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X-2901
Oct '97

MOLLER-WEDEL

A HAAG-STREIT COMPANY

Adapter for EPICS control
pins 4 & 5
fixed jumper
@ AC side
make adapter
4.50pin → D205
C# 2/2/97

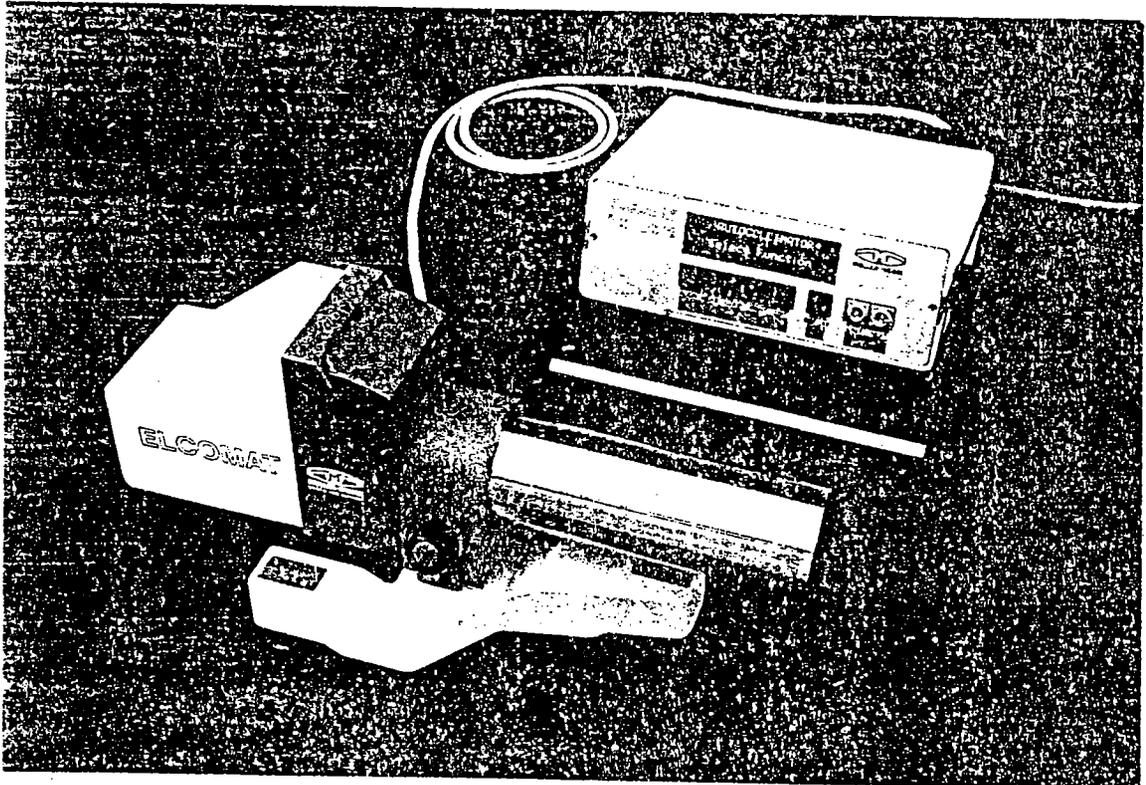
Operation Manual

for the Electronic Autocollimator, 2-axis

ELCOMAT 2000

Ident-No. 219 718

(Elcomat2.TXT-FEL/Pre 02/91)



INTRODUCTION

The Möller-Wedel ELCOMAT 2000 is a complete measuring station for high-precision angle measurement.

The measuring principle used is autocollimation. An illuminated object, in the rear focal plane of the collimator lens, is reflected in a mirror and the image is formed on a light-sensitive receiver.

A small change in the angle between the optical axis of the auto collimator and the mirror causes a deflection which can be very precisely detected.

The electronic autocollimator ELCOMAT 2000 thus permits measurement of very small direction or inclination changes in fractions of angular seconds.

Despite its very high angle resolution, the ELCOMAT 2000 features an extremely large angle measurement range of 30 angular minutes. This permits simple, rapid alignment in practical measurement operation. This enables it to fulfill a wide range of measuring tasks.

The ELCOMAT 2000 measures height and side simultaneously.

The measurements are all made in non-contact manner, working in a spectral range which is visible to the human eye.

The equipment features fully electronic operation via a CCD linear array sensor. It has a highly advanced micro-electronics unit for accurate evaluation and display of the measurement signals with a high degree of reliability. It has a built-in microprocessor for extensive data processing.

For complex evaluation of the measurement results, data transmission from the control unit of the autocollimator can be effected via a standard RS 232 interface for computer control of data.

Extensive software is available for typical applications.

The applications of the autocollimator include, for example, quality control for machine tools, manufacturing facilities and machines of all kinds where angle measurements have to be made with the highest possible degree of accuracy. Use of the equipment in a control loop is also possible, e.g. for monitoring of specified positions, in conjunction with a computer.

In order to ensure the highest possible accuracy of measurement, each autocollimator is individually calibrated and delivered together with a test report.

Applicable for ELCOMAT 2000 - 1 axis -

The standard version of the ELCOMAT 2000 has a calibrated x-axis and a calibrated y-axis.

As an option we deliver the ELCOMAT 2000 with an uncalibrated y-axis. The uncalibrated y-axis only has the task to find the signal. The decimal places are set to zero by the manufacturer.

A further calibration of the y-axis by the manufacturer is possible.

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Annex 1: Description of ELCOMAT 2000 Interfaces.

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A FIRST-TIME OPERATION
A. 1 Unpacking and checking deliveries

The ELCOMAT 2000 is shipped in a stable transportation case. However, do not forget that it is a high-precision measuring instrument, and external mechanical influences should be kept to a minimum.

The ELCOMAT 2000 comprises:

Autocollimation measuring head (AK), Fig.A.1, Fig.D.1
Control unit (AWE), Fig.A.3.

Adjustable mount (option), Fig.D.5
Base mirror (option), (not illustrated)

Power cable, Fig.A.4
Spare fuses (not illustrated)
Lens protection cover

Operation Manual
Test report.

Please check completeness of deliveries with the aid of the delivery note.

Please check whether the seal on the bottom of the auto collimator measuring head is undamaged.

If any parts are missing or assemblies damaged, please inform the manufacturer without delay, or contact the representative for your area.

A.2 Description of assemblies

A.2.1 Autocollimation measuring head (AK), Figs.A.1 and D.1

The autocollimator is mounted on its lens tube (Fig.D.3) in the adjustable mount (Fig.D.5) and attached by means of the screws (Fig.D.2).

The autocollimator is connected with the control unit via the cable (Fig.D.4).

