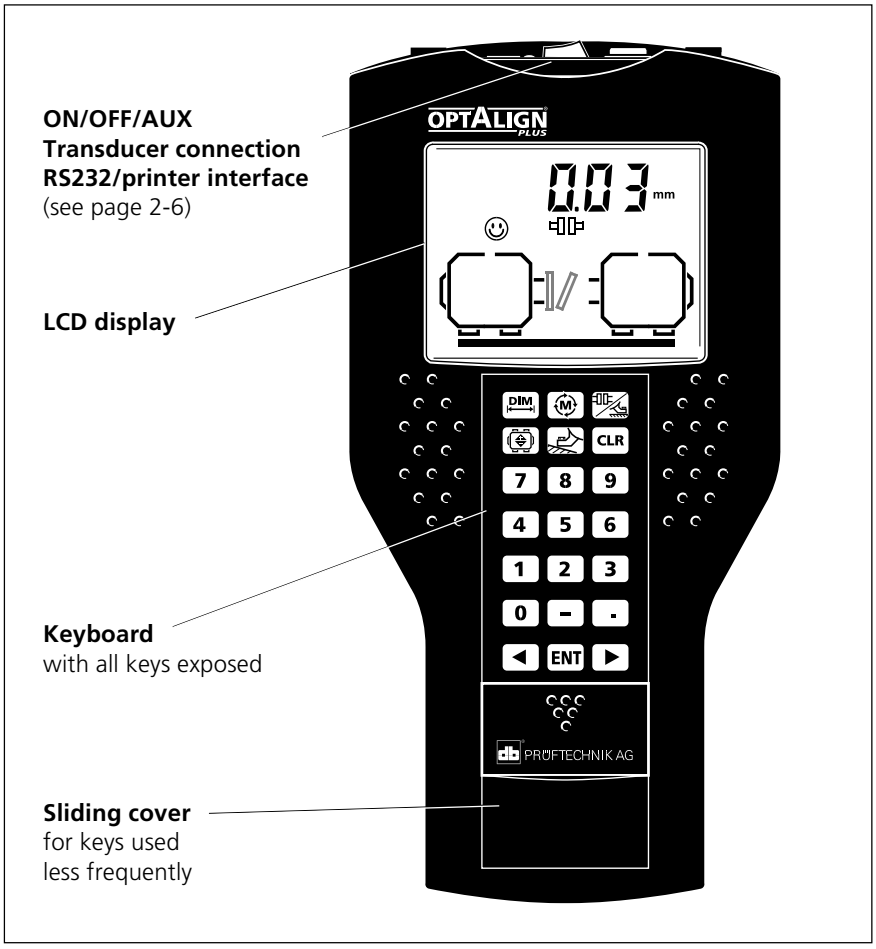
Reflector ..... page 2-12
fits onto the shaft on the other side of the coupling; reflects the laser beam back into the transducer for position measurement.

Brackets ..... page 2-13
mount the transducer and reflector securely on the shaft on either side of the machine coupling.

OPTALIGN PLUS components

Descriptions of the main OPTALIGN PLUS components are given on the following pages.

The OPTALIGN PLUS Control unit ALI 5.200 (EX option)



The heart of the OPTALIGN PLUS system is the OPTALIGN PLUS Control Unit, built to rugged industrial standards of shock and water resistance (IP65). It features an easy-to-read, energy-saving fixed-segment LCD display and numeric-function keypad.

Measurement data passes directly via cable from the transducer to the control & display unit where the results are displayed. Numerous software functions allow you to handle a vast range of alignment situations.

The sliding cover is held in place by a strong magnet. Take care to keep magnetic storage media (such as diskettes or credit cards) at a safe distance from the control unit.

ATTENTION

The OPTALIGN PLUS keyboard at a glance

Dimensions
Initiates entry of machine dimensions
(pages 3-15, 5-7)

M = Measure
Start alignment measurement by rotating the machine shaft
(pages 3-18)

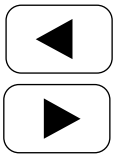
Results
Displays alignment condition at the coupling and at machine feet
(pages 3-24, 5-12)

'MOVE'
Guides the user interactively through machine positioning for alignment correction
(pages 3-30, 5-16)

Soft foot
Checks whether all machine feet rest firmly on the foundation and helps determine corrections
(page 4-2)

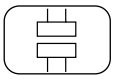
Clear
Deletes displayed value to allow correction
(page 3-15 etc)

Numbers
For entry of numerical values (page 3-15 etc)



Arrows
For progressing through program steps

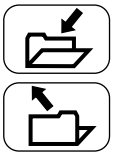
Enter
Confirms displayed value and proceeds to next value
(page 3-15 etc)



Vertical machines
Measurement at 3 or more clock positions gives flange offset and shimming values
(chapter 5)

Alignment targets
Desired offsets and angularity can be entered to compensate for thermal growth. Correction values are then adjusted automatically (page 4-16)

Function
For special functions such as changing units, setting date and time, 6-feet machine setup, coupling type selection etc. (pages 4-22 etc)

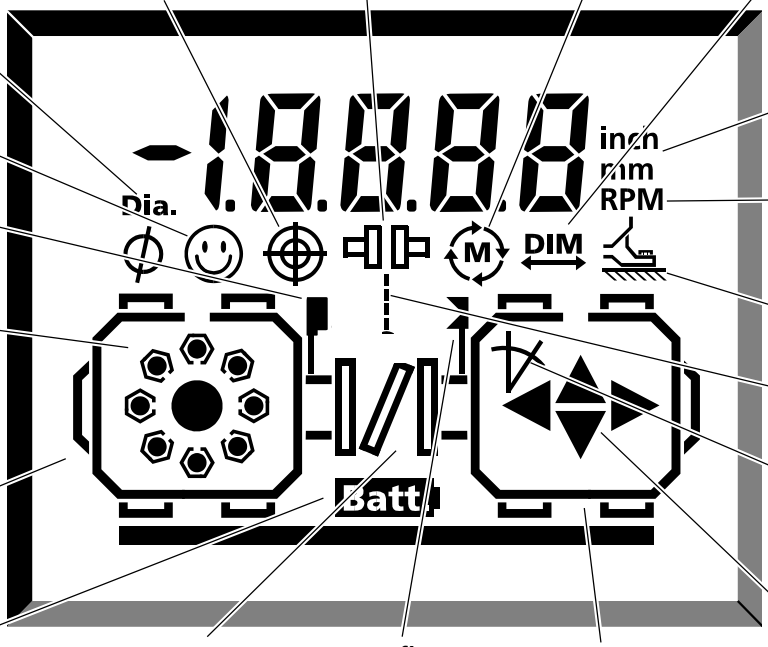


Save/Open file
For storing and recalling machine setups and results in a file. Up to 99 files can be saved
(page 3-35)

Printer
Directs output to the printer for producing a measurement report
(page 3-35)

The OPTALIGN PLUS screen

The OPTALIGN PLUS screen uses energy-saving fixed-segment LCD's to indicate clearly all user input, measurement results and important messages such as 'battery low' and the Smiley symbol which indicates compliance with alignment tolerances. Flashing segments lead the user through the entire measurement procedure, prompting for input when necessary.



Diameter
of coupling or flange (vertical machines) pages 3-16 and 5-8

Targets
For coupling targets and thermal growth, page 4-16

Coupling
results and targets, pages 3-24 and 4-16

Measuring
page 3-22

Dimensions mode
appears during entry of dimensions, pages 3-15 and 5-7

Happy face
Shows in/out of tolerance, page 3-25

Units
Select with F 2. page 4-24

Transducer
page 3-16

RPM
for tolerancing, page 3-16

Rotation/Bolt positions
Shows rotational position, page 3-23 or flange bolt position, page 5-8

Foot corrections
Results, page 3-26

Coupling center
page 3-16

Clock/bolt angle
appears during angle entries. page 5-8

Left machine
With transducer mounted, page 3-16

Battery low
Appears when battery in use runs low , page 2-7. Note: Does not appear during display test.

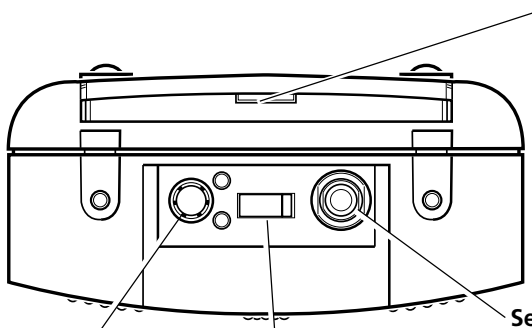
Coupling gap
Appears with gap results, page 3-24

Reflector
page 3-16

Right machine
With reflector mounted, page 3-16

Move direction
shown by arrow, page 3-24

The OPTALIGN PLUS control unit (top view)



Short instructions
Folding instruction card stores in its own slot within the housing. Pull out to consult when needed.

Sensor socket
For connecting the transducer power/data cable (see page 3-13).

RS232 socket
Allows direct connection to a PC or to a printer converter module.
(See page 3-34.)

On/Off/Aux switch
Allows switching between main battery and 9V reserve battery when "battery low" warning appears in display (see pages 2-8, 3-14).

Transducer connection & RS232/printer interface

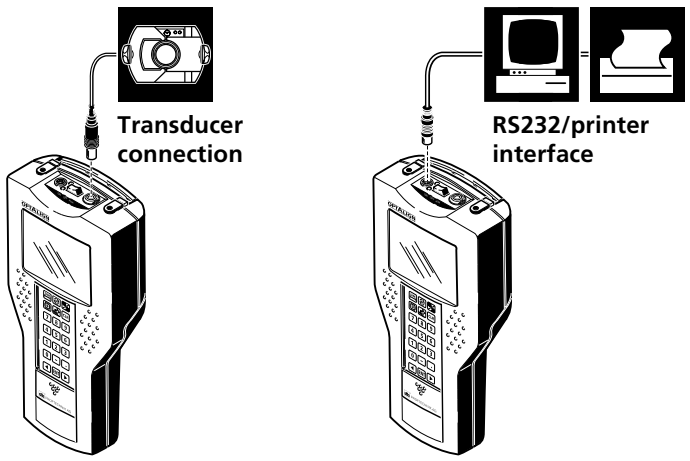
The transducer connects to the right-hand socket on the top of the control unit as shown above. See page 3-13 for details.

The OPTALIGN PLUS is also equipped with an RS232C serial port for connecting to a PC or printer (via Centronics converter) for data transfer and printout of alignment results. The RS232 parameters are set internally and the settings are given on page 3-34.

The RS232C serial port is not certified for use in explosive environments and therefore its use must take place outside the hazardous zone.

Note

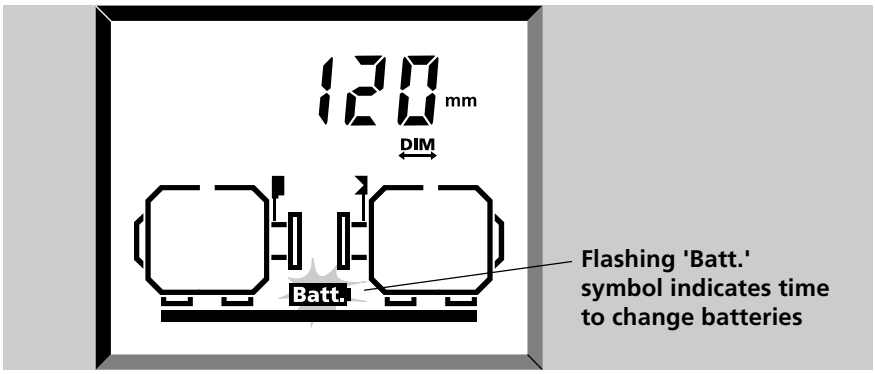
The transducer contains the data memory and the transfer program, and therefore it must be connected to the control unit whenever data is to be transferred to a printer.



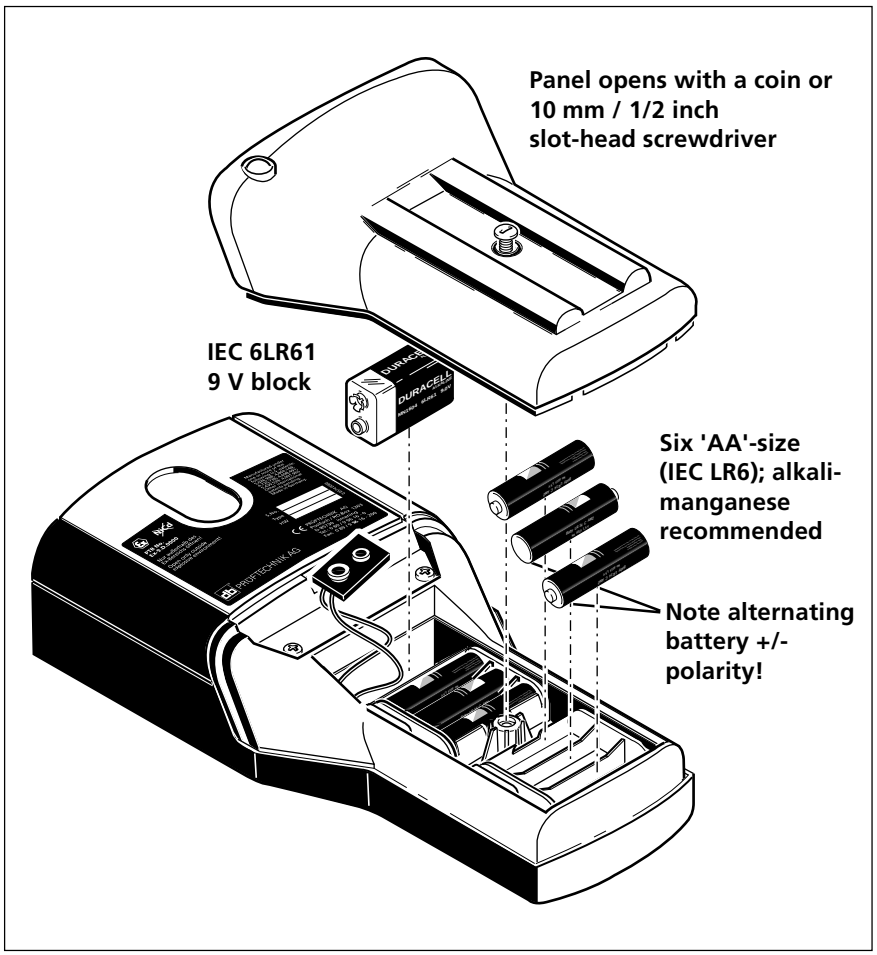
Batteries

Battery replacement

The 'Batt.' symbol appears in the display when the batteries are near depletion:



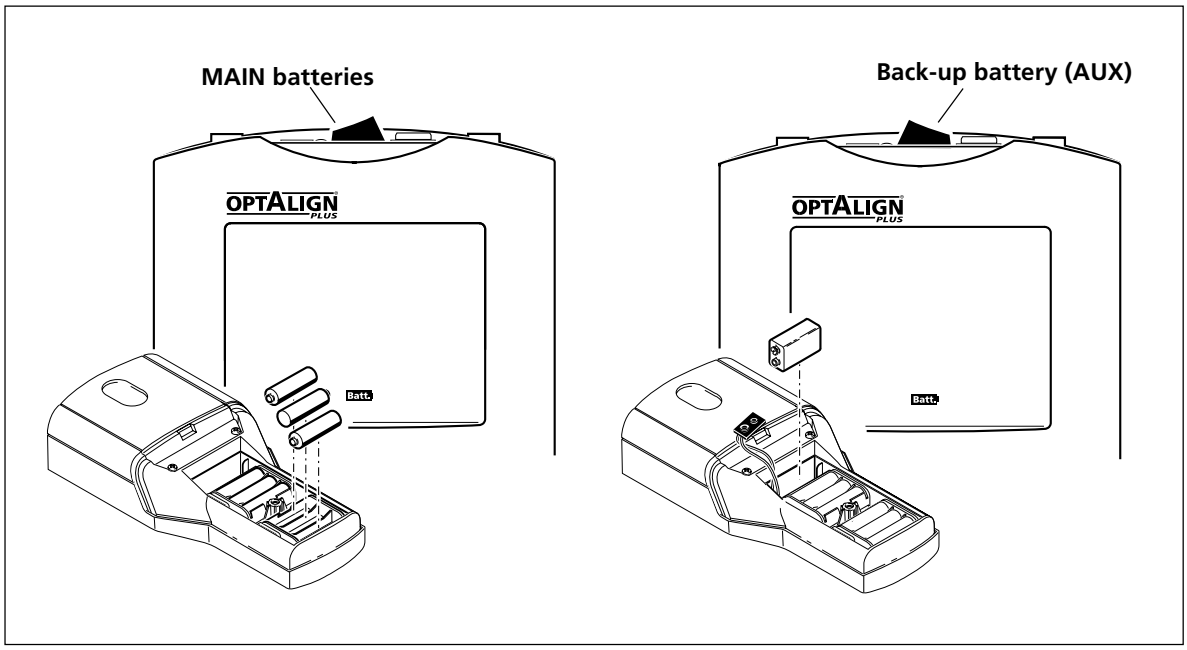
Save your current data if required (page 3-34) and switch off the control unit before changing batteries. Open the back panel to see the batteries, thus:



Intrinsic safety version: Panel requires allen key to open, but this must be done outside the explosive enviroment.

Which batteries do what?

You will notice inside the OPTALIGN PLUS control unit six "AA" batteries and a 9V battery.



1. MAIN batteries

- A set of six standard "AA"-size (IEC LR 6) batteries serves as the main power supply to the control unit and transducer.
- These are in use when the ON/OFF switch on the top of the OPTALIGN PLUS control unit is set to the left.
- These typically allow the system to operate for about 25 hours*.

2. Back-up battery (AUX)

- A 9V battery serves as a back-up (AUX, or Auxiliary) power supply for up to 3 hours*, allowing ample time to change the main battery set.
- This battery is used when the ON/OFF switch is set to the right.
- Keep in mind that the batteries soon need to be changed: otherwise you might find yourself later on halfway through a measurement with no power!

* These battery durations are average values estimated on the basis of a typical usage pattern of 25% measurement, 25% calculation (with laser shut off) and 50% 'sleep' mode.

Main or Back-up (Reserve)?

1. The control unit is normally operated with the MAIN batteries (6 x AA cells), when the ON/OFF switch is set to the left.
2. When these batteries become depleted, the 'Batt.' symbol flashes, indicating that they should be replaced very soon.
3. If you can't or don't want to change the main batteries right in the middle of an important job, you can set the ON/OFF switch to the right to the reserve battery. When the reserve battery becomes depleted, the 'Batt.' symbol reappears.

'*Resume*' function
OPTALIGN PLUS stores all dimensions, measurements and settings in a non-volatile memory which is continuously updated. If the batteries become depleted or the unit is switched off for more than about 2 seconds (e.g. when switching from Main to Reserve), the system will reset itself and all dimensions etc will be cleared. Even then, though, you can *resume* where you left off by switching on and loading file '0'. See chapter 3 for details.


Note

Which batteries do I replace?

When 'Batt.' blinks you know that the battery or batteries currently being used are depleted. Remove batteries as soon as they become depleted or if the system is not to be used for an extended period to avoid any unpleasant consequences of battery leakage. Before switching off, switch over to the other battery or batteries to see if they are dead too, then you can replace them at the same time.

Any type of good-quality batteries can be used with the standard OPTALIGN PLUS, including alkali-manganese or metal hydride cells.

Used batteries should be disposed of in an environmentally responsible manner in accordance with applicable regulations!

Batteries for intrinsically safe version

The intrinsically safe version of OPTALIGN PLUS, ALI 5.000 EX (with all electrical components also suffixed by "EX"), requires special attention with regard to batteries.

Only alkali-manganese batteries of the makes listed below may be used with the intrinsically safe version:
9V: Varta, Duracell or Panasonic
1.5V: Philips or Duracell
Otherwise, intrinsic safety may be compromised.

Be sure to remove the control unit from the explosive environment before changing batteries.

DO NOT USE lithium batteries or nickel-cadmium rechargeable batteries in explosive environments.


WARNING!

Power-saving features

The OPTALIGN PLUS automatically monitors its operation so that it can save considerable battery power by shutting down the transducer, processor and display temporarily when not in use.

- The laser beam is activated only during measurement and when it is required for measuring distances (see chapter 3). Otherwise it is off.

Electronic memory

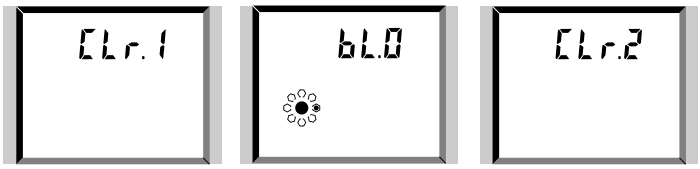
The OPTALIGN PLUS system contains a non-volatile electronic memory for long-term storage of measurements and results, even when the unit is switched off. The most recent data set is automatically stored in a special file named '0' and may be later recalled, immediately after switching on.

ATTENTION

- In common with all electronic memory products of this nature, data can be lost or altered under certain circumstances.
- Please keep a record of important data. PRÜFTECHNIK AG assumes no responsibility for data lost or altered.
- The OPTALIGN PLUS Explorer software program can be used to back-up data to a PC. See chapter 6 for details.

Memory management

The electronic memory is split into two blocks, the main block and the backup. As you use OPTALIGN PLUS, the main block gradually fills up with your measurements and results; when it's nearly full the computer pauses and copies all this data into the backup block. The main block is then cleared and ready to use again.



This transfer is indicated by the above sequence of screens and can take up to 40 seconds. It will not occur during a measurement.

ATTENTION

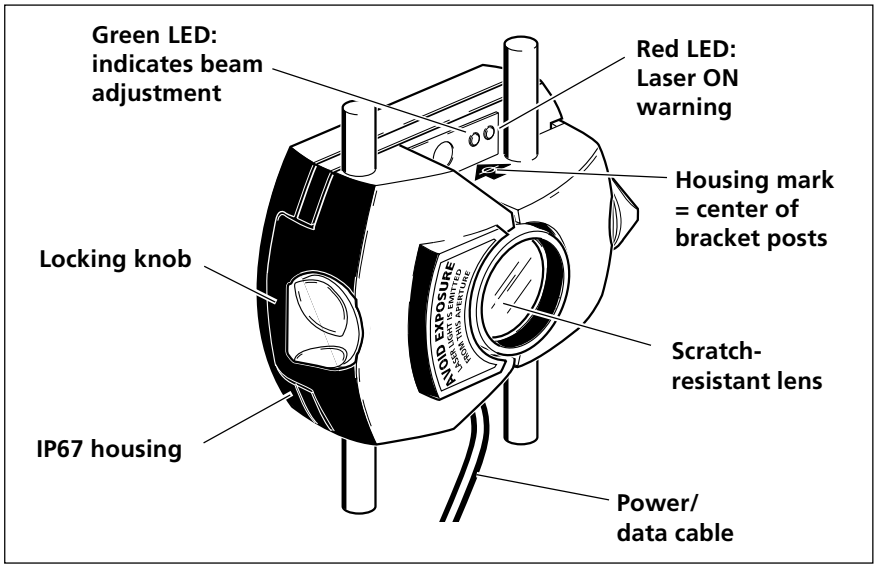
Do not switch off the unit during the transfer! This could lead to the loss of data.

Transducer ALI 5.100 (EX option)

The transducer contains a laser diode which emits a beam of red light (wavelength 675 nm). The beam is visible at the point it strikes a surface. It is emitted with a diameter of approx. 5 mm (3/16"). Also located in the same housing is a beam detector which measures the exact position of the laser beam as the shafts are rotated. This component is a biaxial, analog, photoelectric semiconductor position detector with a resolution of 1 μm. The transducer also contains an electronic inclinometer with resolution better than 1° for measurement of the shaft rotation angle.

The transducer has two indicator LEDs on its front side, one green for indicating beam adjustment, and the other red when the laser is on (see page 3-19). The transducer is powered by the control unit via a cable through which measurement data also passes.

The transducer contains a non-volatile memory of its own so that even if the cable is disconnected during a measurement cycle, none of the measurement data taken up until then will be lost. This feature is quite helpful, for example, if the cable must be unwound from the shaft in order to continue measurement (see page 3-23).



As with all the OPTALIGN PLUS components, the transducer is IP67 protected to resist water spray and dust. The internal optics and electronics are sealed to prevent any possible contamination. The transducer lens, however, must be kept clean. Use the ALI 2.905 cleaning set or a fine dusting brush such as that normally used to clean other optical devices. Keep the dust cap on when not in use.

Avoid polishing the lens too vigorously to prevent irreparable damage to its anti-reflective coating.

Under no circumstances may the six smaller housing screws be removed, as that would result in misadjustment and would void all warranty coverage.

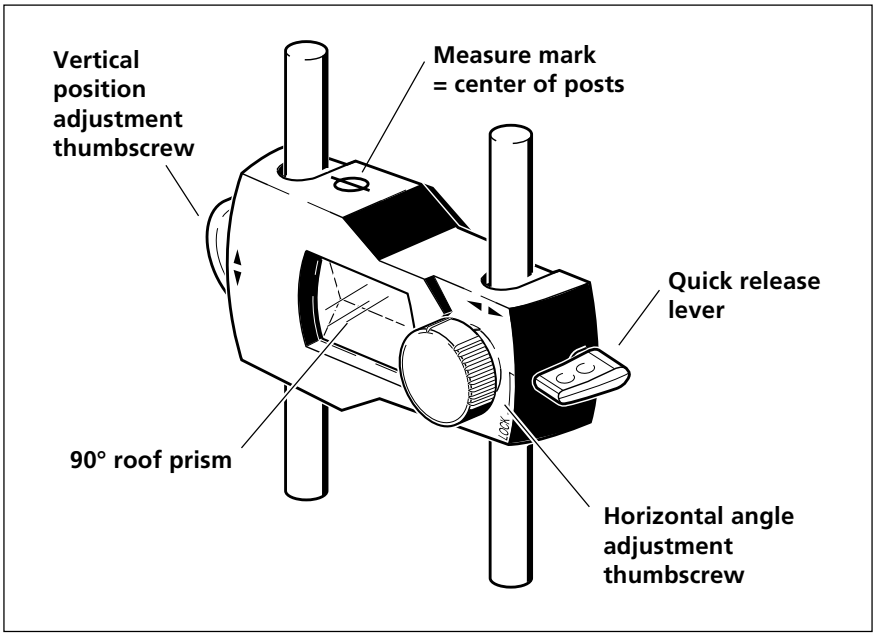
Do not stare into the beam! See page 1-11 for laser safety details.


ATTENTION


WARNING!

Reflector ALI 5.110

The reflector is always mounted on the shaft or coupling side of the machine to be moved. It reflects the laser beam back into the position detector as the shafts are rotated. The locking lever flips down to hold the reflector in place on the bracket posts. The reflector is adjusted by changing its vertical position and its horizontal angle (using the thumbscrews) so that the beam is reflected directly back into the transducer.



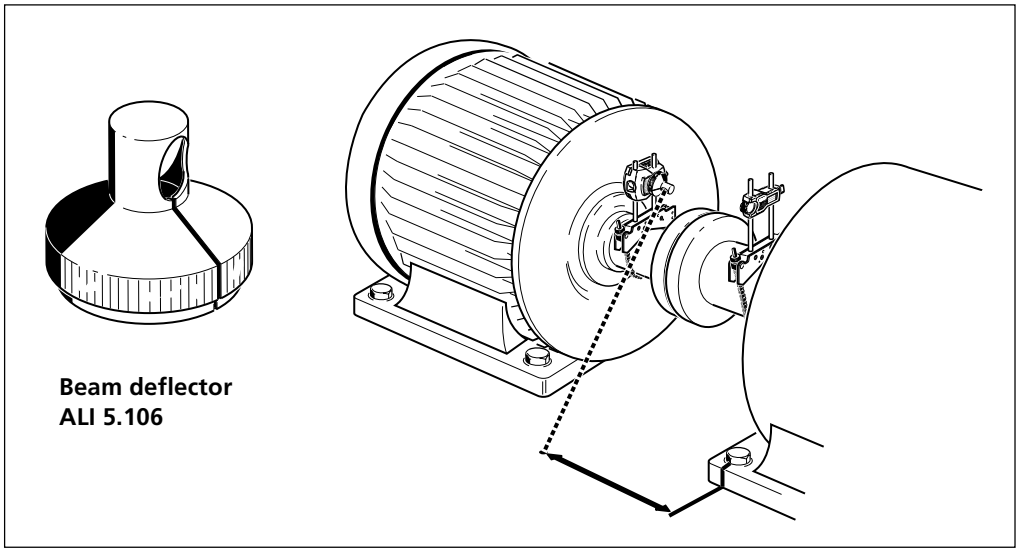
The reflector must be kept clean. Use the ALI 2.905 cleaning set or a fine dusting brush such as that normally used to clean other optical devices.

ATTENTION

Avoid vigorous polishing to preserve the anti-reflective coating. Keep the dust cap on the reflector when it is not in use.

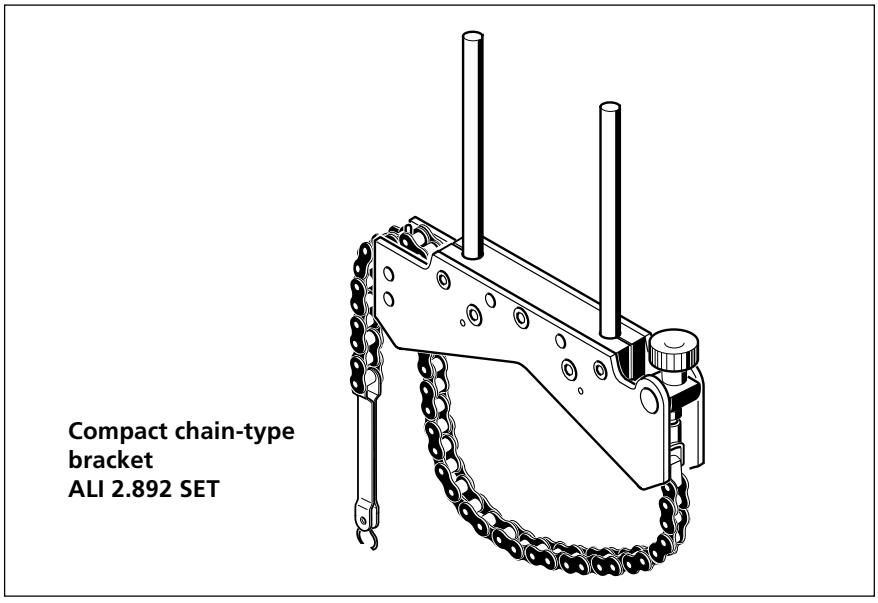
Beam deflector ALI 5.106

Used only for measuring the distance from the transducer to the machine feet. The unit mounts onto the front of the transducer and can be rotated to deflect the laser beam down onto the floor. The distance from the laser spot to the machine feet can then be easily measured. See page 3-17 for details.



Beam deflector
ALI 5.106

Compact chain-type bracket ALI 2.892 SET



Compact chain-type bracket
ALI 2.892 SET

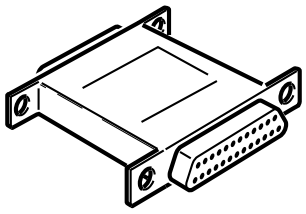
Compact and lightweight, this bracket is designed to provide extremely rigid support for the measurement components with a minimum of mounting time and effort. The compact chain-type bracket fits onto shafts and couplings ranging from 15 to 500 mm (1/2" to 20") in diameter. Longer chains are also available. Mounting instructions are given on page 3-8. Other bracket types are also available; these are described in chapter 6.

Serial/parallel converter ALI 5.220

This is used to connect the serial output of the OPTALIGN PLUS control unit to the 25-pin cable of a parallel (Centronix) printer. (It is not needed for PC connection as a serial port of the PC can be attached directly, if necessary using the 25M-to-9F-pin adapter ALI 3.265.) The unit has 2 LEDs for the following indications:

Green LED = Data transfer OK
Red LED = Data transfer interrupted or printer off-line.

See page 3-35 for how to print a report.



Serial/parallel converter ALI 5.220

Accessories

Among the most useful accessories are the various brackets specially designed for mounting OPTALIGN PLUS on specific machine configurations. These are described in detail in the appendix to this manual (chapter 6).

The 'Product Catalog for Laser Alignment Systems' illustrates and describes the additional accessories available for OPTALIGN PLUS. It is available under order number ALI 9.300.

Chapter 3: Horizontal machine alignment

This chapter includes detailed instructions on basic alignment of horizontal machine sets.

Chapter 1 Introduction ..... 1-1 to 1-12

Chapter 2 Description ..... 2-1 to 2-14

Chapter 3: Horizontal machine alignment 3-1

Short instructions 3-2

Horizontal machine alignment flow chart 3-4

Horizontal machine alignment 3-6

1. Preparing for the alignment procedure 3-7
2. Mount the brackets 3-8
3. Mount the transducer and reflector 3-10
4. Connect the transducer 3-13
5. Switch on the control unit 3-14
6. Machine dimensions 3-15
   Enter the dimensions 3-15
7. Laser beam adjustment 3-18
8. Take measurements 3-22
9. Results 3-24
   a. Misalignment at coupling 3-24
   b. Foot corrections 3-26
10. Align machine 3-28
    Vertical Shimming 3-28
    Horizontal and vertical alignment using MOVE 3-30
11. Alignment completion 3-34
12. Saving data and printing 3-35
13. Hot alignment check 3-36

Chapter 4 Further functions ..... 4-1 to 4-36

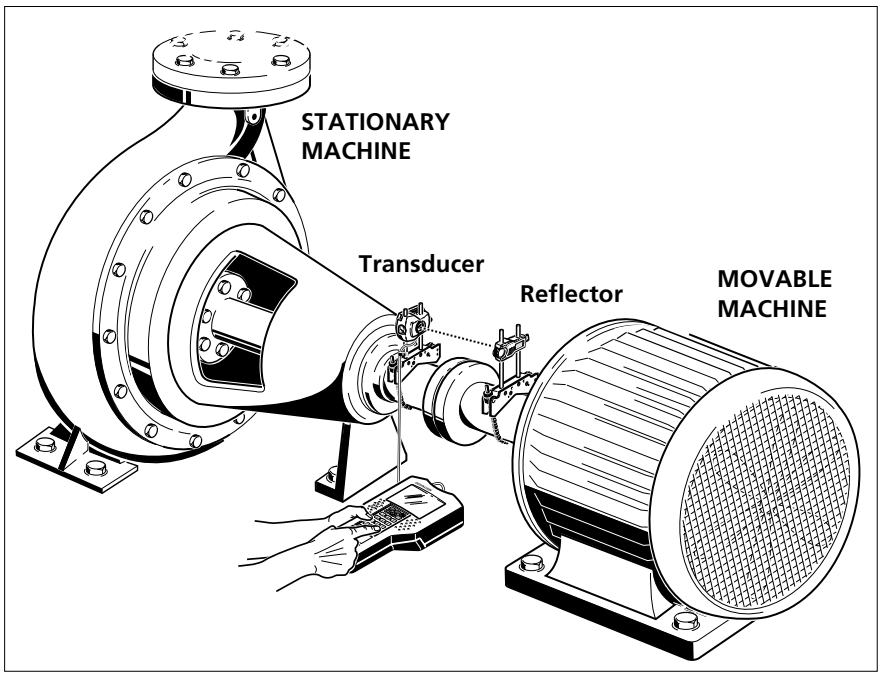
Chapter 5 Vertical alignment ..... 5-1 to 5-18

Chapter 6 Appendix ..... 6-1 to 6-50

Short instructions

1. Set up OPTALIGN PLUS

1. Prepare the machines
   see page 3-7 for details
2. Mount brackets, transducer and reflector
   Transducer on left (stationary) machine,
   pages 3-8 to 3-12
3. Connect cable, switch on
   Yellow rocker switched LEFT to 'ON',
   pages 3-13,14



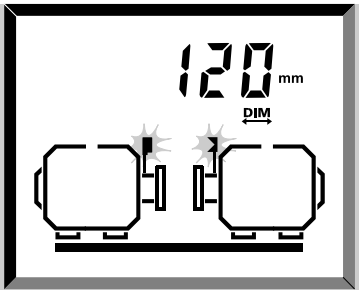
2. Enter Dimensions

DIM

ENT

Press DIM

Enter dimensions, pressing ENT each time, page 3-15
(UNITS, mm/inch: Use F2, page 4-24).



Distance between transducer and reflector

3. Adjust beam and measure

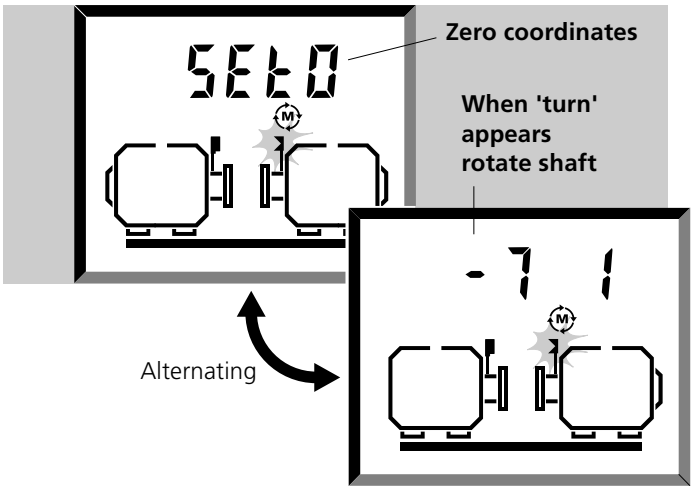
1. Press 'M' to switch on laser

2. Center beam

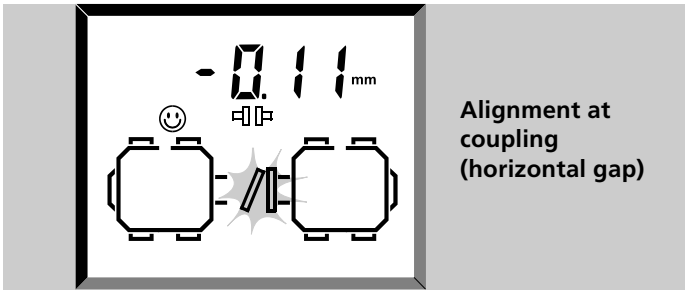
Loosen bracket if necessary to center beam horizontally onto reflector; retighten bracket. Use side thumbwheel to center beam vertically onto reflector dust cap, then remove cap and center reflected beam with displayed coordinates at or near (0 0) (pages 3-18 to 3-21).

3. Rotate shafts

To measure, rotate slowly by one full turn, or as far as possible - at least 60° (page 3-22).



4. Results



Press  for coupling values. Cycle with  through horizontal/vertical offsets and gaps. Compare these results with the machine specifications (see page 3-24).

If alignment is required then switch to the foot correction values with  . Shim to the vertical values and align horizontally with MOVE function, page 3-30.

Remember:
Remove all components from the shaft before restarting the machine!


WARNING!

Horizontal machine alignment flow chart

Start

Connect transducer to control unit and switch on.

Vertical machines: chapter 5

Enter Dimensions (page 3-15)

Press **ENT** after each entry. Cycle through with ◀ and ▶.

1. Transducer to reflector
2. Transducer to coupling center
3. Coupling diameter
4. RPM (for 'happy face' tolerances, page 3-25)
5. Transducer to front feet, right machine
6. Front feet to rear feet, right machine

OPTIONS: 6 feet (use F3, page 4-24)
Spacer shaft length (use F73, page 4-30)

Measure (page 3-22)

1. ***Set0*** appears. Adjust laser to about (0,0), page 3-21
2. Start measurement:

turn	Continuous Sweep	Rotate shaft by one revolution (or as far as possible, at least 60°), pages 3-22, 4-8.
0369	Static mode	Turn shaft to any 45° clock position, enter its position (e.g. 3 or 10.30) via the keyboard, page 4-12
Pt.	Multipoint mode	Press **ENT** to enter this mode, then rotate shafts to each point in turn, pressing **ENT** to enter individual measurements, page 4-10.

Results (page 3-24)

Press to toggle between coupling values and corrections at feet.

1. Alignment at coupling
   Cycle through Offset / Gap / Horizontal / Vertical with ▶
2. Corrections at feet (these INCLUDE targets etc., page 4-16)
   Cycle through Horizontal / Vertical / Front / Back with ▶

Sign Convention:
Positive = upwards or away from user; Negative = downwards or toward user

Horizontal and vertical Move (page 3-30)

1. Press
2. Turn shafts to any 45° position, horizontal view position appears.
3. Select desired view position with ▶ and press **ENT**.
4. ***Set0*** appears. Adjust laser to about 0,0, page 3-21
5. Press **ENT**. Selected view and feet adjustment appear on screen.
6. Loosen machine feet bolts.
7. Shim or Move as the case may require until the happy face appears (or until values approach zero).
8. Tighten bolts. Remeasure and continue alignment.

