# SKF TMEA 2

Instructions for use
Mode d'emploi
Bedienungsanleitung
Instrucciones de uso
Manuale d'instruzioni
Bruksanvisning
Gebruiksaanwijzing
Instrucções de utilização
Brugervejledning
Käyttöohje
Οδηγίες χρήσης

**EU-DECLARATION OF CONFORMITY**

We, SKF Maintenance Products, Kelvinbaan 16,
3439 MT Nieuwegein, The Netherlands, declare that the

# SHAFT ALIGNMENT TOOL TMEA 2

has been designed and manufactured in accordance with
EMC DIRECTIVE 89/336/EEC as outlined in the harmonised norm
for

Emission EN 50081-1, EN 55011 (B)
Immunity EN 50082-2, EN 61000-4-2, -3, level 3.

The laser is classified in accordance with the
Swedish Standard SS-EN-60825-1-1994
British Standard BS 4803 Parts 1 to 3
Deutsche Industrie Norm DIN SEC 76 (CO) 6
USA FDA Standard 21 CFR, Ch 1, Part 1040.10 and 1040.11
and is provided with the European CE approval.

The Netherlands, November 2004

Ebbe Malmstedt
Manager Product Development and Quality

## SAFETY RECOMMENDATIONS

- Always turn off the power of the drive machine before you start working.
- Do not expose the equipment to rough handling or heavy impacts.
- Always read and follow the operating instructions.
- The tool uses two laser diodes with an output power below 1 mW. Still, never stare directly into the laser transmitter.
- Calibrate the equipment regularly.
- Never aim the laser line into someone's eyes.
- Opening the housing of the measuring unit may result in hazardous light exposure and voids warranty.
- The equipment should not be used in areas where there is a risk for explosion.
- Do not expose the equipment to high humidity or direct contact with water.
- All repair work should be taken care of by an SKF repair shop.

# 1 INTRODUCTION

Perfect alignment of machinery shafts is crucial to prevent premature bearing failure, shaft fatigue, sealing problems and vibrations. It further reduces the risk of over-heating and excessive energy consumption. The SKF Shaft Alignment Tool TMEA 2 offers an easy and accurate way of adjusting two units of rotating machinery so that the shafts of the units are in a straight line.

## 1.1 Principle of operation

The TMEA 2 system uses two measuring units both provided with a laser diode and a positioning detector. As the shafts are rotated through 180° any parallel misalignment or angular misalignment causes the two laser lines to deflect from their initial relative position.

The measurements from the two positioning detectors automatically enter the logic circuitry inside the display unit, which calculates the misalignment of the shafts and advises on corrective alignments of the machine feet.

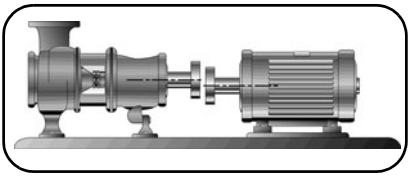

*Fig. 1 Parallel misalignment*

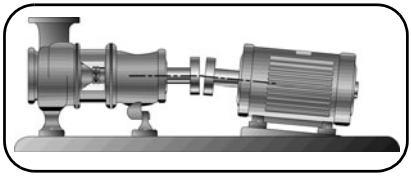

*Fig. 2 Angular misalignment*

After a straightforward measuring procedure, the tool immediately displays the misalignment of the shafts and the necessary corrective adjustments of the feet of the machine. Since the calculations are done in real time the progress of the alignment can be followed live.

## 1.2 Machine configuration

During the alignment procedure we will refer to the part of the machinery which will be adjusted as the "Movable machine". The other part we will refer to as the "Stationary machine".

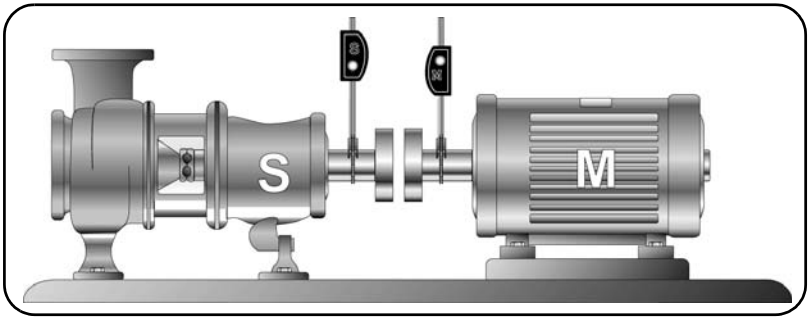


*Fig. 3. Stationary and Movable machine*

## 1.3 Measuring positions

To define the various measuring positions during the alignment procedure we use the analogy of a clock as viewed from behind the Movable machine. The position with the measuring units in an upright position is defined as 12 o'clock while 90° left or right is defined as 9 and 3 o'clock.

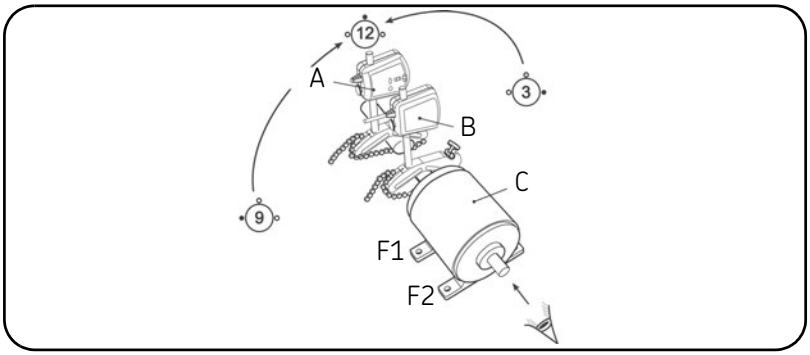


*Fig. 4. The analogy of a clock*
*A Stationary*
*B Movable*
*C Movable machine*

## 2 SHAFT ALIGNMENT TOOL

The following components are included with the TMEA 2 tools:

- Display unit
- 2 measuring units with spirit levels
- 2 magnetic / mechanical shaft fixtures
- 2 locking chains
- 5 sets of shims
- Measuring tape
- Instructions for use
- Set of alignment reports
- Carrying case

*Fig. 5. Tool components*

Details of the display unit and the mechanical fixture with measuring unit can be seen on figures 6 and 7.