All electronic autocollimators from MÖLLER-WEDEL are checked and calibrated individually. A computer-controlled calibration, in connection with a highly developed reference system, takes account of all the systematic errors that occur in the specific system, e.g. the lens, the autocollimation head and the CCD element.

All correction coefficients are individually entered in the control unit at factory calibration and the microprocessor provides quadratic interpolation for continuous compensation.

Each instrument is shipped with its own test certificate, which documents the absolute accuracy of the instrument.

The ELCOMAT 2000 unit should be sent to the manufacturer regularly for inspection of its calibration state. The inspection intervals are very much dependent on the area of application of the autocollimator; but the calibration intervals should not be greater than 18 month.

A.2.2 Control unit (AWE), Figs. B and C

The control unit contains not only the power supply, but also the complete unit for electronic processing of the measurement signals, the digital measurement display and the corresponding software for simplified handling of measurement jobs.

The luminous display (Fig.B.1) permits easy reading of the data and menu-guided programs, even under poor lighting conditions.

Operation is effected via a keypad with a total of 8 keys.

The individual programs can be called up with the 5 program keys (Fig.B.2) on the left. A detailed presentation of the programs is given in Section B of this manual.

The rear of the control unit (Fig.C) accommodates the power switch with the power connector socket and the fuse.

The fuses shown in Figs. C.7 and C.8 are for protection of the low-voltage supplies.

The measuring head is connected to the socket Fig.C.1.

An oscilloscope can be connected to socket (Fig. C.2) for testing the measurement signals that are present.

The "PRINTER" output (Fig.C.3) is an RS 232 interface for connection of a printer.

The "COMPUTER" output (Fig. C.4) can be used for reading data direct into a computer.

A.2.3 Adjustable mount

The ELCOMAT 2000 is mounted for alignment in an adjustable mount, as shown in Fig. A or Fig. D.

Two versions are available:

Adjustable mounting D 65
Ident No.: 223 032

The ELCOMAT tube is slid into the mount and fastened with the pipe attachment.

Two of the three mounts are height-adjustable via knurled screws, thus permitting adjustment of the measuring head.

Adjustable mount (option) with bearing support
Ident No.: 223 018, combined with 223 003 (see Fig. D).

This adjustable mount permits independent setting of the two axes via two knurled screws. For attachment, slide the autocollimator measuring head into the bearing support and secure against turning by means of two screws (Fig.D.2).

A.2.4 Selection of mains voltage

The appropriate mains voltage can be set on the voltage selector of the control unit (Fig.C.9). Ensure that the appropriate fuse is inserted, depending on the mains voltage. The fuse for power supply is located in a small drawer below the power switch (Fig.C.11).

Mains voltage 220V - Fuse T 0.16
Mains voltage 110V - Fuse T 0.315

Together with the voltage selector, the fuses (Figs. C.7 and C.8) serve to protect the low-voltage supplies in the unit. The values of these fuses remain the same, regardless of which mains voltage is selected.

A.3 First-time operation of the unit

IMPORTANT:

Before first-time operation of the ELCOMAT 2000, check whether the mains voltage corresponds to the voltage indicated on the nameplate (Fig.C.6).

If this is not the case, set the voltage selector (Fig.C.9) to the correct value and insert the appropriate fuse (Fig.C.11).

Slide the autocollimator into the bearing support of the adjustable mount, as shown in Fig.D. Two hexagon socket head screws with opening size SW 5 are provided for fixing the autocollimator in the bearing support.

For data transfer, the autocollimator measuring head is linked with the control unit (socket Fig.C.1) via the cable (Fig.D.4).

IMPORTANT:

When connecting the control unit and the autocollimation head with the connection cable, the control unit must be switched off !

The ELCOMAT 2000 is started up via the power switch (Fig.C.5).

B NOTES ON OPERATION

Thanks to the modular structure of the integrated microprocessor system, the autocollimator is simple to operate and is clearly structured; it does not require any specific prior knowledge on the part of the operator.

Visual guidance via the luminous alphanumeric display and audible guidance via a buzzer is provided to guide the operator through the operating program and to draw his attention to any faults or operating errors that occur.

The following sections give detailed instructions for handling the ELCOMAT 2000

IMPORTANT:

When connecting the control unit and the autocollimation head with the connection cable, the control unit must be switched off !

B.1 Menu-guided control unit

After the ELCOMAT 2000 is switched on, the display shows

"AC SELECT FUNCTION".

If the display is given:

"AC IS UNCALIBRATED"
"SELECT FUNCTION"

this means that an uncalibrated measuring head has been connected to the control unit.

To call up the individual programs, type the corresponding program key (Fig.B.2) once. To quit the program, press the same key again.

All actions which are executed are confirmed by an audible signal (beep).

The following programs are available for further execution of measurements:

B.1.1 "ALIGN" program

This program serves as an alignment aid.

If the program is called up by pressing a key at a time when there is no baseline mirror aligned in front of the measuring head, the following message appears:

"NO SIGNAL on X"
"NO SIGNAL on Y"

If a mirror is set up and aligned in autocollimation, the measurement data are indicated as "angular seconds". The displayed angle data are absolute values, related to the optical axis of the autocollimator.

Below this, a graphic display appears, with a cursor showing the position of the autocollimation diagram and the height of the cursor representing the signal strength.

To toggle between the channels X and Y use the keys NEXT and LAST. If one channel is not aligned

"NO SIGNAL on X,Y"
"TRY OTHER CHANNEL"

respectively appears.

B.1.2 "MEASURE" program

After this program is called up, the absolute values are displayed in angular seconds.

At the same time, the display shows the file number under which the data are to be stored. The quantity of data stored is shown behind the slash. A total of 80 data can be stored per file. For extensive measurements, up to 10 data files can be recorded, with 80 data each.

The keys "LAST" and "NEXT" can be used to store the data displayed in sequence, and if necessary to delete them individually in the reverse sequence. This is necessary, for example, if an actual data value is incorrect and has to be recorded and stored again.

To store a first data value, press "NEXT". Then there is a relative display of the data and the first data is set to zero. For all data which follow, press the "NEXT" key again. All further data are related to the first data (relative measurement).

If there are already data stored under the file numbers shown in the display, after pressing the NEXT key, the following appears on the display:

"FILE HAS VALUES"
"ERASE IN EDIT"

The data stored under the file number indicated can only be erased in edit mode (see "EDIT" program).

If stored data are to be retained, select a new data file which has nothing written in it for data to be recorded new (see notes on "EDIT" program). For this purpose, quit the "MEASURE" program by pressing the "MEASURE" key again. Then call up the "EDIT" program.

The actual quantity of stored data is shown in the display.