Targets & Thermal Growth (page 4-16)

Press to switch between coupling targets (for cold alignment) and expected thermal growth at the machine feet. Enter required values. If all are entered (enter '0' if none), then the target symbol appears in results.

Further functions

F **1** Display (x,y) coordinates as raw values, page 4-23

F **2** Units selection, mm/inch, page 4-23

F **3** Foot results for more than 2 foot pairs, page 4-24

F **4** Display time and date, page 4-26 (set via F80, page 4-32)

F **6** Extend measurement range, page 4-27

Settings

F **7** **0** Select static machine or feet, page 4-29

F **7** **1** Select report format (graphic or text), page 4-29

F **7** **3** Select coupling type, short or long, page 4-30

F **7** **4** Default setting for Results key (coupling or feet), page 4-32

F **7** **8** Default coupling diameter, page 4-32

F **7** **9** Default RPM, page 4-32

F **8** **0** Set time and date, page 4-32

F **8** **1** Set language for reports (0 = English), page 4-32

F **8** **2** Set number of readings for averaging, page 4-32

F **8** **3** Set the deviation band, page 4-33

F **8** **4** Set result resolution, page 4-33

F **9** **0** Delete all stored data, page 4-34

F **9** **8** Reset all settings to the factory defaults, page 4-34

F **9** **9** New machine: erase all dimensions/measurements, page 4-34

See also page 6-28 for test functions and page 4-22.

Horizontal machine alignment

The OPTALIGN PLUS program covers practically any alignment situation. A multitude of options are available using the 'F' function keys described later on. For most applications though, the "straight through" approach should apply where the default settings are perfectly suitable and the special options are not required.

For clarity, only the "straight through" method is described in detail here. The options are mentioned briefly and page references as to where they are described within the manual are provided. The flow chart on the previous page gives a complete overview.

As this is the main instruction procedure, it is important to acquaint yourself with this chapter before moving to vertical machines or special cases.

Step by step

1. Preparing for the alignment procedure ..... page 3-7
2. Check for soft foot 4-2
3. Mount the brackets 3-8
4. Mount transducer and reflector 3-10
5. Connect transducer to control unit 3-13
6. Switch on OPTALIGN PLUS 3-14
7. Enter machine dimensions 3-15
8. Adjust laser beam 3-18
9. Take measurements 3-22
10. Results at coupling and at machine feet 3-24
11. Align machine 3-28
    a) Shim vertically 3-28
    b) MOVE horizontally and vertically. Final measurement 3-30
11. Finished! 3-33
12. Save and print results 3-34
13. Hot alignment check 3-35

Note

A set of short instructions appears on pages 3-2 and 3-3.
(Also see the mini manual stored in the back of the computer.)

1. Preparing for the alignment procedure

Before using OPTALIGN PLUS, make sure the machine is properly prepared for alignment as described below. See page 6-6 for further information.

Switch off the machines before commencing work, and make sure that they cannot be started accidentally!

WARNING!

a. Solid, flat foundation

b. Machine mobility

Start with about 2 mm (80 mils) of shims beneath each foot. Hydraulic or screw-type positioning aids are recommended for horizontal movement.

c. Rigid couplings

Rigid couplings must be loosened before measurement so that they do not distort the alignment condition.

d. Shaft play and coupling backlash

The OPTALIGN PLUS raw coordinate display function can measure radial play when the shafts are lifted. Axial shaft play—up to 3 mm (1/8")—can be tolerated during measurement (although not necessarily for machine operation!). Up to 5° of coupling backlash can be tolerated during measurement. By turning the shaft on the reflector side, even larger degrees of play will have no effect on measuring accuracy.

e. Soft foot

Soft foot causes the machine to tip into a different position every time the bolts are loosened, making proper alignment difficult or impossible. This can be checked with OPTALIGN PLUS immediately before measuring alignment (pages 3-21 and 4-2).

f. Thermal growth, alignment targets, tolerances

Find out from specifications what these values are for your machines. They can then be entered into the program (page 4-16).

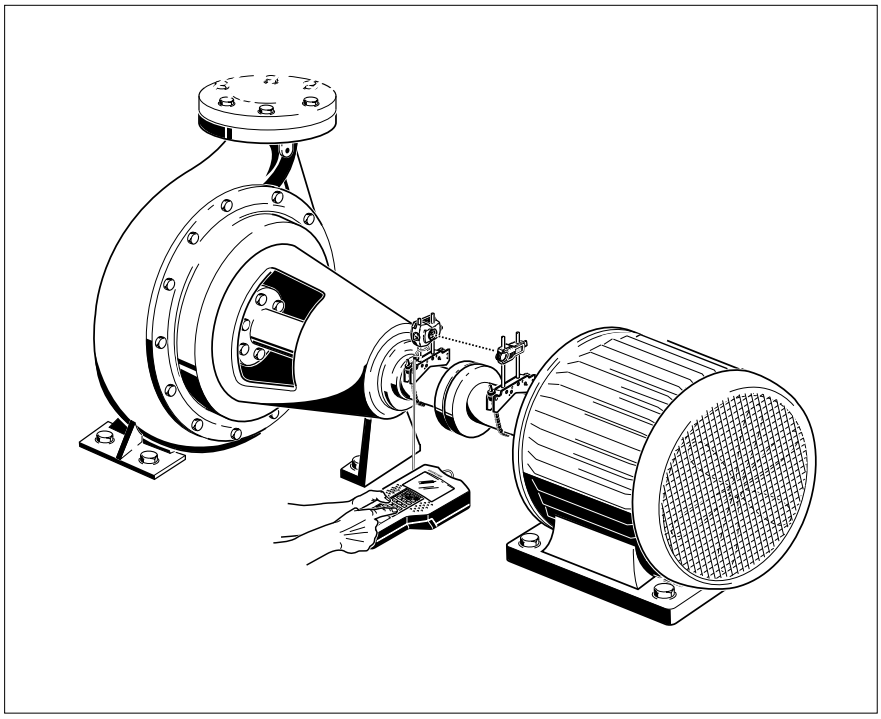
g. Measurement separation

Since the OPTALIGN PLUS system requires no mechanical connections (such as cantilevered dial indicator brackets) to span over the coupling during measurement, alignment may easily be performed over large transducer–reflector separations. Longer separations are possible using "Extend" function, pages 4-27.

Note that over very large distances the shafts and coupling may sag, and the machines may need to be aligned to take this into account. Refer to the machine manufacturer's specifications.

2. Mount the brackets

Mount the brackets on either side of the machine coupling, and at the same angle as shown below.



Please note the following in order to obtain the highest possible measurement accuracy and to avoid damage to equipment:

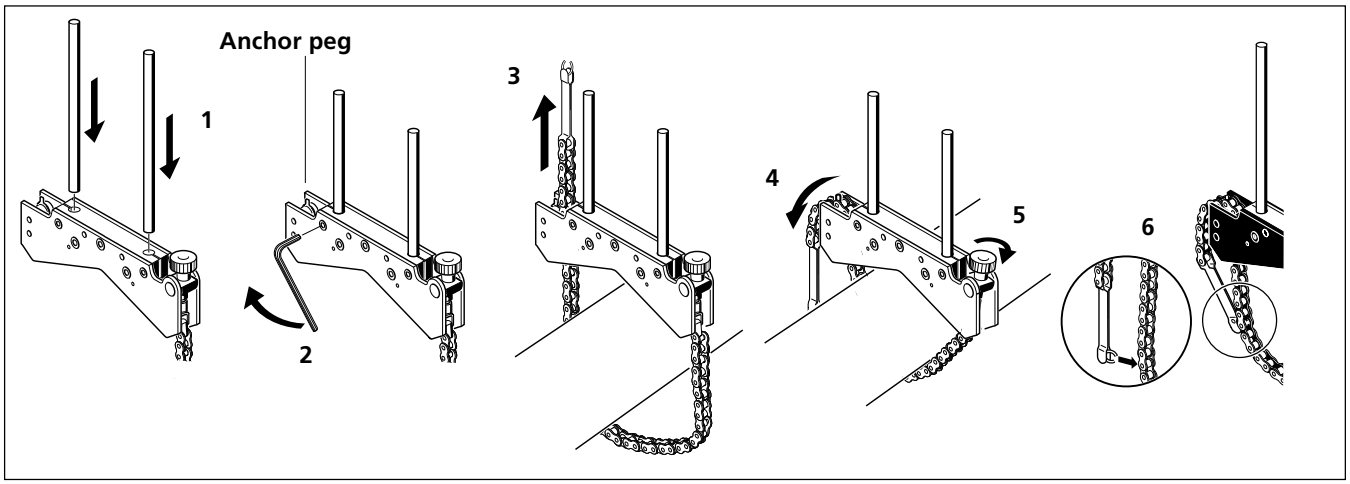
ATTENTION

- Ensure that the transducer and reflector brackets fit solidly onto their mounting surfaces!

- Never use self-constructed mounting brackets or modify the original bracket configuration supplied by PRÜFTECHNIK AG (for example, even by using longer support posts than those supplied with the bracket).

Bracket mounting procedure:

To fit the compact bracket chains, refer to the shown diagram and follow the instructions below.



1. Choose the shortest support posts which will still allow the laser beam to pass over the coupling flange. Insert the support posts into the bracket.

2. Fasten them in place by tightening the hex screws on the sides of the bracket frame.

3. Place the bracket on the shaft or coupling, wrap the chain around the shaft and feed it through the other side of the bracket: if the shaft is smaller than the width of the bracket frame, insert the chain from the inside of the bracket as shown above ; if the shaft is larger than the bracket width, insert the chain into the frame from the outside.

4. Catch the chain loosely on the anchor peg.

5. Turn the bracket thumbscrew to tighten the assembly onto the shaft.

6. Clip the loose end of the chain back onto itself.

Now the bracket should be tight upon the shaft. Do not push or pull on the bracket to check, since that would only loosen its mounting.

To remove the brackets, first loosen the thumbscrew, then remove the chain from its anchor peg.

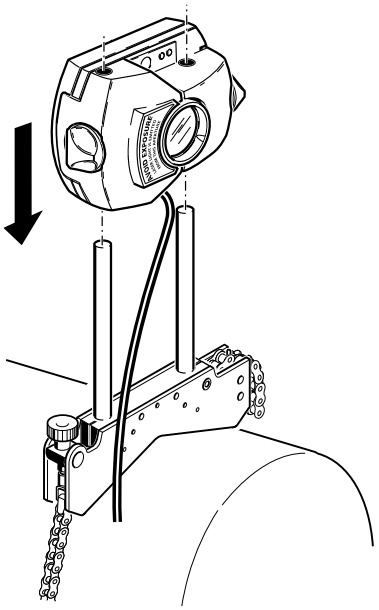
Note: the compact chain-type brackets cover most situations, but in cramped or special cases, others may be required, see chapter 6. If one or both sides of the coupling cannot be rotated, you will require the sliding magnetic brackets. (See page 4-15)

3. Mount the transducer and reflector

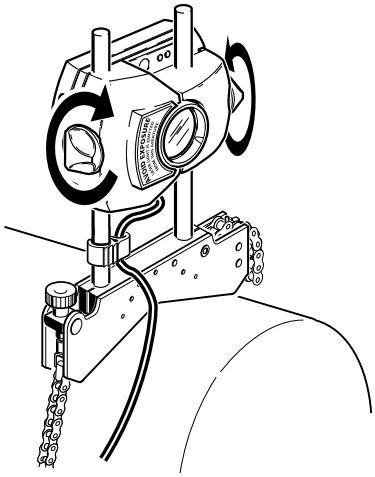
Mount transducer

Install the transducer on the support posts of the bracket installed on the shaft of the machine on your left (as viewed from normal working position). Ensure that its yellow knobs are loosened enough to let you slide the housing onto the support posts with the cable side downward.

Clamp the transducer onto the support posts by tightening the yellow knobs. Ensure that the laser can pass over the coupling and is not blocked. Fasten the cable to one of the support posts using a cable clip.



1. Loosen the yellow knobs and push the transducer down onto the posts.

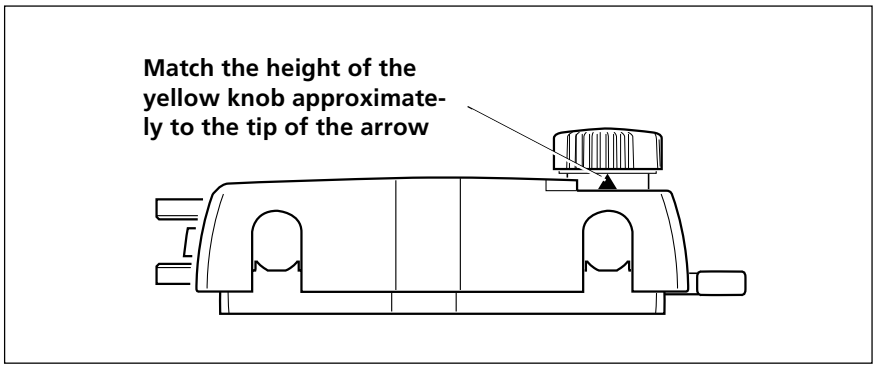


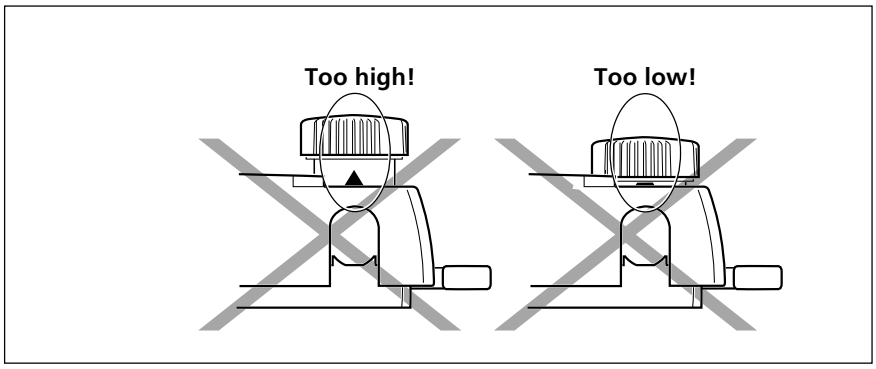
2. Tighten the yellow knobs; attach cable clip to post.

Mount reflector

a. Center reflector

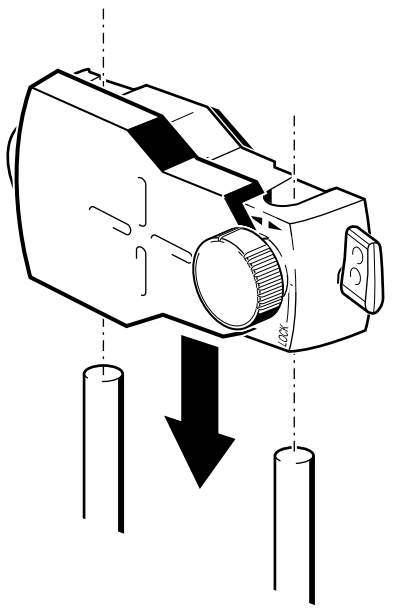
The yellow knob on the front of the reflector allows you to adjust the angle of the reflected laser beam. Before you mount the reflector make sure that this knob is centered so that you have maximum adjustment range later on. The bottom of the knob should be flush with the arrow marking on the reflector housing, thus:



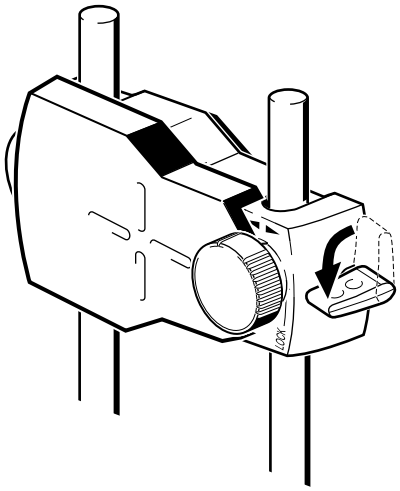


b. Mount prism on reflector

Flip up the quick-release lever on the side of the reflector housing, then slide the reflector onto the right-hand bracket posts. Return the lever to its horizontal position to secure the reflector on the posts.



Set the lever vertically to mount reflector onto the posts



Flip the lever horizontally to hold the reflector on the posts, allowing fine adjustment with the side thumbwheel

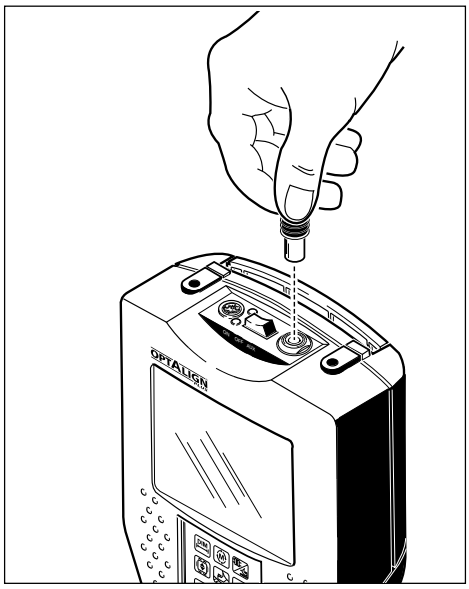
Both transducer and reflector should be at the same height, as low as possible, yet just high enough for the beam to clear the coupling flange. They should also appear parallel to each other by eye.

Make the final adjustments, loosening the brackets slightly if necessary, then rotating them and retightening.

Note

In environments where vibration is severe, an external clamp (ALI 5.116) can be attached to the bracket posts for extra stability (see chapter 6).

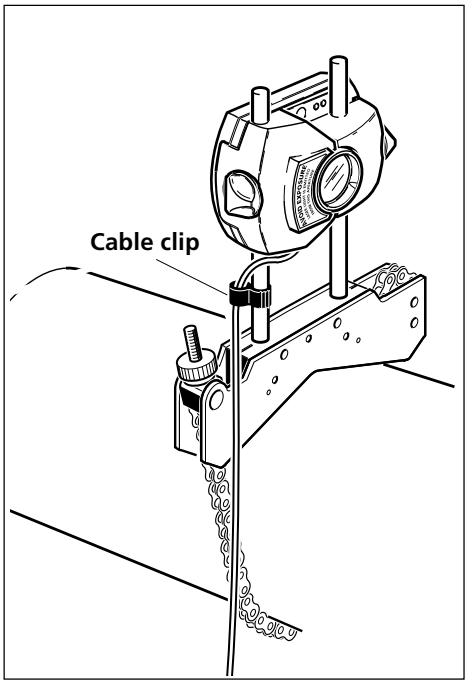
4. Connect the transducer



Insert the straight-ended cable plug into the eight-pin socket on the top of the control unit housing, with the arrow at the front.

Note the arrow on the plug and the keyway indicating proper plug orientation; otherwise the pins inside the plug may be damaged.

ATTENTION



The cable is permanently attached to the transducer. In case of damage, it may be replaced as directed in the appendix (chapter 6).

Attach the plastic cable clip to the lower portion of the support post as shown. This helps avoid measurement disturbance and damage to the cable or socket if the cable is pulled.

Disconnecting the transducer

Grasp the rubberized transducer plug by its ribbed front portion and carefully pull it out of the control unit socket.

If the cable should become wound around the shaft during measurement, it may be unplugged, then unwound and reconnected. The measurement program automatically resumes where it left off.

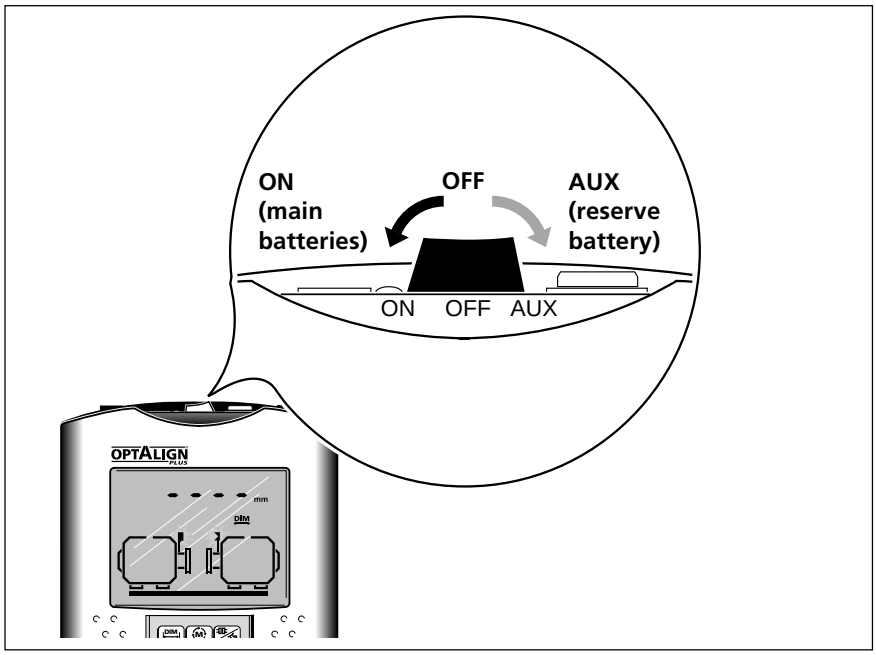
ATTENTION

5. Switch on the control unit

Press switch to the left (ON)

Press the LEFT side of the yellow rocker switch on the top of the OPTALIGN PLUS control unit to switch ON.

- After a few seconds the opening screen first appears showing the software version number, then the machine dimensions screen appears as shown below.



Note

Be sure to press the LEFT side of the switch in order to operate the computer from the main battery set! The right-hand position for reserve battery power should be used only after the 'Batt.' symbol has appeared for the main battery set! (See page 2-9.)

Hints on using the control unit

The OPTALIGN PLUS control unit is intended to be easy to use. Feel free to experiment with the keys and options as no physical harm can come to the instrument.

Use the three keys shown below to switch between main program segments.

Dimensions **Measure** **Results**

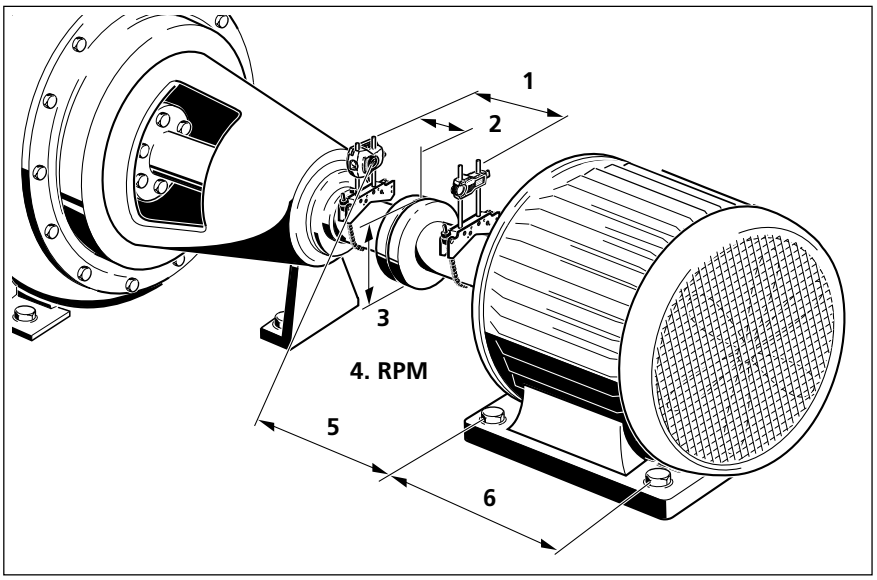
These keys allow you to switch quickly from the results screen to the dimensions screen.

6. Machine dimensions

When you switch on the control unit and select the DIM button, you can now enter the dimensions for a horizontal machine. (For vertical machines see chapter 5.) The control unit displays a diagram of the machines to be aligned and prompts for the machine dimensions. The default arrangement is:

- The left machine is stationary
- The right machine is moveable and has four feet
- The coupling is a 'short' type

To change these settings see pages 4-29 and 4-30.



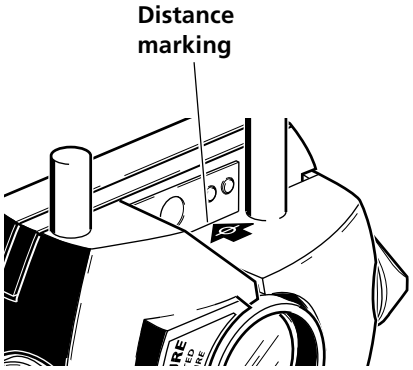
Enter the dimensions

- Tape measure readings are perfectly sufficient for determining dimensions. The required dimension flashes in the screen together with the units, inch or mm.
- To change the units, use the F2 function, page 4-24. (press the DIM key again to continue)
- In the metric mode, enter the dimensions in millimeters; when working in inches, enter whole inches and the decimal fraction e.g. 44 3/4" is entered as 44.75. Press ENT after each entry, and use the CLR key to make corrections.
- You can cycle through all the dimensions with the arrow keys, and can edit an entry simply by overwriting it and pressing ENT.

The dimensions you need to enter vary according to machine and coupling types. In the default mode proceed as follows:

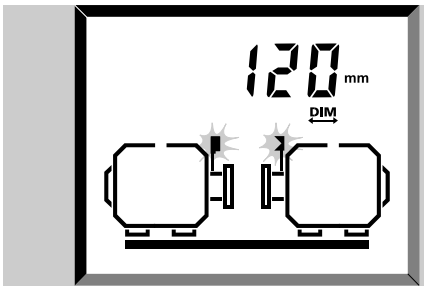
Conversion table
inch fractions to decimal

1/8"	**=**	**0.125"**
1/4"	**=**	**0.25"**
3/8"	**=**	**0.375"**
1/2"	**=**	**0.5"**
5/8"	**=**	**0.625"**
3/4"	**=**	**0.75"**
7/8"	**=**	**0.875"**



1. Transducer to reflector

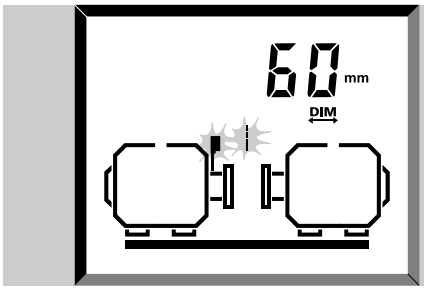
The screen prompts for the distance between the markings on the tops of the transducer and reflector:



Distance between transducer and reflector

(The markings correspond to the post and bracket chain positions.) Confirm each entry with ENT. The computer display then switches to the next dimension.

2. Transducer to coupling center



Distance between transducer and coupling center

Measure from the marking on the top of the transducer housing to the coupling center. (For spacer couplings, enter additionally the spacer shaft length when both coupling symbols flash - see page 4-30.)

3. Coupling diameter

The 'Dia Ø' symbol is lit. To measure this diameter you can simply measure the circumference of the coupling and divide by π (pi) (=3.142).

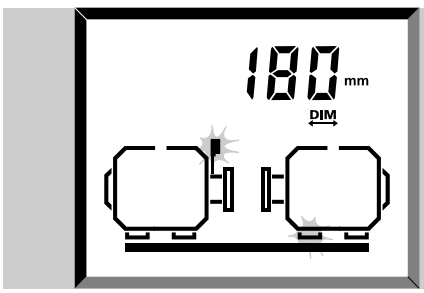
4. RPM (revolutions per minute)

The RPM symbol lights. RPM is required for toleranc-ing - see pages 3-25 and 6-5.

Only these dimensions are needed for a quick check!

Enter all dimensions if corrections are required.

5. Transducer to front foot, right machine

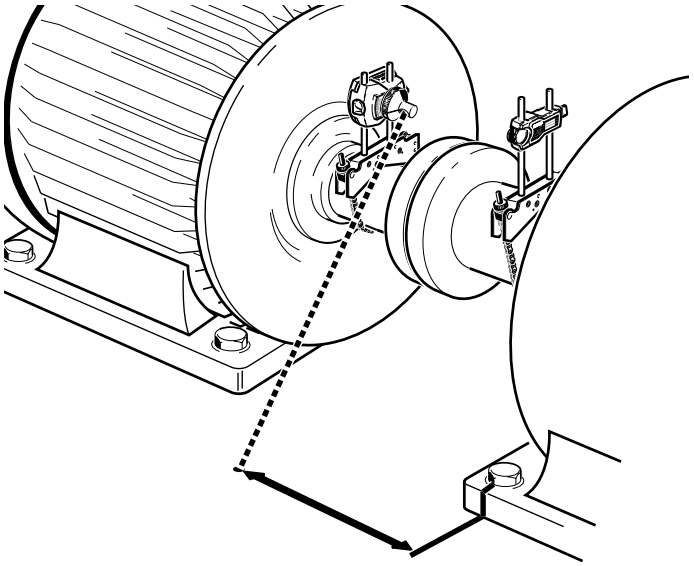


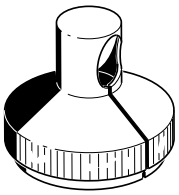
Distance between transducer and front foot, right machine

The laser switches on automatically during this step - Do not look into the beam!


WARNING!

Since this dimension may be awkward to measure, you can use the Beam Deflector (ALI 5.106):





Beam deflector ALI 5.106

Beam deflector is used to measure between the transducer and the machine foot.

• Fix the beam deflector onto the front of the transducer and rotate it to direct the beam on to the floor.

When using the beam deflector, take care not to let the deflected beam land in anyone's eyes or on a reflective surface!


WARNING!

• Measure from the beam spot to the front foot of the right machine.

• Add to this the distance between the beam deflector and the marker on the top of the transducer (50mm/ 2").

• Type in the total and press ENT. The laser then switches off and you can remove the beam deflector.

6. Front foot to back foot, right machine

Both feet on the right machine blink in the display.

7. Other dimensions

Depending on your settings, you may also need..

i. Spacer shaft length - see page 4-30
ii. Further foot pairs, page 4-24
iii. Flange details for vertical machines - see chapter 5

7. Laser beam adjustment

The transducer and reflector need to be adjusted so that the laser beam hits the reflector and is reflected back into the transducer. Adjust as follows, and remember:

WARNING!

Never look into the laser transducer aperture!

1. Press [M] and remove transducer cap

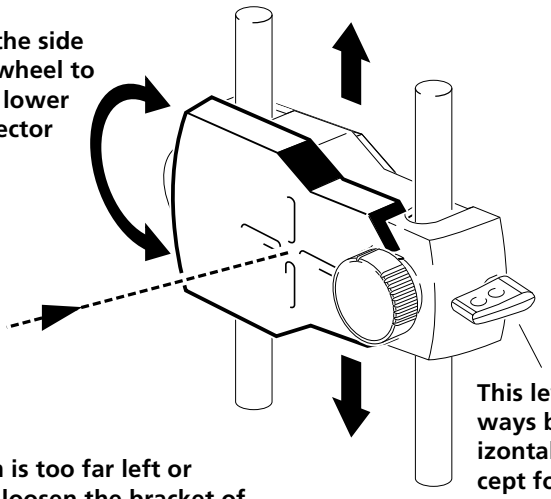
The laser beam is now on! Leave the reflector cap on for now. When the beam strikes the cap it should be readily visible. If the beam is so far off target that it misses the reflector completely, hold a sheet of paper in front of the reflector to locate the beam.

2. Adjust beam onto prism cap

With the reflector dust cap still in place, adjust the beam onto the center of the target:

• To adjust vertically slide the reflector and/or transducer up and down along their support posts. Use the thumbwheel on the side of the reflector housing.

• To adjust horizontally you will have to loosen one of the brackets on the shaft and rotate it slightly. Retighten.

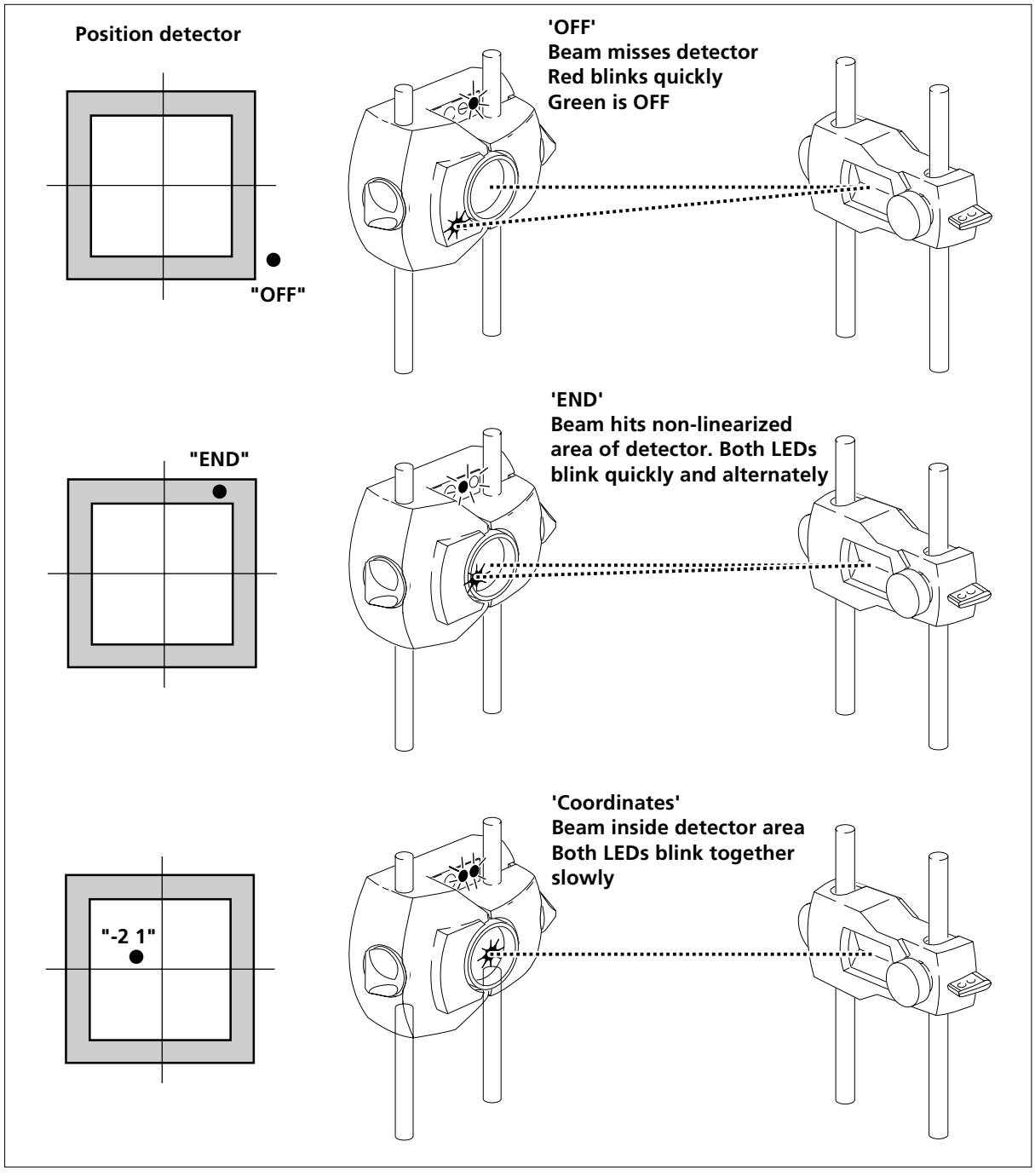


3. Remove reflector cap & check LEDs

Remove the cap so that the beam hits the reflector and is reflected back to the transducer. The transducer has a red and a green LED to indicate the beam adjustment condition, described below.

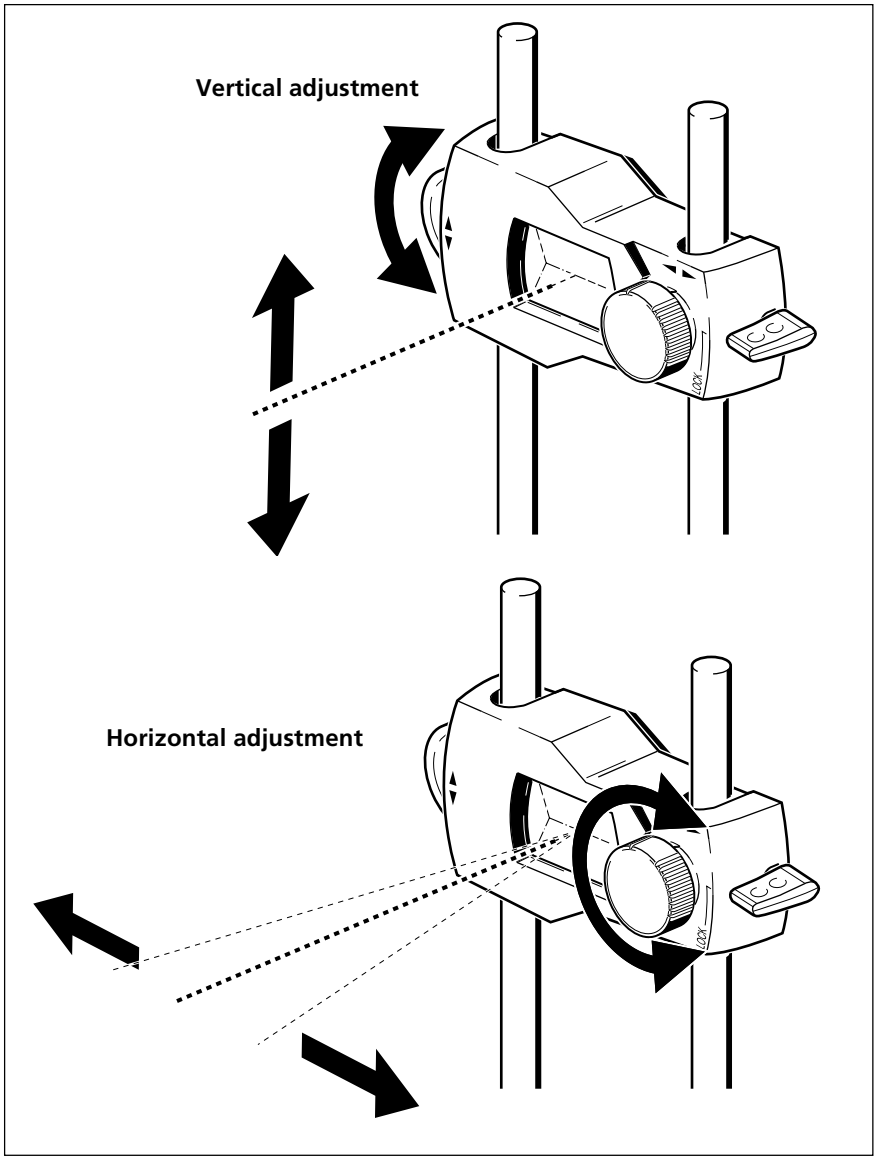
Make sure that the reflector and transducer lens are clean! Use a soft lint-free cloth, page 2-11.

Note



4. Adjust reflector until both LEDs blink together slowly!

If the red LED blinks quickly (0.3s) then the reflected beam is not striking the detector: the message 'OFF' appears in the control unit display. Adjust the reflected beam using the thumbwheels on the reflector as shown below until both LEDs blink together slowly. (Here it may be helpful to use a piece of white paper to trace the path of the reflected beam toward the transducer.)



Laser Status	Green LED	Red LED
Laser misses detector ('OFF')	OFF	Blinks quickly (0.3 s)
Laser in 'END' area	Both blink alternately quickly (0.3 s)	
Laser in detector area	Both blink together slowly (1 s)	

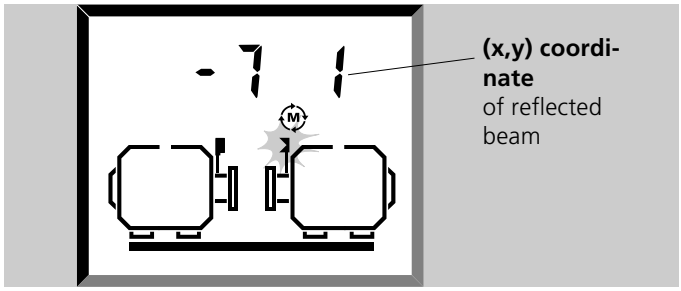
Quick blinking = 'Beam-finder mode'; laser is brighter.
Slow blinking = Laser is dimmed for measurement.