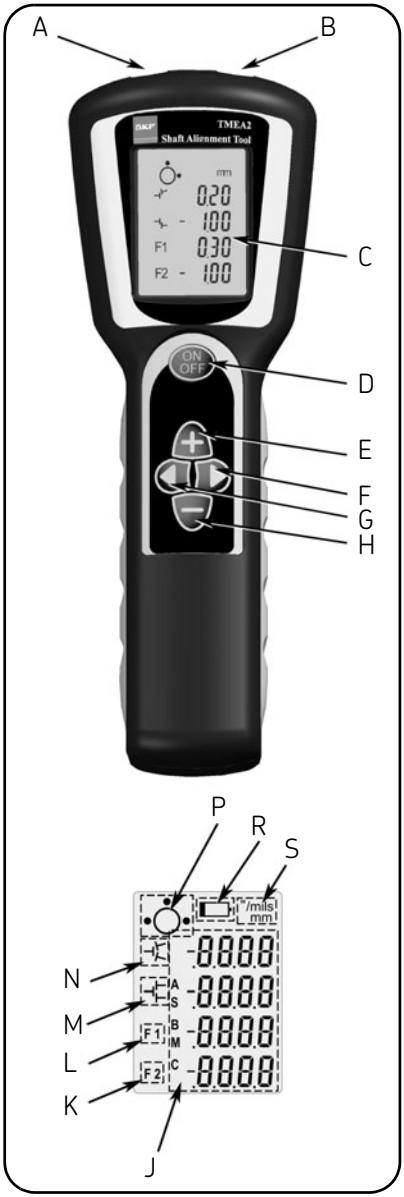


*Fig. 6. Display unit*

*A Connector for measuring unit on Stationary machine*
*B Connector for measuring unit on Movable machine*
*C LCD Display*
*D ON/OFF button*
*E Increase (+) button*
*F Next button*
*G Previous button*
*H Decrease (-) button*
*J Machine dimensions (A,B and C) / Measured values (S and M)*
*K Rear feet values*
*L Front feet values*
*M Indication of parallel coupling value direction*
*N Indication of angular coupling value direction*
*P Position (9/12/3 o'clock) of measuring units*
*R Low battery*
*S Imperial or metric units*

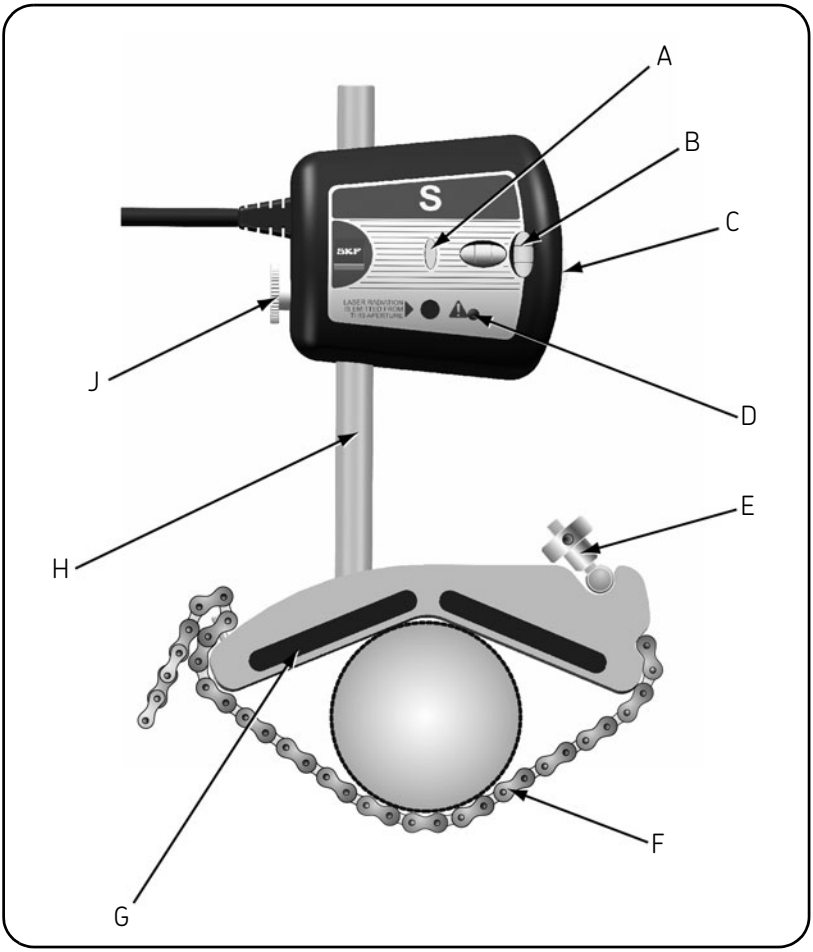


*Fig. 7. Magnetic / Mechanical fixture with measuring unit*

*A Position sensor detector*
*B Spirit level*
*C Wheel for vertical fine adjustment of laser line*
*D Warning LED*
*E Chain fixation screw*
*F Locking chain*
*G Magnetic / mechanical fixture*
*H Connection rod*
*J Release / tightening knob*

