

## I Multi-Axial Configurations ZLM 800

The laser measuring head offers so much power, that several interferometers can be operated. The laser beam can be divided up by Intensity beam splitter (50%, 33% or 25%) on up to 4 measuring systems independent of each other. By the Evaluation unit AE 800 the signals are processed separately for every channel over a special software.

Fig. 1 describes a possible build-up of a two-axis systems with plane mirror interferometers.

At this arrangement are mounted two long plane mirrors by 90° angle on a xy-stage. The coordinates are valid under strict attention of the Abbé's principle for the crossing point of the two laser measuring lines. In this crossing point can align e.g. the axis of a microscope vertical to the measuring level or a 3D caliper. A maximum of accuracy is reached (also at possible pitch movements of the xy-stage).

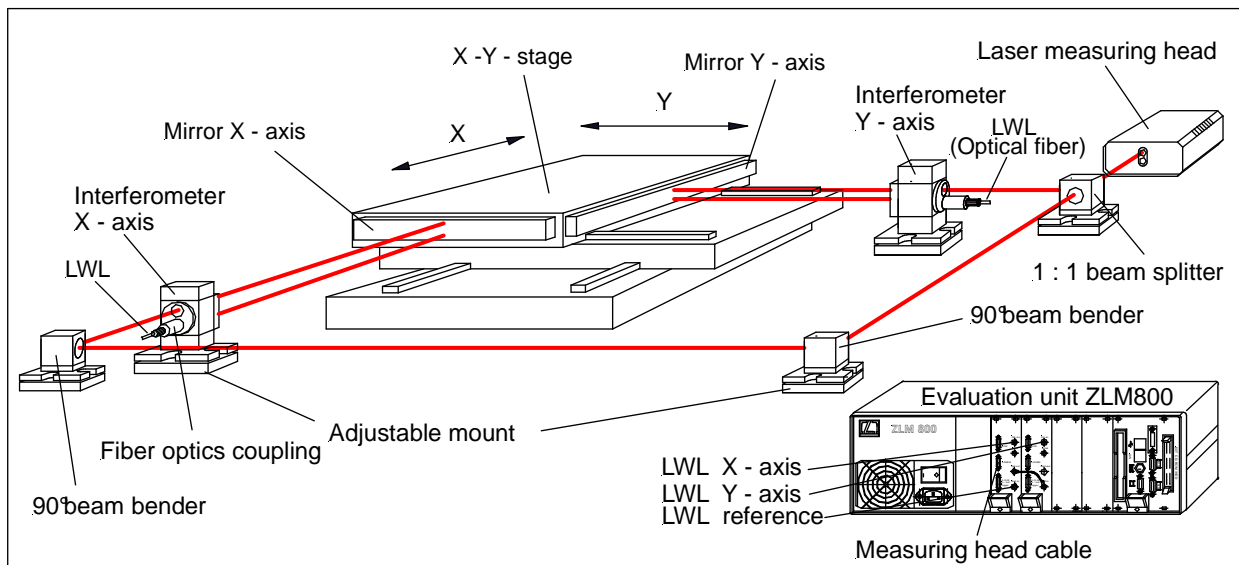


Fig.1 : Build-up of a two-axis systems with plane mirror interferometers

### 1. Optical build-up

The module system ZLM 700/800 allows to build up a variety of variants in accordance with the need. So it is possible to extend the build-up in Fig. 1 by a z-axis or by an Angle interferometer detecting the pitch angle.

#### 1.1. Optical modules for beam control and beam splitting

At the beam control of multiaxis-systems there is the possibility to lead one laser beam into the laser measuring head back. For further axes the beam control from the interferometer must be carried out via fibre optic cables. For the first case optical modules which can control two beams with a distance between each one of 15mm (standard) are necessary.

Therefor there are two groups of optical modules:

- **Optical modules for double beam**
- **Optical modules for single beam**

##### 1.1.1. 90° Beam bender

The optical module consists of a plane tilted by 45°. The 90° angle must be adjusted by tilting of the optical module. The mirror coating is polarization neutral, i.e. the polarization of the laser beam remains unchanged

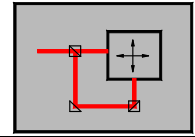


Fig. 2:  
**90° Beam bender 110**  
 for double beam,  
 dielectrically polarization neutral mirror coating  
**Order - No.: 269302-4011.024**

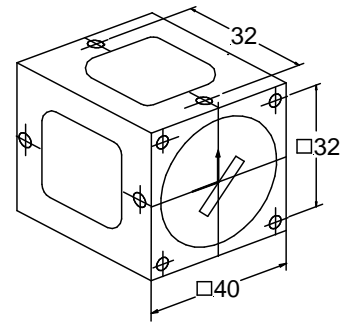
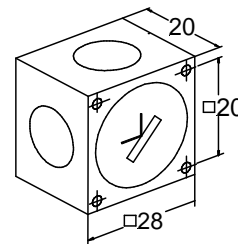


Fig. 3:  
**90° Beam bender 205**  
 for single beam,  
 dielectrically polarization neutral mirror coating  
**Order - No.: 269302-4012.424**



### 1.1.2. Beam splitter

The intensity splitting of a laser beam is made by intensity beam splitter. The laser beam intensity being available shall be divided up on the same quotas for the individual measuring axes. This can be reached by combination with optical components of different dividing behaviour. Intensity beam splitter with higher quota reflection as the transmission are produced only with metal coating. (*Important: Intensity quotas are dependent on the polarization*). In the following table the dividing behaviour of optical modules (into dependence of the polarization) are listed.