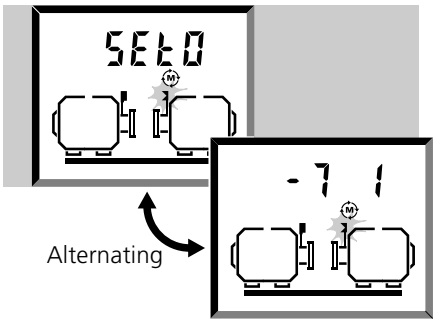
5. Center beam with on-screen (x,y) coordinates

When the laser strikes the linearized (measurement) range of the position detector, both transducer LEDs blink slowly at the same time. The display shows the (x, y) detector coordinates of the reflected laser beam.

Make a final adjustment to bring the on-screen (x,y) coordinates to approximately (0, 0):

- x = horizontal adjustment with reflector front knob
- y = vertical adjustment with the side thumbwheel.





If the beam strikes the detector when the dust cap is first removed from the reflector, the display blinks between 'Set0' and the (x,y) beam coordinates. As soon as the coordinates change by any amount, the 'Set0' message is no longer displayed.

Exactly (0,0) ?: The coordinates do not have to be exactly (0, 0), as this will not affect measurement accuracy. However, when the beam is well centered you have maximum range for measurement.

Note

Coordinate range : The coordinates have a range from -9 to +9 in 'arbritary' units which do not correspond to mm or inches. The transducer actually handles the values internally to much higher precision.

6. Soft foot & coupling backlash

i. If you haven't done so already, now is the time to carry out a soft foot check, page 4-2.

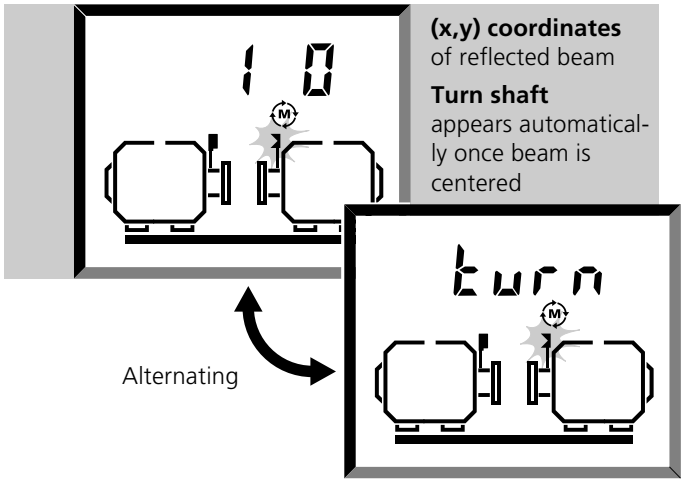
ii. If you have or suspect coupling backlash then turn shafts one revolution before measurement (page 6-7).

Do not touch components!
Once zeroed, the transducer and reflector must not be touched, as any movement during measurement will be interpreted as misalignment!

Note

8. Take measurements

Once the laser is centered to within (±1,±1), the screen displays alternately 'turn' and the (x,y) coordinates of the reflected beam:



The machine is seen end-on as viewed from the coupling toward the transducer.

Note

If coupling torsion play (backlash) is suspected, turn the shaft or coupling end where the reflector is mounted.

1. Turn shafts!

All you have to do to measure is turn the shaft! Rotate the shafts a full turn, or as far as possible—at least 60°. Continuous measurement commences automatically when the shafts begin to rotate (for details of other measurement modes, see chapter 4). The display switches to an end view of the machines.

Note

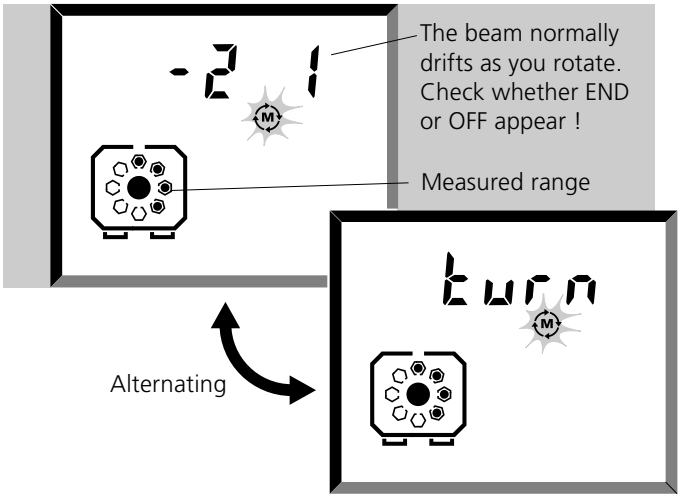
Remember not to touch the components!

It is advised to turn in the same direction as the machine normally rotates, in case the shaft shifts from its normal seating in the bearings.

You may begin measurement by turning the shafts even if the beam is not centered to (0 0) on the detector.

The 'turn' display disappears after about 80° of shaft rotation; only the coordinates are then displayed.

• The extent of measurement is indicated by the dotted bolts:



• The coordinates may be seen to change as you rotate the shaft, indicating already that misalignment is present!

2. Cable tangled?

If the cable gets tangled up around the shaft *during measurement* then proceed as follows:

> OPTALIGN PLUS must be switched off before the cable is disconnected or reconnected.

Note

i. Untangle the cable from shaft WITHOUT disturbing the components

ii. Reconnect cable and switch on. The system resumes where you left off. This feature is only available during measurement.

3. END or OFF? Extend with F6

If END or OFF appear in the display during shaft rotation, the laser has drifted out of the detector due to great misalignment or long beam travel. If this happens, then use special function F6 described on page 4-27 to extend the measurement range.

4. When you finish turning the shafts...

Once you have completed shaft rotation, press the key to stop measurement and automatically display alignment results. See the following page for details.

9. Results

a. Misalignment at coupling

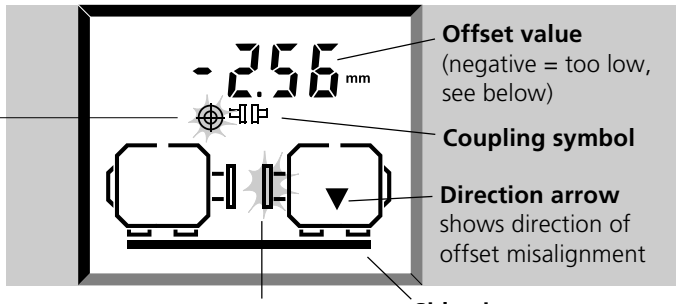
How well is the machine aligned? How much misalignment does the coupling have? Is remaining misalignment within prescribed tolerances? Press the results key to find out!

1. Press [results] until [coupling] appears

The four coupling misalignment values are now given: offset and gap in vertical and horizontal directions. These values indicate the ACTUAL measured alignment condition WITHOUT any target or thermal growth corrections you may have entered (page 4-16). The first display shows vertical coupling offset:

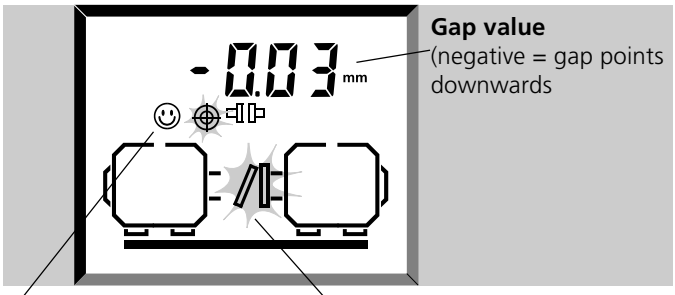
2. Press [▶] to cycle through the following:

a. Vertical coupling offset



refer to coupling targets on page 4-16

b. Vertical coupling gap



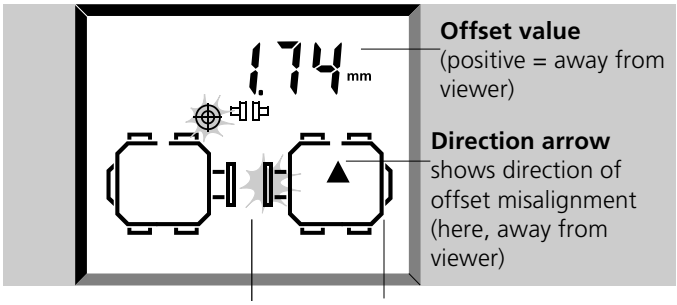
Note

Sign convention

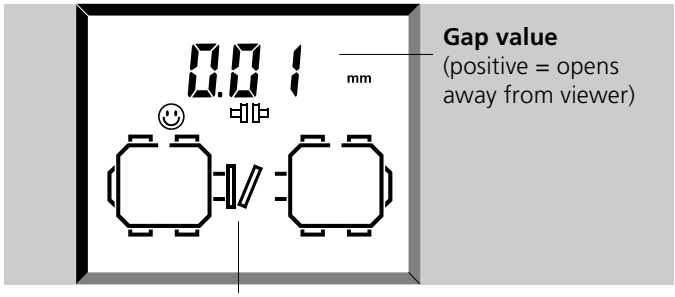
POSITIVE GAP ***opens upwards*** or ***away from*** viewer.

POSITIVE OFFSET when the right machine is ***higher*** or ***further*** from viewer than the left machine
These assume the left machine is static, see page 4-29.

c. Horizontal coupling offset



d. Horizontal coupling gap



3. Changing coupling type with F73

The coupling type can be changed from either 'long' to 'shrt' while in coupling results using F73. See page 4-30 for details.

4. TolChek® coupling tolerances

Is there a happy face for the value you are viewing?

☺ always lit: Value within ***Excellent*** tolerances

☺ flashes: Value within ***Acceptable*** tolerances

NO happy face: ***Out of tolerance*** - align!

These are based on a recommended tolerance table given on page 6-5. Ensure that the RPM is correct.

⌖ The happy face always takes into account any targets and thermal growth values which you may have entered - see page 4-16. The target symbol in the display appears if at least one value has been entered.

5. All four coupling values in tolerance?

If so, you don't have to align the machines! Otherwise, read on ..

b. Foot corrections

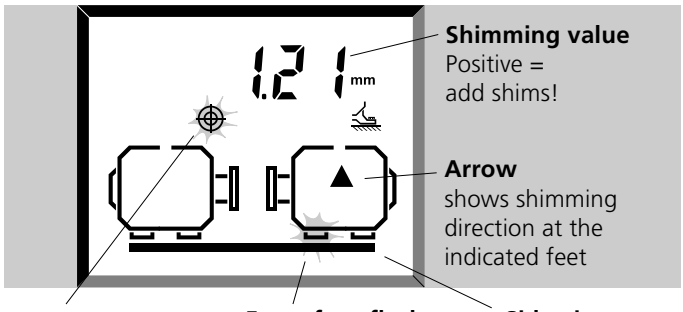
If the coupling results show that misalignment exceeds the tolerance, then the machine must be realigned by shimming vertically and/or horizontal repositioning.

1. Press [⚙] until 🦶 appears

The four foot corrections are now given: Vertical Shimming and Horizontal Move for the front & back feet. These values INCLUDE any target or thermal growth corrections you may have entered (page 4-16). The first display shows vertical shimming, front feet.

2. Press [▶] to cycle through the following:

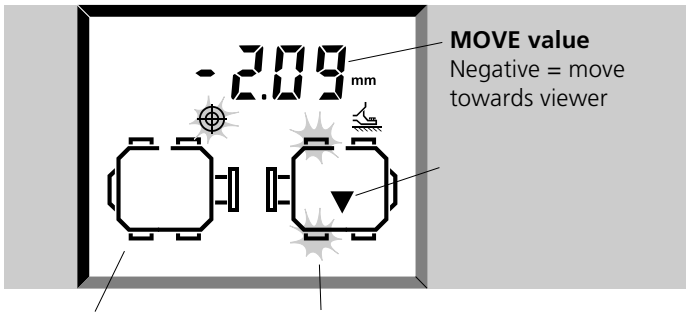
a. Vertical shimming, front feet



b. Vertical shimming back feet

As above, with the back foot flashing.

c. Horizontal move, front feet



d. Horizontal move, back feet

As above, with the back feet flashing.

Sign convention *(for right machine feet)*
- Positive values are upwards or away from the viewer
- Negative values are downwards or towards the viewer


Note

3. More than 4 feet?

To calculate foot corrections at other positions e.g. for 6-foot machines use the F3 function, page 4-24.

4. Selecting static feet with F70

Should the need to change feet positions while in feet results arise, use the function F70 described on page 4-29.

5. Foot Tolerances

As with coupling values described on the previous pages, the happy face symbol appears when the displayed foot is in tolerance. These 'foot tolerances' are calculated from the coupling tolerances.


-always lit - indicates an ***Excellent*** alignment in the displayed plane. The feet positions are such that BOTH the coupling offset AND gap in the displayed plane (i.e horizontal or vertical) are within 'excellent' tolerances (page 6-5).


- flashes - indicates an ***Acceptable*** alignment in the displayed plane. The feet positions are such that BOTH the offset AND gap in the displayed plane are within 'acceptable' tolerances. (One of the values may also be within 'excellent' tolerances).

NO happy face indicates an ***Out of tolerance*** situation! The feet positions are such that the offset AND/ OR gap in the displayed plane are out of tolerance - the machine has to be aligned!

- You will find that in a given direction, BOTH feet are either in tolerance, or BOTH are out of tolerance. This has the implication that by moving one foot, both feet could be in tolerance and vice versa.

- The foot tolerances are dependent on the machine dimensions you entered on page 3-16.


Again, the happy face TAKES INTO ACCOUNT any targets and thermal growth values which you may have entered - see page 4-16.

The following pages explain how to align the machines using these foot correction values. Remember, if ALL the feet are in tolerance, then you DON'T have to align the machines!

10. Align machine

To align your machine you need to move it vertically by shimming the feet, and horizontally by shifting it sideways. You could do these operations in either order or simultaneously, but the recommended procedure is generally as follows.

1) Shim first

We recommend shimming first, unless the horizontal move is significantly larger than the shimming corrections.

Note: if the required horizontal correction is large, e.g. more than 25mm or 1", then move horizontally first. In this case the feet will move onto a different part of the foundation, and you may need to recheck soft foot before proceeding (page 4-2).

2) Remeasure

In case the machine moved horizontally during shimming, remeasure. Entering dimensions is not necessary.

3) Move

Monitor both vertical and horizontal move using the OPTALIGN PLUS on-screen MOVE function.

4) Remeasure

To confirm alignment, remeasure. If it is within tolerances, you've finished!

Vertical Shimming

1. Preparation pays!

You can save time in the long run by paying attention to the machine preparation requirements on page 3-7! To successfully shim the machine you should have met those requirements already, in particular:

i. The foot bolts are clean, intact & removeable,

ii. Soft foot has been eliminated (page 4-2),

iii. The feet have enough shims under them should you have to lower the machine,

iv. You have a set of good quality shims available e.g. LAMIBLOC or PERMABLOC (page 6-9).

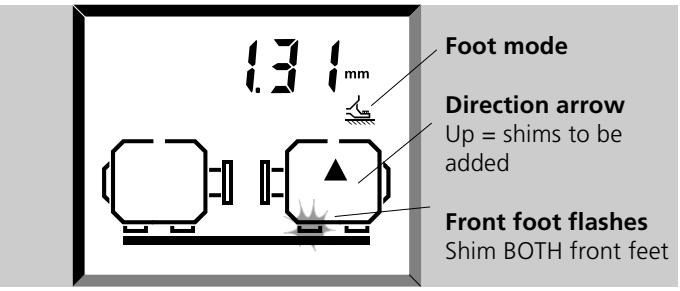
2. Loosen bolts

Try not to inadvertently move the machine horizontally. If any foot comes off the ground when loosened then you have soft foot! - see page 4-2.

3. Display vertical front foot corrections: .. ▶

Press the 'Results' key so that the foot symbol is highlighted (this key cycles between coupling and foot results, see page 3-26. Remember, the foot values include thermal growth corrections etc.)

Then press the arrow keys to show the machine from the side with the foot nearest the coupling flashing:



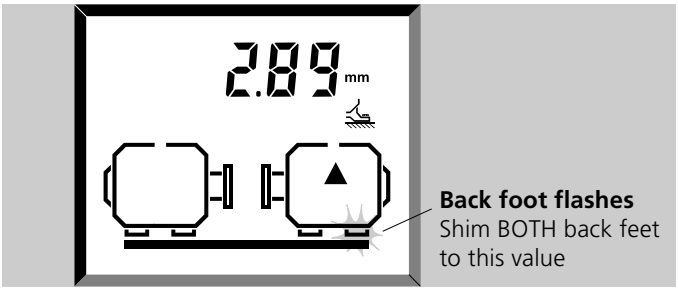
4. Shim front feet

The MOVE function (see next page) may also be used to monitor vertical (shimming) movement.

Shim BOTH front feet to the on-screen value, trying not to move the machine horizontally. A negative value means remove shims!

5. Press ▶ and shim back feet

Display the shimming value for the back feet:



Shim BOTH back feet to the on-screen value, trying not to move the machine horizontally.

Six feet or more? Use the F3 function, page 4-24.

6. Retighten bolts

The machine should now be within tolerance in the vertical direction! Read-on to align horizontally.

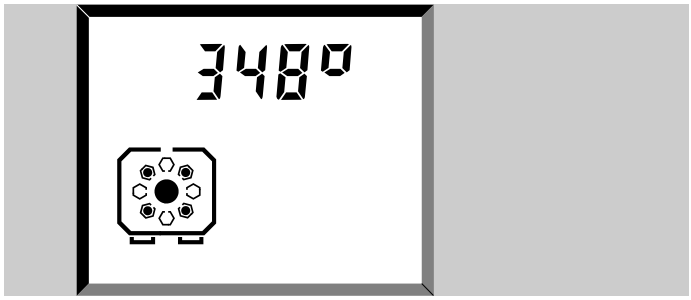
Horizontal and vertical MOVE

Shimming's easy because you simply jack up the machine and slide in or take out the shims of known thicknesses (PRÜFTECHNIK shims have the thicknesses stamped on them!).

The horizontal move on the other hand is rather more challenging because you have to *measure* how much you've moved the machine. This used to be done with a dial gauge at the machine feet, but with the OPTALIGN PLUS 'MOVE' function, you can view both the horizontal and vertical movements live on the computer display.

1. Press [MOVE] to start the MOVE

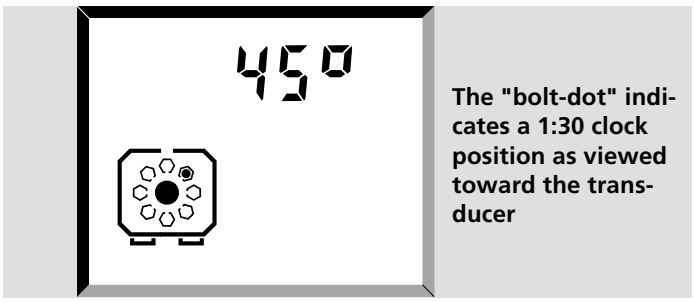
On pressing the move key, the position selection screen with a blinking 'bolt dot' in all four 45° positions comes up.



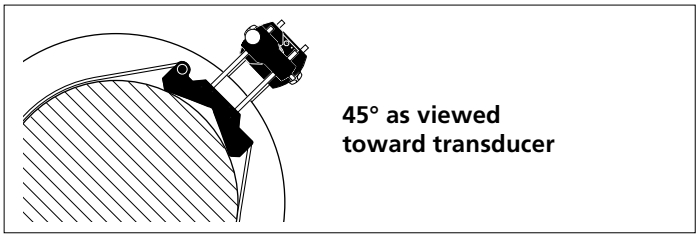
2. Turn the shafts to any 45° position

Rotate the shaft to any 45° position (this could be either the 10:30, 1:30, 4:30 or 7:30 hour hand positions). As the shaft approaches the designated 45° position (say to within ± 5°) the position selection screen shows only a single 'bolt dot' at the designated position.

When the 'static' (0,3,6,9) measurement mode is used, the electronic inclinometer is deactivated. The 45° position is selected using the left / right arrow keys.

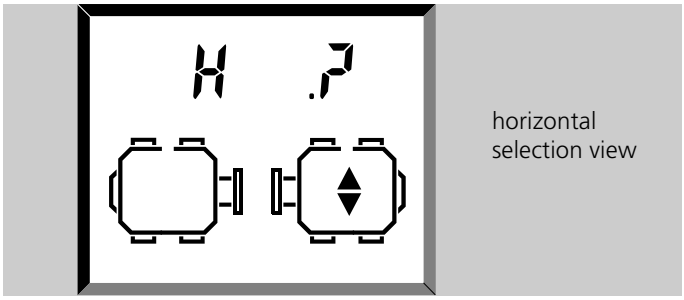


The "bolt-dot" indicates a 1:30 clock position as viewed toward the transducer

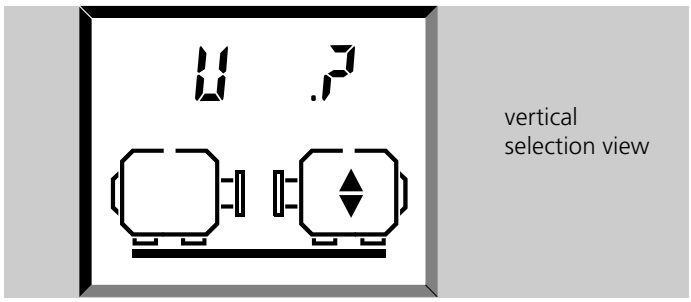


45° as viewed toward transducer

Keep the transducer in the desired 45° position (allowing for a ±5° tolerance) for about 5 sec., the horizontal selection view comes up.

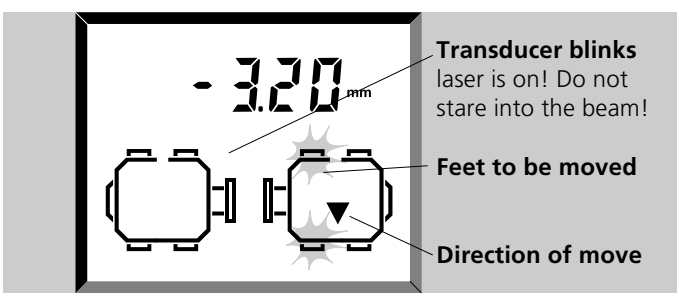


To select the horizontal or vertical view press ◀ or ▶.



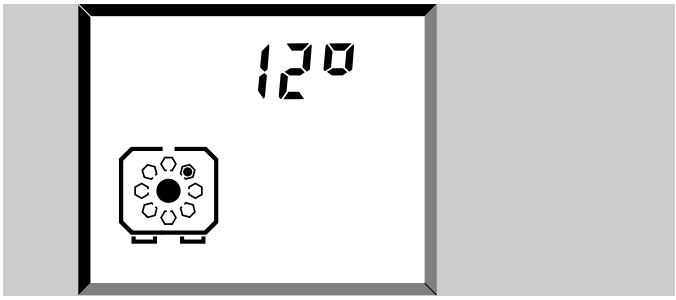
3. Re-zero prism and press ENT

With desired view position selected press **ENT**. 'Set0' appears on the screen and the prism can then be adjusted for 0,0. Press **ENT** again. The selected view appears on screen with a pair of flashing feet and the direction of the necessary adjustment. The forward or rear machine feet can be selected using ◀ or ▶.



4. Have shafts accidentally moved?

The shafts, transducer and reflector MUST remain steady during the entire MOVE procedure!
Should the shaft move out from the designated 45° position while in MOVE, the position selection screen comes up indicating both the angle the shaft has rotated to and the 45° position where the shaft



should be. Live MOVE resumes automatically when the shaft is rotated back to the correct position.
In the above case, live MOVE resumes automatically when the shaft is rotated to the 45° position.

5. END or OFF? Extend with F6

If END or OFF appears on the screen during machine MOVE, then the laser beam has drifted out of detection range due to great misalignment or long beam travel. In this case, the measurement range can be extended using special function F6 as described on page 4-27.

6. Changing view position while in MOVE

The following simple procedure allows the switch from say horizontal to vertical view postion while in move mode: Select MOVE. The view selection appears on the screen. Using the left/right arrow key select the desired position and confirm with **ENT** . 'Set0' appears on the screen. The prism is adjusted for 0,0 and the process described in 3 above is repeated.

7. Loosen anchor bolts

Loosen anchor bolts to be able to move machine as required.

8. Observe and move flashing feet

• Move the machine at the indicated feet in the direction indicated by the arrow.

• The display automatically displays the value for the feet furthest out of line (see overleaf for details), so watch the screen carefully to see which end you should be moving!

• You can *briefly* display the value at the other foot by pressing either the ENT key or the left/right arrow keys.

Note

Temptation may be great to move the machine with a few hefty blows of a sledgehammer. This can cause not only bearing damage, but also less accurate MOVE results. Jack bolts on the feet or other mechanical or hydraulic devices are recommended.

Notes: During the MOVE..

Display switching

As one end of the machine is brought to within half the remaining correction for the feet at the other end, the computer switches automatically to the other end, and causing the other machine foot to blink.

Please pay careful attention to the following points:
- Which foot is flashing in the display?
- When does the display jump to the other foot?
- In which direction is the arrow pointing?

Nearing zero : watch for the happy face

Proceed towards zero at both machine ends until the happy face symbol appears (lit=excellent, blinking=acceptable tolerances, see page 3-25 for details).

Soft foot

If the machine suffers from excessive soft foot, the MOVE function may be hampered by the fact that the machine changes its position on its own every time the bolts are loosened and tightened. Do correct this before aligning (page 4-2).

9. Tighten the anchor bolts

If the machine moves back out of alignment when you retighten the bolts, then first check for soft foot. If it still occurs then note down how much the machine moves horizontally when the bolts are tightened, and try to compensate for it during the 'Move' procedure.

---

10. Final check : In tolerance?

Since the machine has been moved, earlier results are no longer valid, so press the 'M' key and take another measurement.

View the results. If they are in tolerance then your machines are aligned!

11. Alignment completion

This completes the horizontal alignment!

WARNING!

Remove the components from the shafts and replace guards before you switch the machine back on!

1. If you experience poor repeatability..

Possible causes are:

- Incorrect or loose bracket mounting, page 3-8
- Significant shaft play or coupling backlash, page 6-7
- Soft foot, page 4-2, can cause positioning errors that make repeat measurement necessary

See also see the troubleshooting guide, page 6-32.

2. Saving data and printing

See the following page for instructions to save and print your data.

3. ...and finally,

Switch off the control unit and store the components in their case! If the system is not to be used for some time then remove the batteries (page 2-7).

12. Saving data and printing

Before you switch off you can save your dimensions, measurements, results and all settings in a numbered file in the OPTALIGN PLUS non-volatile memory. The files are numbered from 1 to 99 (0 is reserved for the most recent data set, see below). This memory is retained even when the computer is switched off.

1. To save press 

no. x appears where x is the number of the first empty file. Press ENT to save the data with this number.

To store with a different number, enter the number and press ENT. If that file already exists, the screen will blink and you must press ENT again to overwrite the existing file. If you don't want to overwrite then try another number or press any function button (e.g. DIM) to cancel the whole operation. A row of dashes progresses from left to right during the storage process.

Keep a separate record of important data! PRÜFTECHNIK AG assumes no responsibility for losses!

Alternatively, use the OPTALIGN PLUS Explorer PC interface program. (See Chapter 6)


Note

2. To load press 

Before loading, make sure you save whatever you're currently working on if needed. Then press the LOAD key, enter the required file number and press ENT.

'Resume' function (file '0')
File number '0' is reserved as a Resume function. When you switch OPTALIGN PLUS on, press the LOAD key and enter '0' ENT to recall the last non-saved set of measurement data.

3. To print connect printer and press 

Using the supplied adapter/converter any PC compatible printer should work with OPTALIGN PLUS . See page 2-14 for details.

The transducer must be connected to the control unit whenever a printout is to be made, since the data memory and operating program are located in the transducer.


Note

- Laser printers (e.g. HP LaserJet) should be set to the 'PC-8' font.
- The serial parameters set in OPTALIGN PLUS are: Baudrate = 9600, Data bits = 8,
  Parity = None, Stop bits = 1
  Check your printer manual to ensure printer compatability with these settings.

Note

These settings are also used for PC data transfer.

Once connected, press the PRINT key. The green LED on the data converter blinks (red LED = interruption) and a printout similar to that shown on page 6-24 appears.

Problems? See the troubleshooting guide, page 6-32.

13. Hot alignment check

At some point, you may want to check the alignment of a machine set that has been running long enough to reach its 'steady state' ('hot') operating condition. In that case, the OPTALIGN PLUS system can be used to take 'hot' alignment readings in a matter of a few minutes after the machines are shut off.

The procedure described below saves time by allowing you to begin measurement immediately after turning on your OPTALIGN PLUS control unit, i.e. without entering machine dimensions first.

1. As soon as the shafts have stopped rotating, mount the components and connect the transducer to the control unit (see pages 3-8 to 3-13).

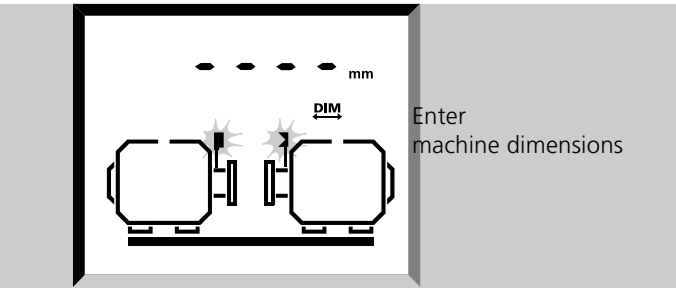
2. Switch on the control unit and press the M key.

3. Center the laser beam on the detector (0 0) (see pages 3-18 to 3-21), then turn the shafts in their normal direction of operation by at least 60°.

4. Press the results key to stop measurement.

5. The display automatically prompts for machine dimension as needed. Once all dimensions are entered, the alignment condition is automatically calculated and displayed.

.



The alignment corrections are now based upon the 'hot' alignment condition of the machines.

To perform a hot alignment check on vertical machines or with a measurement mode other than the standard 'continuous sweep', you must activate the corresponding mode (see pages 5-7, 4-11 or 4-13) after centering the laser beam in step 3.

Note

(Page left blank intentionally)

Chapter 4: Further functions

You have now mastered the straight-through alignnment procedure for standard horizontal machines. We now describe the many special functions and settings available in OPTALIGN PLUS.

Chapter 1 Introduction ..... 1-1 to 1-12

Chapter 2 Description ..... 2-1 to 2-14

Chapter 3 Horizontal alignment ..... 3-1 to 3-38

Chapter 4: Further functions 4-1

Soft foot 4-2

Soft foot procedure 4-4

Determining soft foot corrections 4-6

Measurement modes 4-8

Continuous Sweep mode 4-8

Multipoint mode ('Pt.') 4-10

Static (0369) measurement mode 4-12

Measuring a non-rotatable shaft 4-14

Coupling targets & thermal growth at feet 4-16

1. Coupling targets for 'cold' alignment 4-17

2. Expected thermal growth at the machine feet 4-20

3. Thermal growth for stationary machine 4-21

'F' key functions 4-22

F1 : Display (x,y) coordinates and rotation angle 4-23

F2 : Select mm/inch units 4-24

F3 : 6-foot machines 4-24

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F6 : Extending the measurement range 4-27

F70 : Select static machine/feet 4-29

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Soft foot

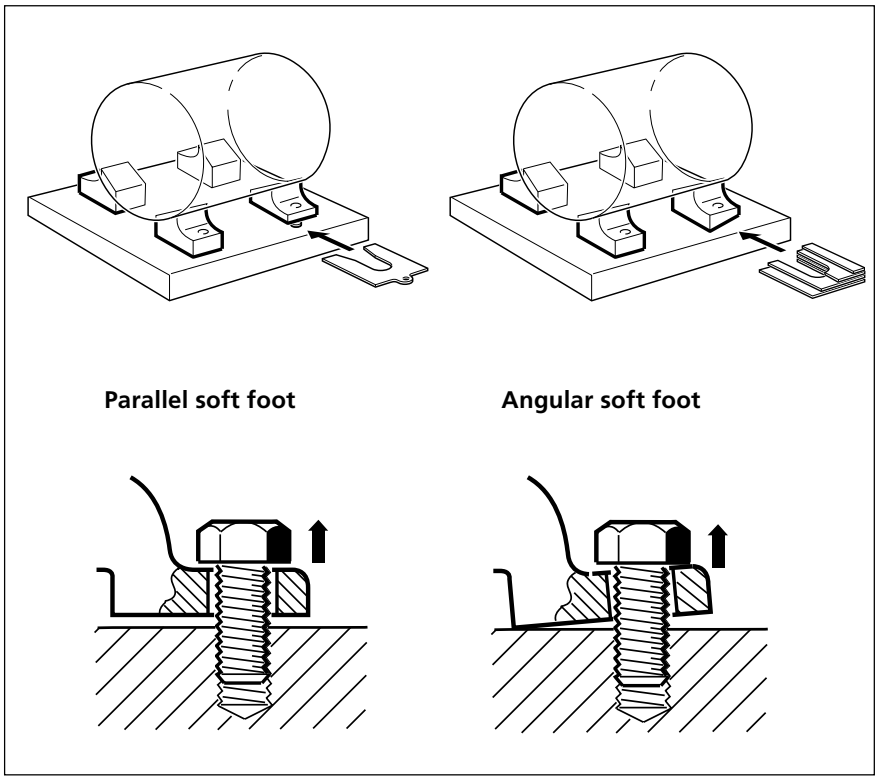
SOFT FOOT is the condition whereby one or more machine feet are not resting properly on the foundation, but are being held down by force with the foot bolts. Soft foot could be a result of:

- Non-coplanar machine mounting surfaces,
- Deformed machine frame or feet,
- External forces e.g. from connecting pipe or bracket,
- Improper shimming or soiled machine feet.

The consequences of forcibly tightening down the feet are deformed machine frames, bent shafts and distorted bearings. This leads to high vibration and premature failure.

Soft foot should be checked before aligning the shafts, and this can be done quickly and conveniently with the aid of the soft foot function. With the transducer and prism mounted on the shaft in the usual way, the system is able to sense any machine movement when the machine bolts are loosened individually. By entering the machine dimensions, the computer is able to calculate, from shaft movement, by how much each foot has risen as it is loosened.

Once you have established the foot movements, the results need to be interpreted and translated into shim thicknesses to place under the feet. How straightforward this is depends on the type of soft foot you have. The two main types are described opposite.



Parallel soft foot

One or more feet are too short or too long. This usually results in the machine rocking on the longer feet. This is corrected by placing a shim under ONE of the short feet (see illustration).

Angular soft foot

The base of the foot is at an angle to its foundation and they are only partly in contact. In this case it is usually necessary to check suspect feet with a feeler gauge and build up wedged shims.

Sometimes a combination of soft foot errors is present, making correction somewhat more complicated. Please refer to the advanced examples of soft foot discussed in chapter 6.

Soft foot procedure

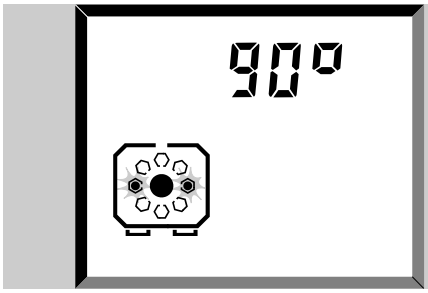
Before you start, check the following..

- The feet to be checked are set to 'movable' (F70 page 4-29)
- Brackets, transducer etc are mounted correctly (page 3-8+)
- Dimensions have been entered as required (page 3-15)
- Six feet? This procedure is intended for a four-feet machine. If it has e.g. six feet then loosen the middle feet and measure the outside four feet only. The middle feet cannot easily be checked with this procedure - after correcting the outer feet, use a feeler gauge to check the middle ones. See also page 4-24 for 6-feet machine results.

Proceed as follows:

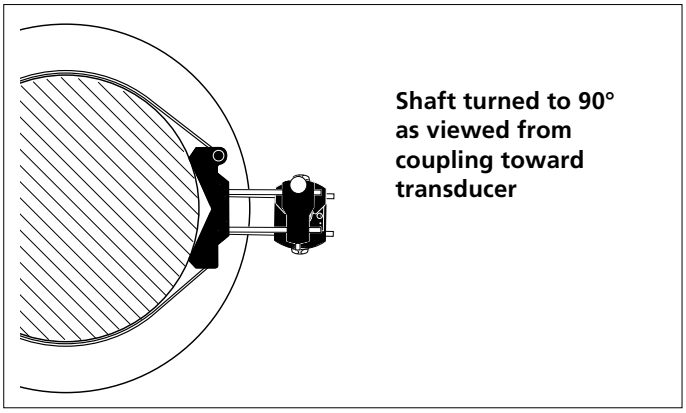
1. Press 

The screen displays the rotation angle (as with the Move function on page 3-30).



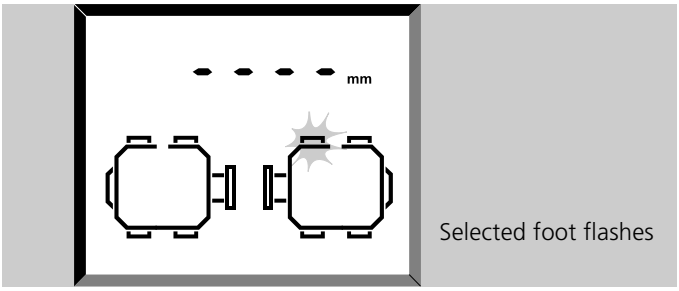
2. Rotate the shaft to 90°/270° (3 o'clock / 9 o'clock)

Rotate to 3:00 or 9:00 o'clock position as viewed from the coupling towards the transducer. As soon as the inclinometer detects a rotation position of 90° or 270°, the screen automatically switches to the 'Set0' and (x,y) display as shown on page 3-21.



3. Zero prism and press ENT

Adjust the reflector as described on page 3-18 and press ENT. The main soft foot screen then appears:



Selected foot flashes

Do not touch the components!
Keep the shaft and components absolutely steady during the soft foot measurement procedure.

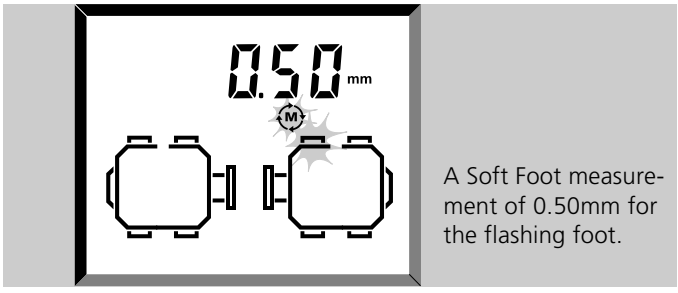
Note

4. Select a foot with ▶ and press 0

There now begins a live display of the measured machine movement.

5. Loosen selected bolt

The measured distance that the foot has risen is shown:



A Soft Foot measurement of 0.50mm for the flashing foot.

The 'M' symbol flashes during measurement.

6. Press ENT to store; retighten bolt

Measurement stops and the reading is stored. The happy face appears if tolerance has been met.

7. Repeat for each bolt

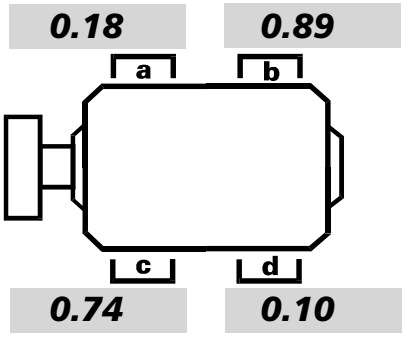
Cycle through stored values with the arrow keys.

Determining soft foot corrections

The two basic types of soft foot, parallel and angular, are relatively straightforward to identify:

Parallel soft foot

If two diagonal values are roughly equal and significantly higher than the others then parallel soft foot can be assumed as a first solution. The machine is rocking on two diagonal feet which are longer than the other two:

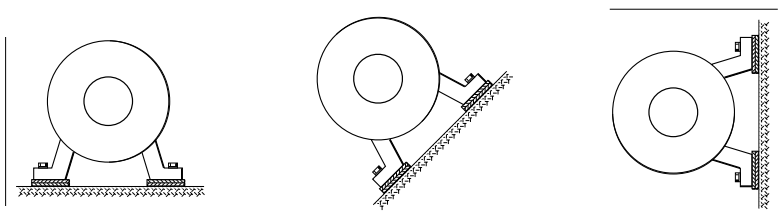


(Dimensions in millimeters)

In the above example the correction would be to place a 0.89mm shim under foot 'b' (the foot with the largest gap) - just like placing a matchbook under the short leg of a wobbly table!

Special case: non-horizontally mounted machines

If the machine is mounted with its feet on a wall or other non-horizontal surface, the angle prompt for soft foot measurement can be ignored by pressing the **ENT** key.