## 2.1 Technical data

| | |
|---|---|
| Denotation | 1 mil = 1 thousandth of an inch |
| **Measuring units** | |
| Housing material | ABS plastic |
| Type of laser | Diode laser |
| Laser wave length | 670 - 675 nm |
| Laser class | 2 |
| Maximum laser power | 1 mW |
| Maximum distance between measuring units (measured between fixture center line) | 850 mm (2.8 ft) |
| Minimum distance between measuring units (measured between fixture center line) | 70 mm (2.7 in) |
| Type of detectors | Single-axis PSD, 8.5 x 0.9 mm (0.3 x 0.04 in) |
| Cable length | 1.6 m (5.2 ft) |
| Dimensions | 87 x 79 x 39 mm (3.4 x 3.1 x 1.5 in) |
| Weight | 210 gram (7.3 oz) |
| **Display unit** | |
| Housing material | ABS plastic |
| Display type | LCD 35 x 48 mm (1.4 x 1.9 in) |
| Battery type | 2 x 1.5V LR14 Alkaline |
| Operating time | 20 hours continuous operating |
| Auto power off | after 1 hour if no keys are pressed |
| Displayed resolution | 0.01 mm (0.1 mil with "inch" setting) |
| Dimensions | 230 x 81 x 62 mm (9.1 x 3.2 x 2.4 in) |
| Weight | 300 g (10.5 oz) |
| **Shims** | |
| Size | 50 x 50 mm (2.0 x 2.0 in) |
| Thickness | 0.05 - 0.10 - 0.25 - 0.50 - 1.00 mm (1.96 - 3.93 - 9.84 - 19.68 - 39.37 mils) |
| Slot width | 13 mm (0.51 in) |
| **Complete system** | |
| Shaft diameter range | 30-500 mm (1.2 - 20 in) |
| Magnetic | 30 - 500 mm (1.2 - 20 in) |
| Chain | 30 - 150 mm (1.2 - 5.9 in) |
| Optional chain | 150 - 500 mm (5.9 - 20 in) |
| Accuracy of system | <2% +/-0.01mm |
| Temperature range | 0-40 °C (32 - 104 °F) |
| Operating humidity | < 90% |
| Carrying case dimensions | 390 x 340 x 95 (15.4 x 13.4 x 3.7 in) |
| Total weight (incl. case) | 3.7 kg (8.1 lb) |
| Calibration certificate | valid for two years |
| Warranty | 12 months |

# 3 INSTRUCTIONS FOR USE

## 3.1 Measurement units

**Metric or imperial sizes**
The tool is delivered with a pre-selection for measurements in mm.
In case you want to change into inches, press the minus sign simultaneously to switching the tool on. To revert back to mm press the plus sign when switching on. The last setting will always be remembered.

## 3.2 Feet on the ground

If there is any doubt whether the machine is resting equally on all feet please check for so called "soft foot". The procedure for this operation is described in chapter 3.10.

### 3.3 Attachment of measuring units

a) Use the magnetic fixtures to attach the measuring units to the shafts. If the shafts are in good condition, only the magnetic fixture is required. When using the magnetic fixture always try to place it on the shaft and press it against the coupling. If the shafts are not in good condition or if the fixtures are not sufficiently secured to them, use the chains. Make sure that the M-marked unit is attached to the Movable machine and the S-marked unit to the Stationary machine. For diameters larger than 150 mm, if chains are still needed an accessory extension chain (TMEA C2) is required.

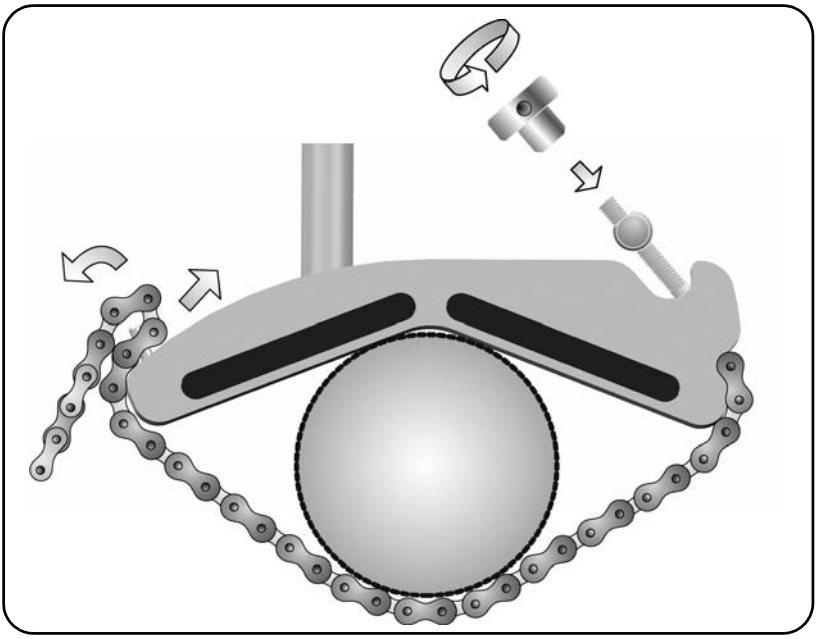

*Fig. 8. Attachment of magnetic / mechanical fixture with chain*

If it is not possible to attach the fixtures directly to the shafts (e.g. in case of space problems) the fixtures can be attached to the coupling.

**Note!**
It is highly recommended to position the measuring units at equal distance from the middle of the coupling.

b) Connect the measuring units to the display unit. Make sure that the marking on the cables corresponds to the marking of the ports in the display unit (fig. 9).

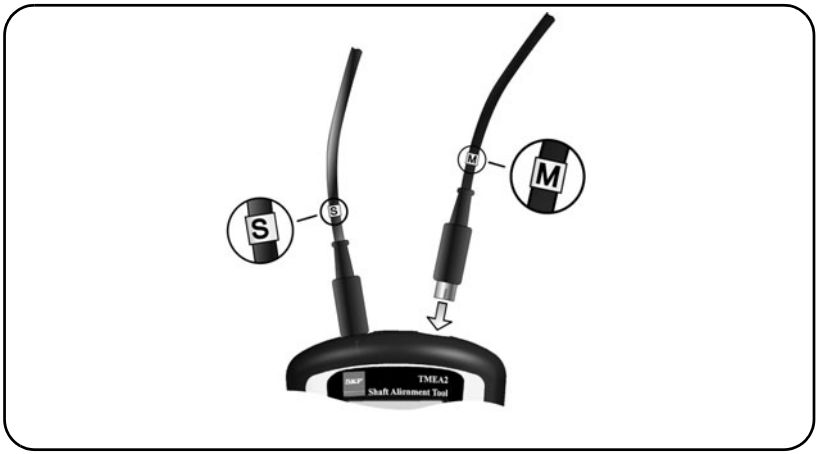


*Fig. 9. Connection of the measuring units*

### 3.4 Switch on

Switch on the display unit by pressing the ON/OFF button. You will now be prompted to enter the machine dimensions as per chapter 3.6. If no button is pressed within 60 minutes, the unit will turn off automatically.

### 3.5 Aiming the laser lines

a) Put the two measuring units in the 12 o'clock position with the help of the spirit levels (fig. 10).