B.1.3 "COMPUTER" program (Option)

If there is no computer and printer connected to the ELCOMAT 2000, after the "COMP" key is pressed the display shows the message:

"COMP.PORT is OFFLINE"
"PRINTER PORT OFFLINE"

Data which are present can be read into a computer via the computer interface on the rear of the control unit.

Further technical data and an interface description are given in Section D of this Operation Manual.

B.1.4 "PRINT" program

The stored data can be printed out via a separately connected printer, via a "PRINTER" interface.

For printing the stored data, the associated measuring head must be connected to the control unit.

The measurement data series selected at the respective point in time is then printed out. The desired measuring data series can be preselected in the "EDIT" program.

If there is no printer selected, the message

"PRINTER IS NOT AVAILABLE"

is displayed.

Further notes and technical data are given in Section D of this Manual.

B.1.5 "EDIT" program

This program enables stored data files to be called up and individual data to be checked.

After the "EDIT" program is called up, the individual files can be selected via the commands "NEXT" and "LAST". These may be stored data series which are intended for printout or only to be checked. For a new measurement series, call up an empty data file. In this case, the display shows:

"EDIT select file(m)"
"FILE IS EMPTY"

The display of the individual data from a data file can be effected by pressing the "DISPLAY" key. The corresponding data can be selected with "LAST" and "NEXT".

The "PRINT" program is for printout of a stored data file on a printer. The desired data file is selected as described above.

In order to printout data, exit from the "EDIT" program.

If data files are to be erased, first select the data file to be erased. This is done by means of "NEXT" and "LAST".

Erase the data file by simultaneously pressing the two keys "DISPLAY" and "LAST". The display shows:

```
"EDIT select file (m)"  
"-- File is erased --"
```

Then it is possible to exit from the program by pressing "EDIT".

If a number of data files are to be erased, repeat the above operation accordingly.

B.1.6 "DISPLAY" program

Apart from the function described under "EDIT", Section B.1.5, the "DISPLAY" program is for switching over from standard measurement to measurement with noise suppression. Pressing the key causes a switchover in each case and the actual mode is shown on the display. In addition, when data are shown on the display, the selected mode can be recognised as follows:

If the "Snake" (~) is displayed, this shows that noise suppression is activated. This is also possible during the "MEASURE" program. However, the "Snake" (~) no longer appears later.

In this measuring mode, too, the displayed data are updated every 0.35 seconds, but the data occurring within this time are damped. Short-term fluctuations in the measurement signal (e.g. due to air turbulences) can then only have a minor effect on the data.

B.1.7 "LAST" and "NEXT" commands

These two keys are for entering and storing data which are currently present.

They can be used to delete files and to call up files or data stored in the programs "EDIT" and "DISPLAY".

B.1.8 Further notes on operating

If the ELCOMAT 2000 is to be used in connection with an IBM personal computer or an IBM-compatible computer, please refer to Section D of this Manual.

Specifically developed programs are available to handle certain measuring jobs such as straightness or flatness measurements.

B.2 Measurement conditions

The reflectivity of the base mirror must be at least 4% with a diameter of 30 mm. This is equivalent to the reflection of an unsilvered glass surface.

For a silvered surface (reflection factor at least 80% for a wavelength of 660 nm), the diameter of the autocollimation mirror must be at least 7 mm.

The optical quality of the mirror surface (flatness) should be better than $\lambda/8$ (for $\lambda = 660$ nm).

If the deviation from flatness is poorer than this, this may lead to a reduction of measuring accuracy.

For all measurements, the distance between the autocollimator and the base mirror should be kept as small as possible. This can reduce the influence of air turbulences and provide the largest possible measuring range.

The ELCOMAT 2000 should have reached its "thermal equilibrium" after any new installation, before starting measurements.

In order to achieve the full measurement accuracy and stability of the autocollimator, measurements should not be started until 30 minutes after setting up.

C NOTES ON PRACTICAL IMPLEMENTATION OF MEASUREMENTS

C.1 Preparations for measurements

C.1.1 Alignment of the autocollimator
with electronic alignment aid and viewfinder prism

- * Slide the autocollimator carefully into the bearing support
- * Place a base mirror on the surface to be measured, at a small distance from the autocollimator.
- * Capturing the autocollimation image can be done quickly and easily via the electronic alignment aid, with the aid of the "ALIGN" program for both direction height and side in an acquisition range of approximately 1°.

Call up the program for aligning the measuring set-up by pressing the key "ALIGN". The "Digital Eyepiece" simplifies proper alignment of the 2 measurement axes of the autocollimator relative to the object mirror.

Normally the following message appears:

"NO SIGNAL on X"
"NO SIGNAL on Y"

In this case the autocollimation image of both axes lies outside the catchment area of the acquisition range of the device. To find the autocollimation signal of the x-axis it is useful to turn the base mirror. If the signal is present press the key "NEXT" to find the y-axis and align the ELCOMAT 2000.

The height of the cursor shown gives a qualitative indication of the signal strength of the autocollimation image. If the cursor consists only of a line, this means that only a weak signal is detected. One reason for this may be that the optical axes of the base mirror and the autocollimator do not coincide. This can be remedied by shifting the base mirror.

A small reflectivity or very small dimensions of the mirror may also cause weak signal strengths.

If the autocollimation signal is too weak, the ELCOMAT 2000 gives an audible warning signal (beep) and the message "NO SIGNAL" appears on the display.

For all measurements it is necessary that when the base mirror is moved it should be illuminated as completely as possible by the collimator beam path. A simple check can be made in a darkened room by holding a white sheet of paper in front of the mirror and observing the slit image which appears on it.

- * The alignment of the autocollimator head in its mounting with respect to the measurement plane is done via the electronic alignment aid "ALIGN".

Once the ELCOMAT 2000 is properly aligned, it can be fixed with the aid of the clamping screws of the mount.

IMPORTANT: *The screws should only be tightened slightly and with care.*

If it is difficult to capture the autocollimation image at great measurement distances, pre-adjustment can be made with the aid of the viewfinder prism (option, Fig. E).

- * The autocollimator should be aligned such that the expected data are as symmetrical as possible to the optical axis, i.e. the angle data shown should be approximately zero.

To exit the "ALIGN" program, press the key again.

C.2.1 Making measurements

After alignment has been completed, the measurements can be started. Although the ELCOMAT 2000 has a very wide measuring range, before starting a measurement it is advisable to check whether there is an autocollimation image, i.e. a data value present for all positions of the base mirror that are to be measured. This can be done simply by observing the cursor in the "ALIGN" program, while the base mirror is moved on the path to be measured.

Measurements are made with the "MEASURE" program, which is called up by pressing the appropriate key.

If there are already data fields stored, use the "EDIT" program (Section B.1.5 and B.1.6) to select a data field which is still free, or simultaneously press the "LAST" key and "DISPLAY" to clear the currently present data field.