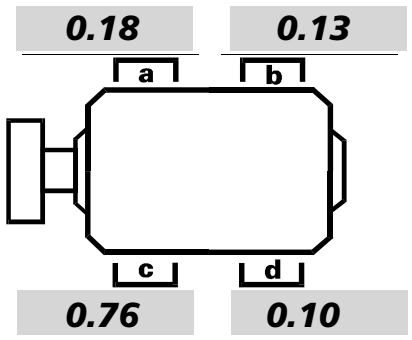
Standard case | **Special case: 45° inclination** | **Special case: Wall mounting**

Note

The measurement components should always be oriented parallel to the mounting surface. The value displayed then corresponds to the amount by which the machine foot lifts from the mounting surface.

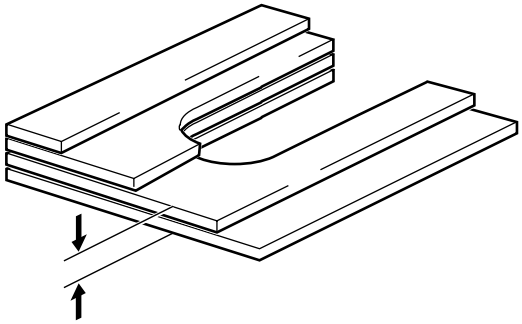
Angular soft foot

If one value is significantly higher than the others then angular soft foot can be suspected:



(Dimensions in millimeters)

The 'problem foot' or machine frame is probably bent or distorted in some way. In this case loosen the bolt and examine the foot more closely. Use a feeler gauge to establish the variation of the gap and use these measurements to sketch the shape and dimensions for a stepped shim:



If the soft foot is purely 'angular' then the stepped shim will vary in thickness from about zero to twice the displayed OPTALIGN PLUS value.

For more complex examples please see the appendix.

Measurement modes

The 'Continuous Sweep' measurement mode used on page 3-22 is the default and is suitable for most standard alignment jobs. For less common alignment cases there are two other measurement modes, 'Multipoint' and 'Static'.

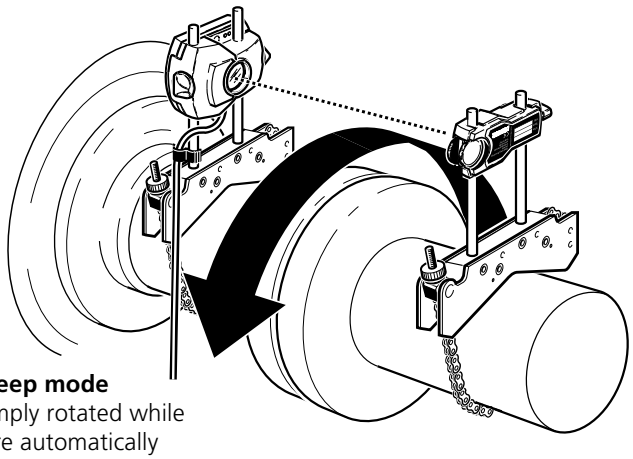
Which measurement mode for which situation

• Standard machines	use CONTINUOUS SWEEP
• Shafts are difficult to turn in one sweep	use MULTIPOINT MODE
• Severely limited measurement rotation	use MULTIPOINT MODE
• Oil film thickness instability in white metal bearings	use MULTIPOINT MODE
• Machines not horizontal	use STATIC MODE
• Shafts are uncoupled	use MULTIPOINT MODE (refer to the attached Technote No.33)
• Shaft(s) cannot be turned	use procedure on page 4-14

Continuous Sweep mode

This mode is..

- quick and easy to use
- suitable for most standard applications



Continuous Sweep mode
The shafts are simply rotated while measurements are automatically made

This is the measurement mode described in the standard horizontal alignment procedure (page 3-22) and is recommended for most standard cases.

Procedure

Turn the shaft through one complete turn, or as far as possible - at least 60°. You can turn in either direction, but it is advised to turn in the same direction the machine normally rotates. This ensures the shafts don't move out of their normal seated position within the bearings, which would alter the alignment measurement.

Note

The measurement process actually stops only once the Results key has been pressed.

How it works:

In the 'Continuous Sweep' mode the transducer is continuously reading its built-in electronic inclinometer. When shaft rotation is sensed, the coordinates of the reflected laser beam on the detector are measured and stored together with the shaft angle; the slower the shafts are rotated, the more numerous and the closer together these measurements will be.

The measurement precision is much higher than the single digit coordinates displayed on the screen, as you can see for yourself with the F1 function described on page 4-23.

Over 100 measurements can be made during rotation which are processed by the OPTALIGN PLUS computer to give a very accurate alignment result.

Minimising effect of coupling backlash

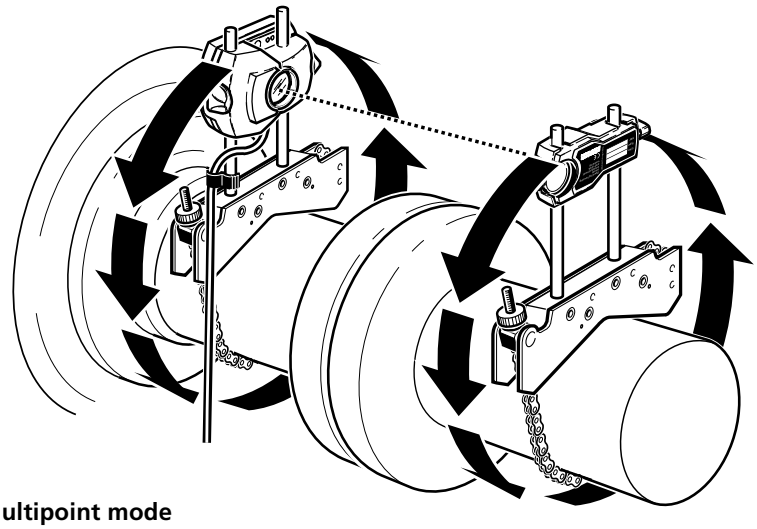
Measurements are not recorded during the first 5° of shaft rotation to prevent coupling backlash from affecting results. See page 6-7 for further details.

Multipoint mode *('Pt.')*

This mode is suitable for:

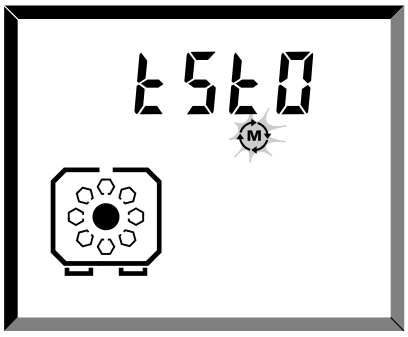
- shafts which cannot easily be turned in one sweep
- shafts where measurement is possible only in limited positions
- measurement of uncoupled shafts (see attached Technote No.33)
- when oil film thickness variations occur in white metal bearings

In multipoint mode individual measurements are made at a series of rotation angles. This gives you more control over the measurement both in terms of the time taken and positioning.



Multipoint mode
individual measurements are made at a series of rotational positions

Measurement stability



The technically advanced measurement procedure utilized by OPTALIGN PLUS provides extremely high accuracy in the single-point measurement modes (i.e. Multipoint and 0,3,6,9). The system waits until the individual measurement reading received remains stable before the reading is accepted and stored for a particular rotation position. During this waiting period, the display shows 'tStX', where X begins at 0 and counts upwards; its final value depends upon the setting of the number of readings for averaging. This setting is accessed using special function F 8 2 (see page 4-32) and can be set to 1, 2, 4, 8, 16, 32, 64 or 128 individual readings.

Note

When only 1 or 2 readings are averaged, the average value can fluctuate enough to jeopardize stability. In that case, the display does not mark the measurement position as having been read with a black bolt as usual: you should then increase the F 8 2 setting.

Multipoint procedure

1. Ready to measure?

Set up the components and enter dimensions.

---

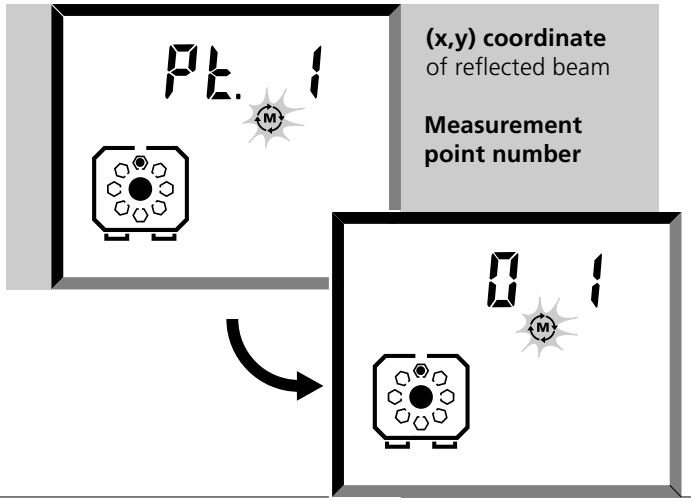
2. Press [M], then center laser beam

Follow the usual beam adjustment procedure described on pages 3-18 to 3-21. If coupling play is suspected, take it up by rotating the end where the reflector is mounted.

---

3. Select Multipoint Mode (*Pt.*) with [ENT]

When you press the ENT key, the multipoint mode is initiated. The display shows 'tStX' (X=1,2,3...), then 'Pt. 1' when the first measurement point is recorded, followed by the laser coordinates. The end view of the machine is shown, with the current measurement position clearly marked by a black bolt.



---

4. Turn shaft to each measurement point; press [ENT]

Rotate the shafts in their normal direction of operation to the next measurement position, then press ENT to trigger actual measurement at that position. The screen displays the second measurement point number, 'Pt.2', then the x,y coordinates. Proceed likewise for the remaining positions.

- At least 5 points are required over at least 60°.
- END or OFF? page 4-27; Cable tangled? page 3-23.
- When finished press Results key and continue from page 3-24.
- The most recent measurement may be deleted using the CLR key.

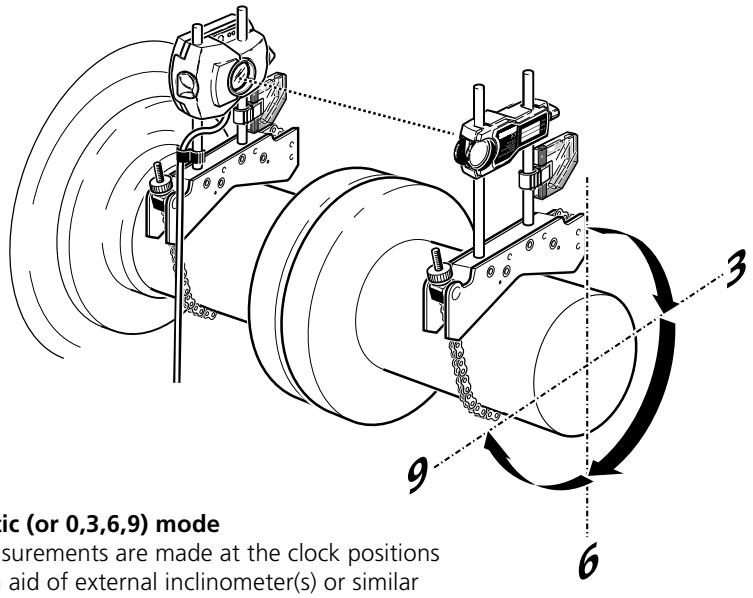
Static *(0369)* measurement mode

This mode is ideal for:

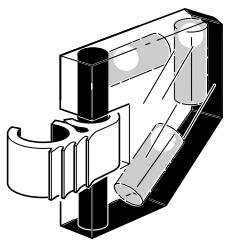
- comparison with dial gauges and with the original OPTALIGN
- uncoupled shafts
- non-rotatable shafts - see page 4-14.
- '4-feet' machines that are mounted vertically.
- using the 10:30 position for the MOVE function (page 3-30).
- using the MOVE function to monitor vertical (shimming) correction (page 3-29).

In static mode individual measurements are made at the eight 45° clock positions, using external inclinometer(s) or protractor to set the angles. The OPTALIGN PLUS internal electronic inclinometer is NOT active in this mode.

For uncoupled shafts both halves must be turned separately.



Static (or 0,3,6,9) mode
Measurements are made at the clock positions with aid of external inclinometer(s) or similar



External inclinometer ALI 5.020
Clips onto the bracket posts for accurate positioning at 0° 45° and 90°, and multiples thereof.

Static procedure

1. Mount components, enter dimensions etc.
(pages 3-8 to 3-17.)

---

2. Press [M], then center laser beam
(pages 3-18 to 3-21).

---

3. Turn shaft, select measurement angle

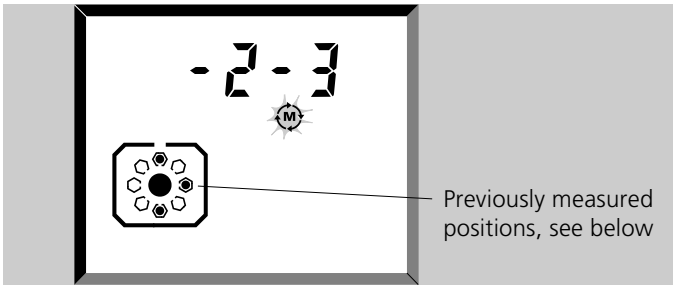
Turn the shaft to the first clock position (0:00, 3:00, 6:00, 9:00) for measurement. This first position must be horizontal or vertical; 45° positions such as 1:30 are available only from the second measurement onward. Position as accurately as possible with external inclinometer, spirit level or protractor.

Uncoupled shafts: Set the positions of both shafts as accurately as possible, using the same method on both sides.

---

4. Take measurement

The first measurement is taken when you press the number key of the clock position (e.g. '0' for 0:00, '3' for 3:00 etc.; the ENT key is not needed here). The display shows 'tStX' (X=1,2,3...), then 'Pt. 1' when the first measurement point is recorded, followed by the laser coordinates. The end view of the machine is shown, with the current measurement position clearly marked by a black bolt.



Subsequent measurements in 45° positions may be entered, for example, by pressing the following keys:
[1] [.] [3] [0] .

---

5. Repeat for each clock position

Proceed to the next position. Any position may be used as desired.

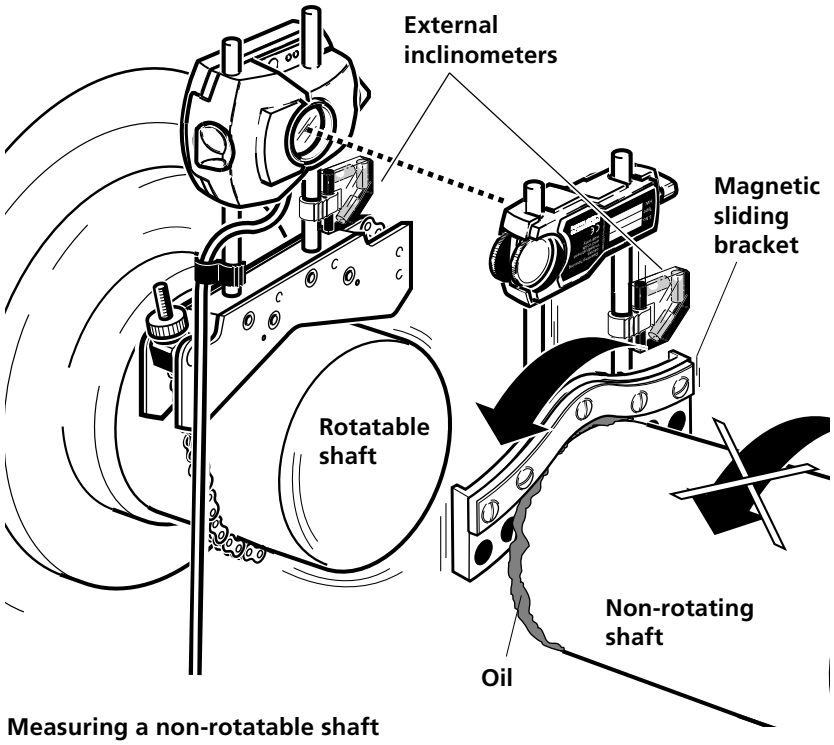
- 3 positions are needed to calculate the results.
- Any position may be remeasured.
- END or OFF? page 4-27; Cable tangled? page 3-23.

Press the [ON/OFF] key when finished.

Measuring a non-rotatable shaft

To measure a non-rotatable shaft:

- Use a magnetic sliding bracket, ALI 2.230 (described opposite) mounted on the coupling face on the non-rotatable side. The face and edge must be ferrous, surface-finished, clean & lightly oiled.
- Use Multipoint mode and refer to attached Technote No.33.
- External inclinometers or similar are used to set the measurement positions of the transducer AND reflector.



Measuring a non-rotatable shaft
Using a magnetic sliding bracket and external inclinometers, together with the 'Static' measurement mode

Both shafts non-rotatable!

Yes, you can do this too, with two sliding brackets, but accuracy achieved is very dependent on the quality of the coupling faces. The transducer should mount on the face with the better finish. This should be seen only as a method of last resort!

Non-rotational measurement procedure:

1. Prepare non-rotating coupling face

The face and edge must be ferrous (steel), and surface-finished, with a large contact area over which the bracket magnets can slide. Clean and lightly oil the surface.

2. Mount sliding bracket & reflector on non-rotating side

The transducer mounts on the rotating side as usual (pages 3-8 to 3-12). Fit cable & switch on.

3. Prepare to measure

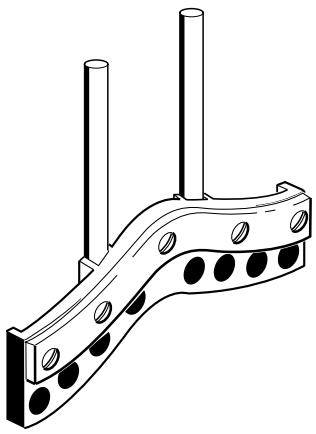
Enter dimensions, press the 'M' key and zero the beam coordinates (see pages 3-15 to 3-21).

4. Turn shafts/brackets

See page 4-13, step 3 for details. Set the positions as accurately as possible with external inclinometer a spirit level or protractor, using the same method on both sides.

5. Repeat for each clock position

Watch out for 'END' or 'OFF' - see page 4-27.
Then view the results in the usual way (page 3-24).

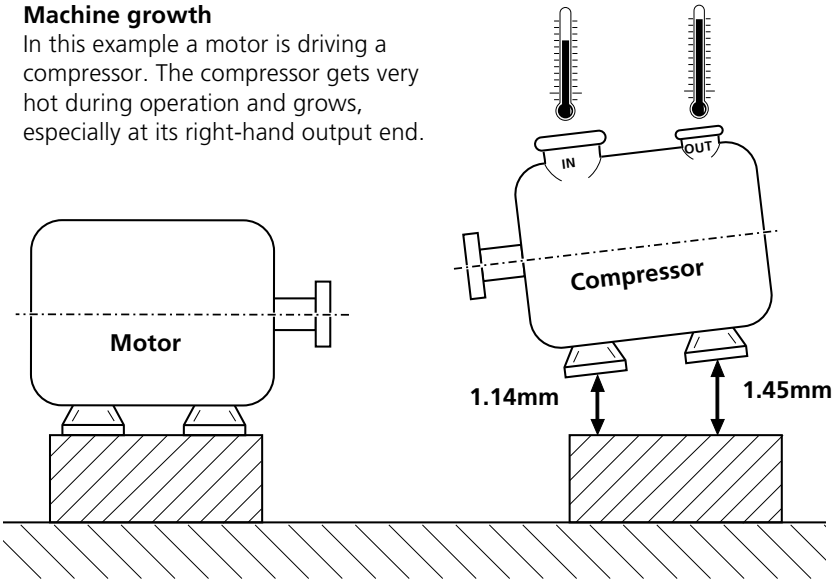


Magnetic sliding bracket ALI 2.230
The magnetic sliding bracket fits onto the coupling flange as shown and simply slides around to the required measurement positions. Its powerful magnets ensure the mounting stability needed for accurate measurement. It is suitable for all shaft diameters over 80 mm (3 1/8").

Coupling targets & thermal growth at feet

In certain instances, it is desirable to introduce a specific amount of misalignment, for example, to compensate for growth of machines which are aligned when cold, but operate at high temperature.

Machine growth
In this example a motor is driving a compressor. The compressor gets very hot during operation and grows, especially at its right-hand output end.

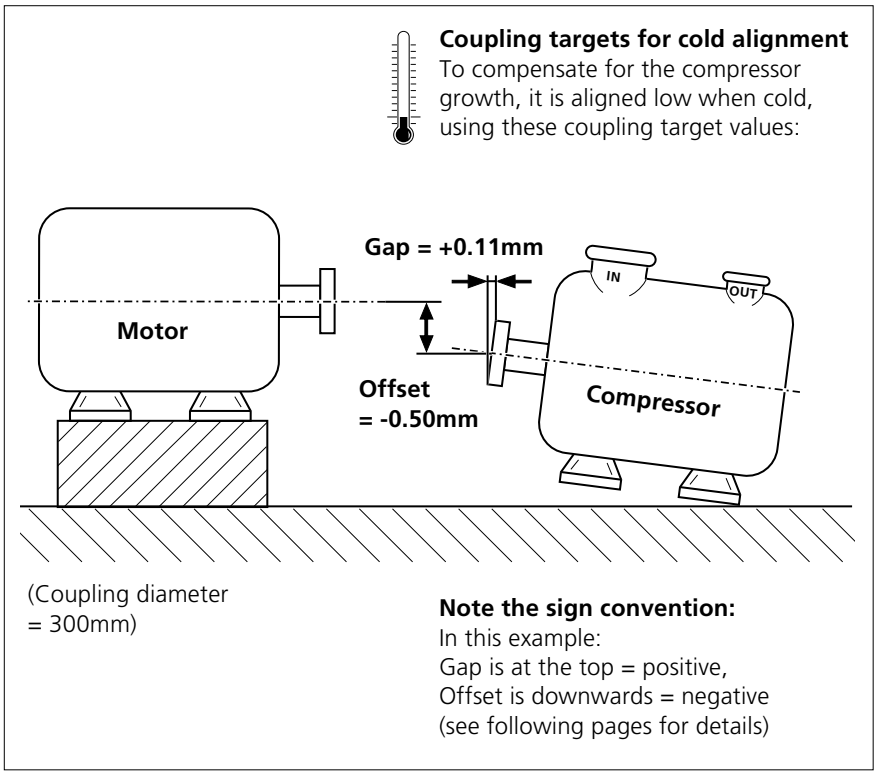


Here we have assumed the motor growth is negligible, although you can enter thermal growth values into OPTALIGN PLUS for BOTH machines.

- Use the OPTALIGN PLUS 'Target' key to enter the required misalignment at either the coupling or at the machine feet.
- This information is then automatically calculated into the alignment corrections, and a 'target' symbol appears in the results screen whenever any target or thermal growth information has been entered.
- You can enter the targets before or after measurement.
- Coupling targets can be entered for vertical machines: see page 5-18 for details.

1. Coupling targets for 'cold' alignment

Some machine manufacturers define target values in terms of the misalignment at the machine coupling when then machines are COLD. This is shown in the following diagram where the compressor is deliberately aligned low when cold to compensate for its thermal growth when hot:



Compare the above diagram with that on the opposite page. Both refer to the same example viewed in different ways:

- Opposite shows how the HOT machines would look if aligned cold and uncorrected
- Above shows how the COLD machines should be aligned using coupling targets to correct for the thermal growth.

To enter coupling targets:

1. Press [⊕] to show 'coupling' symbol

(Press again to switch to foot values, page 4-20)

---

2. Enter coupling diameter

If you haven't entered the coupling diameter yet then the display will now prompt you for it. OPTALIGN PLUS needs to know at what diameter your target coupling gaps will be specified.

The coupling flashes in the screen and the DIM symbol lights. The default is 100mm (or, in inch mode, 10"). Press ENT to continue.

---

3. Enter offsets and gaps

Enter the coupling targets in the following order, pressing ENT each time (CLR clears a value):

i. Vertical Offset
ii. Vertical Gap
iii. Horizontal Offset
iv. Horizontal Gap

Pay attention to the display to see which symbol is flashing and which direction is displayed (see diagrams opposite).

Remember that coupling targets specify how you want to align the machines COLD; the example on the previous page shows what this means.

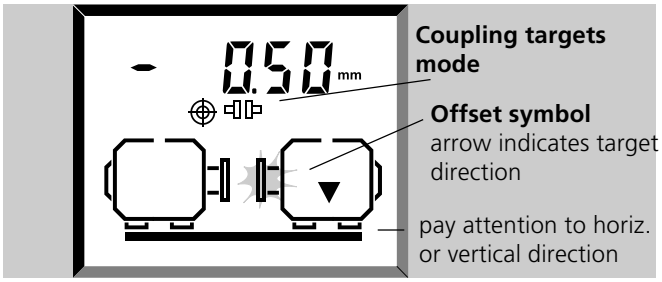
Note

Sign convention *(if left machine static)*

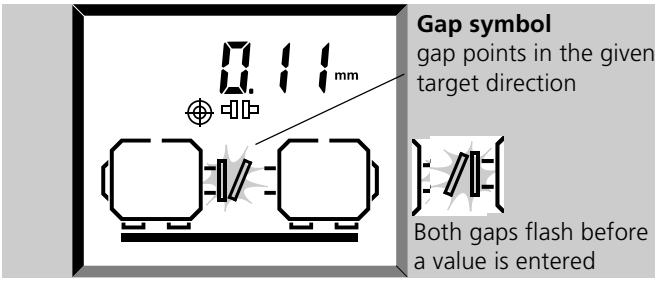
- GAP is **positive** when it opens **upwards** or **away from** viewer.
- OFFSET is positive when the right machine is **higher** or **further** from viewer than the left machine.

See page 4-29 if the left machine is movable.

Entering offsets:



Entering gaps:



4. View results

• Your foot correction results (page 3-26) and the happy face symbol will now incorporate your target values.

• Remember that coupling results (page 3-24) display actual measured alignment ignoring targets.

• If you have entered any target values, then the target symbol appears in the results screen to show that they are in use.

Angle to gap conversion

If shaft angularity is specified in terms of arc seconds you can easily convert to a gap value when you set the coupling diameter to 2062mm (or 206.2"). At this diameter, the gap width increases by precisely 0.01 mm (0.001") for every 0° 0' 01" (1 arc second) of shaft angularity. Example:

Maximum angle = 0° 0' 42" = 42 arc seconds

Multiply the no. of arc seconds by 0.01mm (0.001")

Therefore enter: 0.42mm (0.042") as the gap size.

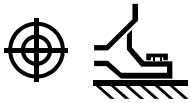
Note

2. Expected thermal growth at the machine feet

Instead of coupling target values, you can enter the expected thermal growth values at the machine feet. Take another look at the example on page 4-16.

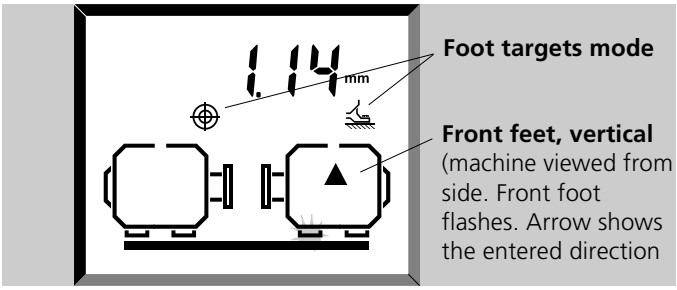
These are the values the machine is EXPECTED to move when it warms up. OPTALIGN PLUS performs the necessary calculations to convert these into the required 'cold' misalignment conditions.

You can also enter a combination of coupling targets and feet values, and OPTALIGN PLUS will add them together when determining the required corrections.



1. Press (twice) to show 'foot' symbol

2. Enter feet alignment values



When entering values always check in which direction the machines are displayed and which foot or feet are blinking. Press ENT after each entry.


Note

Sign convention *(for feet on right machine)*

- Positive is upwards or away from the viewer
- Negative is downwards or towards the viewer

See page 4-29 for left machine corrections.

3. View results

- Your foot correction results (page 3-26) and the Smiley symbol will now incorporate your thermal growth corrections.
- Remember that coupling results (page 3-24) show actual measured alignment ignoring corrections.
- Again, if you have entered any feet values then the target symbol appears in results.

3. Thermal growth for stationary machine

If, for example, the left machine cannot be moved during alignment, yet exhibits thermal growth, then proceed as follows:

1. Set the left machine to be moveable using F70

Use arrow keys to make a selection. See page 4-29.

---

2. Press DIM key, enter further required dimensions

OPTALIGN PLUS needs to know the distance from the transducer to the right feet of the left machine, and the distance between the left machine feet.

---

3. Press ⊕, enter targets for left machine

The display will prompt for the coupling targets and thermal growth values at the feet as described on the previous pages. See 'sign convention' below.

---

4. Set left machine back to static with F70

---

5. Enter target values for the right machine if required

OPTALIGN PLUS will then take the target values for BOTH machines into account when calculating the alignment results for the moveable machine.

Universal sign convention

The sign convention shown on the opposite page, and elsewhere in this manual does not work when applied to the left machine. Instead we use a universal sign convention which applies to either machine:

i. The 'Machine To Be Moved' (MTBM) is the name we shall give to the machine to which our target value will be applied.

ii. The target value will be for the MTBM RELATIVE TO the stationary machine.

The value is POSITIVE if the MTBM is HIGHER (or gap opens upwards).

The value is POSITIVE if the MTBM is further TOWARDS 9 O'CLOCK (or gap opens toward 9 o'clock).
[The clock is as viewed from the coupling toward the MTBM]

You will see that this convention also works for the right machine as we would expect!


Note

'F' key functions

On the following pages are further OPTALIGN PLUS functions using the 'F' key. These encompass tolerancing, machine settings, extending measurements and 6-foot machine corrections.

F 1 Display (x,y) coordinates and rotation angle, page 4-23
F 2 Units selection, mm/inch, page 4-23
F 3 6-foot machine foot results, page 4-24
F 4 Display time and date, page 4-26 (set via F80, page 4-32)
F 6 Extend measurement, page 4-27

F 7 0 Select static machine or feet, page 4-29
F 7 1 Select report format (graphic or text), page 4-29
F 7 3 Select coupling type, short or long, page 4-30
F 7 4 Default setting for results key (coupling or feet), page 4-32
F 7 8 Default coupling diameter, page 4-32
F 7 9 Default RPM, page 4-32
F 8 0 Set time, month, day and year, page 4-32
F 8 1 Set language (0=english), page 4-32
F 8 2 Set number of individual readings for averaging, page 4-32
F 8 3 Set the deviation band, page 4-33
F 8 4 Set result resolution, page 4-33
F 9 0 Delete all stored data, page 4-34
F 9 1 Test entire display, page 6-28
F 9 2 Test individual display segments, page 6-28
F 9 3 Test keyboard, page 6-28
F 9 4 Display version, ID No., page 4-34, 6-28
F 9 5 Memory test, page 6-28
F 9 8 Reset all settings to the factory defaults, page 4-34
F 9 9 New machine - all dimensions deleted, page 4-34
F 0 0 PC communication, page 4-34
F 0 8 List of all special functions, page 4-34
F 0 9 List of languages for report generation, page 4-34

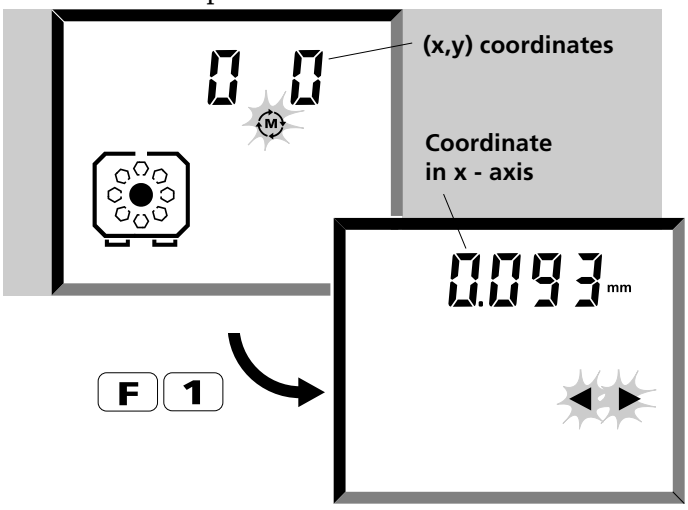
Display (x,y) coordinates and rotation angle

F 1

You can use OPTALIGN PLUS to make precision measurements of, for example, radial bearing play. On page 3-21 it was mentioned that the system measures to a much higher accuracy than the displayed single digit -9 to +9 coordinates. To view this higher precision, set up the system as shown on page 3-21 and proceed as follows:

1. When x,y coordinates are displayed press F 1

The screen coordinates switch from the (x,y) format to a readout of just the horizontal (x) coordinate with increased precision.



2. Cycle through x,y and the angle of rotation by pressing ▶

The flashing arrows change from horizontal (x) to vertical (y) and the vertical coordinate is displayed. A further cycle reveals the rotation angle of the transducer.

The CLR key may be pressed to set the display to zero (for example, before lifting the shaft to check radial bearing play). The target symbol then appears to remind you that the displayed value has been zeroed. The original absolute (non-zeroed) display can be recalled by temporarily blocking the laser beam and pressing CLR at the same time.

Remember that if END or OFF appear, you can use the range extension function F6. (See page 4-27) Note that it could be the axis that you are NOT currently viewing that has gone off the detector!

F 2

Select mm/inch units

1. Press F 2

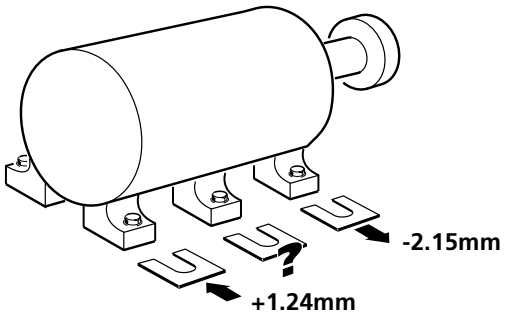
After switching dimensions, press ⊕ to verify (or correct, if necessary) the new default coupling diameter.

2. Select mm or inch with ▶

3. Press ENT to confirm

F 3

6-foot machines



While viewing the foot correction results as shown on page 3-26, you can also find out the correction required at another foot position e.g. for a 6-foot machine. Start by entering its position:

Entering the 3rd foot dimension:

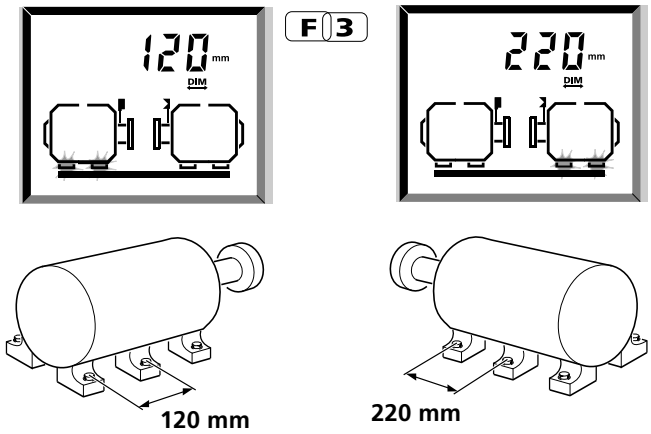
1. Press DIM, select ***both feet flashing*** with ▶

   The distance between the front and back feet is displayed (you should have entered this on page 3-17).

2. Press F 3

3. Enter distance from ***left foot*** to ***3rd foot***. Press ENT

   The entered value is always referenced to the foot to the LEFT of it, i.e.,
   Right machine: Enter the distance from the front foot on the right machine to the '3rd foot'.
   Left machine: Enter the distance from the back foot on the left machine to the '3rd foot'. See diagram on page next.



Results for the 3rd foot:

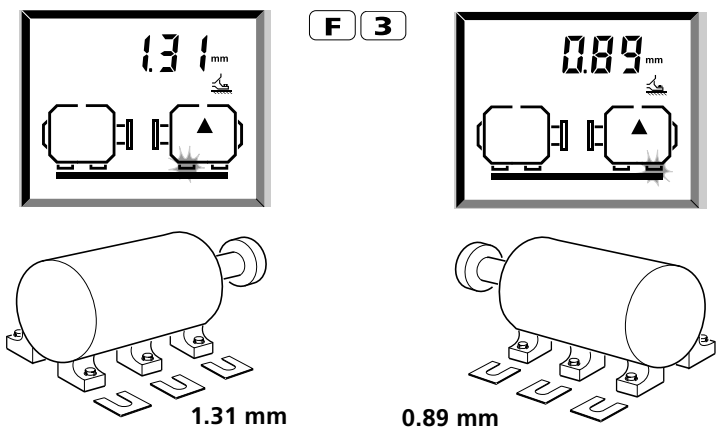
1. Press [ ] until [ ] appears

2. *Front foot* displayed

If not then press the arrow keys to select (page 3-26).

3. Press F 3

The rear foot blinks. The vertical shimming value for the 3rd foot is displayed:



4. Press ▶ to cycle between vertical and horizontal

The display switches between the vertical shimming, and the horizontal move corrections for the 3rd foot.

---

5. Press F to return to *4 feet*

The values apply for the 4-feet machine again. Press F3 any time to show the 3rd foot corrections.

F 4 Display time and date

1. Press F 4

The time, month+day, then year are displayed in turn. The date and time are stored with each file, and these can be viewed on a PC using OPTALIGN PLUS Explorer, page 6-33. Use F80 to set the time/date (page 4-32).

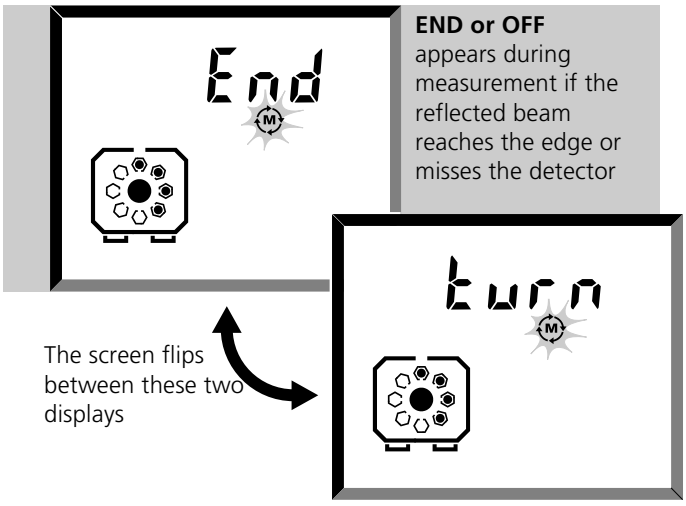
---

2. Press F to return to previous screen

Extending the measurement range

F 6

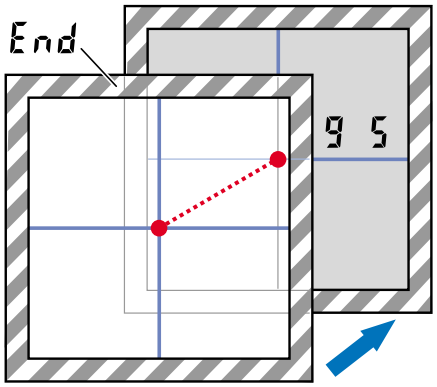
Should 'END' or 'OFF' appear during measurement (page 3-23) or in MOVE mode (page 3-31), the range extension F 6 comes into use.



END or OFF appears during measurement if the reflected beam reaches the edge or misses the detector

- END means the reflected beam hits the edge of the detector and cannot be accurately measured; OFF means it has missed the detector altogether.
- This may occur when the machines are severely misaligned, or when there is a long beam travel.
- Measurements are not made while END or OFF are shown. If the measurement rotation were to continue in this state, then there could be a loss in accuracy of the alignment results.

To cope with this use the 'Extend' function to re-center the laser beam for cumulative measurement as directed on the following pages.



Extending the measurement range with special function F6: The detector area is mathematically readjusted to a new location

Extend procedure:

1. If END/OFF, turn back until coordinates reappear

Watch the display coordinates as the shafts are turned. If either value should reach ±9, stop rotating the shafts before 'END' or OFF' comes into the display. If you go too far and 'END' or 'OFF' appears, rotate the shafts backwards just until the numbers reappear (in 'Sweep' mode, 'Set0' appears: then proceed from Step 3 below). If coupling backlash is present: rotate backwards a bit further, then forward just until torsional play is taken up.


Note

Once set, do not move the shafts from this position - keep them there all the way through to step 4 below!

2. Press F 6

The transducer notes the exact beam coordinates before re-centering occurs. The display briefly shows 'tStX' (X=1,2,3), then 'Set0' alternates with the (x,y) coordinates as shown on page 3-21.