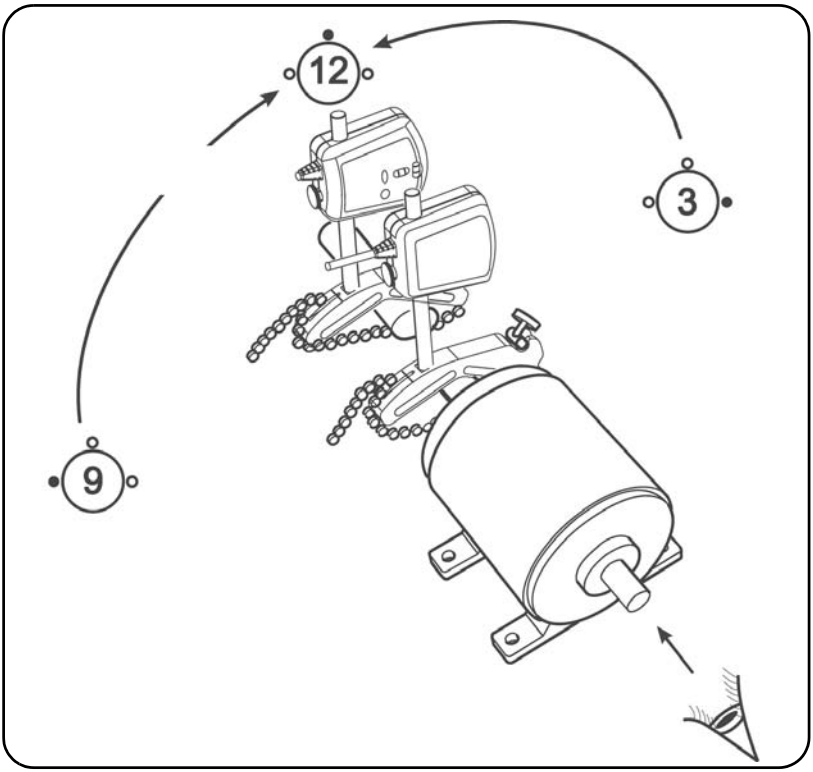


*Fig. 10. The 12 o'clock position*

b) Aim the laser lines so that they hit in the centre of the target of the opposite measuring unit (fig. 11).

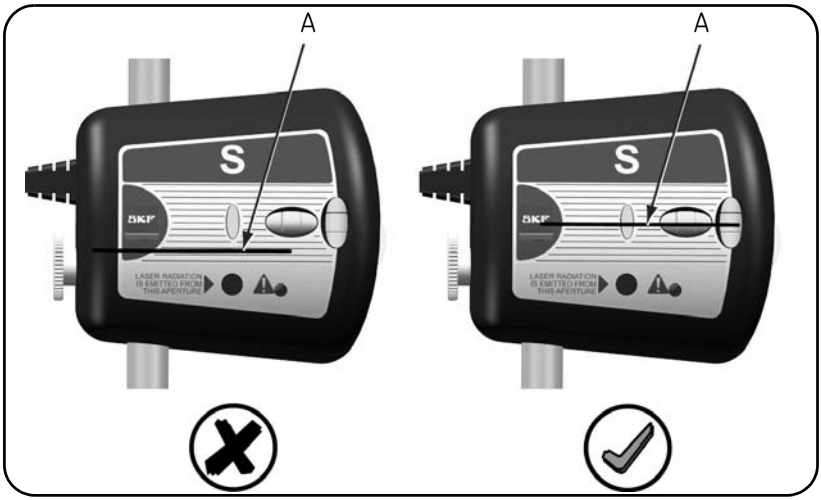


*Fig. 11. Hit the target*
*A Laser line*

c) For coarse adjustment release the measuring unit by unlocking the knob on the side of the unit (fig. 12). This allows the measuring unit to slide up and down the rod at the same time as it can swivel freely. For the fine adjustment in height use the adjustment wheels on the measuring units.

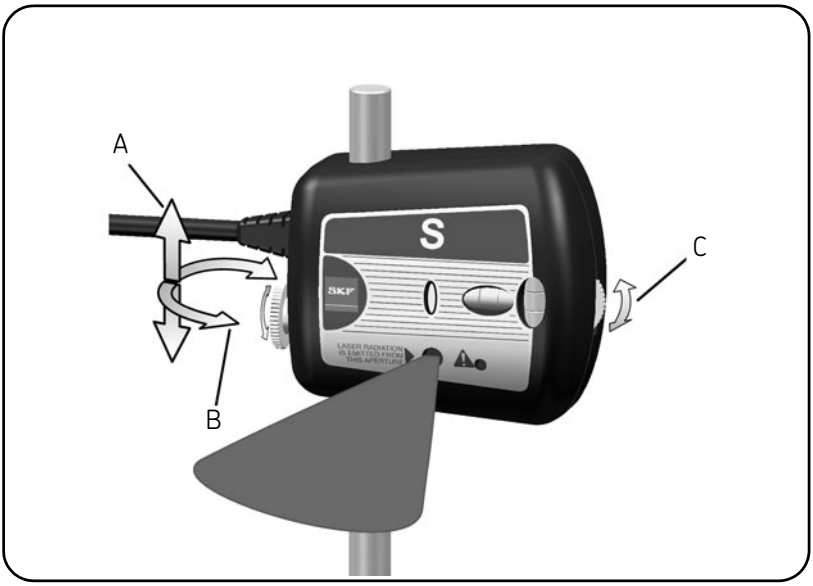


*Fig. 12. Adjustment mechanism*
*A Vertical positioning of measuring unit*
*B Horizontal rotation of measuring unit*
*C Vertical fine adjustment of laser*

d) If the horizontal alignment is very poor the laser lines might travel outside the detector areas. If this happens a rough alignment must be done. Do this by aiming the laser lines at the positioning detectors in the 9 o'clock position. Turn the measuring units to the 3 o'clock position when the lines will hit outside the detector areas. Adjust the lines to the position half-way between the detector centre and the actual position by means of the adjustment mechanism as per fig. 13. Align the Movable machine until the lines hit the centre of the positioning detector.