Fig. 4:  
**Beam splitter A**  
 for double beam,  
**Order - No.: see into the table**

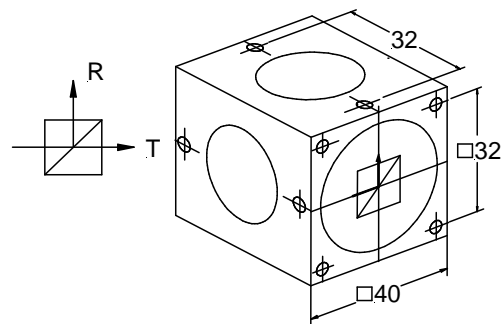
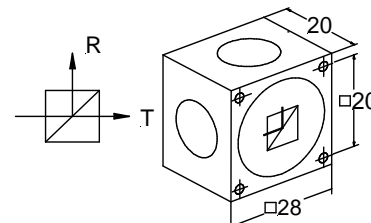
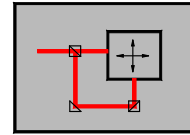


Fig. 5:  
**Beam splitter B**  
 for single beam,  
**Order - No.: see into the table**





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| Splitting ratio  | Article-No. | R / %<br>(Reflection) | T / %<br>(Transmission) | Order-No.       |
|--|-------------|-----------------------|-------------------------|-----------------|
| with dielectric, polarizing neutral coating<br>⊥ vertically polarized       horizontally polarized |             |                       |                         |                 |
| A 1:1  | 201         | ⊥ 50       50         | ⊥ 50       50           | 269302-4011.424 |
| A 1:2  | 212         | ⊥ 33       33         | ⊥ 67       67           | 269302-4017.824 |
| A 1:3  | 211         | ⊥ 25       25         | ⊥ 75       75           | 269302-4017.624 |
| B 1:1  | 203         | ⊥ 50       50         | ⊥ 50       50           | 269302-4012.124 |
| B 1:2  | 210         | ⊥ 33       33         | ⊥ 67       67           | 269302-4017.924 |
| B 1:3  | 209         | ⊥ 25       25         | ⊥ 75       75           | 269302-4017.724 |
| with metallic coating  |             |                       |                         |                 |
| A 2,5:1  | 207         | ⊥ 72       61         | ⊥ 21       32           | 269302-4011.724 |
| A 4:1  | 202         | ⊥ 80       70         | ⊥ 14       24           | 269302-4011.824 |
| B 2,5:1  | 208         | ⊥ 72       61         | ⊥ 21       32           | 269302-4012.324 |
| B 4:1  | 204         | ⊥ 80       70         | ⊥ 14       24           | 269302-4012.224 |

### 1.1.3. Interferometer

The module system of ZLM700/800 offers a variety of build up possibilities (fig.s 10a,b,c). At this a machine part (measuring level) is moved opposite the stationary machine part (reference level). The correct position as well as the tilting of the measuring level shall be measured at this opposite the reference level into two axes.

Fig.10a: shows a measuring build up, - consists of standard components

Fig. 6:

**Polarizing beam splitter 101**  
**Order-No.: 269302-4010.124**

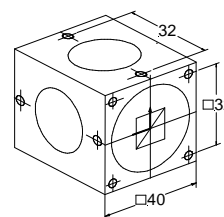


Fig. 7:

**Cube corner reflector 102**  
**Order-No.: 269302-4010.224**

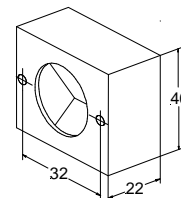
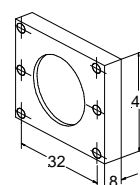


Fig. 8:

**λ/4 – Plate 104**  
**Order-No.: 269302-4010.424**



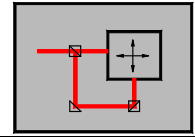


Fig. 9:  
**Fibre optics coupling 222**  
 for Polarizing beam splitter 101  
 Order-No.: 269302-4015.724