If F 6 is pressed when the laser beam lands outside the position detector ('END' or 'OFF'), then the transducer cannot record the beam coordinates: after nine seconds, the system automatically switches back to measurement mode.

3. Rezero beam & press ENT

Repeat the beam centering procedure so that the display reads close to (0 0). The shafts must be held steady during reflector readjustment!

Once both coordinates are within ±1, the 'Set0' display changes to 'Entr', signifying that measurement can be resumed as normal.

Press ENT, and the amount of reflector readjustment is registered and added to all subsequent measurements.

4. Proceed with measurement

Resume shaft rotation and measurement.

5. Repeated 'extends'

Repeat the 'Extend' as often as necessary. However, if it must be repeated more than once or twice, it may be better to take a measurement over a smaller angle and perform a rough alignment first.

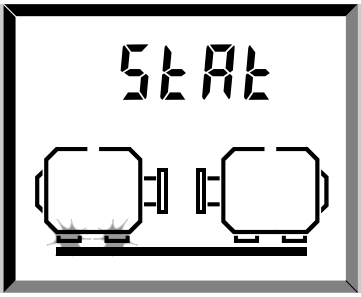
Select static machine/feet

F 7 0

The default is the left machine is static and the right machine is the machine to be moved (MTBM). You can switch the static machine to the right, or set a combination of static feet from both machines:

1. Press F 7 0

The 'Stat' screen appears, showing the currently selected static feet:



Currently selected static feet flash
Change selection with arrow keys and confirm with ENT

2. Select static feet with ◀ & ▶

There are 6 static options:
i. Left machine, both feet
ii. Right machine, both feet
iii. Front feet (nearest coupling)
iv. Back feet (furthest from coupling)
v. Front foot, left machine & back ft, right machine
vi. Back foot, left machine & front ft, right machine

3. Confirm with ENT

On pressing ENT the computer automatically prompts for any undefined dimensions, e.g. the distance between the left machine feet. You can review these dimensions at any time with the DIM key (page 3-15)

Select report format (graphic/text)

1. Press F 7 1

F 7 1

2. Select graphic or text format with ▶

3. Press ENT to confirm

Sample reports in both formats can be found on pages 6-24 to 6-27.

F 7 3 Coupling type

You can select from two basic types of coupling:

Short: Default setting where alignment is defined in terms of the gap/angle & offset at the coupling flange (see page 3-24).

Long: If the coupling has a 'spacer shaft' the alignment is defined in terms of the offsets A & B at each end of the shaft.

1. Press F 7 3

The screen shows the current setting, 'Shrt', or 'Long'.

2. Change type with ▶ , confirm with ENT

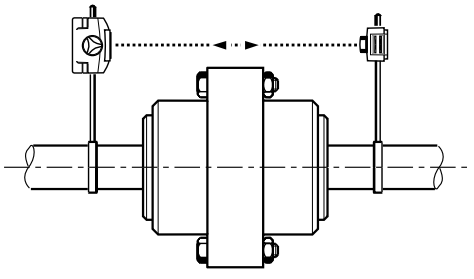
3. If 'Long' selected, enter spacer shaft length

When you press the Results key the computer automatically prompts for the length of the spacer shaft between the coupling faces (see diagram below), In this case both coupling faces will blink in the screen. Alternatively, use the DIM key (page 3-15).

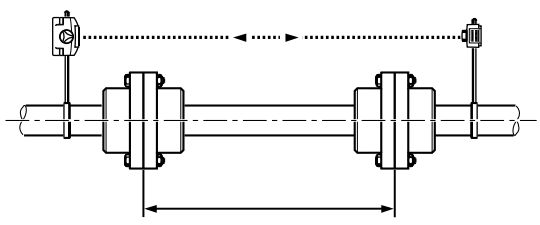
When cycling through the coupling results (page 3-24) the offsets A & B are indicated by blinking coupling halves on the left and right machines - see opposite.

Notes on coupling types:

Short couplings (short flex, single-plane etc.)
The term short flex is used for most common types of 'compact' flexible coupling, e.g. chain, bellows, diaphragm, elastomeric, gear, spring, grid or pin types. Single-plane couplings ('rigid' or 'fixed' couplings) normally consist simply of two flanges bolted together. Note: single-plane couplings must be loosened slightly during alignment so that one machine does not influence the other.

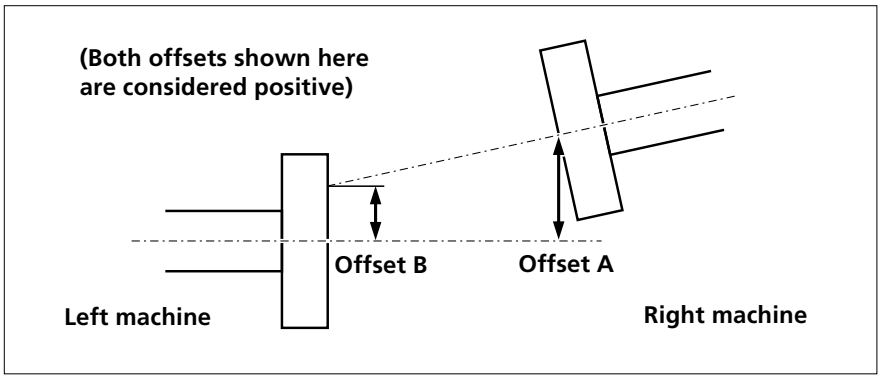


Long couplings (or spacer shafts)
Spacer shaft couplings have two bending planes and a spacer. The length of the spacer must be entered when entering machine dimensions, see above.



Coupling targets for 'long' couplings

See page 4-17 for details on entering coupling targets. When entering coupling targets for 'long' couplings, the Offsets A and B horizontally and vertically must be entered. The following diagram shows how these are defined:



1. To enter targets, press 

---

2. Enter Vertical Offsets, A and B

The machines are viewed from the side. For Offset A the right coupling blinks and vice versa.

---

3. Enter Horizontal Offsets, A and B

The machines are viewed from the top. Repeat as above.

Results for 'long' couplings

On page 3-24 we saw how the results are displayed for the short coupling. Here is the variation for long couplings:

1. Press  **until**  **appears**

---

2. Press  **to cycle through the following..**

a. Offset B, vertical
(left coupling blinks, side view)

b. Offset A, vertical
(right coupling blinks, side view)

c. Offset B, horizontal
(left coupling blinks, top view)

d. Offset A, horizontal
(right coupling blinks, top view)

Setting defaults, time, resetting, etc

The following settings can be changed:

Coupling or Foot results, F 7 4

The factory default is Coupling results (see page 3-24). Press the ▶ arrow key to select between the Coupling or Foot symbols and confirm with ENT. Note that the order of the entered dimensions will change if 'Foot' is selected (page 3-16).

Default coupling diameter, F 7 8

Note

The factory default is 100mm (10"), but you can enter another value (e.g. 2062mm (206.2"), see page 4-19). Confirm with ENT.

Default RPM shaft rotation, F 7 9

There is no default value given. Enter value and confirm with ENT.

Time and date, F 8 0

1. Press F 8 0.

2. The time is shown with AM or PM. Enter the correct time in 12-hour clock format (use the . key to specify AM or PM) and press ENT.

3. The month and day are shown. Enter a four digit number corresponding to the month and day, using zeros to fill single digit values e.g. '0102' is 2nd January. Press ENT

4. The year is shown. Enter the correct value and press ENT. To exit press any one of the six functtion keys above the digits.

F 8 1 : Select language

This applies to report printouts only. 0 = English (default), 1 = German, 2 = French. For other languages available see printout F 0 9

F 8 2 : Set number of readings for averaging

This applies to 'point' measurement modes only (i.e. Multipoint and 0,3,6,9). It gives you a degree of control over measurement stability (and measurement duration) by specifying the number of individual readings to be averaged together into one composite reading at each measurement point. F 8 2 lets you enter this number as a power of 2: $2^2 = 4$ readings, $2^3 = 8$, ..., $2^7 = 128$ readings.

Measurement duration depends on the number of individual readings set for averaging; each reading takes 50 ms, so for example, 32 readings would take (50 ms x 32) = 1.6 sec. per averaged measurement.

Note: Only half as many readings are taken during soft foot and MOVE measurements in order to speed up system reaction time

Note

F 83 : Set the deviation band

It is often difficult to obtain measurement results in an enviroment where there is vibration. F 8 3 allows the stabilising of the coordinates while in "tSt" screen by setting the oscillation band to between 5μm and 20μm. Default is 10μm.

F 84 : Set result resolution

The special function F84 enables us to set the resolution of results at either a low resolution (rS Lo) or a high resolution (rS Hi). Use ◀ or ▶ to select desired resolution and confirm with the enter key.

F 9 0 : Delete all files and data

The message 'CLr?' appears. Press the CLR key to proceed or any other key apart from the number keys to cancel.

F 9 4 : Transducer sleep mode / ID display

When the special function F94 is selected, instrument ID No., firmware version and hardware version appear consecutively on the screen. 'HArd 1' indicates hardware version 1 and this does not support the sleep mode. 'HArd 3' supports sleep mode. To be able to utilise this function, firmware 1.18 or higher is required. If the processor inside the sensor is activated but the laser is not yet firing and no key is pressed or laser activity initialised, the receiver LED is shut off after a few seconds. The display will still be alive but the transducer has entered the sleep mode. Pressing any key re-initializes the transducer immediately.

F 98 : Reset to factory defaults

All changed defaults are reset to the factory settings.

F99 : New machine

All current dimensions and measurements are cleared ready for the next job.

See also page 6-28 for various test functions.

PC connection

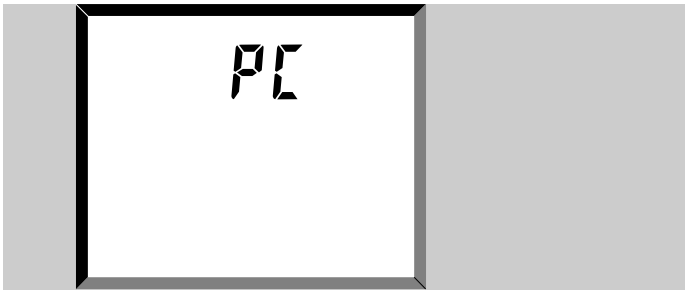
A PC can be connected to OPTALIGN PLUS to back-up data in compliance with ISO9000 requirements, and for long-term analysis of alignment data throughout your factory. Use the OPTALIGN PLUS Explorer PC software described on page 6-30. Full connection instructions are supplied.

F 00 : PC communication

The transducer must be connected to the control unit since the data memory and operating program are located in the transducer.

Note

Connections and data transfer settings must be made as directed on page 6-31. Then communication may be started by pressing F00. 'PC' appears in the screen and data transfer begins.



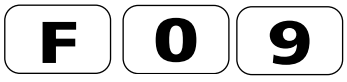
Lists

F 0 8: Special functions overview

This function lists and prints out all the special functions of OPTALIGN PLUS.

F 0 9: Languages for report generation

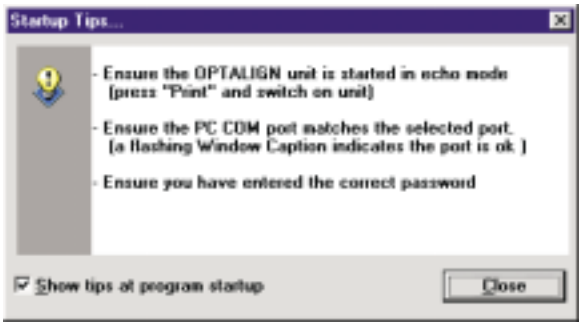
This function prints out all the available languages for generation of alignment reports using OPTALIGN PLUS.



Display viewer

The OPTALIGN PLUS display viewer is used to monitor the OPTALIGN PLUS control unit display on a computer screen. This feature is quite useful for training purposes. Not unlike most software, the program requires to be registered before use.

On selecting the program for use, the tips dialog window below pops up.



On the background of this dialog window is the main OPTALIGN PLUS PC Display Software window. Under menu point 'Options' select 'General settings' to establish serial communication and to complete registration. The necessary password can be obtained from PRÜFTECHNIK Alignment or your local representative.

After registration is complete, proceed to use the programme by switching on the control unit and pressing the print key ( ) simultaneously. The figure 1.02E appears on the display and demonstrations may now proceed.

Chapter 5: Alignment of vertical machines

This chapter tells how OPTALIGN PLUS transforms alignment of vertical machines from a major measurement challenge to a straightforward and relatively simple task.

Chapter 1 Introduction ..... 1-1 to 1-12

Chapter 2 Description ..... 2-1 to 2-14

Chapter 3 Horizontal alignment ..... 3-1 to 3-38

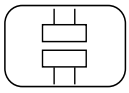
Chapter 4 Further functions ..... 4-1 to 4-36

Chapter 5: Alignment of vertical machines ..... 5-1 to 5-18
Vertical machine alignment flow chart 5-2
Vertical machine alignment 5-4
1. Setup OPTALIGN PLUS components 5-5
2. Enter dimensions 5-7
3. Adjust laser beam 5-10
4. Measure 5-11
5. Results 5-12
6. Align machine 5-14
6a. Shimming at the flange 5-15
6b. Remeasure 5-15
6c. Move horizontally 5-16
6d. Final check 5-17
Coupling targets for vertical machines 5-18

Chapter 6 Appendix ..... 6-1 to 6-50

Vertical machine alignment flow chart

SWITCH ON



(Press again to resume horizontal mode)

DIM Enter Dimensions (page 5-7)

Press **ENT** after each entry. Cycle through with ◀ and ▶.

1. Transducer to reflector
2. Transducer to coupling center
3. Flange maximum diameter
4. Transducer to flange (flashing feet denotes flange)
5. Coupling diameter
6. RPM (for tolerances, page 6-5)
7. Bolt positions:
   a. Bolt number displayed. Press **ENT**
   b. Enter angle. Press **ENT**
   c. Enter equivalent diamter. Press **ENT**
   d. Repeat for each bolt.

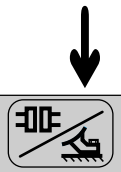
M Measure (page 5-10)

1. '**Set0**' appears. Adjust laser to about 0,0 (See page 3-18)

2. Turn shaft to first clock measurement position (0°/90°/180°/270°).

3. Press numerical keys (e.g. 0 = 0°, 3 = 90° etc.) to enter first position measurement.

4. Repeat for at least 2 further positions (minimum of 3 measurements; 45° = 1.30, 135° = 4.30 etc.)



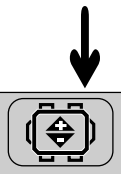
Results (page 5-12)

Press the Results key repeatedly to cycle through the following options:

1. COUPLING GAPS & OFFSETS in 0-6 and 3-9 directions
   Cycle through with **ENT**

2. SHIMMING VALUES AT BOLTS:
   a. Select bolt number with ◀ and ▶.
   b. Shim to the given value
   c. Repeat for all bolts
   d. Remeasure.

3. HORIZONTAL OFFSETS AT FLANGE in 0-6 and 3-9 directions
   Switch between directions with **ENT**. Use MOVE to align.



Alignment correction (page 5-13)

1. Loosen bolts and shim machine according to results (2) above. Take a new set of readings to verify shimming results.

2. Press 

3. Rotate shaft to 45° (1:30 o'clock) position and press ENT.

4. Center laser

5. Loosen bolts

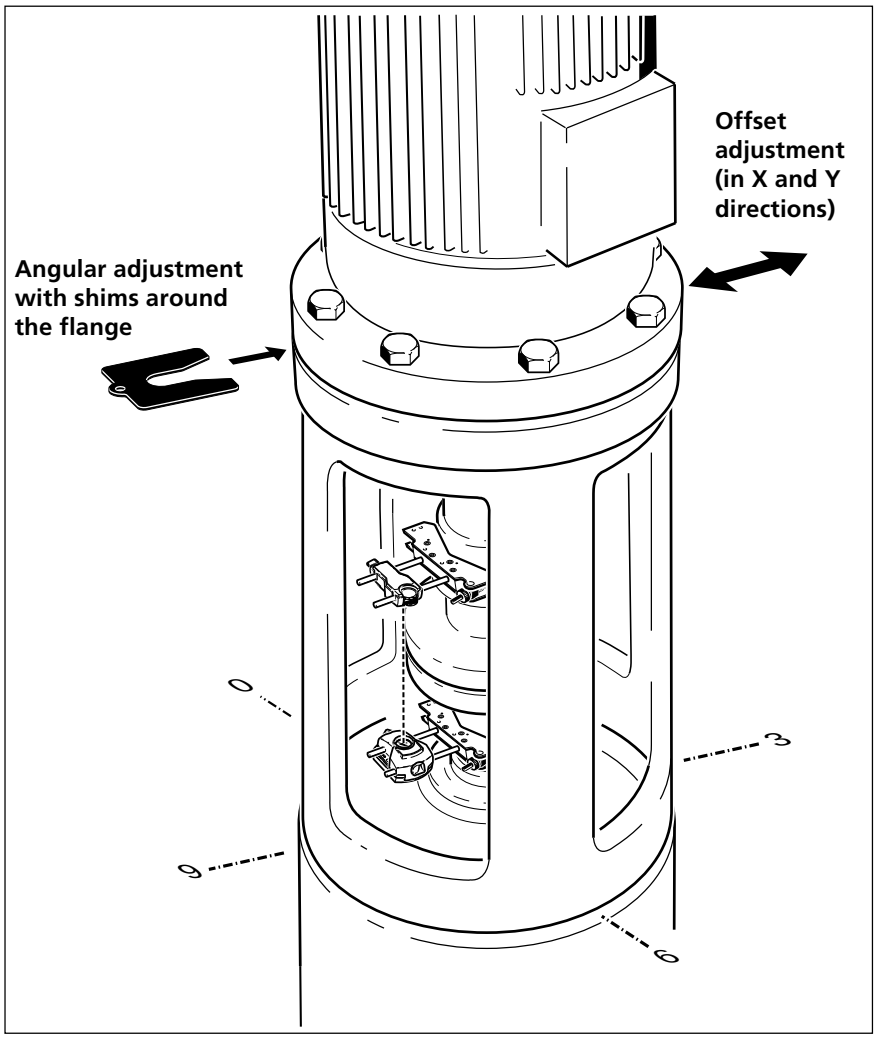
6. Move: Press **ENT** to switch directions, 0-6 and 3-9

7. Retighten bolts

8. Remeasure.

Vertical machine alignment

Here is a typical vertical machine arrangement comprised of one machine mounted on top of the other with a bolt flange:



The OPTALIGN PLUS transducer and reflector are mounted on either side of the coupling as for horizontal machines, with the transducer below and the reflector above. Measurements are then made at a series of 90° or 45° rotational positions.

The computer then calculates the offset correction, performed by sliding the upper machine on its flange.

Enter the bolt positions and the computer calculates the amount of shimming required at each bolt.

The vertical alignment procedure is now described in detail on the following pages. Please acquaint yourself with the horizontal alignment method first.

1. Setup OPTALIGN PLUS components

Since the OPTALIGN PLUS electronic inclinometer is unable to detect the rotational position of the vertical shaft, it is necessary to mark out a series of angular positions for measurement. This may be done either by numbering the shaft or the coupling housing. In both cases the shaft will be rotated clockwise during measurement. Choose one of the conventions and adhere to it:

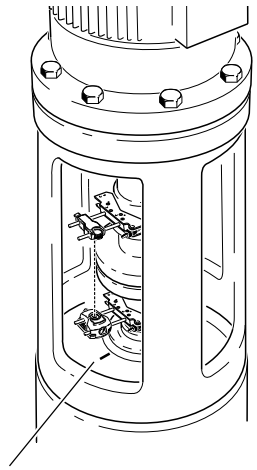
Shaft numbering

1. Mark a reference position on the coupling housing close to the shaft and in line with one of the pillars or bolts. Likewise, mark a starting point on the shaft. Use a thick felt pen or similar.
2. Measure the circumference of the shaft and divide by four. Use this distance to make four evenly-spaced marks on the shaft beginning at your chosen start point. Number the points *counterclockwise* looking down onto the shaft with '0' as your first followed by 3, 6 and 9. The transducer-prism pair MUST be mounted exactly in line with the mark at number '0'.

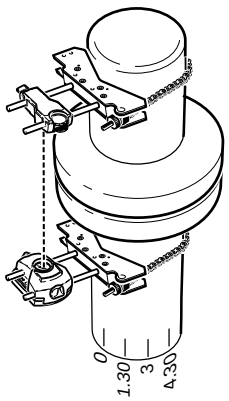
   > ***Beam deflector:*** (see page 3-17) The experienced OPTALIGN user may find this useful to help position the points, but take care that the beam does not land in anyone's eyes or on any reflective surfaces!

3. ***Restricted movement:*** If you have restricted rotational movement, you can mark out eight 45° positions (dividing the circumference by 8) on the shaft. During measurements you can measure at as few as 3 of these positions. Keep in mind that accuracy increases with the number of points measured—try, therefore, to make the maximum 8 measurements whenever possible.

Shaft numbering



Mark a reference point on the coupling housing



Number the shaft counterclockwise 0, 3, 6, 9 (or 0, 1.30, 3, 4.30..)

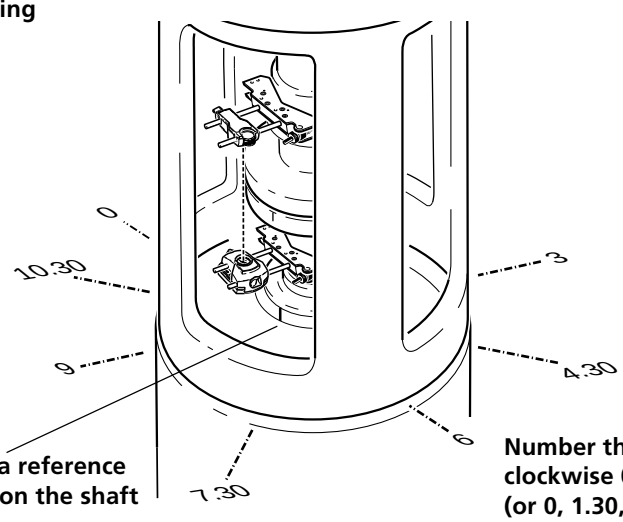
Coupling housing numbering

For circular housings, the following method may be easier:

1. As for the shaft numbering method on the previous page, mark a starting position on the coupling housing close to the shaft and mark a reference point on the shaft; the transducer and laser MUST be mounted exactly in line with this point.
2. Measure the circumference of the coupling housing and divide by four. Use this distance to make four evenly-spaced marks on the housing beginning at your chosen start point. Number the points *clockwise* looking down onto the shaft with "0" as your first followed by 3, 6 and 9 (see below).

   Again, the beam deflector may be useful, see previous page.
3. If you have restricted rotational movement, you can mark out eight 45° positions (dividing the circumference by 8) as described on the previous page.

Coupling housing numbering



Mount transducer & reflector in-line with shaft marking

Fit the OPTALIGN PLUS transducer and reflector on either side of the coupling, aligned EXACTLY with the '0' or reference mark on the shaft.

See pages 3-8 to 3-12 for mounting details. The transducer mounts on the lower machine which is defined as the stationary machine. Connect transducer to control unit (page 3-13).

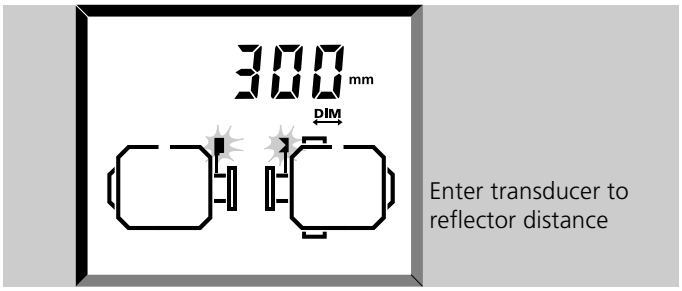
Note

Important: The mounting brackets MUST be correctly mounted to ensure accurate measurements.

2. Press and enter dimensions

Switch on the system (page 3-14) and press the vertical machine key located beneath the sliding key cover. (To revert to a horizontal machine application press this key again.) Enter the following dimensions, refering to the notes on page 3-15:

1. Transducer to reflector

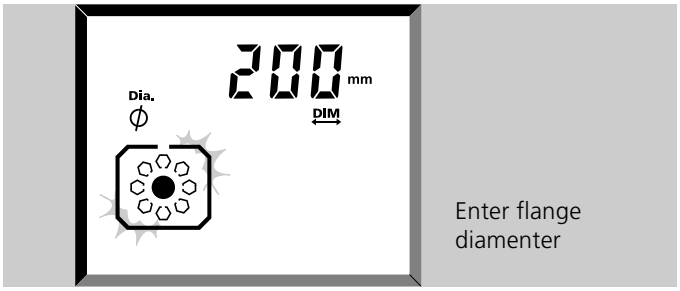


Measure from the marking on top of the transducer housing to the marking on top of the reflector.

2. Transducer to coupling center

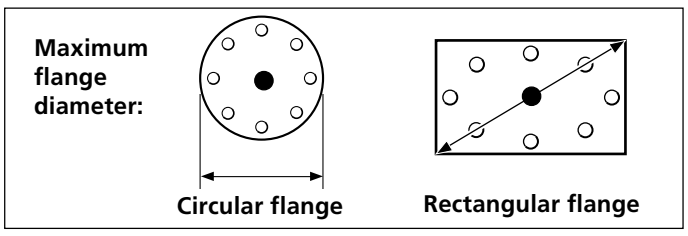
Measure from the marking on the top of the transducer housing to the coupling center (the marking is in the same position as the posts and bracket chain).

3. Flange diameter

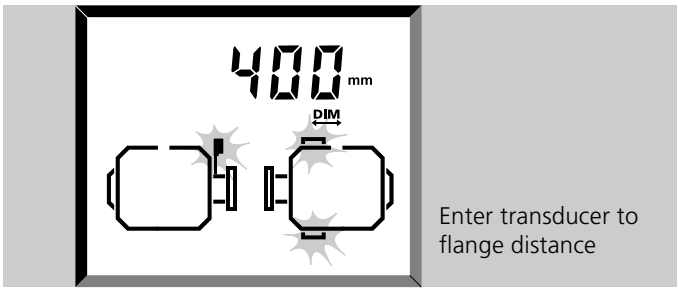


Enter the outer diameter of the flange. This is the point where the upper machine rests and tilts on the lower machine. It is used to calculate the minimum number of shims at each bolt to separate the flange. The bigger the flange, the more shims required.

If the flange is not circular then enter the maximum diameter across the flange, thus:



4. Transducer to flange



Enter transducer to flange distance

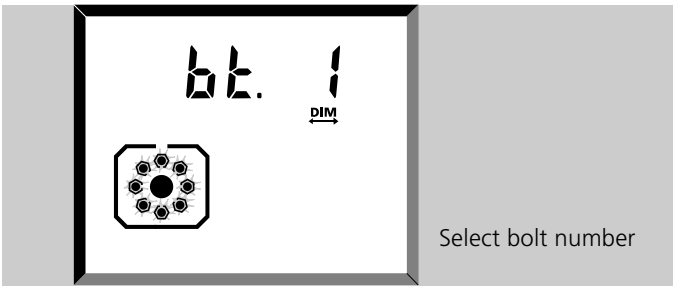
Enter the distance between the marking on the top of the transducer and the center surface of the flange.

5. Coupling diameter

The 'Dia Ø' symbol lights. You can measure the coupling circumference and divide by π (pi) (3.142).

6. RPM (revolutions per minute)

7. Flange bolt dimensions: Select bolt number

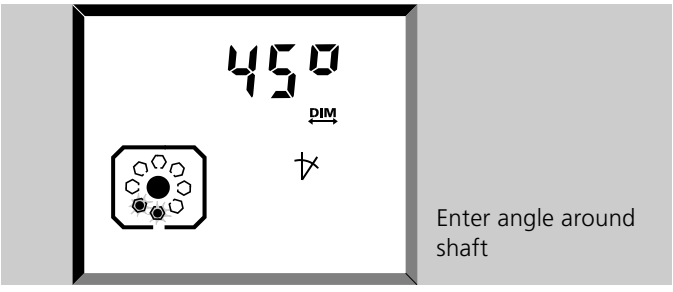


Select bolt number

We now define the positions of the flange bolts in order to calculate their shimming requirements..

The screen above shows that we are about to define bolt number '1'. Press ENT to proceed.

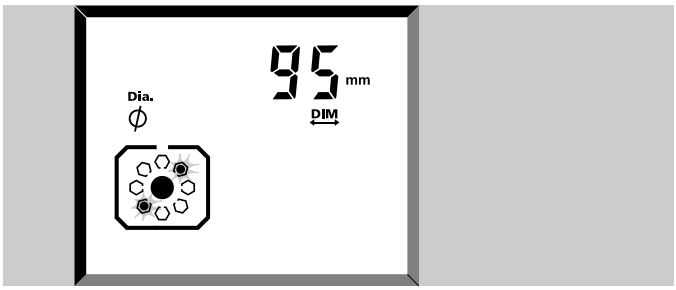
8. Bolt angle



Enter angle around shaft

Enter the angular position around the flange of the bolt. The angle is defined clockwise in degrees, starting with ***0°*** corresponding to the ***12 o'clock*** position as defined on page 5-6.

9. 'Diameter' at which bolt lies



Type-in the *diameter* at which the bolt lies. This is TWICE the distance from the shaft center to the bolt.

10. Next bolt

Bolt number '2' is now shown. You can use the arrow keys to go back to the previous bolt.

Repeat steps 7. to 9. for each bolt. You will notice that suggested angle and diameter values are offered, based on the previous values. Note that the flashing bolt indicates approximately the bolt's actual position, and that the same bolt symbol may flash for two bolts close together.

11. Finish bolts with DIM

When finished press the DIM button All the dimensions for vertical machine alignment are now entered. You can change them or add more bolts at any time by pressing the DIM key.

3. Adjust laser beam

Carry out the laser adjustment procedure described on pages 3-18 to 3-21. This is summarized as follows:

1. Press (M) to turn on laser

Remove transducer cap. The screen is now blinking the message 'Set0'. Remember..


WARNING!

Don't look into the laser beam!

2. Adjust beam onto prism cap

Rotate the reflector side thumbwheel, and if necessary, loosen and move the bracket slightly. Retighten!

3. Remove cap, adjust reflector for slow blinking LEDs

Adjust with the front knob and side thumbwheel so that both LEDs blink slowly.

4. Center the beam coordinates

They do not have to be exactly zero as this doesn't affect accuracy.


Note

Do not touch the components once the beam is centered!

You are now ready to measure...

4. Measure

1. 'Static' measurement

Once the beam is centered, the program automatically switches to '0369' measurement mode (static measurement). The display alternates between beam coordinates (0 0) and '0369' (measurement mode).

2. Rotate shaft to first point

i. Rotate the shaft to your first measurement position. This can be any one of the four 90° positions (45° positions may be taken from step 4 onward). The '0' reference position is at the TOP of the on-screen 'clock' display and is viewed toward the transducer.

3. Take the first measurement

Press the number key corresponding to the transducer position (e.g. '0' for 0:00) and the measurement at that point is immediately made. 'tStX' (X=1,2,3) appears briefly in the display, then the beam coordinates reappear. In the end view of the machines, the bolt position measured is then highlighted.

4. Take at least 3 measurements

Repeat steps 2 and 3 for the other positions. At least 3 measurements are required in total, and the more measurements are taken, the more accurate will be the results.

If the cable gets tangled or wrapped around the shaft, see the corresponding note on page 3-23.

Note: you can make a measurement by pressing the following numerical keys or key combinations, representing the clock positions.

0	3	6	9
1.30 ENTER	4.30 ENTER	7.30 ENTER	10.30 ENTER

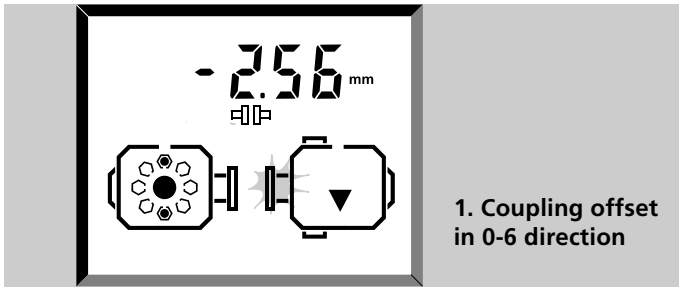
Measurements may be repeated as necessary; the new measurements simply overwrite the old ones in the same positions. The CLR key may be used to completely erase any desired measurement position.

5. Results

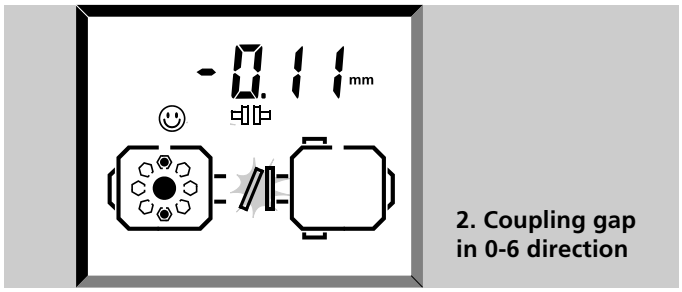
a. Coupling offsets and gaps

i. Press [icon] show coupling alignment

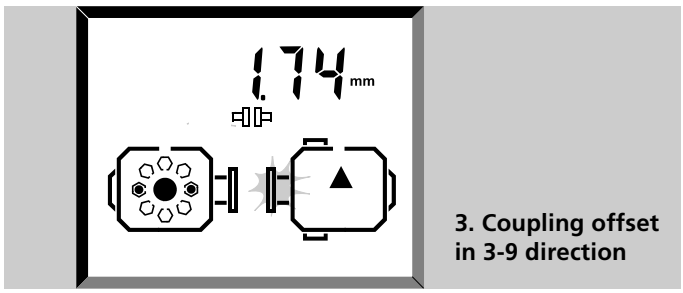
ii. [ENT] cycles gaps & offsets, in 0-6 & 3-9 directions



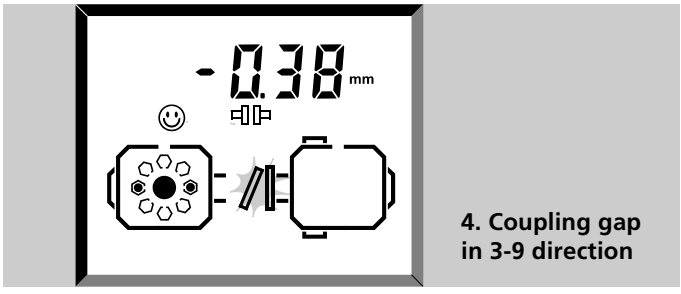
1. Coupling offset in 0-6 direction



2. Coupling gap in 0-6 direction



3. Coupling offset in 3-9 direction



4. Coupling gap in 3-9 direction

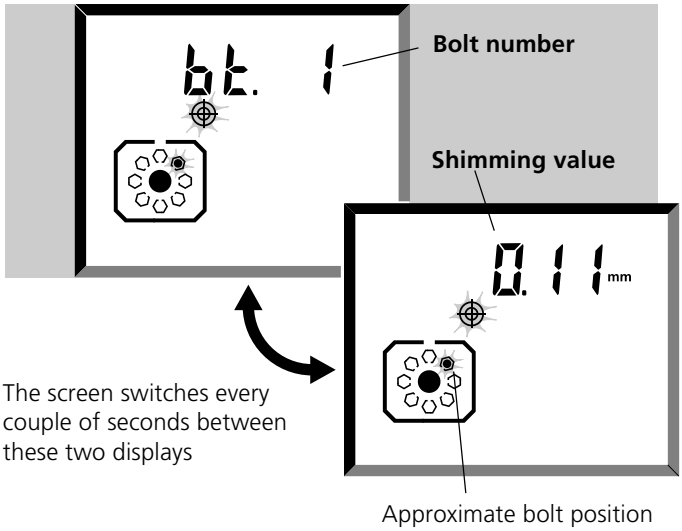
Note the sign convention opposite. See also page 3-24 for complete details.

The happy face appears if the given value is in tolerance. Check ALL of them! (see page 3-25 for full details)

b. Shimming values at the bolts

i. Press  **again to show shimming values**

ii. Select bolts with ◀ ▶



This function is described fully in the following section when we actually shim the machine.

Sign convention *(for vertical machines)*

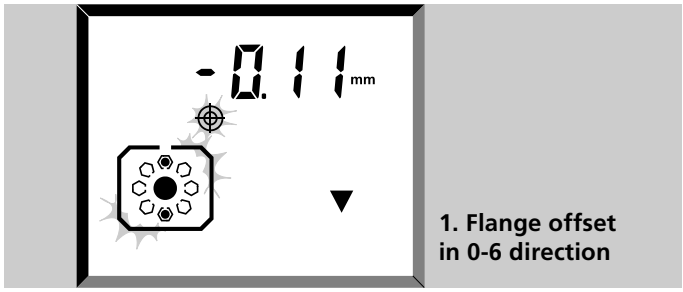
POSITIVE GAP opens towards **0.00** or **3.00**
POSITIVE OFFSET if the top machine is towards **0.00** or **3.00**

Note

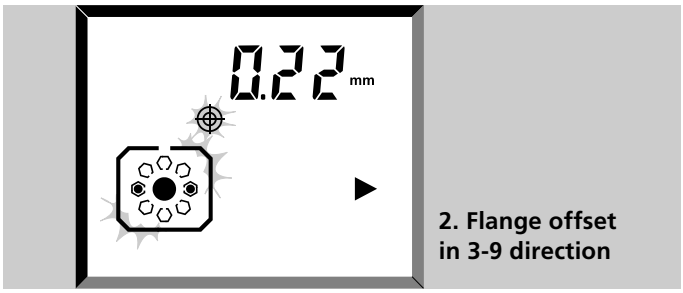
5c. Offset corrections at flange

i. Press [icon] again to show flange offset corrections

ii. ENT switches between 0-6 & 3-9 o'clock directions



1. Flange offset in 0-6 direction



2. Flange offset in 3-9 direction

The arrow indicates the direction of the required correction. Use the OPTALIGN PLUS Move function to make these adjustments, page 5-16.

6. Align machine

As with horizontal machines described on page 3-28, to align your machine you need to move it vertically by shimming the flange and horizontally by shifting it sideways. You could do these operations in either order or simultaneously, but the recommended procedure is as follows:

a) Shim first
Shim flange keeping horizontal movement to a minimum, and then retighten the bolts.

b) Remeasure
In case the machine moved horizontally during shimming, remeasure. Entering dimensions is not necessary.

c) Move horizontally
Monitor both vertical and horizontal move using the OPTALIGN PLUS on-screen MOVE function.

d) Final check
To confirm alignment, remeasure. If it is within tolerances, you've finished!

6a. Shimming at the flange

Here is the procedure for shimming the vertical machine.

1. Preparation!
As for horizontal machines, i.) The machine bolts should be clean, undamaged and removeable, and ii.) You should have a set of good quality shims available e.g. LAMIBLOC or PERMABLOC - see page 6-9 for details.

2. Loosen bolts
Try not to inadvertently move the machine horizontally.

3. Select shimming mode with
After successful measurement press the 'Results' key three times to show the shimming values at each defined bolt starting with bolt no. 1 (page 5-8). You can add further bolts at any time by pressing the DIM key.

4. Select bolt number ◀ & ▶
Press the arrow keys to select the first bolt you want to shim. The display switches slowly between the bolt number and the shimming value for that bolt. See page 5-13 for an example.

5. Shim machine
Insert the correct shim thickness under the selected bolt.

6. Repeat for each bolt
Step through each bolt with the arrow keys and shim to the given value.

7. Tighten bolts
When you have shimmed evenly all round the flange, tighten the bolts again. The shimming is now complete.

6b. Remeasure

A new set of alignment readings should be taken before moving horizontally because the machines usually move slightly during shimming. The remeasure process can be accomplished quickly as new dimensions need no be re-entered. The initial dimensions remain stored in the computer until new machine dimensions are entered. If horizontal misalignment values are outside tolerance, then the machine must be repositioned...

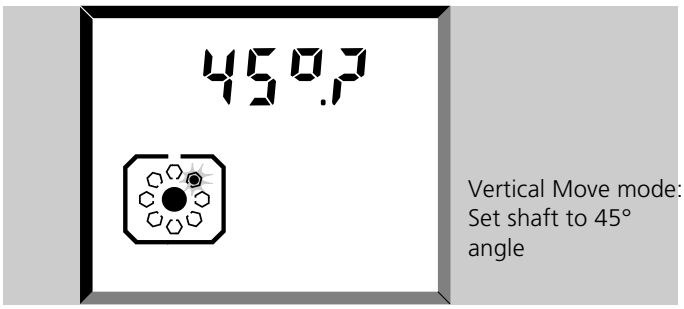
6c. Move horizontally

Rather than simply sliding shims in and out, the horizontal move requires measurement of how far you have moved. This could be done with dial gauges on the flange, but with the OPTALIGN PLUS 'MOVE' function you can view the horizontal movement live on the computer display.