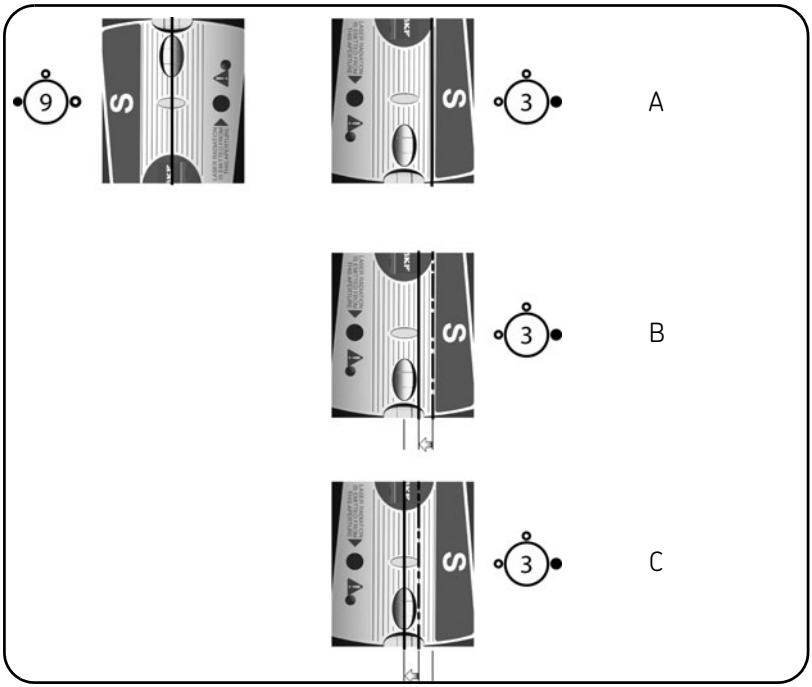


*Fig. 13. Rough alignment*
*A The beam moves outside the detector area*
*B Adjust the beam to half the travel*
*C Direct the machine to hit the centre*

## 3.6 Machine dimensions

The configuration of the machinery is defined by three dimensions.

A: The distance between the two measuring units, as measured between the fixture centre marks.

B: The distance between the M-marked measuring unit and the front pair of feet of the Movable machine.

C: The distance between the front feet and the rear feet of the Movable machine.

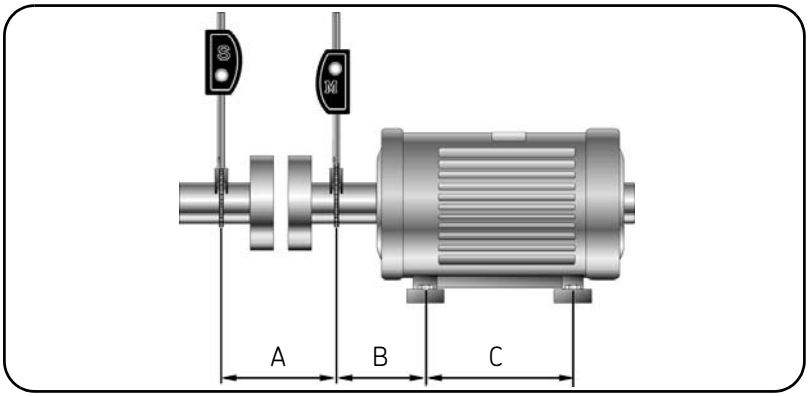


*Fig. 14. Machine dimensions*

a) Measure the A, B and C distances. The default values for these three distances are:
   A = 200 mm (8 in)
   B = 200 mm (8 in)
   C = 400 mm (15 in)
b) Adjust each value by using the + and - buttons.
c) Confirm the setting of each value by pressing the "next" button.

**Note!**

If you need to go back and change values already entered use the "previous" button.

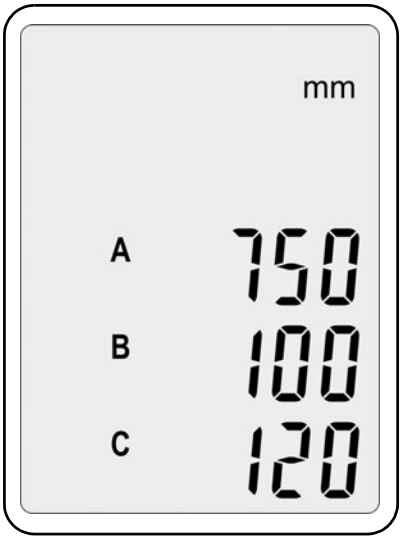


*Fig. 15. Distances A, B and C*

## 3.7 Measuring sequence

During the measuring cycle the shafts are rotated through 180 degrees. Any relative movement of the laser lines during this rotation indicates some sort of misalignment. The logic circuitry within the tool will translate this movement to misalignment figures and advise on how to correct it. A circle symbol on the display will help, indicating the required position of the measuring units during each step (fig. 16). As described earlier (chapter 1.3) we use the analogy of a clock to describe the different positions.


*Fig. 16. Display guides you to the 9 o'clock position*

a) Adjust the measuring units to the 9 o'clock position with the aid of the spirit levels (fig. 17).
b) Confirm the measurement by pressing ▶.

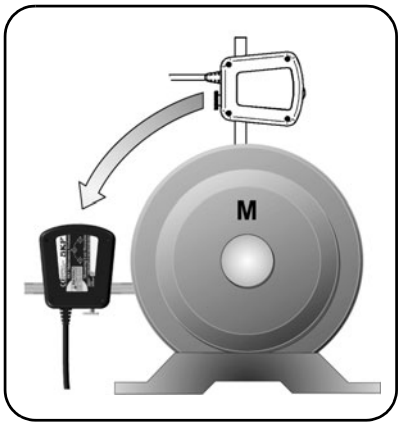


*Fig. 17. Adjust to the 9 o'clock position*

c) Follow the circle symbol on the display and rotate the measuring units to the 3 o'clock position (fig. 18).
d) Confirm the measurement by pressing ▶.

**Note!**
By pressing the "previous" button, you will reverse the process in order to repeat any of the measurement steps or to adjust any of the machine dimensions

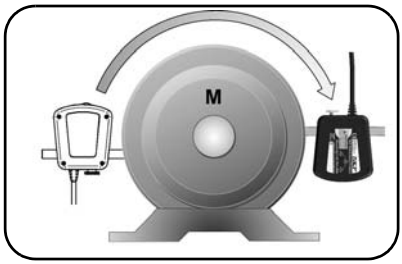


*Fig. 18. Rotate to the 3 o'clock position*

## 3.8 Alignment results

### 3.8.1 Measured misalignment

After the second measurement at 3 o'clock has been confirmed, the misalignment of the two machines in the measurement plane, the plane where the measuring units are (i.e. horizontal in this case) is displayed (fig. 19).