To store the first data, use the "NEXT" key. Each stored data is consecutively numbered on the display.

To repeat a data, press the "LAST" key to delete the last data entry. If a new value is to be stored in place of it, press the "NEXT" key.

Each pressing of the "LAST" key permits deletion of the last data, so that repeated pressing permits deletion of parts of a measurement series. However, it is not possible to delete individual data within a series of data and then to restore.

Once all data have been recorded and stored, a log for these can be printed out via a printer (option). See section B.1.4, "PRINT" program.

Up to 10 data fields, each with 80 data, can be stored in the ELCOMAT 2000.

The stored data are retained in the ROM memory even after the ELCOMAT 2000 is switched off, so that the data can still be processed at a later stage.

Further indications on the progress of measurements are given in the optionally available software packages.

D TECHNICAL DATAD.1 Autocollimator (two axes measuring head)

| | |
|--|---|
| Lens: | <ul style="list-style-type: none"> ● free aperture 50 mm ● Outer diameter 65 mm ● Focal length 300 mm ● Illuminated aperture: approx.32 mm |
| Light sources: | <ul style="list-style-type: none"> ● High-performance LED ● Wavelength 660nm |
| Detectors: | <ul style="list-style-type: none"> ● 2 CCD linear arrays |
| Adjustment and alignment aid: | <ul style="list-style-type: none"> ● "Digital Eyepiece" |
| Aquisition range: | <ul style="list-style-type: none"> ● 3600" |
| Measuring range: | |
| - total | <ul style="list-style-type: none"> ● >30 angular minutes (corresponds to $\pm 1000''$) |
| - for distance auto-collimator mirror | <ul style="list-style-type: none"> ● up to 200mm: $\pm 1000''$ ● up to 3000mm: $\pm 500''$ ● up to 7500mm: $\pm 100''$ |
| Measuring accuracy: | |
| - Over any 20" within a measuring range $0^\circ \pm 100''$ (in absolute measuring mode) | $\pm 0.15''$ |
| - For relevant total measuring range | $\pm 0.50''$ |
| (Measuring range is dependent on measurement distance, see above.) | |
| Resolution: | 0.05" |
| Reproducibility: | 0.05" |
| Maximum measurement distance: | 10 m |

D.2 Mirror

- quality (for $\lambda = 660 \text{ nm}$): better $\lambda/8$
- minimum diameter at distance 0.1 m:
 - unsilvered glass surface (refractive index 1.5): 30 mm
 - silvered surface (80% reflection at 660 nm): 7 mm

D.3 Control unit

A microprocessor-controlled control unit with clearly structured software modules ensures rapid acquisition of data.

The inclusion of AGC amplifiers together with automatic luminous flux control and patented fully digital evaluation provides extremely good long-term constancy and accuracy.

Software-controlled online compensation of systematic errors is effected by a high-speed numerical algorithm.

Alphanumerical display of measurement data via a luminous display.

Memory divided in 10 files, each capable to store 80 values. Edit-functions to display and modify any stored measurement values.

"Digital Eyepiece" - display shows the position of the mirror direction within an acquisition range of approximately 1° depending on measuring distance.

Electronic adjustment aid "ALIGN" with signal strength dependent display of deflection.

Power supply:

- According to indications on nameplate (Fig. C.6).
- Selectable: 110/220V.

Fuses:

- 1 main fuse T 0.16/0.315, depending on mains voltage (Fig.C.11)
- 1 fuse T 0.5 (Fig.C.7)
- 1 fuse T 2.0 (Fig.C.8)

Standard interfaces:

- Printer interface, serial, RS 232
- Computer interface, serial, RS 232
Both as 25-pin D-subminiature connectors
(detailed description of interfaces in Annex 1).

E MAINTENANCE AND SERVICING

The electronic collimator requires no particular maintenance if operated in a clean environment.

The painted, anodized and hard-chrome-plated surfaces can be cleaned with a moist cloth and a mild commercially standard cleaning agent.

The measuring head lens should be dusted carefully with a blower brush if necessary. If this treatment is not sufficient for cleaning, use a clean linen cloth to wipe afterwards.

If there are marks or fingerprints on the lens surface, these can be cleaned off with a mixture of ether and acetone (mixing ratio 8:1).

CAUTION: The solvents are combustible.

A complete lens cleaning set is available under Ident No. 241 146.

Each instrument is shipped with its own test certificate, which documents the absolute accuracy of the instrument.

The ELCOMAT 2000 should be sent to the manufacturer regularly for inspection of its calibration state. The inspection intervals are very much dependent on the area of application of the autocollimator; but the calibration intervals should not greater than 18 month.

F GUARANTEE PROVISIONS

12 months after date of shipment

G FIGURES

- Fig. A - ELCOMAT 2000 with control unit
- Fig. B - Control unit - front view
- Fig. C - Control unit - rear view
- Fig. D - ELCOMAT 2000 in adjustable mount with bearing support
- Fig. E - Viewfinder eyepiece (option)
- Fig. F-I - Flowchart for menu guidance

Control unit (front view)

- B. 1 Luminous display
- B. 2 Keys for program call up
- B. 3 Key for signal noise suppression and individual data display in connection with EDIT
- B. 4 Keys for data recording in connection with EDIT
- B. 5 Handle, swivelling with rest positions