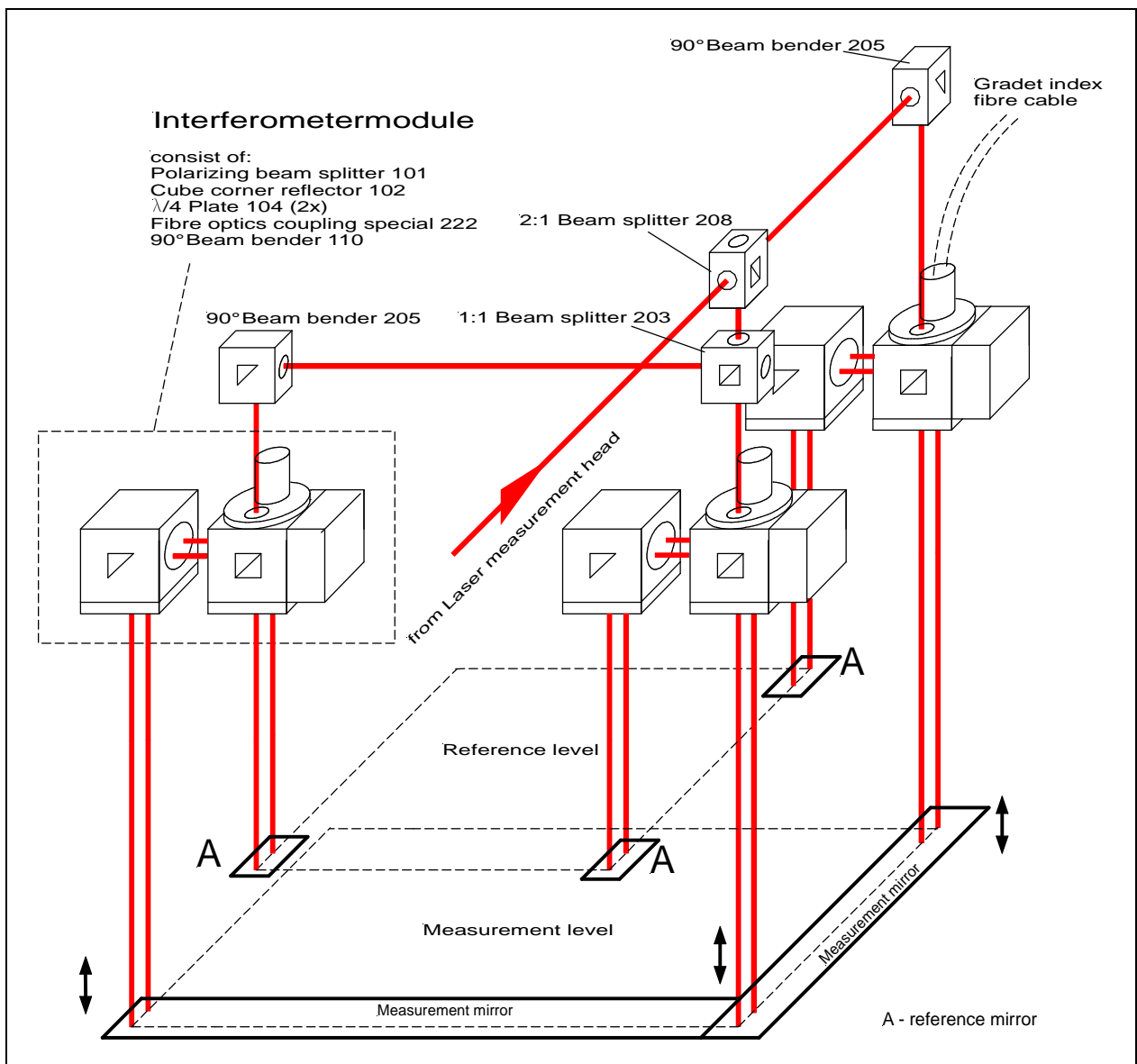
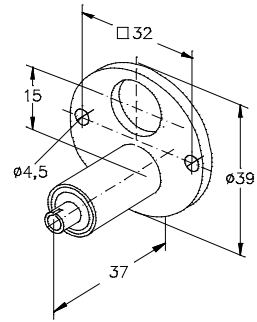


Fig. 10a: Multi-axis-measuring system (3axes interferometer with standard modules)