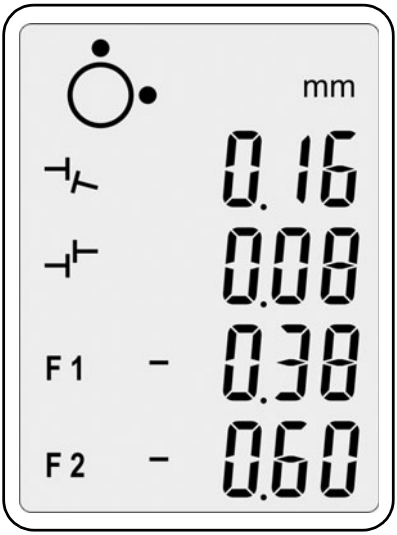


*Fig. 19. Measured misalignment*

**Coupling values**
The coupling value on top of the display shows the angle between the centre lines of the two shafts in the measurement plane (measured in mm/100 mm or 0.001"/1").

The value below on the display shows the parallel off-set of the two centre lines in the measurement plane.

These two values are the coupling values in the measurement plane.

**Feet values**
The values F1 and F2 on the display indicate the relative positions of the Movable machine in the measurement plane.

The F1 value indicates the relative position of the front pair of feet of the Movable machine.

The F2 value indicates the relative position of the rear pair of feet of the Movable machine.

### 3.8.2 Vertical alignment

Adjust the measuring units to the 12 o'clock position (fig. 20) with the aid of the spirit levels

Observe the coupling and feet values live adjustment.

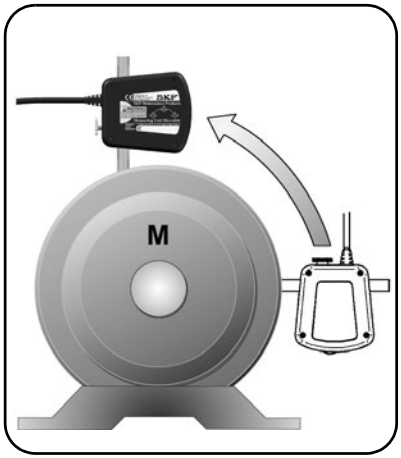


*Fig. 20. The 12 o'clock position*

The machine misalignment should always be within the manufacturer's specified tolerances. In case such tolerances are missing table 1 can be used as a rough guide-line.

Table 1. Acceptable maximum misalignment

| | ⊣⊿ | ⊣⊾ | ⊣⊢ | ⊣⊢ |
|---|---|---|---|---|
| **rpm** | **mm/100 mm** | **0.001"/1"** | **mm** | **0.001"** |
| 0 - 1000 | 0.10 | 1.0 | 0.13 | 5.1 |
| 1000 - 2000 | 0.08 | 0.8 | 0.10 | 3.9 |
| 2000 - 3000 | 0.07 | 0.7 | 0.07 | 2.8 |
| 3000 - 4000 | 0.06 | 0.6 | 0.05 | 2.0 |
| 4000 - 6000 | 0.05 | 0.5 | 0.03 | 1.2 |

a) If the measured coupling values are within the tolerances, the Movable machine does not have to be adjusted. Correct the horizontal misalignment.

   Continue to chapter 3.8.3 Horizontal alignment.

b) If the measured coupling values are higher than the acceptable tolerances check the recommended corrections of the feet.

The F1 and F2 values on the display indicate the relative positions of the Movable machine when viewed from the side (fig. 21).

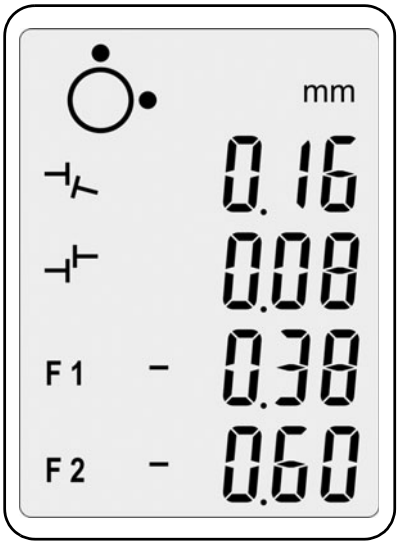


*Fig. 21. Display vertical alignment*

A positive value means that the feet are too high and need to be lowered while a negative value means the opposite (fig. 22).

Loosen the feet of the movable machine.

Use the shims included with the tool to adjust the height of the machine. Observe the coupling and feet values live adjustment.

After having carried out the vertical alignment proceed to the horizontal alignment (chapter 3.8.3).

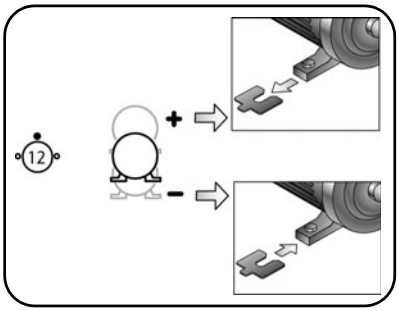


*Fig. 22. Vertical alignment*

### 3.8.3 Horizontal alignment

Move the measuring units to the 3 o'clock position (fig. 23).

Observe the coupling and feet values live adjustment.

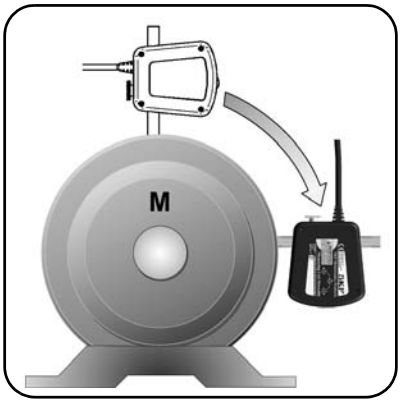


*Fig. 23. The 3 o'clock position*

Machine misalignment should be within the manufacturer's specified tolerances. In case such tolerances are missing, table 1 can again be used as a general recommendation.

a) If the measured coupling values are within the tolerances, no sideways adjustment is necessary.
b) If the measured coupling values are higher than the acceptable tolerances check the recommended correction on the feet.