Follow these simple steps to carry out the function:

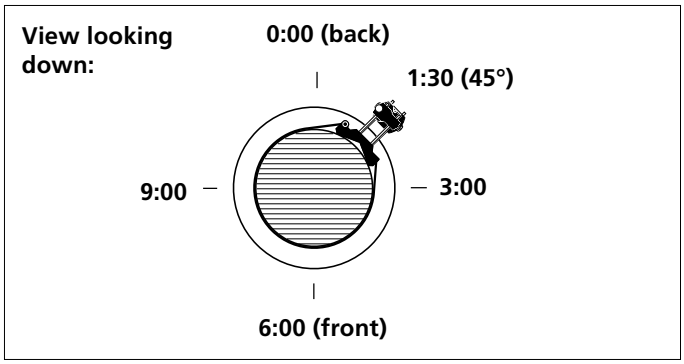
1. Press the MOVE key

2. Turn the shaft to 45° (1.30), press ENT



Vertical Move mode: Set shaft to 45° angle

The screen shows ***45°?*** Rotate the shaft to the 45° position (1.30 o'clock). Note that the internal inclinometer is not operational during alignment of vertical machines, so positioning must be done manually.



3. Center the laser

See page 3-18 for details. Do NOT rotate the shaft.

Note

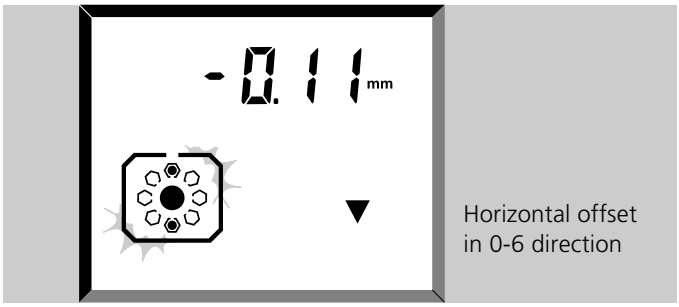
Keep steady!
The transducer, reflector and shafts MUST remain steady during the entire MOVE procedure!

4. Loosen bolts

Loosen all the flange bolts just enough so that the machine can be moved.

5. Position horizontally; Press ENT to switch direction

The display shows initially the 0-6 direction, thus:



Press the ENT key to switch to the 3-9 direction and back. The arrow on screen indicates the required move direction.

Watch for the happy face symbol (see page 3-25 for details) and make the required corrections, being careful not to let the shims slip out of place!

6. Tighten bolts

When correctly positioned tighten the bolts again.

6d. Final check

Make one final measurement to check that it is now in tolerance!

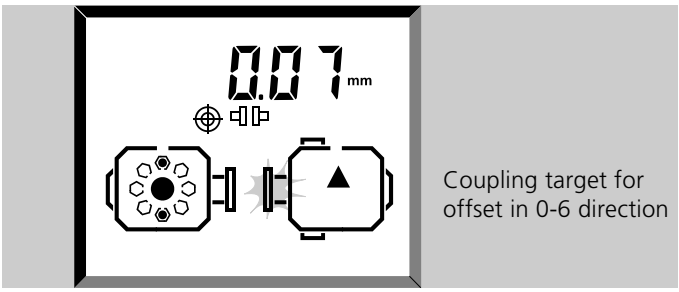
Coupling targets for vertical machines

It is not very common to enter coupling targets for vertical machines, but if you need to then read on. First, read pages 4-17 to 4-19 for full details on coupling targets. Remember that these are used to align the machines COLD to correct for thermal growth. As before, the coupling results shown on page 5-12 do NOT incorporate these target values, but the happy face symbol does.

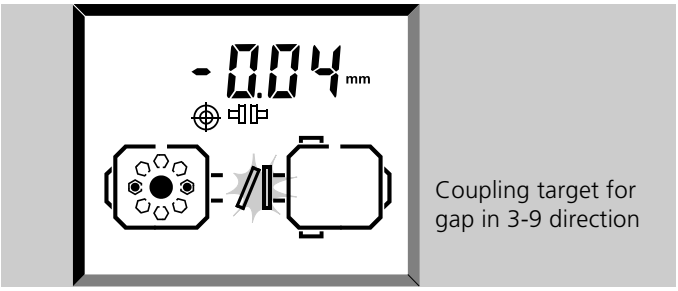
Press 

Enter the following parameters, observing the sign convention given below, and confirming each entry with ENT:

a) Coupling diameter (if not already entered)
b) Offset, 0-6 direction
c) Gap, 0-6 direction
d) Offset, 3-9 direction
e) Gap, 3-9 direction



Coupling target for offset in 0-6 direction



Coupling target for gap in 3-9 direction

Remember, if any targets have been entered, the target symbol will appear in the results screen.


Note

Sign convention *(for vertical machines)*

POSITIVE GAP opens towards **0.00** or **3.00**
POSITIVE OFFSET if the top machine is towards **0.00** or **3.00**

Chapter 6 Appendix

This chapter contains a great deal of useful supplementary information on shaft alignment in general and on OPTALIGN PLUS in particular.

Chapter 1 Introduction ..... 1-1 to 1-12
Chapter 2 Description ..... 2-1 to 2-14
Chapter 3 Horizontal alignment ..... 3-1 to 3-38
Chapter 4 Further functions ..... 4-1 to 4-36
Chapter 5 Vertical alignment ..... 5-1 to 5-18

Chapter 6 Appendix 6-1
What is "alignment?" 6-2
Comparison of alignment methods 6-3
How accurate should alignment be? 6-4
Suggested Shaft Alignment Tolerances 6-5
Machine preparation 6-6
Solid, flat foundation 6-6
Coupling play (backlash) 6-7
Soft foot 6-8
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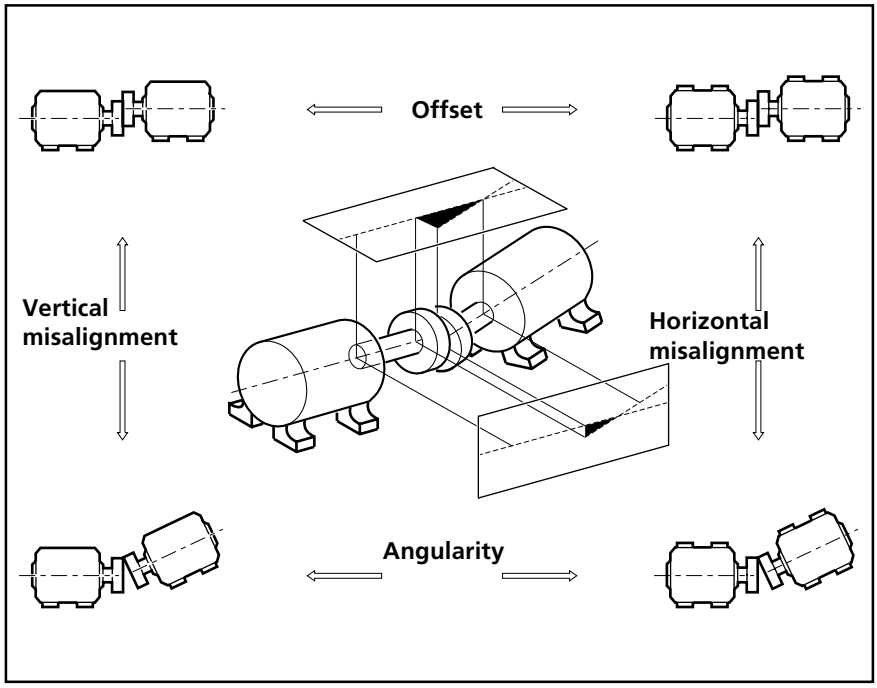
What is "alignment?"

Two machines are aligned with one another when the rotational axes of both shafts are colinear during operation. The following chart shows the possible deviations from this ideal condition:



Any misalignment between the two machine shafts, as shown above, may be considered in terms of four basic alignment parameters:

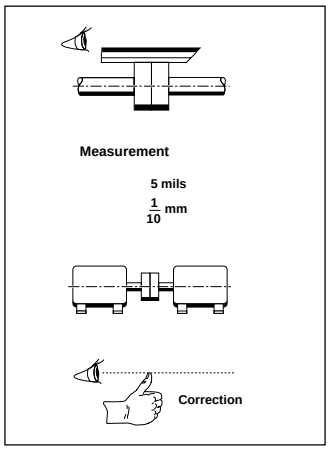
Vertical offset	Vertical angularity
Horizontal offset	Horizontal angularity

These four degrees of freedom must be measured in order to achieve correct alignment. OPTALIGN PLUS displays four values which combine to correct all these parameters simultaneously by

- raising or lowering the front and back feet of the machine and
- moving the front and back ends of the machine left or right.

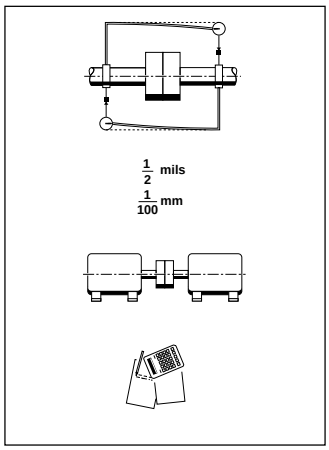
Precut shims (available from your OPTALIGN PLUS dealer), such as PERMABLOC or LAMIBLOC, can greatly reduce the time and effort needed for vertical alignment adjustments (see page 6-9). The OPTALIGN PLUS MOVE function allows you to monitor the lateral position of the machine on screen for quick and reliable horizontal alignment.

Comparison of alignment methods



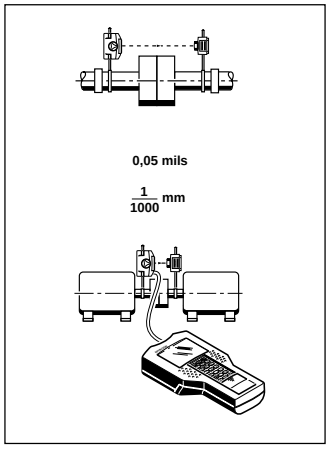
Straightedge

The straightedge was once the most well-known and widespread shaft alignment tool. If both the coupling surface and the measuring eye were in good condition, alignment accuracy could approach 1/10 mm (5 mils). These days coupling surfaces tend not to be machined, making this a rather less relieable test, but it can usually be used as a quick check for preliminary alignment.



Dial indicators

Dial indicators offer much more accurate alignment readings: when used correctly, they can achieve shaft alignment accuracy of 1/100 mm (1/2 mil). To do so, however, bracket sag must always be measured first, and the mounting arrangement must be very rigid. The measurement values must be recorded correctly (without mixing up +/- signs or transposing values, of course) and then the alignment corrections must be correctly calculated from the indicator readings.



Laser optics

This approach has the highest accuracy available. OPTALIGN PLUS has an actual resolution of 1/1000 mm—better than any other available system (except for our other products!). Laser optics also give the user several other distinct advantages. Custom-made brackets are no longer required for each individual machine/coupling arrangement. Instead, since no mechanical linkage across the coupling is involved, just a few universal brackets can be used to mount quickly on nearly every machine. Measurements must no longer be read and written down, and correction values for the machine feet appear automatically in the display.

How accurate should alignment be?

The suggested alignment tolerances shown at right are general values based upon experience and should not be exceeded. They are to be used only if existing in-house standards or the manufacturer of the machine or coupling prescribe no other values.

Consider all values listed to be the maximum allowable deviation from the alignment target, be it zero or some desired value to compensate for thermal growth. In most cases, a quick glance at the table will tell whether coupling misalignment is allowable or not.

As an example, a machine running at 1500 rpm has coupling offsets of -0.04 mm vertically and +0.02 mm horizontally: both these values fall within the "excellent" limit of 0.06 mm. Or in inches: e.g. at 1800 rpm offsets are -1.3 mils vertically and +.6 mils horizontally: both values fall within "excellent" limit of 2 mils.

Angularity is usually measured in terms of gap width at the edge of the coupling. For a given amount of angularity, the larger the diameter, the wider the gap at the coupling edge. The table lists values for coupling diameters of 100 mm or 10". You may compare results directly by entering this coupling diameter into OPTALIGN PLUS, or alternatively, if actual coupling diameter is entered, then multiply the value from the table by the appropriate factor.

For example, a machine running at 1500 rpm has a coupling of diameter 75 mm. At this diameter, the maximum allowable gap would be

(0.07 mm) x 75/100 = 0.0525 mm (or 5/100 mm)

In inches: 1800 rpm, diameter = 20"; 5 mils x 20"/10" = 10 mils

For spacer shafts, the table gives the maximum allowable offset for each 100 mm or inch of spacer shaft length. To take an example, a machine running at 6000 rpm with a 300 mm spacer shaft installed would allow a maximum offset of

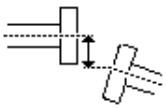
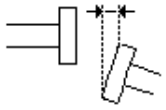
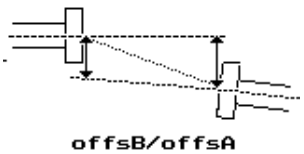
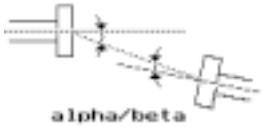
(0.03 mm) x 300/100 = 0.09 mm (or 9/100 mm)

at either coupling at the ends of the spacer shaft.
In inches: 7200 rpm, Length = 10"; 0.25 mils x 10"/1" = 2.5 mils

"Acceptable" limits are calculated from sliding velocity of lubricated steel on steel, using a conservative value of 12 mm/sec. (0.5 in./sec.) for allowable sliding velocity. These values also coincide with those derived from elastomer shear rates, so they also apply to short couplings with flexible elements. The "excellent" values draw on vibration observations made upon a wide variety of industrial machines to determine the critical misalignment for vibration; however, compliance with these tolerance values does not guarantee vibration-free operation of a particular machine.

Since rigid (flanged) couplings have no tolerance for misalignment, they should be aligned as accurately as possible.

Suggested Shaft Alignment Tolerances

		Tolerance			
	[RPM]	metric [mm]		inch [mils]	
Soft foot	any	0.06 mm		2.0 mils	
Short "flexible" couplings		Acceptable	Excellent	Acceptable	Excellent
Offset	600			9.0	5.0
	750	0.19	0.09		
	900			6.0	3.0
	1200			4.0	2.5
	1500	0.09	0.06		
	1800			3.0	2.0
	3000	0.06	0.03		
	3600			1.5	1.0
	6000	0.03	0.02		
	7200			1.0	0.5
Angularity	600			15.0	10.0
(gap difference at coupling edge	750	0.13	0.09		
per 100 millimeters diameter	900			10.0	7.0
or per 10" diameter)	1200			8.0	5.0
	1500	0.07	0.05		
	1800			5.0	3.0
	3000	0.04	0.03		
	3600			3.0	2.0
	6000	0.03	0.02		
	7200			2.0	1.0
Spacer shafts and membrane (disk) couplings					
Offset	600			3.0	1.8
(per 100 millimeters spacer length	750	0.25	0.15		
or per inch of spacer length)	900			2.0	1.2
	1200			1.5	0.9
	1500	0.12	0.07		
	1800			1.0	0.6
	3000	0.07	0.04		
	3600			0.5	0.3
	6000	0.03	0.02		
	7200			0.3	0.2
		mrad		**mrad**	
Angularity (mrad)	600			3.0	1.8
	750	2.5	1.5		
	900			2.0	1.2
	1200			1.5	0.9
	1500	1.2	0.7		
	1800			1.0	0.6
	3000	0.7	0.4		
	3600			0.5	0.3
	6000	0.3	0.2		
	7200			0.3	0.2

Note:

Metric tolerances are given for machines with a 50Hz supply running at multiples/fractions of 3000 RPM.

Imperial tolerances are given for machines with a 60 Hz supply running at multiples/fractions of 3600 RPM.

Machine preparation

Certain preparations should be made before beginning any alignment to ensure efficient measurement and successful results.

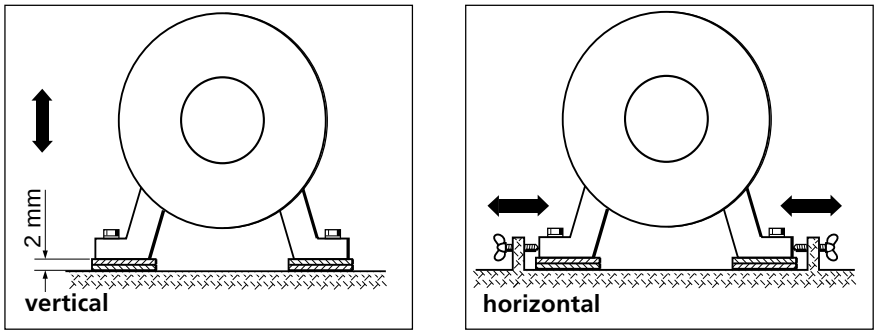
Tag out (lock out) machines

Do not forget to ensure that the machines cannot be started accidentally during maintenance work!

Solid, flat foundation

A solid, rigid foundation is required to obtain correct, lasting shaft alignment that allows long-term uninterrupted machine service.

Machine mobility



If the machine to be moved stands directly on the foundations, it cannot be lowered for alignment correction. Therefore, it is generally advisable to start with about 2 mm (80 mils) of shims beneath the feet of both machines.

Precut shims such as single-thickness PERMABLOC or laminated LAMIBLOC shims, available individually or as complete assortments in carrying cases, should be on hand before beginning alignment (see page 6-9). Horizontal alignment can be made easier and more precise if hydraulic or screw-type positioning aids are available. The "hammer method" is not only inexact, but it can also damage the machine housing and bearings (by chatter marking).

Rigid couplings

Rigid couplings, typically found on turbines, must be loosened before measurement so that they do not distort the alignment condition. How this is done depends on the type of machine:

Steam turbines with single bearing shafts

Remove the coupling bolts, split the coupling faces 2-3 mm (1/8") and insert a couple of undersize dummy bolts.

Steam turbines with two bearing shafts

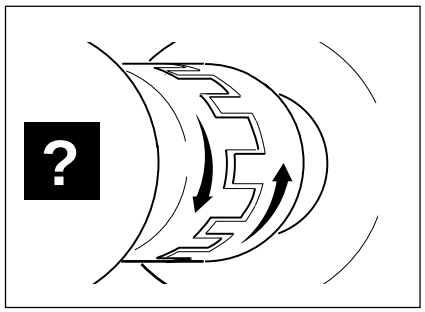
The coupling faces normally locate together; the coupling must, therefore, be split sufficiently in order to dislocate them. Alternatively, there may be a spacer component which can be dropped out and the two halves linked with a bar.

Gas turbines

These are usually fitted with a spacer shaft to accommodate large thermal growths. Either a) remove the spacer and use the Static mode (page 4-12) or b) loosen the coupling as above and use the Multipoint mode (page 4-10).

Coupling play (backlash)

If you have or suspect coupling backlash turn the shaft or coupling end where the reflector is mounted. Torsion play is eliminated as readings are taken only when the transducer moves.



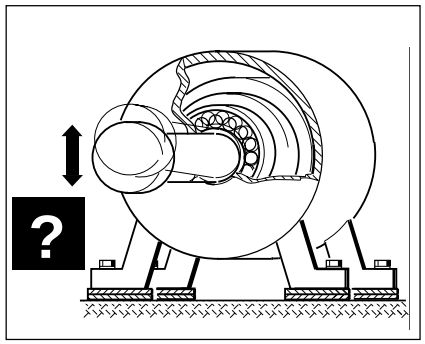
In the OPTALIGN PLUS Continuous Sweep mode (page 3-22) no measurements are recorded during the first 5° of shaft rotation in order to avoid backlash problems.

If the backlash is found to be considerable and is interfering with the measurements then you can either link both halves of the coupling together or uncouple them.

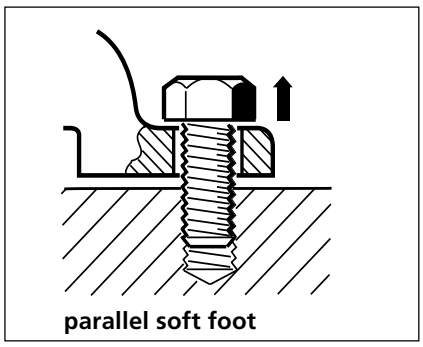
Uncoupled shafts may be aligned using multipoint measurement mode as described in Technical Note No. 33.

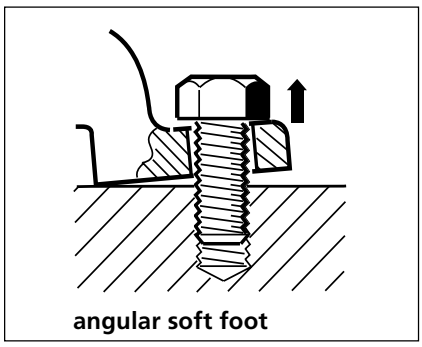
Shaft play

Excessive radial play of the shaft within the bearing will lead to poor alignment results because the shaft position varies during rotation. The OPTALIGN PLUS F1 function (for precision display of laser beam coordinates) can measure radial play when the shafts are lifted. A small amount of axial shaft play (up to 3 mm / 1/8"), however, will have no adverse effect on accuracy.



Soft foot


parallel soft foot


angular soft foot

One of the most important prerequisites for achieving good shaft alignment is ensuring that all machine feet contact the foundation properly without requiring that excessive force be exerted by the anchor bolts. Such forces, caused by nonparallel contact surfaces, can deform the machine feet and housing. Uneven foundations and dirty or corroded machine feet can leave the machine standing on only three feet. If not corrected before alignment, the resulting "soft foot" allows the machine to tip into a different position every time the bolts are loosened, making proper alignment difficult or impossible.

The OPTALIGN PLUS soft foot function is invaluable in checking and correcting this condition. Thanks to its simple operation, there is less temptation to skip this crucial step when alignment must be done quickly. See page 4-2 for comprehensive information on the subject.

Suggested reading

For further reading on the subject of shaft alignment we suggest the following literature:

The OPTALIGN Training Book
by Galen Evans and Pedro Casanova.
Published by Ludeca Inc. 1527 NW 89th Court, Miami FL 33172

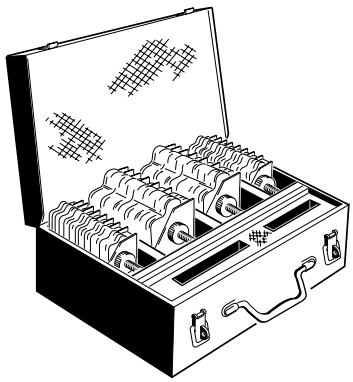
Machinery Component Maintenance and Repair
by Heinz P. Bloch and Fred K. Geitner
Published by Gulf, P.O. Box 2608, Houston, Texas 77001

Shims

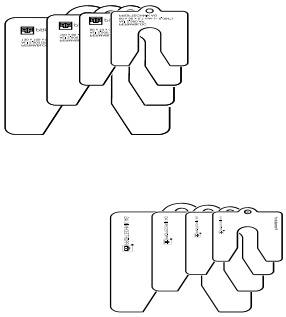
Proper shims must be used for satisfactory alignment results based upon OPTALIGN PLUS shimming corrections.

What constitutes a "proper" shim? First, its thickness must match the correction values (within 0.025 mm [1 mil], since shimming stock is not made thinner than this). The thickness must be consistent over the whole shim area, without any thick or thin spots. The shim must be flat, without seams or folds from bending. Burred edges must be removed or the shim will act as a spring, compressing a bit each time the foot bolt is tightened, especially when several burred shims are stacked upon one another. The shim material must be dimensionally stable, without appreciable cold flow effects when subjected to high compression over long periods of time. It must also withstand the demands of the service environment without corroding, since rusty shims can also act as springs.

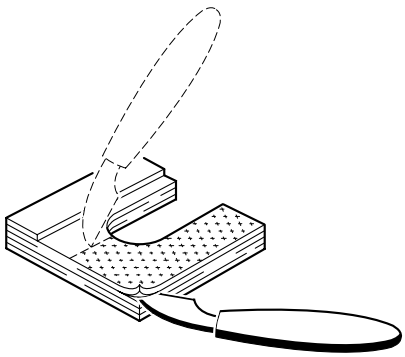
Commercial precut shims fill these requirements best, while saving a major portion of alignment time compared with shims hand cut from rolls of sheet stock. PRÜFTECHNIK offers two different types of shims in a wide range of metric thicknesses and sizes to fit most machine feet. Check with your OPTALIGN PLUS dealer for inch thicknesses and other custom shims.



Complete set of shims



PERMABLOC®



LAMIBLOC®

PERMABLOC® individual stainless steel shims are obtainable in single thicknesses or as complete sets in their own carrying case. Each shim is permanently etched (not printed or stamped) with its thickness. By simply pulling the single shims from the case, the proper thickness can be achieved in just a few seconds.

LAMIBLOC® shims are laminated from 12 layers to give a total thickness of 1 mm; the correct shimming amount is obtained simply by peeling off the excess layers. Only a handful of shims are, therefore, needed at the job site. They may also be ordered as a complete set in their own case and are available in brass or stainless steel.

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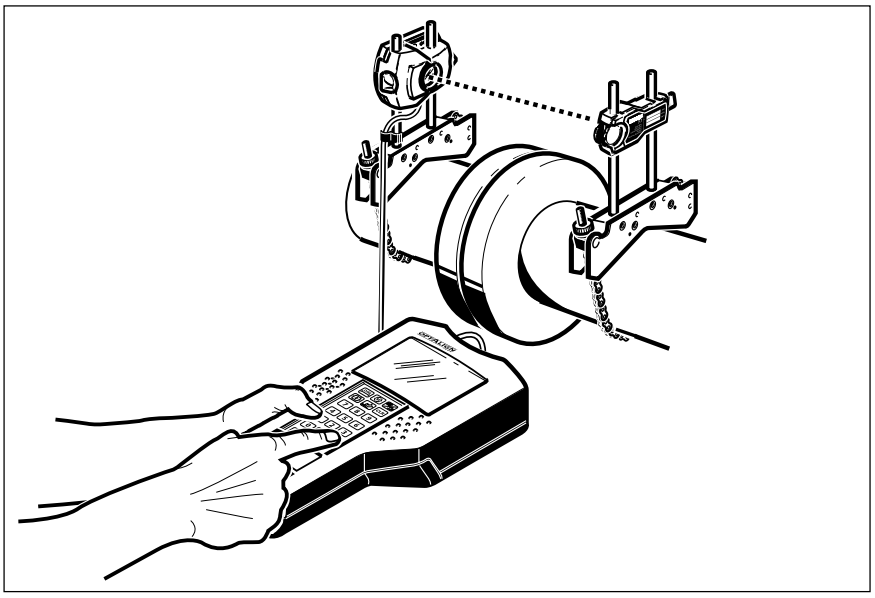
OPTALIGN PLUS measurement principle



To measure the misalignment, the shafts are rotated. The laser beam is reflected by the reflector back into the transducer, where it strikes the position detector. During rotation, any shaft misalignment causes the laser beam to change its position in the detector.

The exact location of the beam is recorded by registering its coordinates along with the corresponding rotation angle of the shafts. This takes place at a number of points during shaft rotation through 360° or less. Several different measurement procedures (described starting on page 4-8) are available to handle special situations such as limited rotation and coupling play (backlash).

The computer then uses the minute displacements measured by the detector to calculate the current alignment condition. It displays the resulting machine alignment diagram complete with coupling alignment values and correction values for the machine feet. The former allow the operator to compare the situation at hand with prescribed tolerances.

Checking alignment with vibration analysis

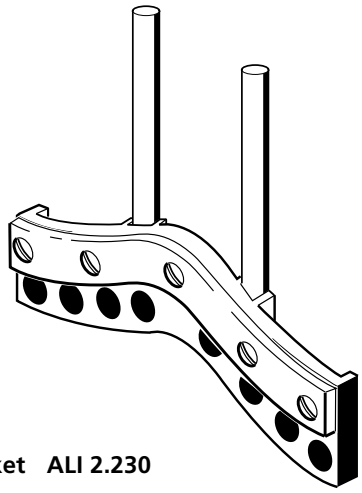
One very impressive method of demonstrating the importance of good alignment for smooth operation of rotating equipment is comparative vibration measurement (for example, using PRÜFTECHNIK VIBROSPECT® FFT or VIBROTIP®) before and after alignment. A comprehensive vibration analysis can also point out other specific machine problems.

OPTALIGN PLUS accessory brackets

Magnetic sliding bracket ALI 2.230

See the measurement procedure for non-rotable shafts on page 4-14. In order to accurately align two machines to each another, the position of their shafts must be measured by measuring radial displacement (such as OPTALIGN PLUS does) while the shafts are rotated. Unfortunately, some machines do not fulfill this requirement as their shafts cannot be rotated slowly for measurement. Especially when long separations between machines are involved, this condition compromises alignment accuracy when conventional measurement methods are used.

However, the OPTALIGN PLUS magnetic sliding bracket offers an elegant solution to this dilemma. The bracket fits onto the coupling flange as shown and simply slides around to the required measurement positions. Its powerful magnets ensure the mounting stability needed for accurate measurement. The magnetic sliding bracket for stationary shafts is suitable for all shaft diameters over 80 mm (3 1/8").



Magnetic sliding bracket ALI 2.230

Anytime shafts cannot be rotated during measurement (regardless what method is used), alignment accuracy depends upon angular positioning accuracy and machining quality of the shaft and coupling:

■ The flange and perimeter of the coupling or shaft must be surface-finished.

■ The coupling or shaft must be made of ferrous material (steel) with a large magnetic contact area provided for the magnets to guide the bracket properly.

■ Before mounting the sliding bracket, the coupling or shaft should be cleaned, then lightly lubricated at the appropriate location to allow the bracket to slide around smoothly.

■ The transducer should always be mounted upon the side with the highest-quality finish.

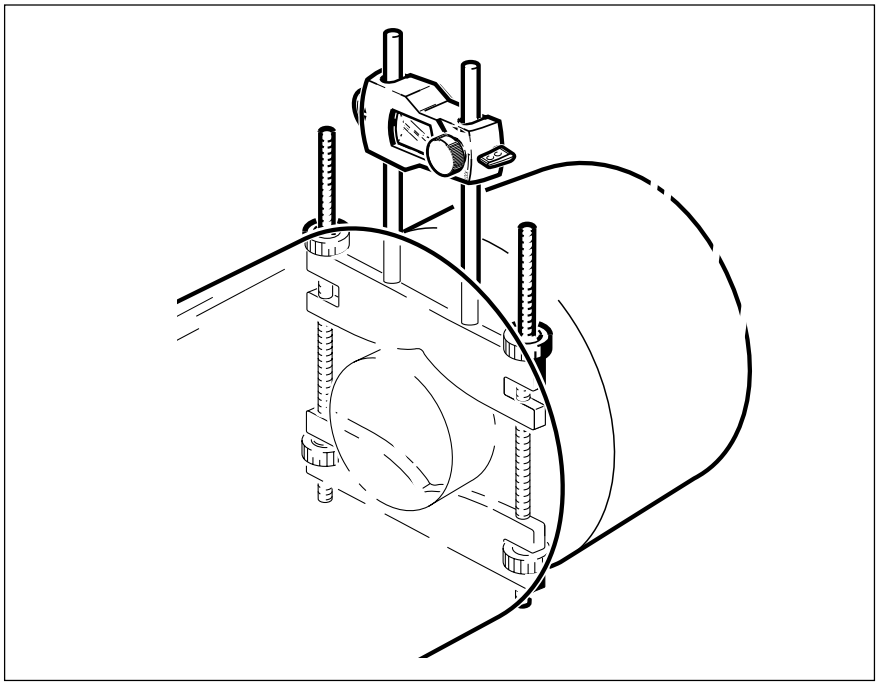
For best possible alignment accuracy, always try to rotate at least one shaft (with the coupling bolts removed). In that case, always try to mount the transducer on the shaft that can be rotated (any quick-fit bracket can be used on the rotating side).

Remember:
Accuracy achieved from non-rotating shaft alignment methods is always less than that of the OPTALIGN PLUS when both shafts are rotated and the usual belt-type quick-fit brackets or chain-type brackets are used. Therefore, non-rotating measurement should be seen only as a method of last resort.

Extra-thin bracket

ALI 2.109 SET
ALI 2.109L SET

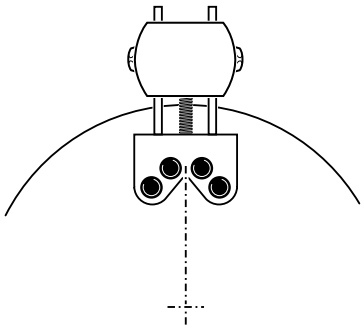
The extra-thin bracket is just 8 mm (less than 3/8") thick and comes in two sizes, one for shaft diameters up to 160 mm (6 5/16") available as ALI 2.109 SET, and a smaller version for shaft diameters up to 100 mm (3 15/16") under order number ALI 2.109L SET. Each set consists of one pair of brackets.

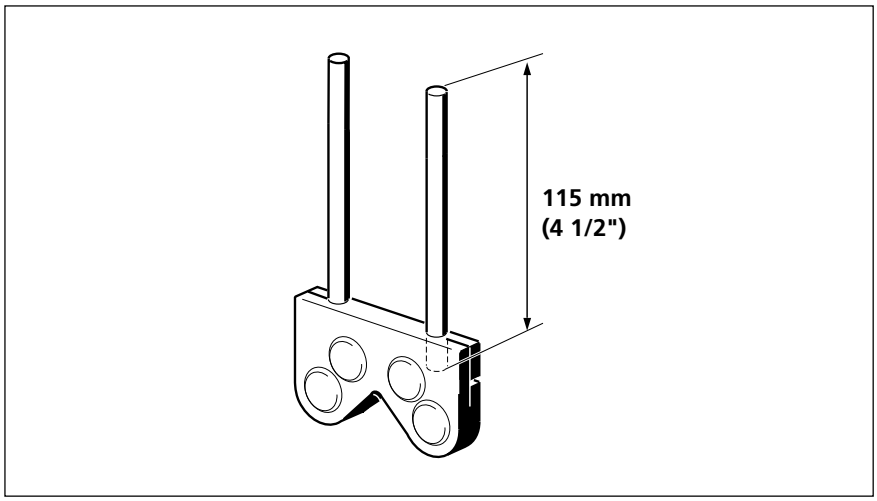


Compact magnetic bracket ALI 2.112 set

- The quickest brackets to mount!
- Ideal for machines with large coupling flanges!

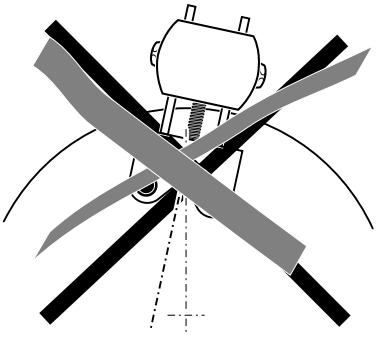
This compact bracket uses four powerful magnets to hold the standard OPTALIGN PLUS support posts against any flat, smooth ferromagnetic surface. This makes mounting extremely quick and convenient while maintaining the same high accuracy as that achieved with other OPTALIGN PLUS brackets.



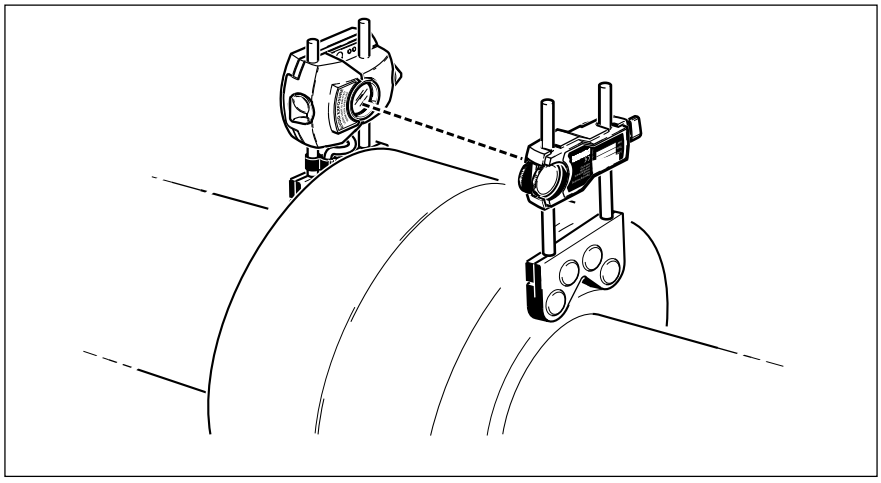


Important:
Use a leveling device (such as the ALI 2.207 inclinometer) if necessary to ensure that magnetic brackets are mounted perfectly square to the shaft radius. Otherwise, skewed mounting can result in measurement error.

Wipe any traces of grease or oil from the mounting surface to avoid bracket slippage (which would reduce measurement accuracy).



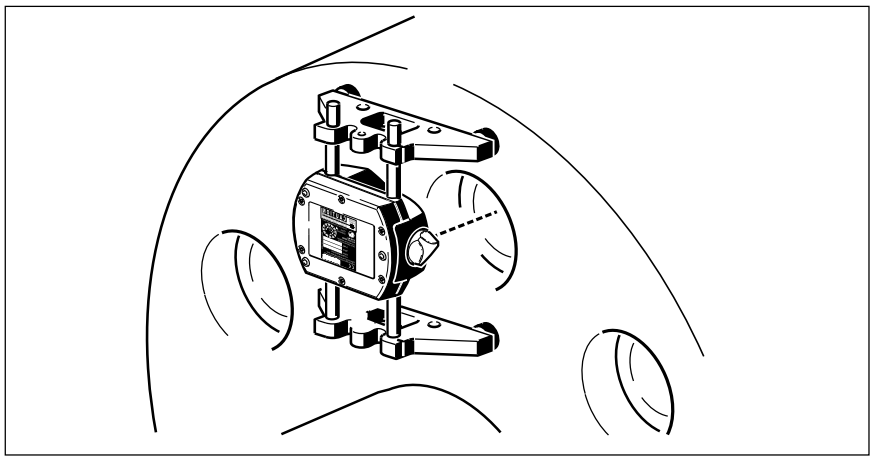
Mount the bracket on the coupling flange. Although the bracket fits onto even very small shaft/coupling configurations, all four magnets should contact the mounting surface completely for maximum holding power. Use only the 115 mm (4½") support posts supplied.



Coupling bolt hole bracket ALI 2.106 set

This magnetic bracket can serve as a useful substitute for the standard chain-type bracket when the system must be mounted on large couplings with large bolt holes. Thanks to its four powerful samarium-cobalt magnets, this bracket provides quick and sturdy mounting by straddling the bolt hole; no radial clearance is required beyond the coupling circumference. This space-saving design can save alignment time when space is tight around the coupling.

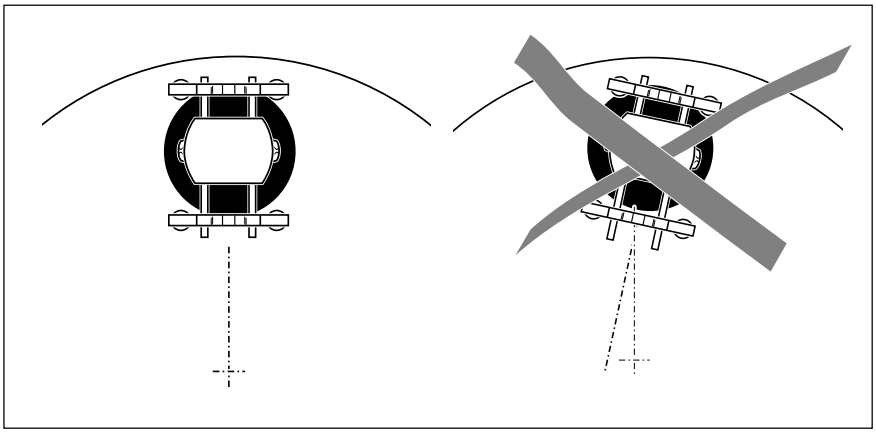
The basic principle remains the same as when other OPTALIGN PLUS brackets are used. However, once the coupling bolt is removed, this bracket can be placed upon the coupling flanges as shown below. The OPTALIGN PLUS transducer and prism simply slide onto their support rods and are fixed into place by the upper bracket arm. The entire assembly is then positioned on the coupling so that the laser beam passes directly through the bolt hole. The spring bridge allows easy and precise adjustment of the components and provides additional rigidity for optimum measurement results.