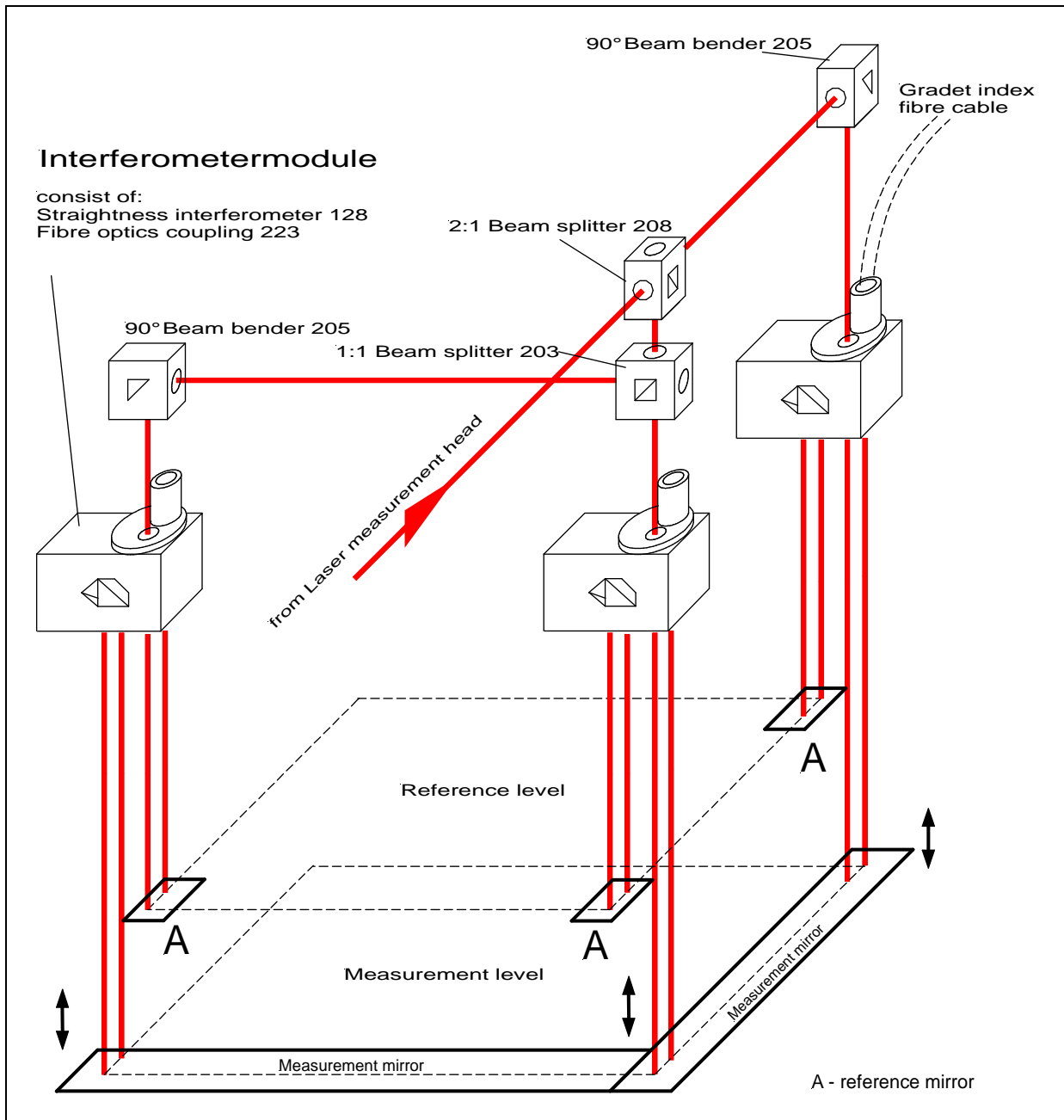
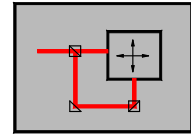
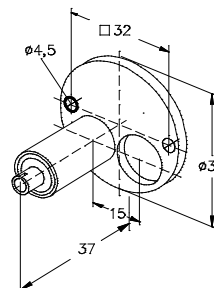
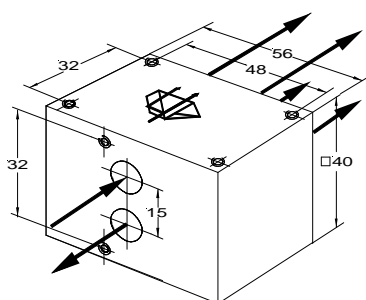


Fig. 10b: Multi-axis-measuring system (3axes interferometer with Straightness interferometer)

Fig. 11:  
**Straightness interferometer 128**  
**Order-No.: 269302-4012.824**

**Fibre optics coupling 223**  
 for Straightness interferometer  
**Order-No.: 269302-4015.824**



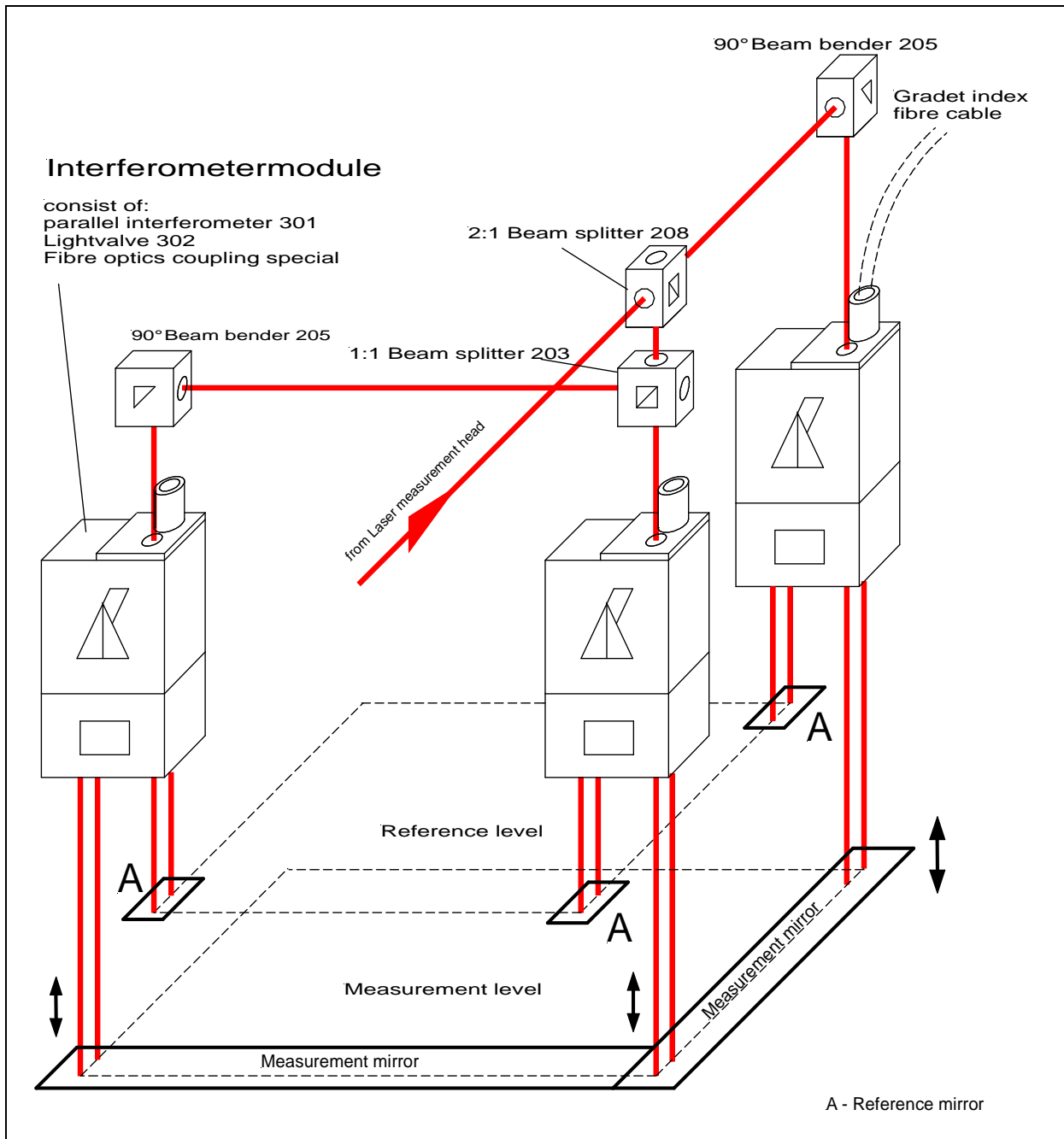
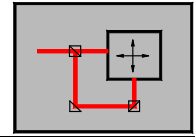