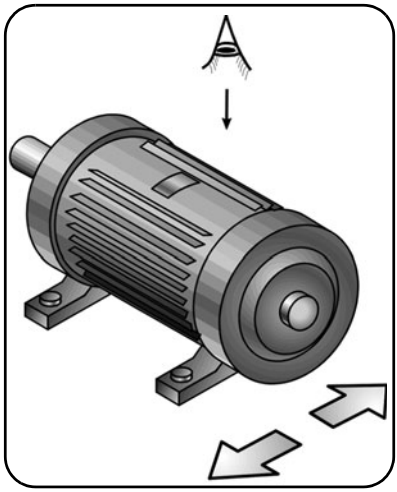

*Fig. 24. Horizontal alignment*

The F1 and F2 values indicated on the display give the relative positions of the Movable machine when viewed from above (fig. 25). The F1 value for the front pair of feet, the F2 value is for the rear pair of feet.

The alignment values indicate the necessary corrective sideways movement of the Movable machine (when viewed from behind the Movable machine).
A negative value means that the feet have to be moved to the right. A positive value means that the feet have to be moved to the left (fig. 26).

Observe the coupling and feet values live adjustment while moving the movable machine sideways.

The alignment is complete. Tighten the feet of the movable machine.


*Fig. 25. Display horizontal alignment*

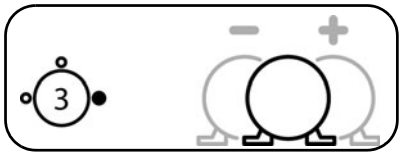


*Fig. 26. Horizontal alignment*

## 3.9 Verify alignment

To verify the alignment of the machinery, it is recommended to execute the measuring procedure once again. To do so, go back by using the previous button until you reach the first measuring step (9 o'clock position) and continue as per chapter 3.7.

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## 3.10 Soft foot

Before starting the alignment it is recommended to check the Movable machine for soft foot. "Soft foot" is the expression used when a machine is not resting equally on all feet.

To find and correct the soft foot do as follows:

1. Tighten all bolts.
2. Execute all preparation steps as per chapter 3.1 to 3.6.

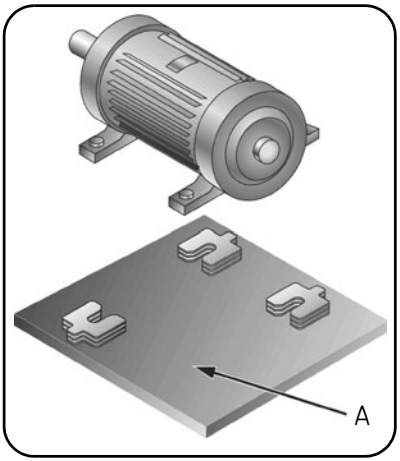



*Fig. 27. Soft foot*
*A Soft foot*

3. Press + and - simultaniously to reach the soft foot mode. The text "soft foot" should now be visible on the screen as shown on the figure 28.
4. Position the measuring units in the 12 o'clock position.
5. Press Next to zero the display values.

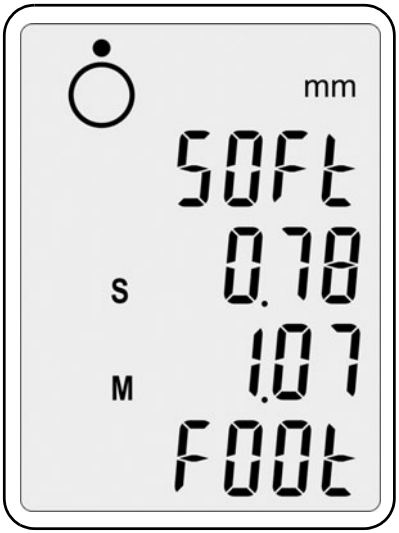



*Fig. 28. Soft foot display*

6. Loosen one of the bolts and monitor the change of the displayed values.
   - If the deviations are less than 0.05 mm (2 mils), the foot has a good support. Tighten the bolt and go to the next foot.
   - If any of the deviations is larger than 0.05 mm (2 mils), the foot or its diagonally opposed foot is a soft foot. Tighten the bolt and check the diagonally opposed foot.
   - If the deviation is larger than the previously tightened foot, then this is the soft foot.
   - If not, tighten the bolt and go back to the previous diagonally opposed foot. It is normally worthwhile to try to improve the support of the soft foot by adding shims. Add the amount of shims corresponding to the larger deviation measured.
7. Tighten and loosen the bolt once again to check that the deviation does not exceed 0.05 mm (2 mils).
8. Repeat steps 5 to 8 for the remaining feet. The soft foot is now checked and corrected.
9. Press + and - simultaniously to leave the soft foot mode and enter the measuring sequence.

## 4 ALIGNMENT REPORT

In order to facilitate recording of the alignment operation, the TMEA 2 is provided with a set of alignment reports.
The report contains the following data fields:

a) Name of the equipment
b) Name of the operator
c) Date
d) Name and/or reference of Stationary machine
e) Name and/or reference of Movable machine
f) Maximum rotational speed
g) Maximum acceptable angle between centre lines of the shafts
h) Maximum acceptable off-set of centre lines
i) Selection of metric or imperial dimensions
j) Machine configuration; distances A, B and C
k) Soft foot correction done
l) Vertical alignment: resulting angular error
m) Vertical alignment: resulting parallel offset
n) Horizontal alignment: resulting angular error
o) Horizontal alignment: resulting parallel offset
p) Vertical alignment: resulting height position of the front feet
q) Vertical alignment: resulting height position of the rear feet
r) Height of shims to be added or removed under front feet (excluding soft foot correction)
s) Height of shims to be added or removed under rear feet (excluding soft foot correction)
t) Horizontal alignment: resulting sideways position of the front feet
u) Horizontal alignment: resulting sideways position of rear feet
v) Remaining vertical angle
w) Remaining vertical off-set
x) Remaining horizontal angle
y) Remaining horizontal off-set
z) Space for own notes