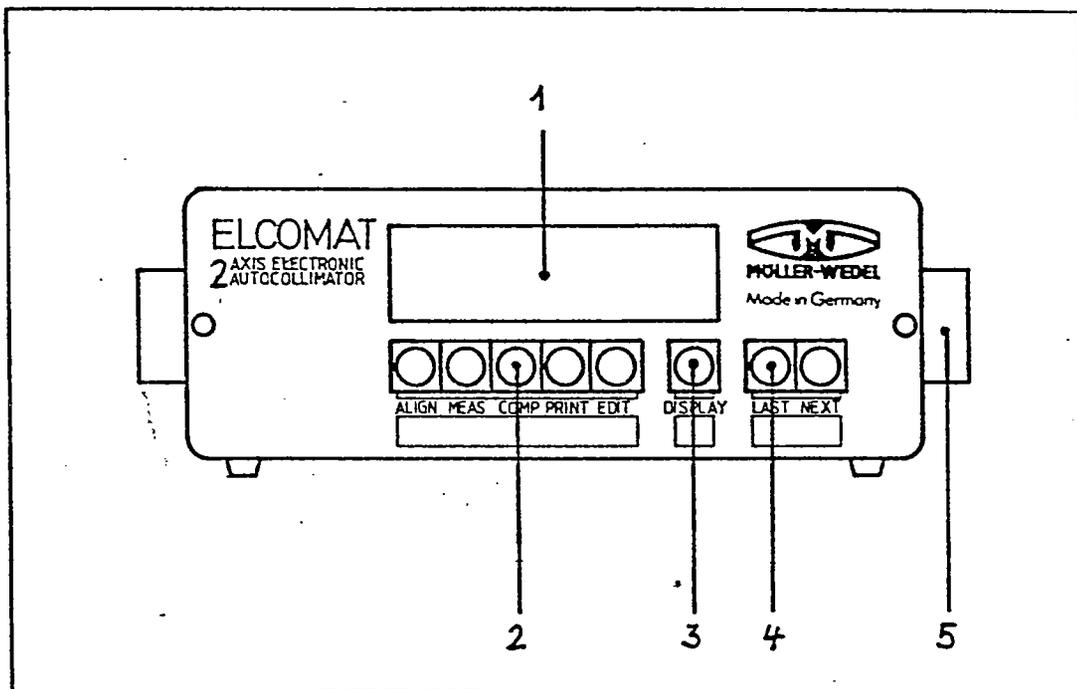


Fig. B

Control unit (rear view)

- C. 1 Socket for data transmission to measuring head
- C. 2 Socket for system test
- C. 3 Interface for printer
- C. 4 Interface for external computer connection
- C. 5 Power switch
- C. 6 Nameplate
- C. 7 Fuse for low-voltage supplies
- C. 8 Fuse for low-voltage supplies
- C. 9 Voltage selector
- C.10 Socket for mains connector
- C.11 Mains fuse

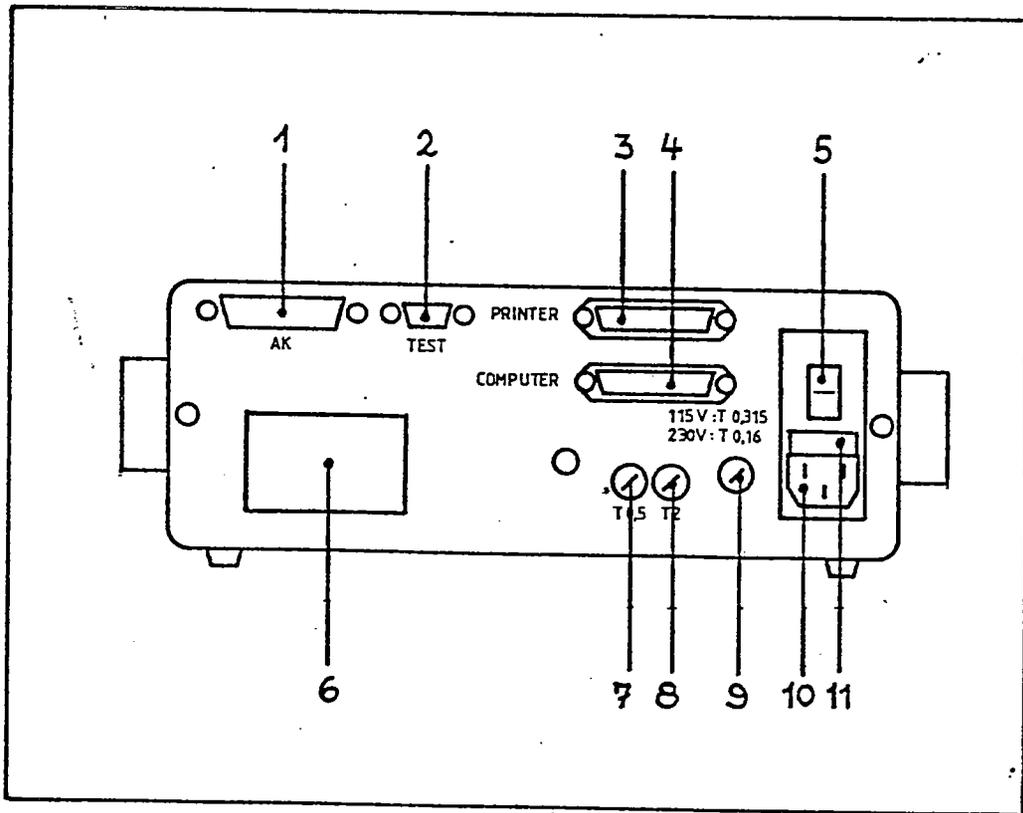
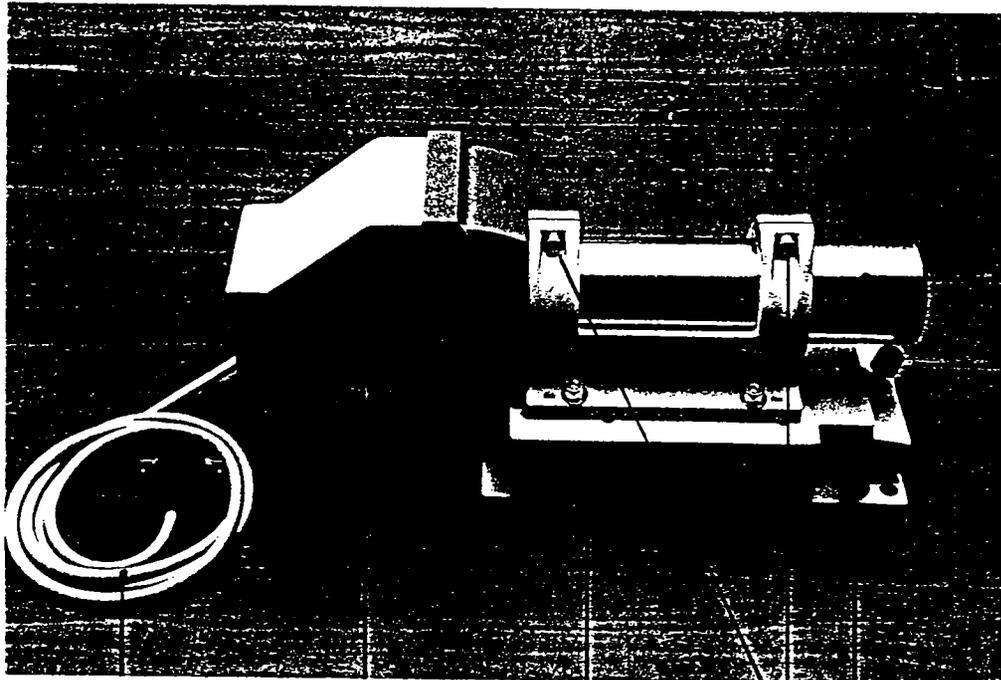