Fig. 10c: Multi-axis-measuring system (3axes interferometer with Parallel interferometer)

Fig. 12:  
**Parallel interferometer 301**  
 („Kösters“ – Interferometer)  
**Order-No.: 269302-4013.324**

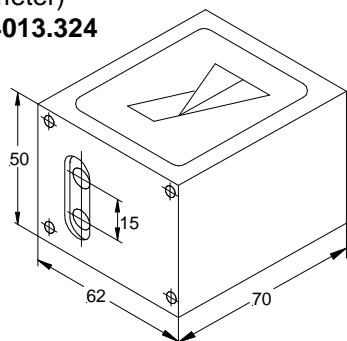
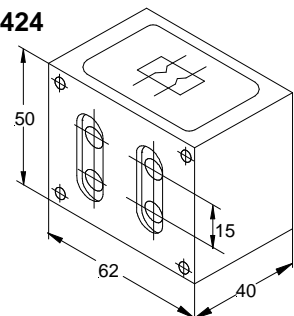


Fig. 13:  
**Light valve 302**  
 (only in connection with parallel interferometer  
 applicatively)  
**Order-No.: 269302-4013.424**



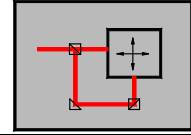
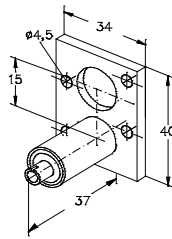


Fig. 14:  
**Fibre optics coupling 224**  
 for Parallel interferometer 301  
**Order-No.: 269302-4015.924**



**1.2. Functional description of the Parallel interferometer**

The part of the laser light branched off from the intensity divider as measuring beam is directed to the Kösters prism (figure 2) where it is divided on the dielectric separating layer into its two partial beams polarized in mutually perpendicular planes. One partial beam is reflected in the direction of the measuring mirror, while the second beam is reflected in the direction of the comparison mirror. They emerge parallel from the Kösters prism and pass through two plane plates before they enter the so-called light valves. One of the plane plates is a  $\lambda/2$  plate which rotates the polarization plane of one partial beam  $90^\circ$ , so that both partial beams then vibrate in the same direction. The second plate does not have a polarization-optical effect, but just serves the preservation of the symmetry of the glass paths. The light valves consist of a polarization-optical beam-splitter which is combined with a triple prism. Rectified and polarized, both partial beams now enter a light valve each where they pass unhindered through the dielectric layer in the beam-splitter, traverse a  $\lambda/4$  plate and are reflected by the measuring and comparison mirrors back onto themselves. While traversing the  $\lambda/4$  plate, both linearly polarized partial beams are converted into circularly polarized light. After the reflection of the two partial beams at the plane mirrors and their renewed passage through the  $\lambda/4$  plate the circularly polarized light again becomes linearly polarized light, but now with the polarization plane rotated  $90^\circ$ , so that the light retroreflected to the dielectric layer of the light valve is no longer transmitted by it but reflected into the direction of the triple prisms. In the triple prisms the two partial beams are reflected parallelly displaced and again reflected by the dielectric layer into the direction of the measuring and comparison mirrors. The partial beams are again circularly polarized through the  $\lambda/4$  plate, reflected at the plane mirrors along the input path and, after traversing the  $\lambda/4$  plate, again linearly polarized. But now the vibration plane is rotated  $90^\circ$  in such a way that the two partial beams are transmitted by the dielectric layer of the light valve and thus can leave it. One partial beam is now again rotated on the  $\lambda/2$  plate in its vibration plane, so that it is reflected at the polarization dividing layer of the Kösters prism and can interfere with the second partial beam transmitted there and directed to receiver 2 of AE800.