Use only the 115 mm (4½") support rods supplied with the bracket. The position of the support rods may be changed by loosening the hex screws which clamp them in the bracket.

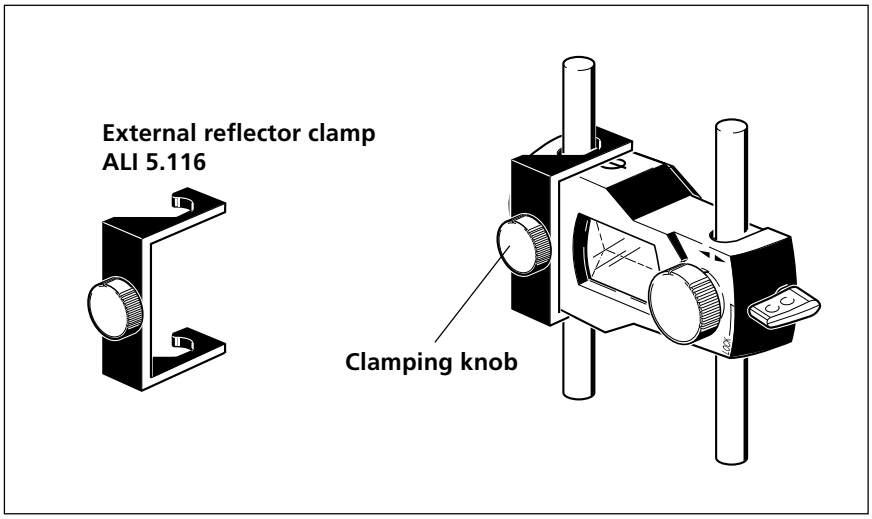
Note

Important:
Use a leveling device (such as the ALI 2.207 inclinometer) if necessary to ensure that magnetic brackets are mounted perfectly square to the shaft radius. Otherwise, skewed mounting can result in measurement error.



External reflector clamp ALI 5.116

In environments where vibration is extremely severe (for example, from adjacent machinery), the reflector may possibly slide slightly from its original, adjusted position. In this rare case, an external clamp (ALI 5.116) can be attached in order to anchor the prism securely to the bracket posts for extra stability.



Once the reflector is adjusted, attach the clamp as shown above, then tighten down the clamping knob to lock the reflector in place.

Do not screw down the clamping knob too tightly! Otherwise the reflector housing could be damaged.

ATTENTION

Advanced diagnosis and correction of soft foot

Besides the two most common types of soft foot previously discussed (page 4-2), parallel and angular soft foot, a number of other problems may cause excessive soft foot readings:

If OPTALIGN PLUS measures a soft foot, but feeler gauges cannot be inserted beneath the foot, there may be rust or dirt beneath the foot: This type of 'spongy' foreign matter can expand when the foot bolt is loosened so that OPTALIGN PLUS reads a soft foot, yet still keep a feeler gauge from being inserted. Correct the situation by using a power wire brush to clean the undersides of the machine feet and the base, and replace any damaged shims. Take care to completely remove all dust and dirt from the top and sides of the feet as well to prevent recontamination, and limit the number of shims beneath any one foot to 4.

External forces such as those exerted by attached piping, supports, couplings or other machine parts may induce soft foot readings until the shaft alignment is improved. This may be checked by removing the suspected source of strain, then taking a second set of readings for comparison.

Sometimes OPTALIGN PLUS will register little or no soft foot, yet feeler gauge measurements indicate quite a substantial gap beneath the machine feet. This can occur if either the base or machine feet bend without bending the machine housing (for example due to underdimensioning or damage). As a result, shimming corrections may not bring the expected improvement, but often satisfactory alignment may still be achieved, even without filling the foot gap beforehand. So long as the OPTALIGN PLUS shows no soft foot reading when the foot bolts are tightened or loosened, the shaft is not moving, so no harm can occur to the rotor, bearings or coupling.

In some cases, the OPTALIGN PLUS soft foot function registers shaft deflections which are actually caused by irregularities of the individual feet. The only way to check the contact of each foot to the machine base is to use feeler gauges at the corners of the feet. These readings may then be considered in combination with the OPTALIGN PLUS soft foot results as illustrated by the examples on the following pages.

Note

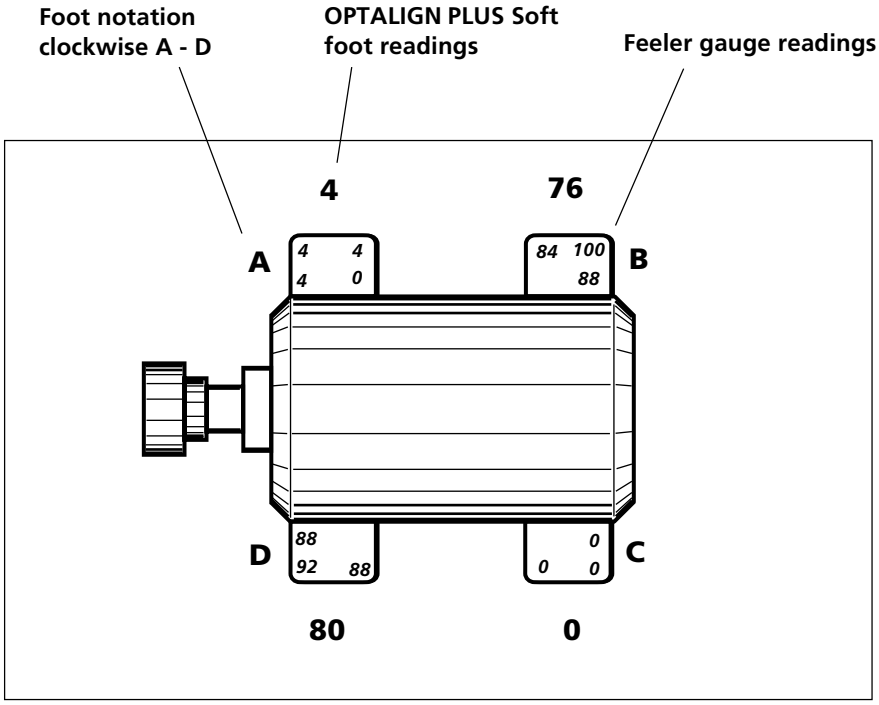
For maximum accuracy during soft foot measurement (and especially when coupling play is present), the shafts should be rotated so that the sensors are oriented vertically (12:00 - 6:00 direction).

Soft foot examples

The following notation is used for these examples:

- The feet are shown oversize outside of the machine outline.
- OPTALIGN PLUS readings are outside the feet.
- Feeler gauge readings are inside the feet.
- Blank spaces mean the reading is not available.
- Feet are named clockwise A to D

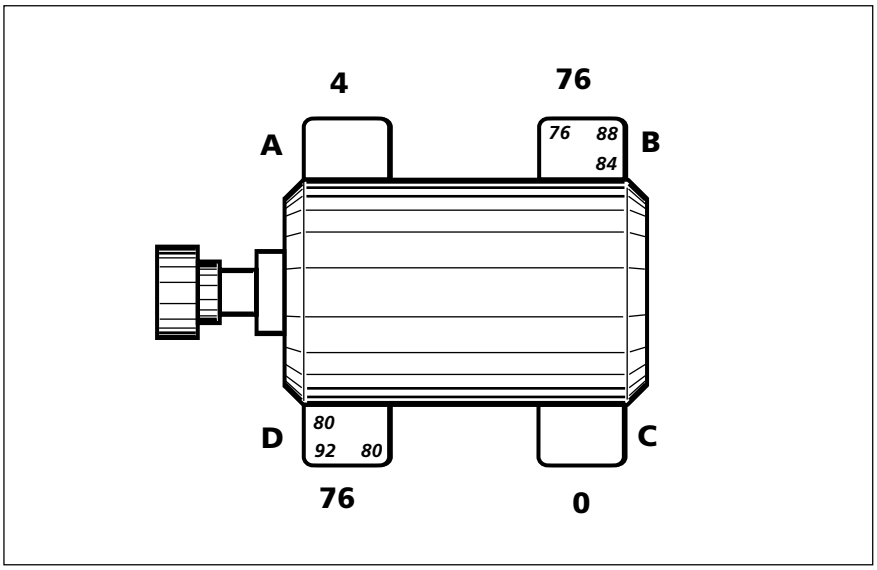
Example 1



OPTALIGN PLUS readings show near perfect rock, tempting the inexperienced aligner to shim feet B and D. In this case, that would be a mistake. The 4/100 mm difference diagonally, with near zero readings on the other diagonal, prompts feeler gauge examination of feet B and D. The feeler gauge results show very similar average gaps between feet B and D but one is plainly sloped while the other is nearly flat.

Conclusion: shim only foot D 88/100 mm and recheck all four feet.

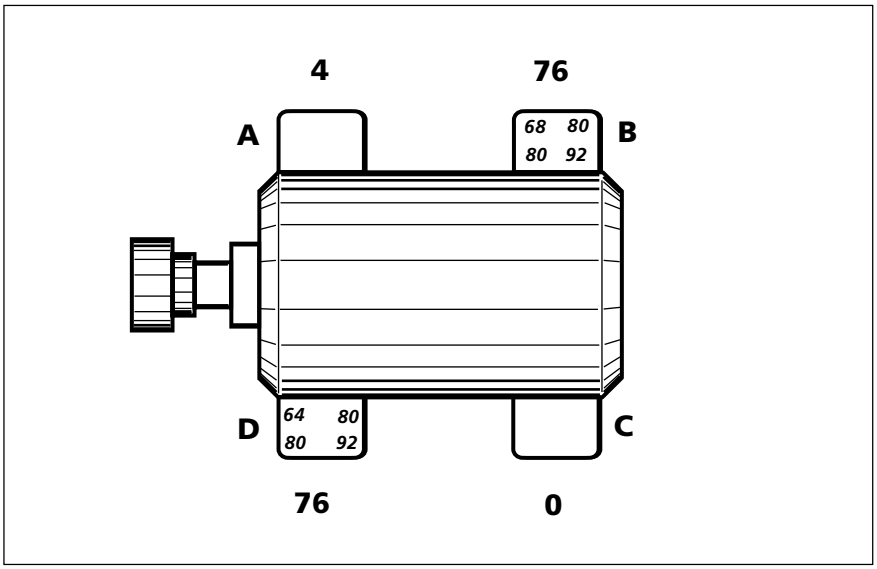
Example 2



Identical and opposing OPTALIGN PLUS readings prompt feeler gauge examination of feet B and D. Feeler gauges indicate equal rock from one foot to another. Feet B and D are equally out of plane with feet A and C. The inside feeler gauge readings were left out of this example because they are often impossible to take in the field.

Conclusion: Shim both feet B and D about 50-60% of the feeler gauge amount and recheck all four feet.

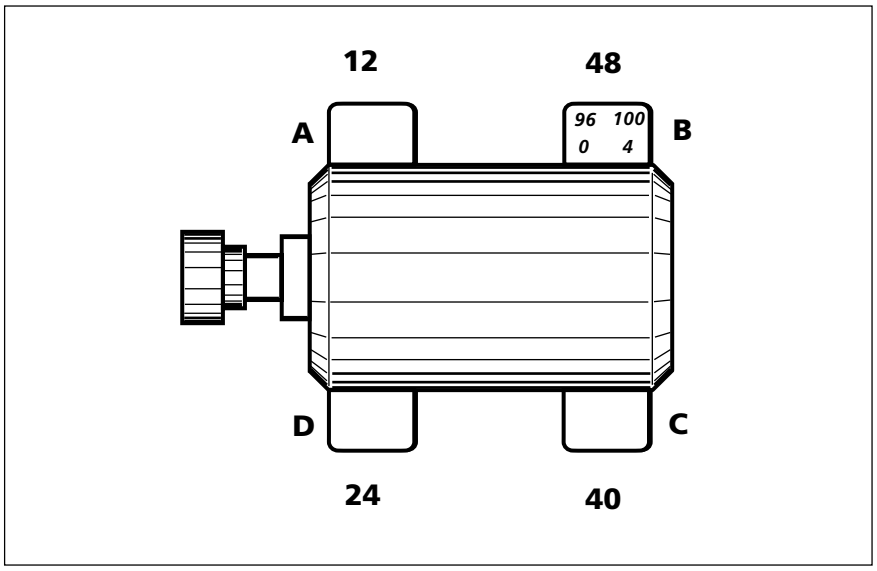
Example 3



Identical OPTALIGN PLUS readings to example 2. Feeler gauge are used to examine feet B and D. Feeler gauges indicate equal rock, but definite slope from foot C to foot A. This suggests that foot C is out of plane compared to feet A, B and D.

Conclusion: remove 80/100 mm from foot C (or add 80/100 mm to feet A, B and D). Then recheck all four feet.

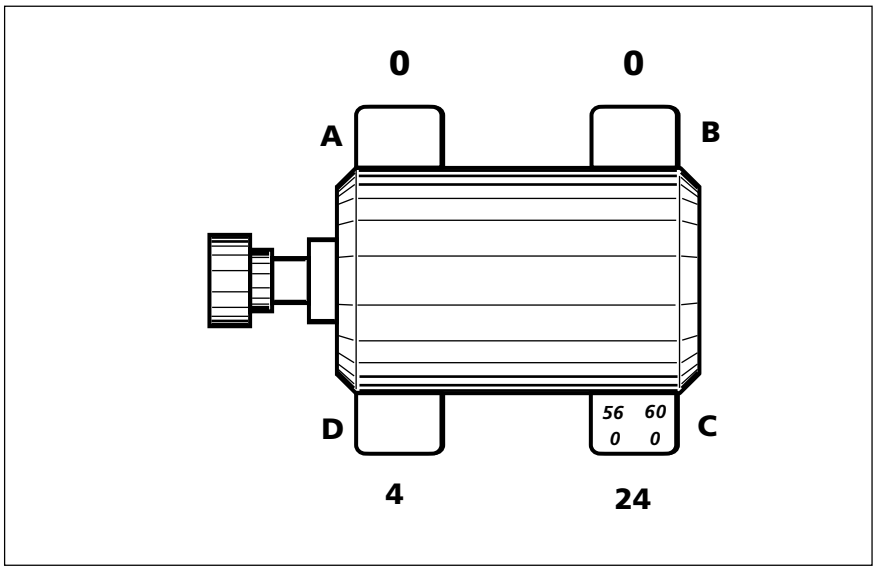
Example 4



One foot having high OPTALIGN PLUS readings prompts feeler gauge examination of foot B. The feeler gauge readings show a clearly defined bent foot. It is possible that all of the other readings are being induced by the bend in foot B.

Conclusion: step shim 0-1 mm at foot B and recheck all four feet.

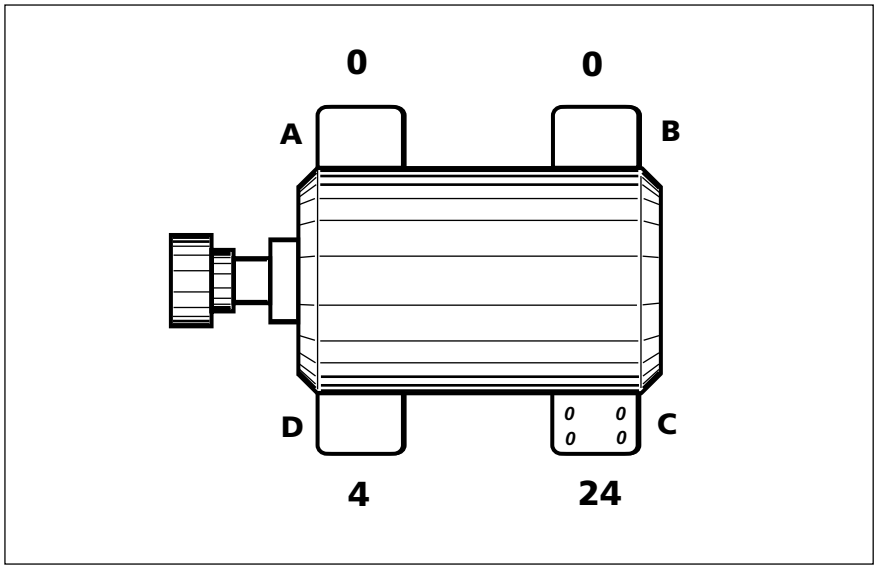
Example 5



Feeler gauge readings are taken to examine the foot with the high OPTALIGN PLUS reading, and a bent foot is found. It is possible that other feet have problems that are being masked by foot C.

Conclusion: step shim 0-60/100 mm at foot C and recheck all four feet.

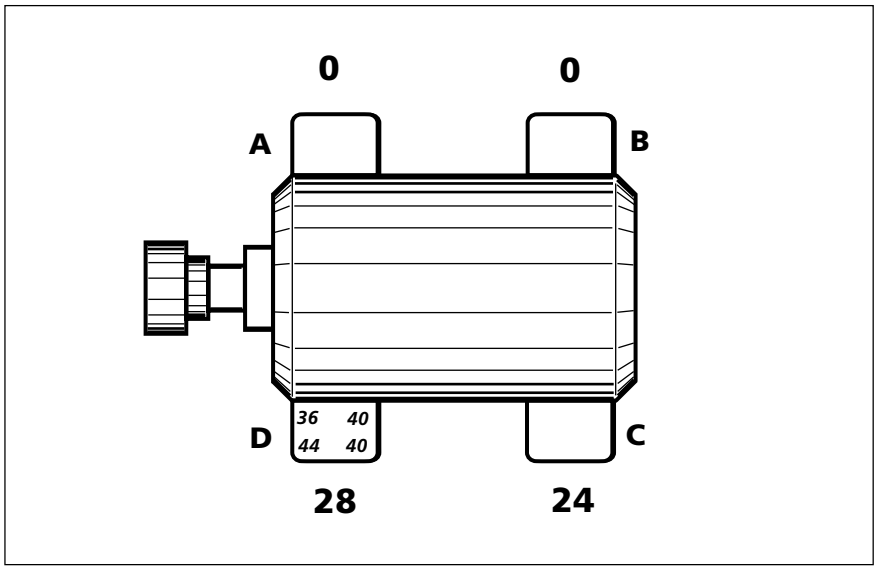
Example 6



Feeler gauges are used to examine the foot with the largest OPTALIGN PLUS reading, but no gap is found.

Conclusion: 'squishy foot:' do not add or remove shims, rather eliminate the cause of the spring action. Recheck all four feet.

Example 7



Two large OPTALIGN PLUS readings on one side with opposite side near zero cause suspicions of induced soft foot. Feeler gauge readings are taken at foot D (with the largest OPTALIGN PLUS value). Presence of parallel gap at foot D supports these suspicions. Presence of parallel gap at foot C as well would prove induced soft foot.

Conclusion: relieve external forces (probably caused by horizontal offset misalignment or by pipe strain).

Summary

When eliminating soft foot follow these steps:

1. Check all four feet of one machine with OPTALIGN PLUS. If any of the feet shows over 8/100 mm (or 2 mils) proceed with step 2, otherwise go to step 5.

2. Examine the largest (or two largest, if the same) soft foot with feeler gauges to determine the type of soft foot. It never hurts to examine the other feet as well, but concentrate on finding and fixing the largest single problem, one problem at a time.

3. Correct the condition diagnosed, usually by shimming only one foot, if any.

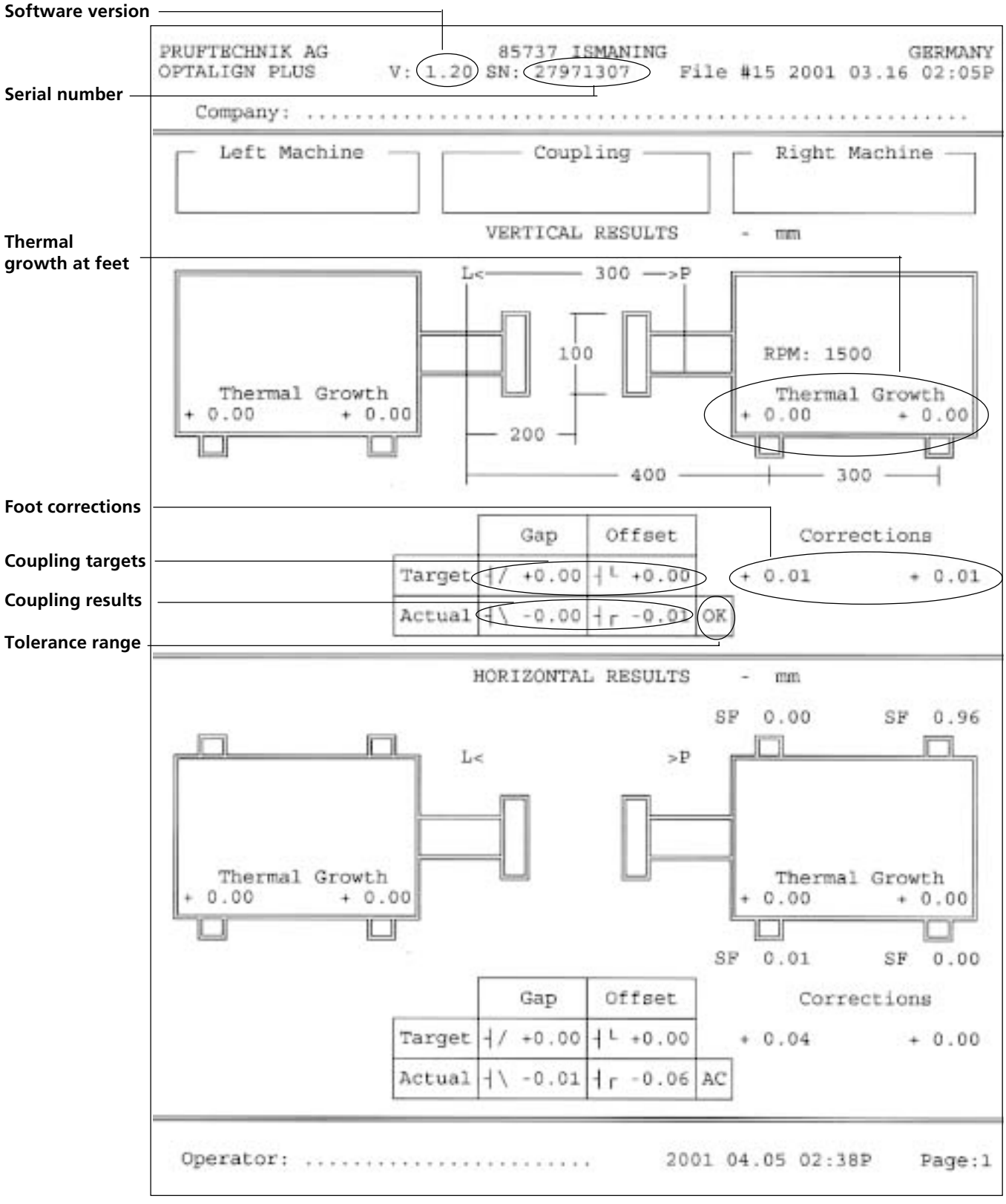
4. Go to step 1.

5. If both machines have been checked for soft foot and are within tolerances, perform final alignment.

   If the adjoining machine is set to 'movable' (page 4-29) then it can also be checked for softfoot. Start again at step 1.

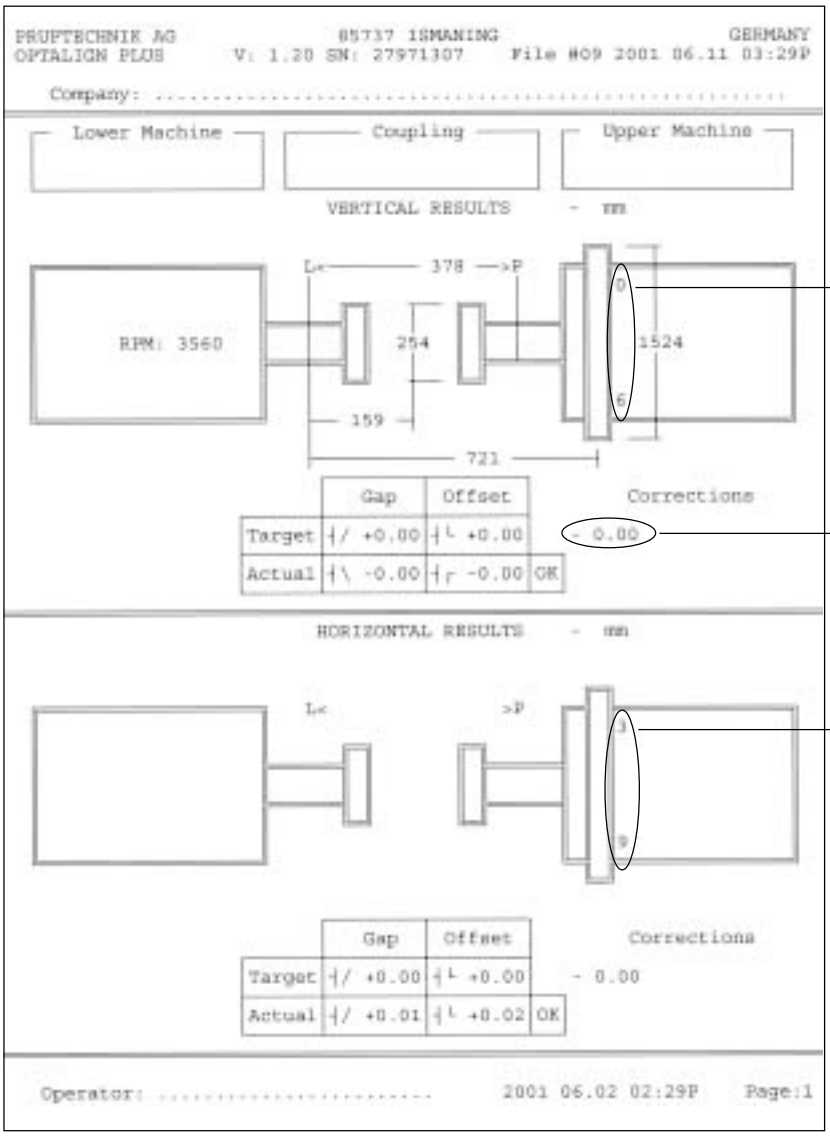
Sample OPTALIGN PLUS report

Horizontal machine report (graphic format)



Vertical machine report (graphic format)

Page 1

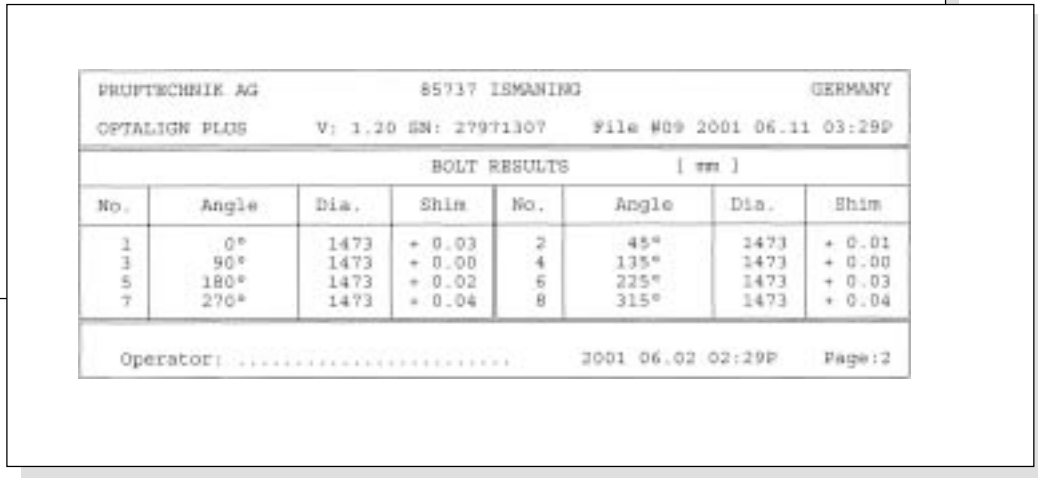


0 - 6 plane

Correction value and direction

3 - 9 plane

Page 2



Horizontal machine report (text format)

```
PRUFTECHNIK AG                85737 ISMANING              GERMANY
OPTALIGN PLUS       V: 1.20 SN: 27971307 File    #15 2001 03.16 02:05P

Company    : ....................  Operator  : ....................

Left Machine     : ..............  Right Machine   : ..............

***** Machine Dimensions -  mm
  Transducer to reflector                          300       ( mm )
  Transducer to coupling                           200       ( mm )
  Coupling diameter                                100       ( mm )
  Revolutions per minute (RPM)                     1500
  Left foot to Transducer, Right Machine           400       ( mm )
  Left foot to right foot, Right Machine           300       ( mm )
***** Coupling Targets, short
  Target diameter                                   ---      ( mm )
  Gap       vertical                               0.00      ( mm )
  Offset    vertical                               0.00      ( mm )
  Gap       horizontal                             0.00      ( mm )
  Offset    horizontal                             0.00      ( mm )
***** Thermal Growth, Right Machine
  Left foot vertical                               0.00      ( mm )
  Right foot vertical                              0.00      ( mm )
  Left foot horizontal                             0.00      ( mm )
  Right foot horizontal                            0.00      ( mm )
***** Tolerance, 50Hz
  Gap       excellent                              0.05      ( mm )
  Offset    excellent                              0.06      ( mm )
  Gap       acceptable                             0.07      ( mm )
  Offset    acceptable                             0.09      ( mm )
***** Coupling Results, sweep
  Gap       vertical                              -0.00     excellent
  Offset    vertical                              -0.01     excellent
  Gap       horizontal                            -0.01     excellent
  Offset    horizontal                            -0.06     acceptable
***** Foot Corrections, Right Machine
  Left foot vertical                               0.01     excellent
  Right foot vertical                              0.01     excellent
  Left foot horizontal                             0.04     acceptable
  Right foot horizontal                            0.00     acceptable
***** Softfoot Results, Right Machine
  Left foot nearest to viewer                      0.01     ( mm )
  Left foot furthest from viewer                   0.00     ( mm )
  Right foot nearest to viewer                     0.00     ( mm )
  Right foot furthest from viewer                  0.96     ( mm )
```

Vertical machine report (text format)

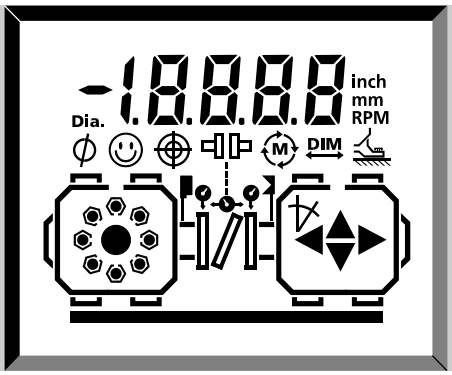
```
PRUFTECHNIK AG          85737 ISMANING                    GERMANY
OPTALIGN PLUS Ver.: 1.14 SN: 48971603   File #15 1997 12.10 03:48P

Company: ..................    Operator: .....................

Lower Machine: .............    Upper Machine: .........

***** Machine Dimensions -  mm
   Transducer to reflector                          150     ( mm )
   Transducer to coupling                            70     ( mm )
   Coupling diameter                                100     ( mm )
   Revolutions per minute                           750     ( RPM )
   Transducer to flange                            1070     ( mm )
   Flange diameter                                  100     ( mm )
***** Coupling Targets, short
   Target diameter                                  100     ( mm )
   Gap         vertical                            1.00     ( mm )
   Offset      vertical                            0.00     ( mm )
   Gap         horizontal                          0.00     ( mm )
   Offset      horizontal                          0.00     ( mm )
***** Tolerance, 50Hz
   Gap         excellent                           0.00     ( mm )
   Offset      excellent                           0.00     ( mm )
   Gap         acceptable                          0.13     ( mm )
   Offset      acceptable                          0.10     ( mm )
***** Tolerance, 50Hz
   Gap         excellent                           0.08     ( mm )
   Offset      excellent                           0.08     ( mm )
   Gap         acceptable                          0.11     ( mm )
   Offset      acceptable                          0.16     ( mm )
***** Coupling Results, clock
   Gap         vertical                            0.30  out of tol
   Offset      vertical                            0.00  excellent
   Gap         horizontal                          0.00  excellent
   Offset      horizontal                          0.00  excellent
***** Offset Corrections
   '+' -> 0   '-' -> 6                          -10.00  out of tol
   '+' -> 3   '-' -> 9                            0.00  excellent
***** Bolt Results -  mm
  No.    Angle    Dia.    Shim        No.    Angle    Dia.    Shim
    1       0°     100    1.00          2      30°     100    0.93
    3      60°     100    0.75          4      90°     100    0.50
    5     120°     100    0.25          6     150°     100    0.07
    7     180°     100    0.00          8     210°     100    0.07
    9     240°     100    0.25         10     270°     100    0.50
```

Test functions

The following test functions should be used if you suspect you have a problem with your OPTALIGN PLUS system:

Testing the entire display F91

By pressing keys F 9 1, the user activates all segments of the LCD display simultaneously. The resulting display should match that pictured below. If any segments are missing, contact your authorized PRÜFTECHNIK representative for service information.



All segments lit!

Testing individual display segments F92

Press keys F 9 2 to activate the LCD segments one at a time. Proceed from one segment to the next by pressing any key.

Testing the keyboard F93

Press keys F 9 3 to activate this test mode. Then, as each key is pressed, its function is shown in the display (or as nearly so as possible given the LCD graphic limitations).

Display version/ID number F94

Press keys F 9 4 to show the version number of the hardware followed by the version number of the software. The 8-digit transducer ID number is also displayed in two sequential 4-digit screens; for example, ID number '12345678' is displayed as '1234' --- '5678'.

Memory test F95

Press keys F 9 5 to start a memory test. If all is OK then the display alternates between 'Good', 'dAtA', 'Good' and 'FLSH'. If not, report the situation to your PRÜFTECHNIK dealer.

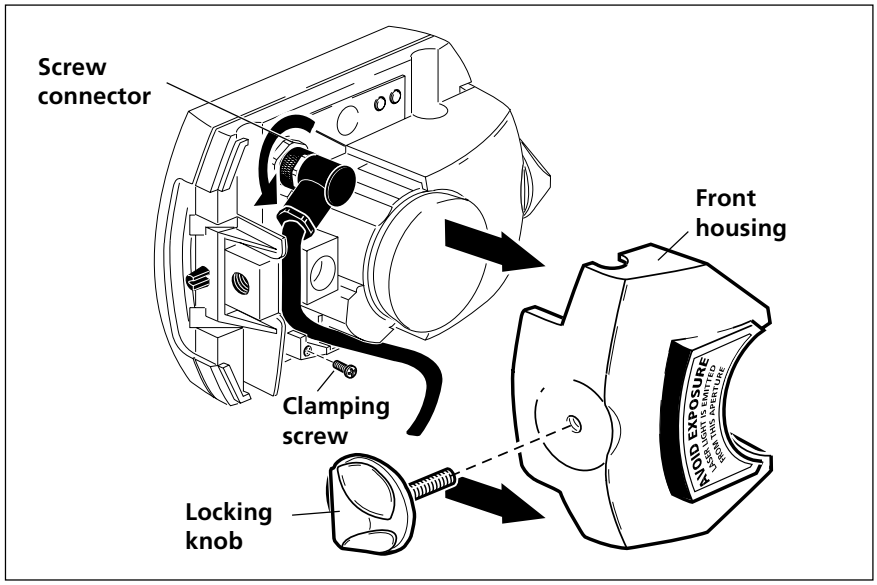
See page 4-22 for further 'F' functions.

Replacing the transducer cable

As previously noted, the transducer cable ordinarily remains attached to the transducer during storage as well as operation. If the need should ever arise, however (e.g. in case of damage), it may be replaced with cable ALI 3.581-2 as follows:

1. Open the front of the transducer housing

Remove the cable from the control unit (page 3-13). Completely unscrew the left-hand locking knob as shown below, then lift off the front of the transducer housing. Note how the cable is held in place by grooves in the transducer frame.



2. Remove cable clamping screw

See diagram for location.

3. Unscrew and remove cable

Unscrew connector and carefully lift cable out of its guide grooves.

4. Attach the new cable

Screw down the connector and carefully thread the cable into its guide grooves just as you found the old cable installed. Replace the clamping screw and tighten it down to hold the cable in place.

5. Close the transducer housing

Replace the front portion of the transducer housing, then retighten the yellow locking knob into place.

6. Test the new cable

Reconnect the cable to the control unit, then switch on. With the dust cap fitted, Press 'M' to switch on the laser. The red indicator LED of the transducer should blink to indicate beam emission. If not, ensure that the cable has been properly connected; otherwise, consult your PRÜFTECHNIK dealer.

Alignment Explorer and Editor

The PC partner for OPTALIGN PLUS

The Alignment Explorer (registered through a registration certificate - ALI 5.250) and the OPTALIGN PLUS Editor (registered through a registration certificate - ALI 5.260) are the two main programs designed to help you archive and evaluate your OPTALIGN PLUS measurement files.
The description on the following pages covers software installation, PC connection to the OPTALIGN PLUS control unit and transfer of measurement files. For detailed description of the software refer to the online help tools.


Note

Please refer to the special note on page 1-9 regarding data storage

System requirements

The following PC requirements must be met in order to ensure that the program can operate as intended:

System	Windows 95/ 98/ NT4 (SP5)/ 2000/ ME
Browser (online help)	Internet Explorer 4 or later
Processor	Pentium, 100MHz or faster
Memory	32MB RAM
Hard disk	50MB available
CD-ROM drive	for installation
Monitor	SVGA color
Mouse	with left and right click buttons
Serial interface	RS232
Printer	any

Program overview

The Alignment Explorer transfers measurement data between OPTALIGN PLUS and PC. It uses 'drag & drop' to transport files to Word documents which could then easily be attached to E- mails. This program is a sort of 'File Manager', but without display and manipulation capabilities.

To make full use of the Alignment Explorer and the OPTALIGN PLUS Editor, both software have to be registered.

A registered version of OPTALIGN PLUS Editor lets you make changes to measurement files (which are non-cryptic) and is opened directly from the Alignment Explorer.

ID Number

To register the Alignment Explorer, the instrument ID No. is required. To obtain the ID No., connect the control unit to the transducer and switch it on. Press the keys **F** **9** **4** to display the ID number of the unit.

Installation

Insert the OPTALIGN PLUS CD into the CD-ROM drive. The installation program which is self-explanatory starts and an introduction screen then appears. If automatic installation is deselected, start the program as follows. In the START menu, click onto RUN. Enter X:\START.EXE (where 'x' is the corresponding CD-ROM drive). Follow the instructions that appear on the screen to complete installation.

Check the Windows 'control panel' settings for this serial interface and change them, if necessary, to the following:

baud rate	=	9600
data bits	=	8
parity	=	None
stop bits	=	1

Confirm these settings with OK. Data transfer can now begin.

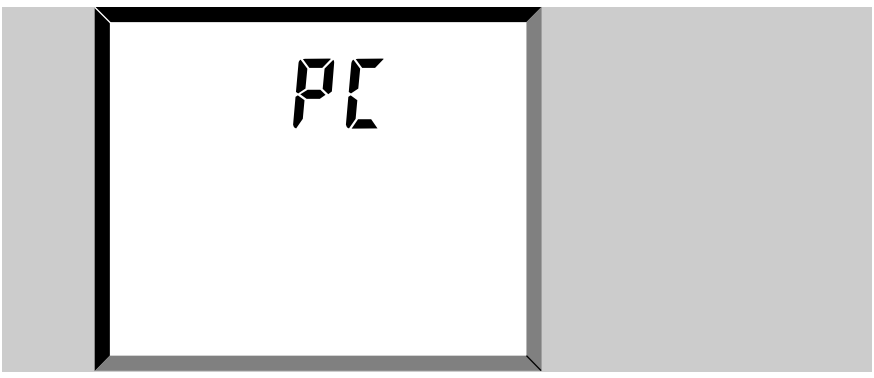
PC connection

1. Connect the cable

- Connect the OPTALIGN PLUS PC/printer cable (ALI 5.221) to the serial interface of the control unit.
- Note the proper orientation of the plug in its socket. Do not twist or turn the plug, as that could damage its contact pins.
- Connect the other end of the cable to an unoccupied serial interface (e.g. COM 2) on the PC. 9-pin plug interfaces require the appropriate adapter (25M - 9F) such as ALI 3.265.

2. Switch OPTALIGN PLUS to PC mode

- With the control unit connected to the transducer and switched on, press the keys **F** **0** **0**. The display below appears on the OPTALIGN PLUS control unit.



After program installation double click onto the Alignment Explorer. Select TOOLS/COMMUNICATIONS SETTINGS. The communication setup dialog display appears. This allows you select the serial interface to be used (e.g. COM 2) as illustrated below.