Fig. C

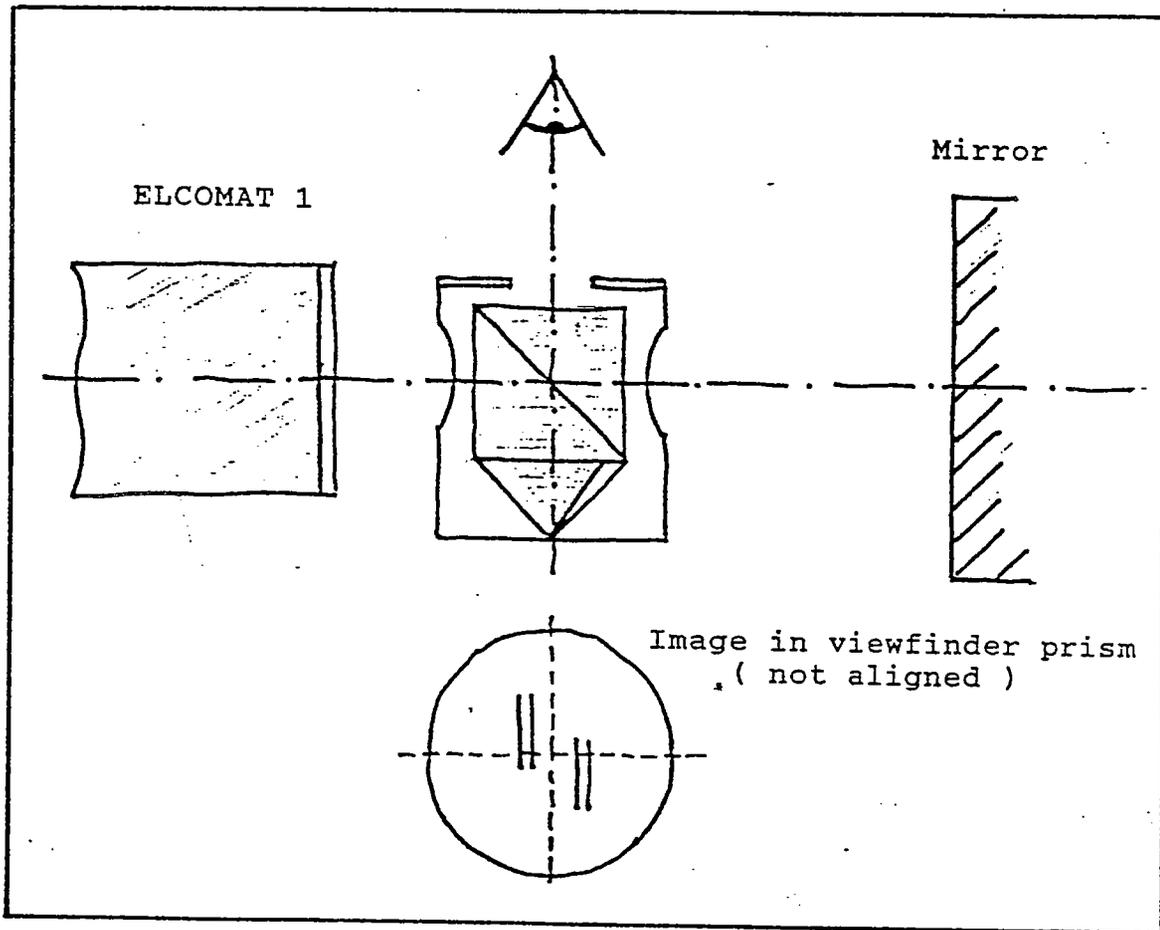
ELCOMAT 2000 in adjustable mount with bearing support



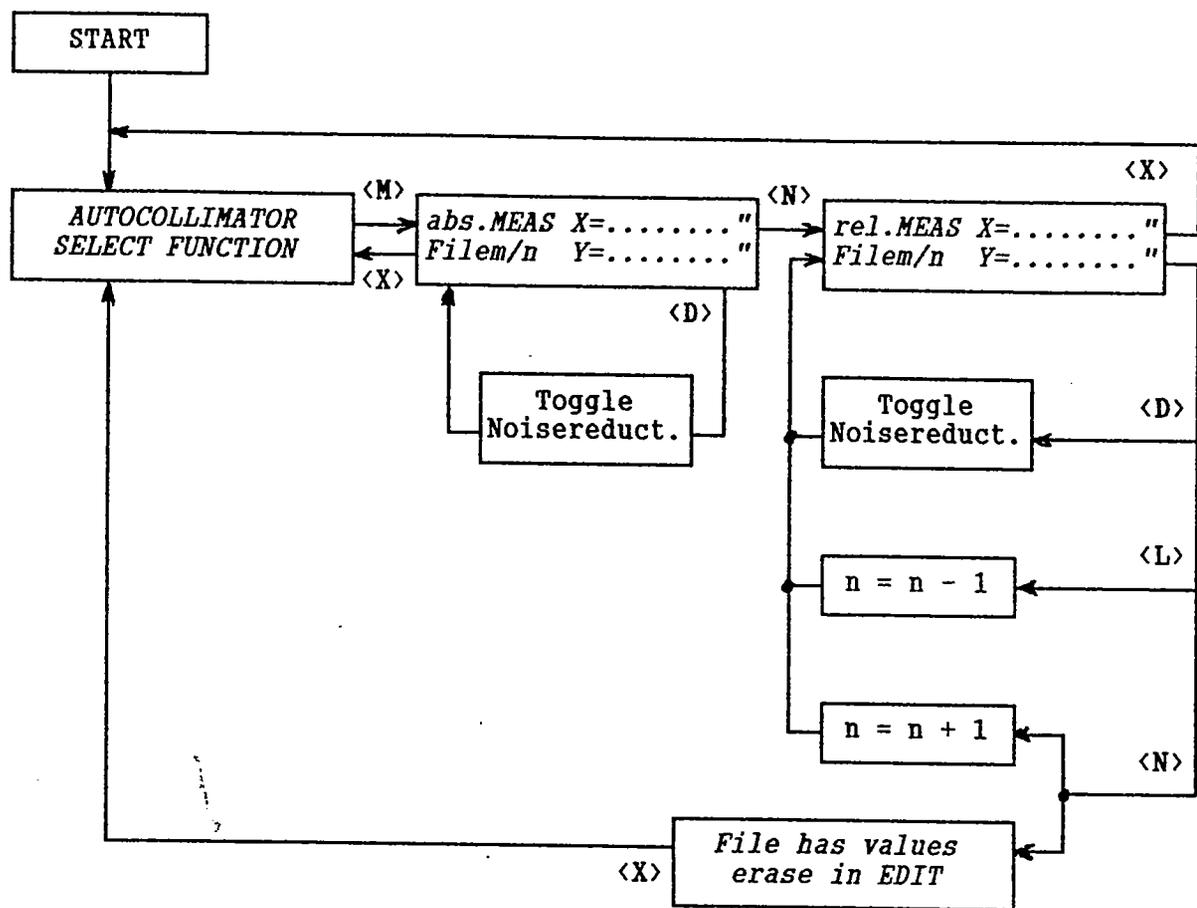
- D. 1 Measuring head
- D. 2 Clamping screws for lens tube
- D. 3 Lens tube
- D. 4 Cable to control unit
- D. 5 Adjustable mount
- D. 6 Adjustable button, side
- D. 7 Adjustable button, height