The double reflection at the plane mirrors realizes at the same time an optical fourfold interpolation. The fourfold way off the laser beam results by movement off the measuring mirror in optical configuration a resolution off 1,25nm. The beam arrangement is so designed that both beams cover the same ways. A large metrological advantage of this arrangement lies in the symmetry of the beams. (Fig.s 15, 16)

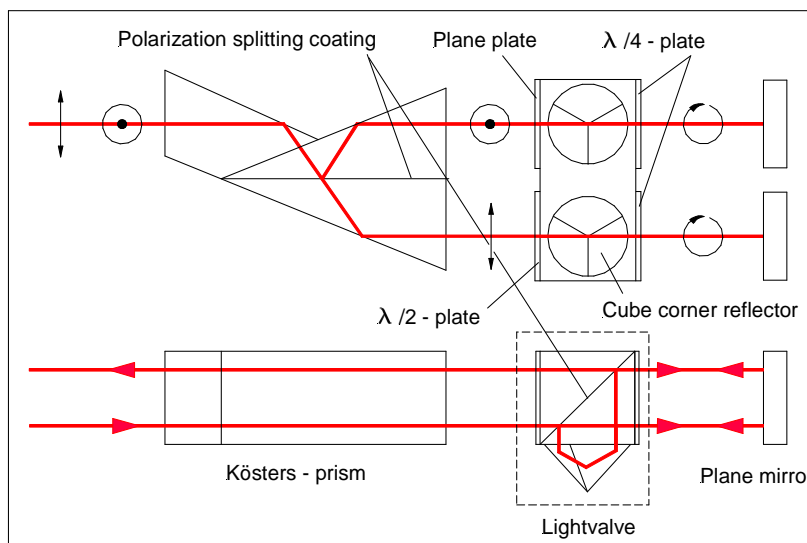


Fig. 15: Parallel interferometer

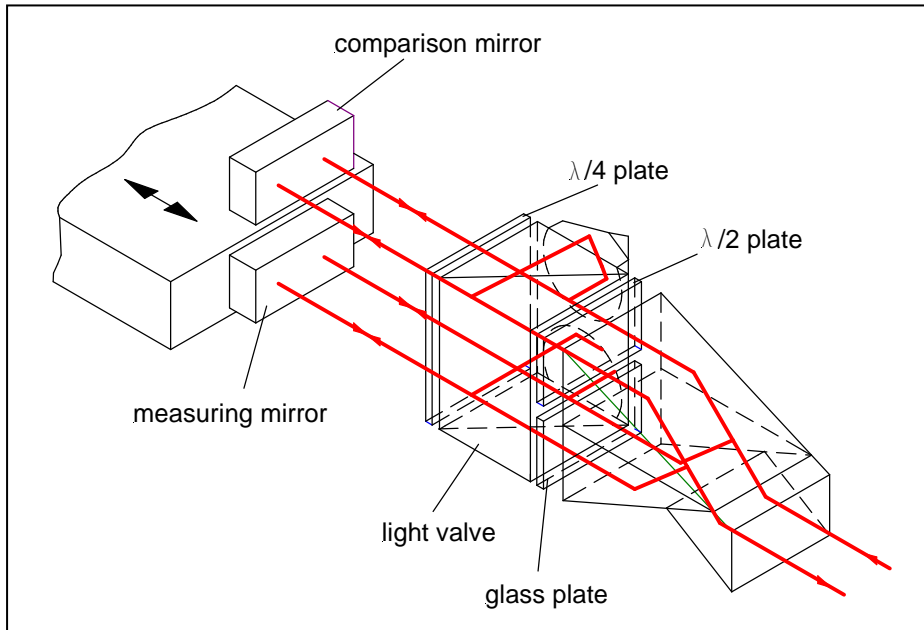
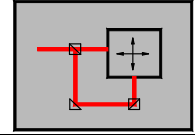


Fig. 16: Schematic diagram of the interferometer optics for difference plane mirror interferometers

### 1.3. Adjustable mount for optical modules

Following adjustable mounts serve to adjustable mounting the optical modules:

Fig. 17:  
**Adjustable mount 588 for optical components □ 40**  
**Order-No.: 269302-4009.025**