Machinery Equipment / Position

*a*

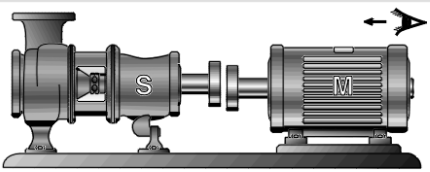
Operator *b*

Date *c*

Stationary Machine Type

*d*

**Alignment report**




Moveable Machine Type

*e*

Rotational Speed

*f* rpm

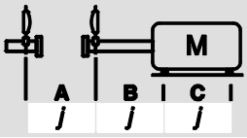
Acceptable Coupling Values

*g* *h*

Measurement System

mm / inch (°/mils)

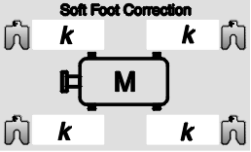
Dimensions




Machine Configuration

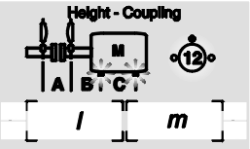
*z*

Soft Foot Correction



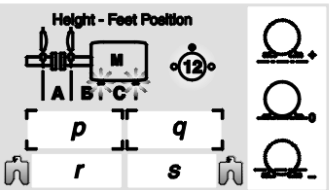

Measuring Results Height

Height - Coupling




*z*

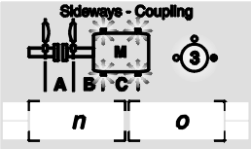
Height - Feet Position




*z*

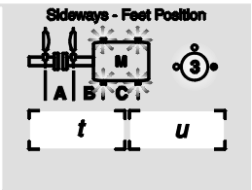
Measuring Results Sideways

Sideways - Coupling

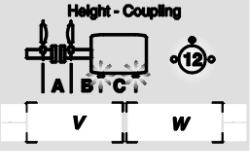



*z*

Sideways - Feet Position



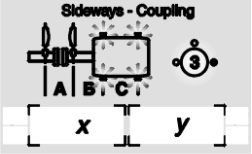

Height - Coupling




Remaining Misalignment

*z*

Sideways - Coupling




TMEA 1 Alignment Report

# 5 ADVANCED USE

## 5.1 Limited rotation

In some applications, limited space around the shaft coupling forbids the rotation of the measuring units to the 9 or 3 o'clock position. However, it is still possible to perform the alignment as long as the measuring units can rotate 180°.

Execute all preparation steps as per chapter 3.1 to 3.6.

Measuring sequence:

1. The display unit indicates that the measuring units should be placed in the 9 o'clock position. Since you can't reach it, place the measuring units in your start position (in our example 11 o'clock) and confirm the measurement by pressing the "next" button: .
2. The display unit now indicates the measuring units should be placed in the 3 o'clock position. Rotate the measuring units by 180° (in our example to the 5 o'clock position) and confirm the measurement: .
3. You can now complete the alignment following the instructions sequence as per chapter 3.8.

## 5.2 Trouble shooting

### 5.2.1 The system does not switch on

a) Check that batteries are inserted in the right way.
b) Replace the batteries. Use principally Alkaline batteries for a better life span.

### 5.2.2 No laser lines

a) Make sure that the display unit is switched ON.
b) Check the cables and connectors. Assure that all cables are properly connected.
c) Check to see if the measuring units' warning LEDs flash.
d) Replace the batteries.

### 5.2.3 No measurement values

a) Check the cables and connectors.
b) Assure that the laser lines hit the positioning detectors.
c) Assure uninterrupted travel of the laser lines.

### 5.2.4 Fluctuating measurement values

a) Assure tight attachment of fixtures and measuring units.
b) Assure that the laser lines hit the detectors.
c) Assure that air turbulence does not influence the measurement.
d) Assure that direct bright light or obstructed laser lines do not influence the measurement results.
e) Assure that external extensive vibrations do not influence the measurement.
f) Assure that radio communications (like walkie-talkies) do not influence the measurement.

### 5.2.5 Incorrect measuring results

a) Assure you face the Stationary machine from behind the Movable machine.
b) Check the attachment of fixtures and measuring units.
c) S-cable to S-unit and M-cable to M-unit?
d) S-unit on Stationary and M-unit on Movable machine?
e) Assure right position before confirmation of measurements.

### 5.2.6 Measurement results cannot be repeated

a) Check if there is a soft foot condition.
b) Check if there are any loose mechanical parts, play in bearing or movements in the machinery.
c) Check the status of foundation, base plate, bolts and existing shims.

# 6 MAINTENANCE

## 6.1 Handle with care

The measuring units are equipped with sensitive electronic and optical parts. Handle them with care.

## 6.2 Cleanliness

For best function the system should be kept clean. The optics near the laser and detector should be free of finger prints. If necessary clean with cotton cloth.

## 6.3 Batteries of the display unit

The display unit is powered by two LR14 (C) batteries. Most LR14 (C) batteries can be used, but Alkaline batteries have the longest life. If not using the system for a long period, remove the batteries from the display unit. Flat batteries will be indicated by the battery signal on the display.

## 6.4 Replacement of measuring units or display unit

Both measuring units are calibrated in pairs and hence they must be replaced as a pair.

## 6.5 Spare parts and accessories

| Designation | Description |
|---|---|
| TMEA 2-DU | Display unit (TMEA 2 system) |
| TMEA 2-MU | Set of measuring units Movable and Stationary (TMEA 2 system) |
| TMEA C1 | Locking chains, set (500 mm) + tightening tool |
| TMEA C2 | Extension chains set (1020 mm) |
| TMEA F2 | 1 chain fixture, complete |
| TMEA MF | 1 magnetic fixture |
| TMEA F7 | Set with 3 pairs of connection rods (short: 150 mm, standard: 220 mm, long: 320 mm) |
| TMAS 340 | Complete kit of 340 pre-cut machinery shims |
| TMAS 360 | Complete kit of 360 pre-cut machinery shims |
| TMAS 510 | Complete kit of 510 pre-cut machinery shims |
| TMAS 720 | Complete kit of 720 pre-cut machinery shims |
| TMAS 360A | Complete kit of pre-cut machinery shims with 2 sets of each TMAS 2, TMAS 3 and TMAS 4 series |