Viewfinder prism (option)

Schematic diagram



"MEASURE" program



"COMPUTER" program

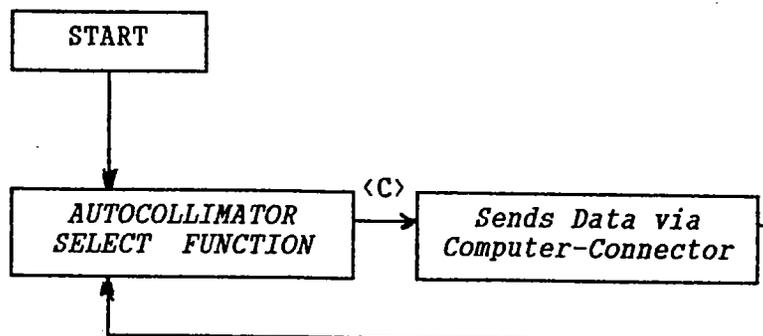
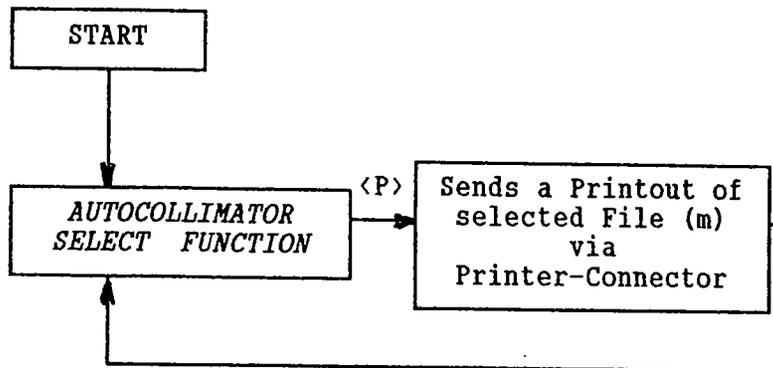


Fig. G

"PRINT" program



"EDIT" program

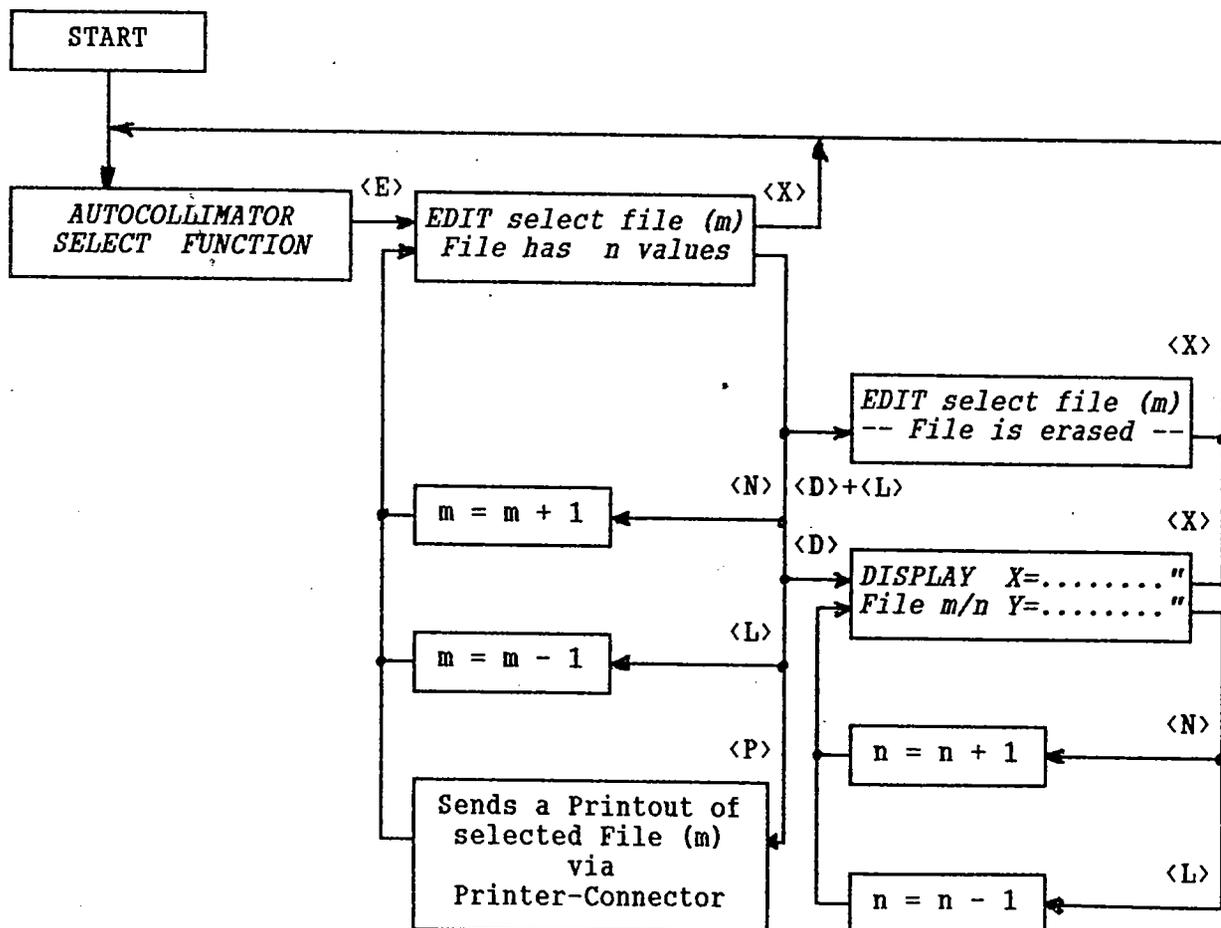
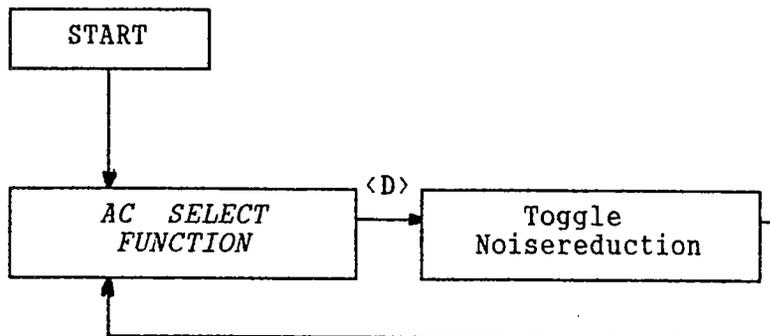