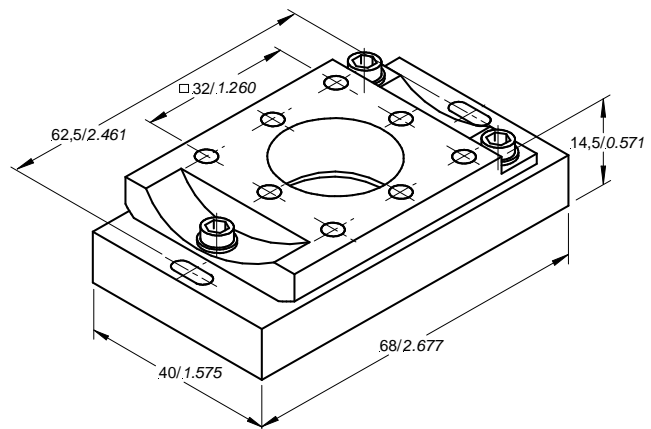
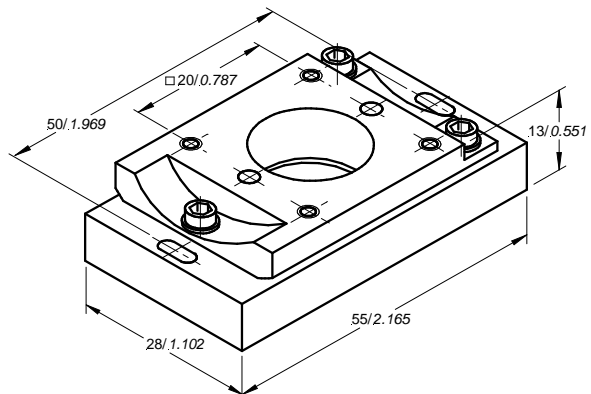
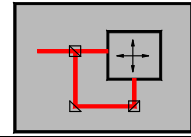


Fig. 18:  
**Adjustable mount 589 for optical components □ 28**  
**Order-No.: 269302-4009.125**





## 2. Evaluation unit AE 800

### 2.1. AE 800cPCI-PXI

The most essential components of the evaluation unit are :

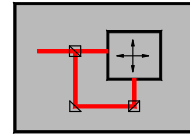
- 19" – 3HE box system for 1 - 4 axis, optionally 6 – 8 axes
- CPCI (PXI) – backplane for 8 slots optionally to 24
- 1 - 4 interpolator assembly (according to quantity off interferometers)
- cPCI/PXI processor insert Pentium III 850 MHz + operating system WINDOWS 2000/XP
- 1 Control unit with RS-232 and CENTRONICS interface
- Interfaces for keyboard, mouse, monitor  
Ethernet, LAN, USB1/2, RS 232, IEEE 488 optionally external Disk drive
- Hardware interfaces of interpolator assembly:
  - 32 bit real time count signals (15ns)
  - AQB – counter input for e.g.. Heidenhain scales (20MHz)
  - AQB – counter output for Motion control (10MHz)
  - 16 x 12 bit ADC - inputs
  - external trigger in / trigger out
  - external to-zero fill

Fig. 19 show the view and the interfaces of the evaluation unit AE 800 cPCI-PXI.

The interfaces of the frontage can be subdivided into interfaces for the data interchange with other units and interfaces, they are necessary for the operation in laser measuring.

#### 2.1.1 Interfaces for operating the laser measuring system

|                      |  |
|----------------------|--|
| Laser measuring head | Measuring head cable to the laser measuring head,<br>(for screen mode of the quality of the alignment of reference and measuring beam) |
| AUK                  | AUK Connection cable   |
| IF - in              | Connections of the Fibre optic cables of each interferometer axis (per axis 1 x)   |
| Ref - in             | Connection of the Fibre optic cables of the reference beam of the laser measuring head   |
| Ref – in/out         | Connections of the cables for the reference signal of the laser measuring head of each measuring cassettes                             |



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### 2.1.2. Interfaces for data interchange

|  |   |
|--|---|
| Keyboard connection and mouse connection | 6-pin Mini-DIN electrical socket (PS/2) and mouse connection  |
| Monitor connection                       |   |
| IDE Interface                            | external connection for a further EIDE – device (Hard disk, CD, disk drive)   |
| Serial Interface                         | data interchange with external units (2 serial ports RS232) to a superordinated computer                                  |
| IEEE 488 or SCSI                         | data interchange with external units (optionally)   |
| IF32 Axis (optionally)                   | 32 Bit-Realtime-Interface f (to get a current position count value in the complement with functions of Reset and Trigger) |
| A-Q-B counter-input 2. counter           | counting of the digital pulses of a Heidenhain-scale (0, 90°, 180°, 270°)   |
| A-Q-B counter-output                     | serial supply off laser position data (0, 90°, 180°, 270°) for Motion control   |

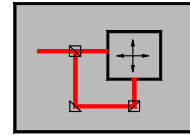
The interfaces important to the user and the operation of the unit are described in the "Software manual".

### 2.2. AE 800 PCI

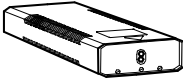
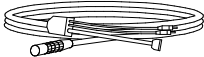


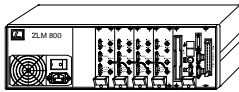
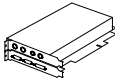
For standard PCs, industry's PCs and portable PCs there are the possibilities of the equipping:

|                          |                                  |
|--------------------------|----------------------------------|
| <b>AE 800 PCI/Master</b> | for the first measuring axis and |
| <b>AE 800 PCI/Slave</b>  | for each further measuring axis  |

Electrical operating conditions and interfaces are as in the case of the compact PXI variant.