Establishing communication

Before communication between the PC and the OPTALIGN PLUS control unit can be initiated, a registered licence code and the instrument ID No. are required.

The licence code is contained in the registration certificate (ALI 5.250) and is obtained from PRÜFTECHNIK Alignment or from your local agent.

Select TOOLS/COMMUNICATIONS SETTINGS. The communication setup dialog screen illustrated above appears. As the Alignment Explorer is a suite that enables communication between the PC and other PRÜFTECHNIK alignment instruments, select the corresponding device - in this case OPTALIGN PLUS. The licence set-up dialog screen appears.

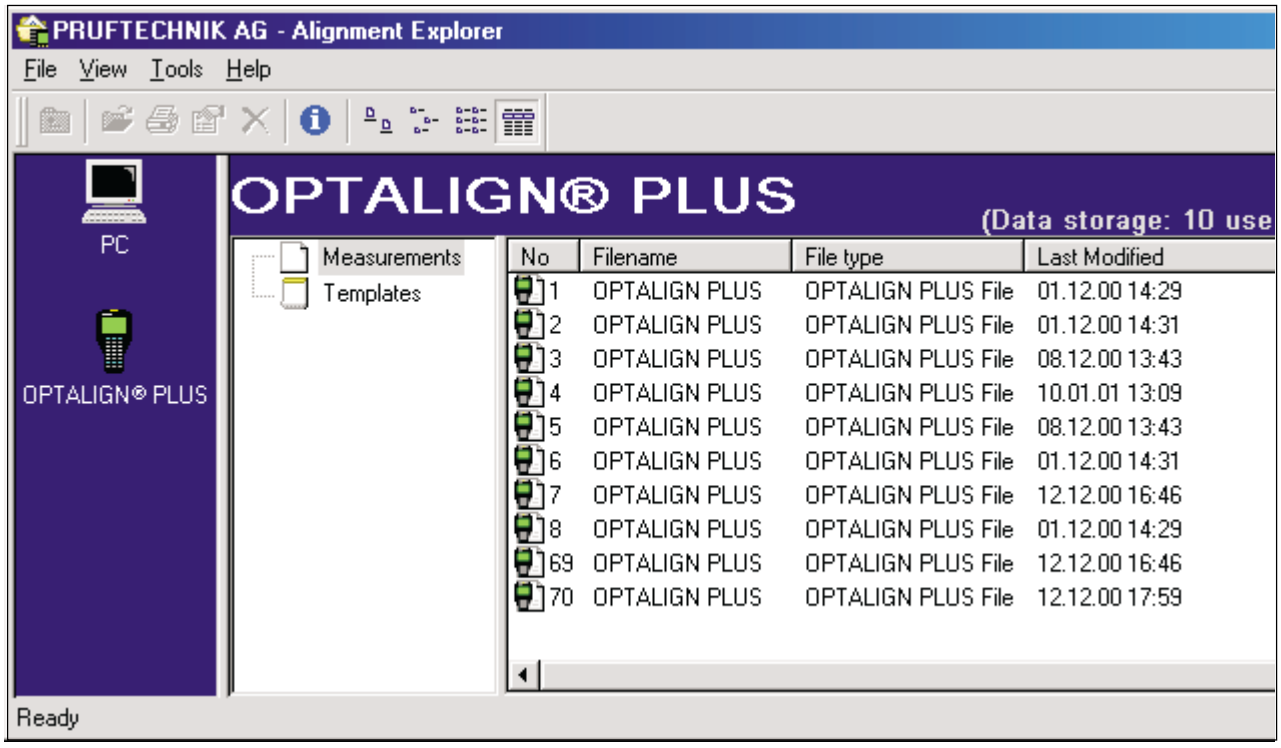
Select ADD and then enter the instrument ID No. and the licence code obtained from ALI 5.250.

Having now registered the device, hence establishing communication between the PC and the OPTALIGN PLUS, we can proceed to transfer, read and file measurements stored in the OPTALIGN PLUS.

File transfer

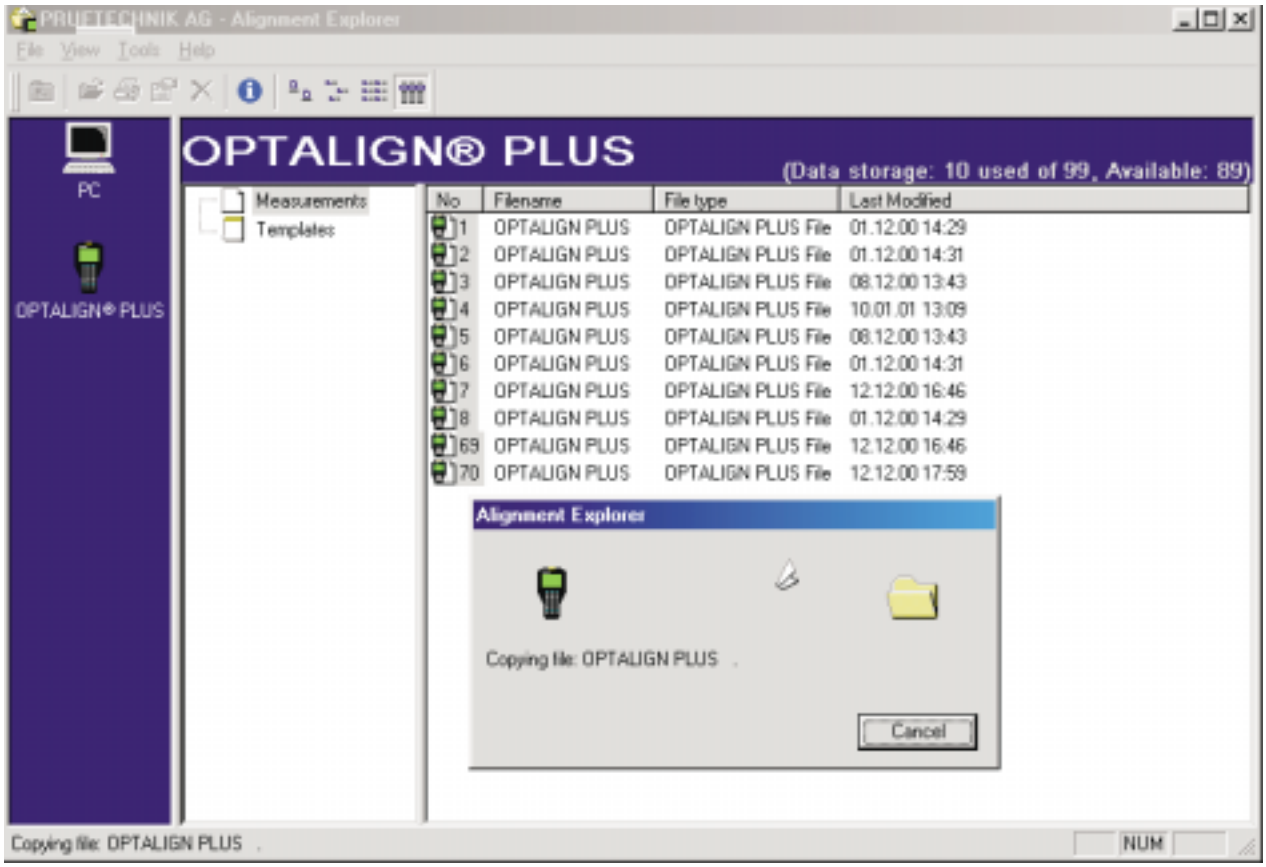
1. Read OPTALIGN PLUS files

Click onto the OPTALIGN PLUS icon. A list of all OPTALIGN PLUS measurement files stored on the device appears on the Alignment Explorer view.

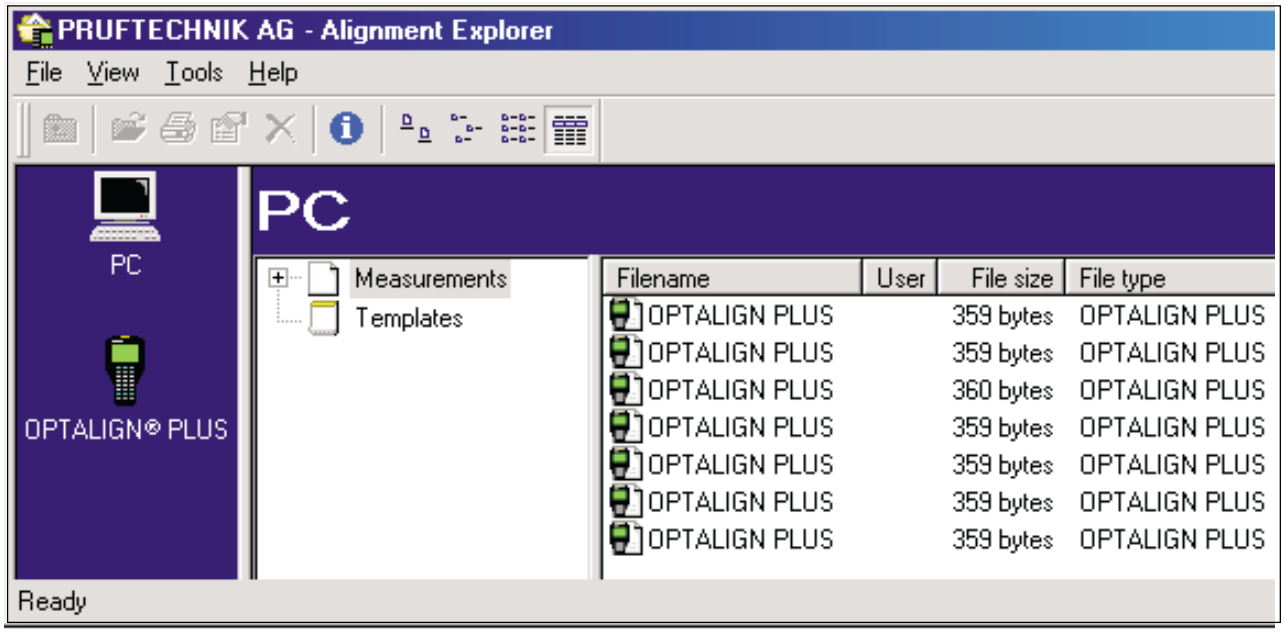


2. Copy files

To be able to view the listed files, simply mark the files and copy them over to the PC in the standard windows procedure using drag & drop. A data copying screen indicating the data transfer appears.

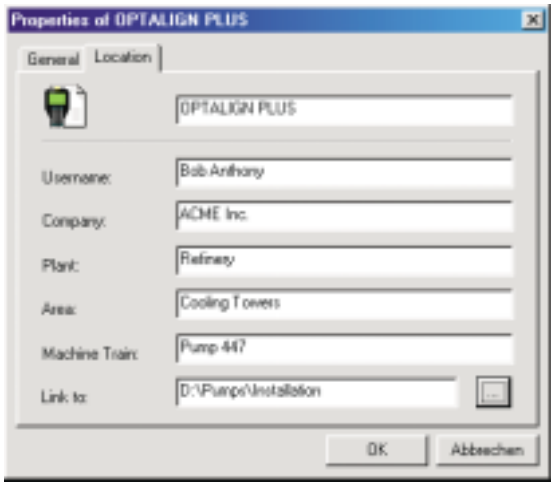


To view the copied files, click on the PC icon. A view of the listed files appears on the screen. (See below)



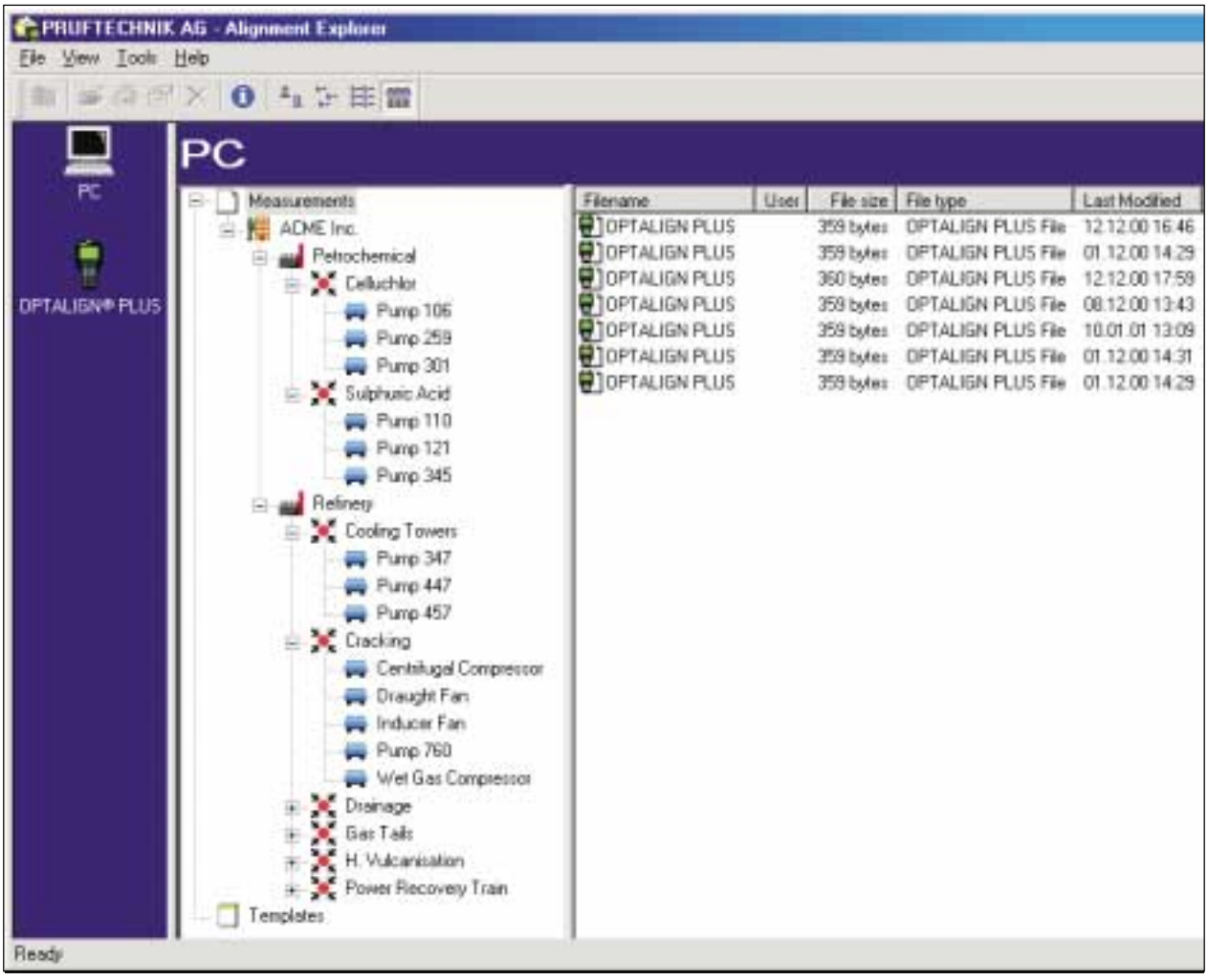
3. Properties menu

If any one of the listed files is selected using the right hand mouse key, a menu appears. Selecting PROPERTIES opens the dialog window shown below. If the selected file has a link, 'open link' appears under menu. The Properties dialog window can also be opened under menu FILE/PROPERTIES



Summary

- The Alignment Explorer allows the establishment of a satisfactory directory tree filing structure (see figure below).
- 'Drag & drop' the marked files from the right hand view window to the left hand view window to copy them into the PC (refer to diagram on page 6-33).
- Alternatively, click the right-hand mouse key then click onto the COPY function in the menu that appears (refer to diagram on page 6-33).
- Files marked in the Alignment Explorer window may be copied from the PC to OPTALIGN PLUS by 'drag & drop' (right to left) or using the COPY function of the right hand mouse key (refer to diagram on page 6-35).



The OPTALIGN PLUS Editor

The Editor allows one to customize the contents of alignment files for horizontal, vertical and flange mounted machines. Three screens (Dimensions, Measurement values and Results) clearly depict all aspects of the OPTALIGNment job.

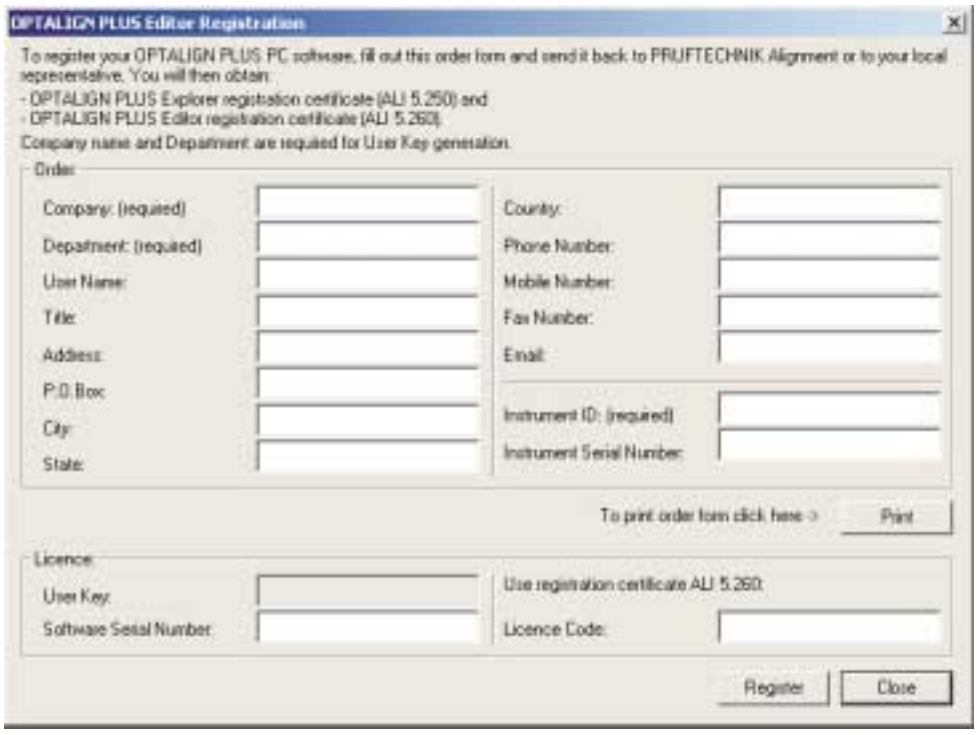
Starting the Editor

After installation, the Editor should start automatically. You can also start the Editor by double-clicking onto a file name in the PC screen of the Alignment Explorer.

The Editor software that is installed works in the demonstration mode. To make full use of the program a licence code and software serial number are required. This information is contained in the registration certificate (ALI 5.260). To obtain the registration certificate an order form has to filled out and sent back to PRÜFTECHNIK Alignment or to your local representative.

Editor registration

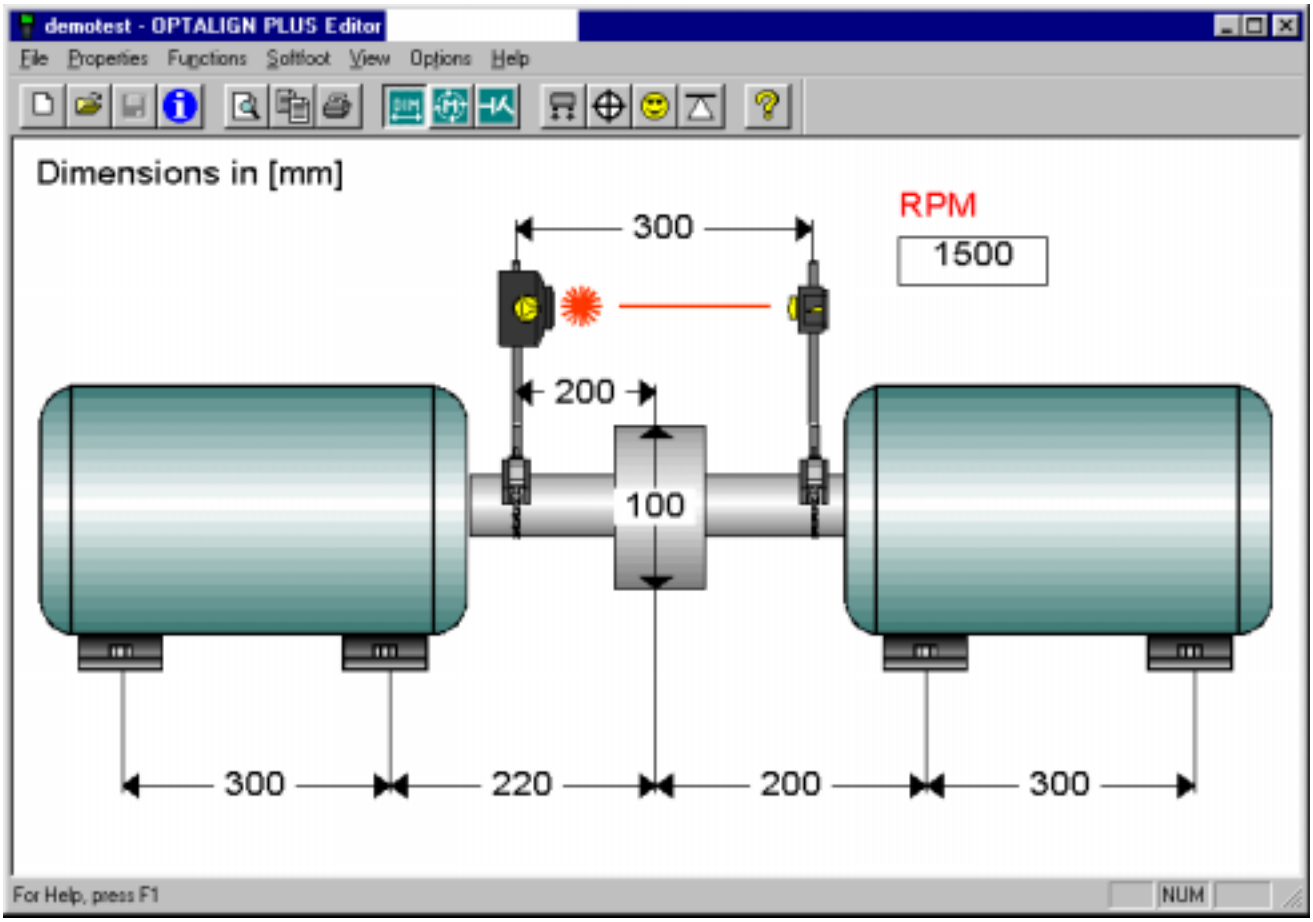
To obtain the order form select under the Editor, OPTIONS/REGISTRATION. The order form below pops up.



Fill out the order form and return it to PRÜFTECHNIK Alignment or your local representative. You will then receive the registration certificate which contains the licence code and the software serial number.

Using the Editor

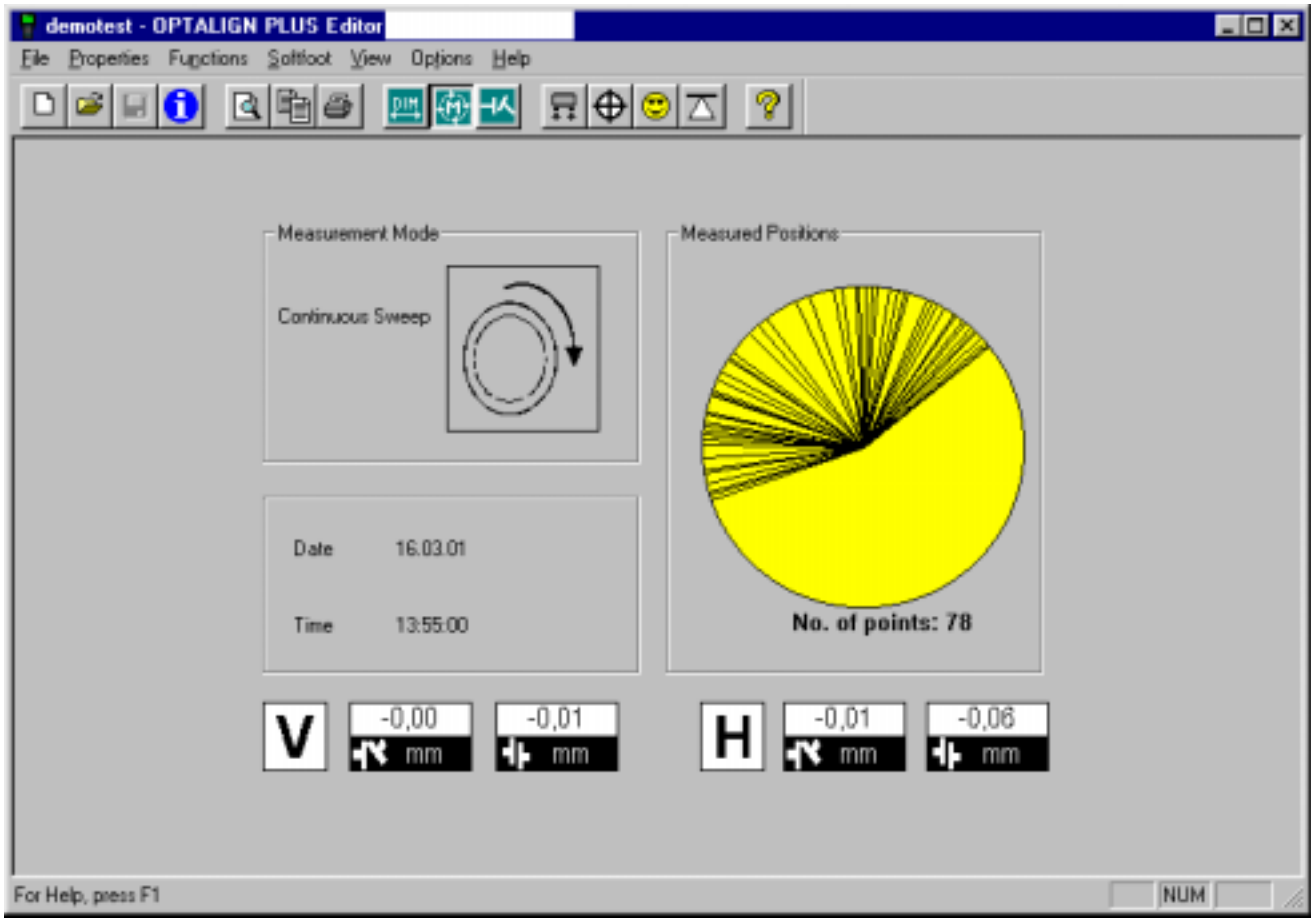
Dimensions 



- Set measurement units under OPTIONS/SETUP.
- Enter dimensions (click onto dimension arrow or components).
- Under menu PROPERTIES you can select machine type. These can be either normal 4 feet, 6 feet or stationary. Dimensions as well as expected thermal growth values can also be entered under PROPERTIES
- Coupling type can also be selected under PROPERTIES. Relevant dimensions as well as coupling target for 'cold alignment' may also be entered.

The cryptic file can be established by selecting  the 'Edit properties file' icon.

Measurement



The bottom portion shows the calculated alignment condition at the coupling.

Measurement mode

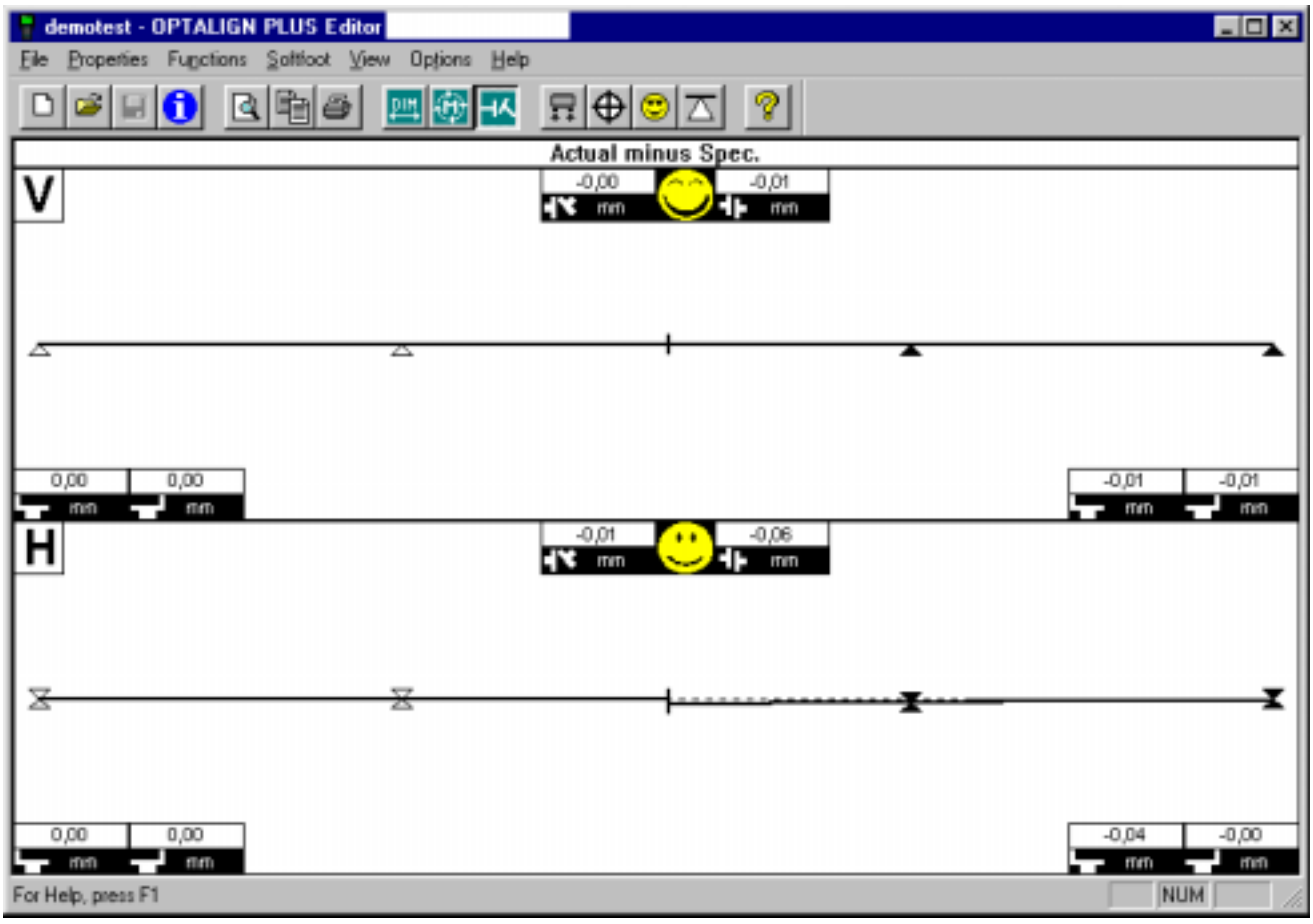
This mode indicates which measurement mode was used. They include:
- Continuous 'sweep' rotation
- Multipoint measurement
- '0, 3, 6, 9' positions

The view also indicates the time and date when the measurement was made.

Results

This display shows alignment results in vertical and horizontal planes.

If tolerances have been specified and met, a 'happy face' symbol appears.



Static feet

Allows you set which machine foot locations are not to be moved for alignment correction. These locations determine the alignment reference.

Troubleshooting checklist

OPTALIGN PLUS is designed to withstand a rough industrial operating environment. Should you nonetheless encounter difficulty someday, the following checklist of possible problems can be a great help in locating and eliminating the source of trouble.

Following each entry is a number indicating the effect of that problem on measurements:
[1] no influence on measurement accuracy and repeatability
[2] measurement accuracy affected
[3] repeatability affected

1. Loose brackets can lead to erroneous results. Check to make sure they fit tightly on the shafts (see page 3-8 for correct mounting procedure). [2, 3]

2. Severe torsion or coupling backlash may affect measurement (see page 6-7). However, OPTALIGN PLUS measurements normally remain unaffected by up to 5° of backlash. [2, 3]

3. Measurement interference due to vibration from adjacent machinery is nearly unheard of; changing X,Y coordinate values in the display would be the result. [1]

4. Axial shaft play does not influence measurement results to any appreciable degree. [1]

5. If neglected, thermal growth effects can result in unexpected alignment changes as the machine warms up during operation (see page 4-16). There will be a loss of repeatability if the alignment is changing while taking a set of readings. This is especially prevalent in a rapid cool-down of a machine immediately after shutdown. [3]

6. Temperature changes can temporarily affect the OPTALIGN PLUS (for example, if the unit is stored in a cool area, then brought into a hot, humid work area, the optics can fog over and the housing may expand slightly). Remedy: allow the OPTALIGN PLUS components to reach ambient air temperature before taking measurements. [2, 3]

7. The electronic components used in the transducer may be temporarily affected by excessive temperatures, so protect the system from extended exposure to high temperatures and observe the operating temperature range of 0° C to 55° C (32° F to 131° F). [2, 3]

8. In a few rare cases, powerful infrared light sources, welding arcs and direct sunlight can overload the detector. The display will then show 'Err,' and measurements cannot be taken until the infrared disturbance is eliminated (simply by shading the transducer). [1]

9. Steam, dust particles, soot suspended in the air, etc. can block the laser beam. When the detector no longer receives the beam, it

causes the display to show 'OFF.' But over the relatively short separations involved, this is a rare occurrence. The situation can be easily remedied by shielding the beam from blockage, best done by holding a tube between (but not touching) the transducer and reflector through which the beam then passes each time readings are taken. [1]

10. With OPTALIGN PLUS, bracket sag is non-existent. [1]

11. Low battery level does not influence measurement accuracy. As the batteries become depleted, the display flashes a 'battery low' message. The user can then switch over to reserve (AUX) battery power to finish the job at hand before replacing batteries. [1]

12. If the machine housing is placed under stress, e.g. by loads from intake/discharge piping or flimsy shafts, loose bearings or other machine defects, OPTALIGN PLUS will still measure displacements in exactly the same manner as always, but all of these defects introduce highly unpredictable (and hence often unrepeatable) shaft displacements during measurement. These factors should therefore be checked before taking measurements to save time and frustration later. [3]

Summary

The exceptionally precise measurement of relative movements between transducer and reflector are converted directly into offsets at the coupling and machine feet. Four conditions must be fulfilled for this principle to deliver correct alignment recommendations:

1. The transducer and reflector must be mounted rigidly on the shafts (or coupling flanges) and may not slip or twist during measurement.

2. The machine shafts must be rigid. No elastic deformation can occur during rotation.

3. The shafts must rotate about their own operating axes during measurement. Any displacement from this position must be constant and predictable so that it may be compensated. The shafts must not trace an elliptical path as they rotate.

4. Soft foot or machine base instability must be checked and corrected before alignment.

In the vast majority of cases, OPTALIGN PLUS measurements which at first may appear to be unreliable or inaccurate can be traced back to some violation of one of these four rules.

Warranty, service and care

Warranty

The OPTALIGN PLUS laser diode is guaranteed for two years. All other system components are covered by a one-year warranty. Please note that any attempt to service the components by unauthorized personnel will render all warranty coverage void.

Service and care

OPTALIGN PLUS is a precision measurement instrument which should be handled as such. When not in use, it should always be stored in its protective carrying case.

Although the OPTALIGN PLUS system is essentially maintenance-free, the following points should be observed: The calibration accuracy of the system should be checked every two years as indicated by the colored label located at the back of the transducer housing. Please return OPTALIGN PLUS to your authorized PRÜFTECHNIK distributor for calibration checking.

All optical surfaces (transducer lens, reflector) must be kept clean. Use the ALI 2.905 cleaning set or a fine dusting brush such as that normally used to clean other optical devices; avoid vigorous polishing to preserve the anti-reflective coatings of the glass elements. The computer housing may be wiped clean using a soft cloth dampened with a mild, nonabrasive detergent.

If any problems are encountered during use, consult the trouble-shooting guide on the previous page for help in locating and correcting the problem. (In particular, check the cable connection between transducer and computer first for signs of damage.) If the problem still cannot be resolved, then contact your PRÜFTECHNIK AG representative for further assistance.

Maintenance may be carried out only by trained personnel.

OPTALIGN PLUS Upgrade Package ALI 5.225set

The operating software ('firmware') of the OPTALIGN PLUS system can be functionally enhanced as newer versions become available: an easy-to-use PC program allows the user to upgrade the firmware in a matter of minutes. (The version number of the firmware appears in the OPTALIGN PLUS display when first switched on.)

Spare parts, accessories

Only original spare parts and accessories may be used. Please consult the Alignment Product Catalog (ALI 9.300) for complete details.

Disposal

Batteries, the OPTALIGN PLUS components and accessories are to be disposed of in accordance with applicable environmental regulations at the end of their operating lives.

Error messages

OPTALIGN PLUS self-diagnostic routines enable the control unit to display the following messages which indicate the exact source of error. The corresponding remedies are listed below.

Symbol

"'Transducer' blinks	Transducer not connected.
'BATT.' blinks	Depleted batteries should be replaced (see page 2-7).

Text

"Abnt'	Excessive ambient light: shade the receiver.
'n.Lin'	Linearization data is corrupted or missing: Return the transducer and control unit for repair.
'in.Er'	Inclinometer faulty. Return transducer for repair.
'End'	Laser beam is outside of linearized measurement range of position detector. Use F6 to readjust the laser (see pages 3-19, 4-27).
'Off'	Laser beam misses detector completely. Use F6 to readjust the laser (see pages 3-19, 4-27).

'The following errors can occur during file loading (page 3-34):

'Er.--'	Error of unknown origin
'Er.01'	No file found under the number entered
'Er.02'	Check sum error (file data corrupt)
'Er.03'	Data set missing (e.g. left machine or specs)
'Er.04'	Error copying file to working file slot #0 (page 3-34)

The following errors can occur during file storage (page 3-33):

'Er.--'	Error of unknown origin
'Er.05'	Memory card faulty
'Er.06'	No more storage space available

All of these file handling errors indicate serious problems in the file management system. In that case, try reformatting the memory card using function F90. If this does not help, then the transducer and control unit must be returned for repair.

OPTALIGN PLUS technical data

Transducer

Measurement principle	Coaxial, reflected laser beam
Measurement types	2 axes (x,y); 1 inclination
Laser type	Ga-Al-As semiconductor laser
Wavelength (typical)	670 nm ±10 nm (red, visible)
Environmental protection	IP 67
Ambient light protection	yes
Intrinsic safety (option)	EEx ib IIC T4
Certificate number	TÜV 01 ATEX 1730
Temperature	
storage	-20°C – 80°C / -4°F – 176°F
operating	0°C – 55°C / 32°F – 131°F
Dimensions	approx. 107 x 70 x 49 mm 4 1/4" x 2 3/4" x 2"
Weight:	approx. 177g / 6½ oz.
Laser	
Safety class	Class 2; FDA 21CFR 1000 and 1040
Beam divergence	< 0.3 mrad
Beam power	< 1 mW
Beam diameter	7 mm
Safety precautions	Do not look into laser beam
Detector	
Measurement area	unlimited, dynamically extendible
Resolution	1 µm
Accuracy	better than 2%
Inclinometer	
measurement range	0° – 360°
resolution	2°

Reflector

Type	90° roof prism
Environmental protection	IP 67
Accuracy	Better than 1%
Temperature	
storage	-20°C – 80°C / -4°F – 176°F
operating	-20°C – 60°C / -4°F – 140°F
Dimensions:	approx. 100 x 41 x 35 mm 4" x 1 5/8" x 1 3/8"
Weight:	approx. 65g / 2½ oz.

Control Unit

Display	fixed-segment LCD display
Display dimensions	approx. 94 x 73 mm / 3 3/4" x 2 7/8"
Keyboard	robust flat keyboard
Environmental protection	IP 65
Temperature	
storage	-20°C – 80°C / -4°F – 176°F
operating	0°C – 55°C / 32°F – 131°F
Main power supply	6 x 1.5V IEC LR6 ("AA") batteries
Back-up power supply	1 x 9V IEC 6LR61 battery
Battery life (typical)	25 hours* on main batteries 3 hours* on back-up battery
Interfaces	1 x sensor; 1 x printer/PC (serial)
Intrinsic safety (option)	EEx ib IIC T4
Certificate number	TÜV 01 ATEX 1730
Dimensions	approx. 145 x 290 x 67 mm 5 3/4" x 11 1/2" x 2 3/4"
Weight	approx. 1.1 kg / 2.4 lb.

Carrying case

Standard	Black plastic, lockable
Case dimensions	Approx. 470 x 400 x 195 mm 18 1/2" x 15 3/4" x 7 3/4"
Weight, including all standard parts	Approx. 6.8 kg / 15.2 lb.

*Based upon an operating cycle of
25% measurement,
25% computation and
50% 'sleep' mode.

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