### 2.3. Equipment

|   |  |   |
|---|--|---|
| <p><b>Laser measuring head</b><br/>269302-4040.026</p>  |    | <p>Quantity 1</p>                             |
| <p><b>Measuring head cable</b><br/>269302-5041.524</p>  |    | <p>Quantity 1</p>                             |
| <p><b>Grandet index fibre cable</b><br/>212.678</p>   |    | <p>Quantity 1<br/>per axis</p>                |
| <p><b>Power cord (DIN-Standard)</b><br/>146.250</p>   |     | <p>Quantity 1</p>                             |
| <p><b>Evaluation unit AE 800:</b></p> <p><b>AE 800cPCI-PXI</b></p> <p>1 Measuring axis    <b>.../1S</b>    269302-5070.126<br/>                 2 Measuring axes   <b>.../2S</b>    269302-5070.226<br/>                 3 Measuring axes   <b>.../3S</b>    269302-5070.326<br/>                 4 Measuring axes   <b>.../4S</b>    269302-5070.426</p> |   | <p>Quantity 1</p>                             |
| <p><b>or</b></p> <p><b>AE 800 PCI</b></p> <p>1 Measuring axis    <b>.../Master</b> 269302-5071.026<br/>                 for each further one <b>.../Slave</b> 269302-5071.526<br/>                 Measuring axis</p>   |  | <p>Quantity 1<br/>Quantity 1<br/>per axis</p> |

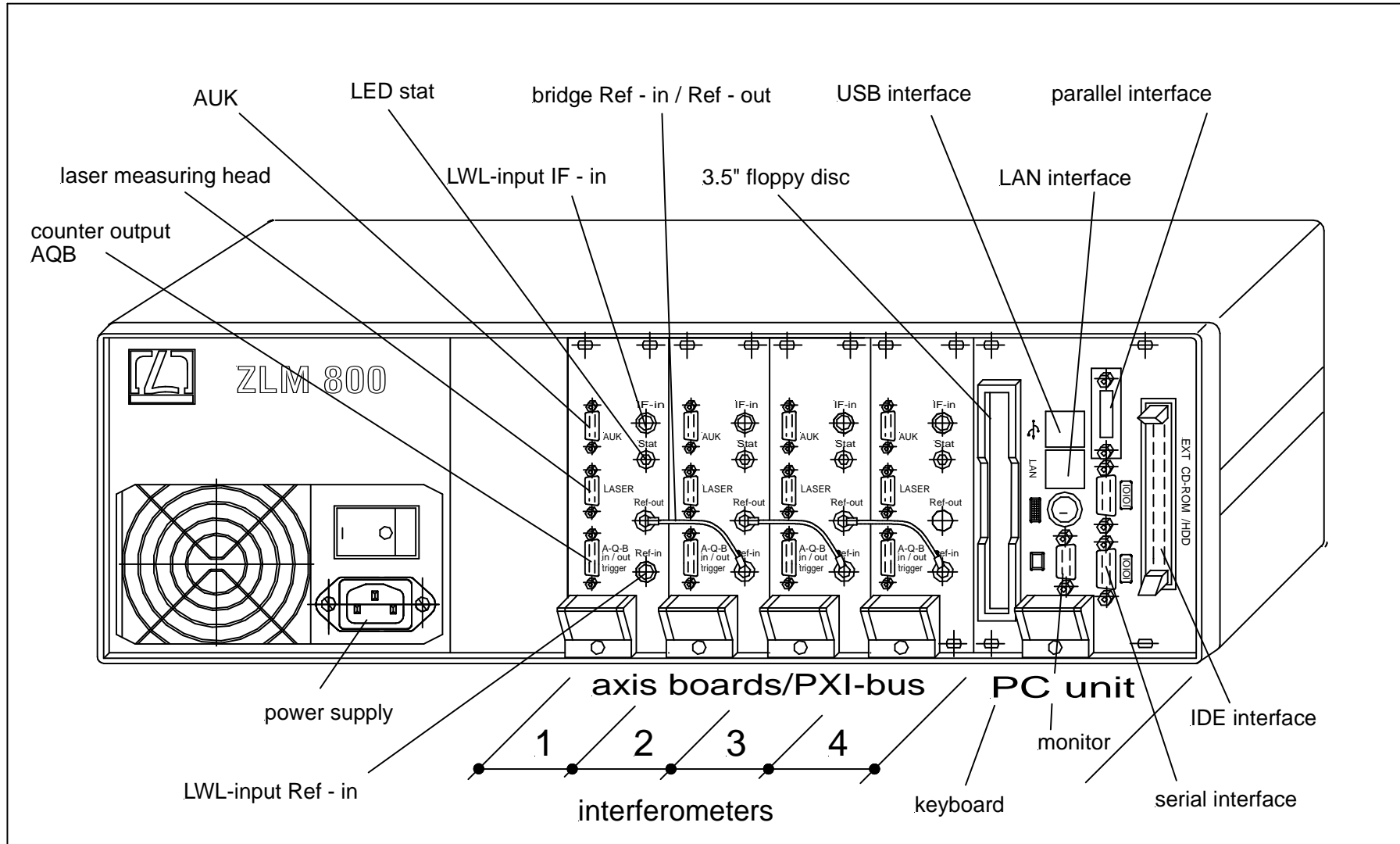
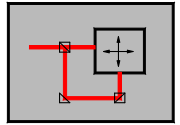


Fig. 19 Evaluation Unit ZLM 800cPCI-PXI