Fig. H

"DISPLAY" program



| | | | |
|------------------|--------|-----------------|---------|
| <A> = "ALIGN" | Button | <L> = "LAST" | Button |
| <M> = "MEASURE" | Button | <N> = "NEXT" | Button |
| <C> = "COMPUTER" | Button | <X> = any other | Button |
| <P> = "PRINT" | Button | | |
| <E> = "EDIT" | Button | m = Fileno. | (0..9) |
| <D> = "DISPLAY" | Button | n = Measureno. | (0..79) |

ANNEX 1

* Description of ELCOMAT 2000 interfaces *
(Status FEE of January 12, 1989)

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INTRODUCTION

The 2-axis electronic autocollimator has two serial interfaces, with outputs via two 25-pin D-subminiature sockets on the rear panel, identified as "PRINTER" and "COMPUTER" (Figs. C.3 and C.4).

1 PRINTER INTERFACE

1.1 General

The "PRINTER" interface is used by pressing the "PRINT" key to print out the currently selected measurement series in the autocollimator, when data are present.

Printout is possible only from the main menu ("AUTO COLLIMATOR, Select Function") or from the "EDIT" mode.

1.2 Examples of a printout

Printer Init: Esc,'4',Esc,'P',Esc,'1',10,Esc,'E'
(for NEC P6, FX800 etc.)

Effect: Italics print, PICA,
left margin = 10, bold print.

```
MOELLER Electronic Autocollimator
----- PROTOCOL of File No. 9 -----
DATE: .... / .... / .....
absolute reference: +136.30 "
absolute reference: +135.20 "
-----
x1=    0.00 "      y1=    +0.05 "
x2=   -3.05 "      y2=    +3.25 "
x3=   +11.35 "      y3=   +15.00 "
x4=   +30.00 "      y4=   +32.30 "
x5= +101.95 "      y5= +105.05 "
x6=   +70.10 "      y6=   +82.10 "
-----
```

The "Absolute Reference" value indicated in the printout refers to the optical axis.

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-----
```

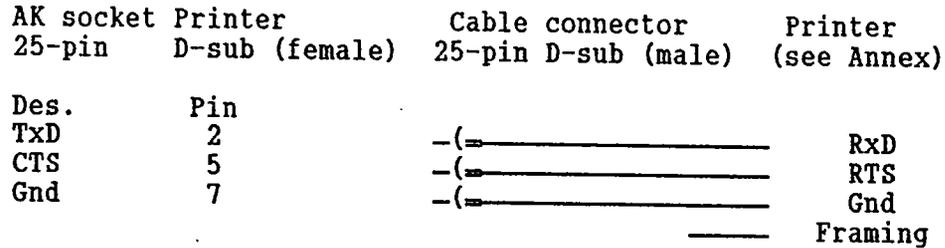
The "Absolute Reference" value indicated in the printout refers to the optical axis.

1.3 Hardware

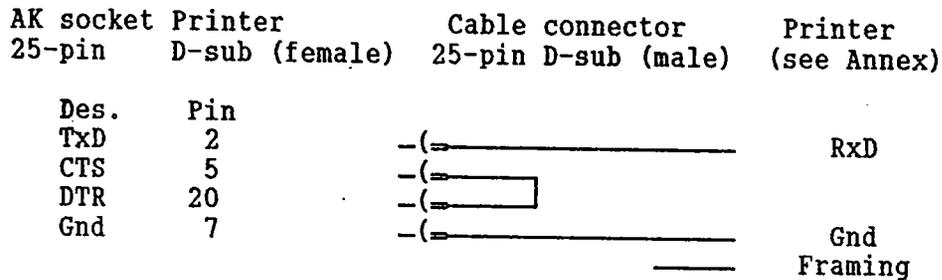
Data transmission is effected as follows:

Baud rate: 2400 baud
 Format: 1 start bit
 8 data bit
 no parity bit
 1 stop bit

The cable connection is as follows:



If no handshake is required by the printer/data receiver (data receiver is a computer or a printer with sufficient buffer memory capacity), the data cable may also be as follows:



If a PC is to be the data receiver, the computer connection cable (see computer interface) should be used.

The pins are assigned as follows:

AK socket Printer
25-pin D-sub (female)

| Designation | | Pin | Direction |
|---------------------|-------|-----|-----------|
| Frame | | 1 | —(|
| Transmit data | (TxD) | 2 | —> |
| Receive data | (RxD) | 3 | <— |
| Request to send | (RTS) | 4 | —> |
| Clear to send | (CTS) | 5 | <— |
| Data carrier detect | (DCD) | 6 | <— |
| | Gnd | 7 | —(|
| | -12V | 18 | —> |
| | +12V | 19 | —> |
| Data terminal ready | (DTR) | 20 | —> |

RXD is ignored at the printer interface; only the output is active.

RTS is operated by the autocollimator, but this has no significance because RxD is not used.

CTS must be on HIGH in order for data to be output.

DCD is not scanned.

DTR is constant on +12V (HIGH).

+/-12V (and DTR) can only be loaded with max. 30mA.

When CTS is on LOW (-12V), there is a wait of 40msec at the beginning of transmission; at every further byte, the wait is max. 30sec. If CTS is still on LOW, after elapse of this time, the printout is stopped and the message "PRINTER is not available" is displayed.

2. COMPUTER INTERFACE

2.1 General

The "COMPUTER" interface can be operated bidirectionally and in full duplex mode. However, data output is operated only if the option is present, otherwise the message "PROGRAM is not available" is displayed. The "COMPUTER" interface can be used for output of measurement data and remote control of the autocollimator.

2.2 Measurement data output

The output is activated when the "COMP" key is pressed from the main menu. If all the conditions are fulfilled, the autocollimator sends a measurement data every 40 msec, and the message "HIGH SPEED COMPUTER-MODE" is displayed on the screen. Exit (also in the event of faults) by pressing a function key.

If there are no data present (autocollimator not in collimation), the error message "NO SIGNAL! ALIGN AC- SYSTEM" appears, and there is no data output.

Likewise, if the handshake line (CTS) is set to "LOW", this delays/prevents data output. After elapse of approx. 100msec, this is indicated again with the message "COMPUTER is not available", but does not abort - it is only for information.

2.3 Measuring data processing

The data format of the COMPUTER interface is as follows:

The transmission of the data comprises 8 transmitted bytes:

| | | |
|-------|--------|----------------------|
| No. 1 | STX | (02 hex) |
| No. 2 | DATA1 | (low value byte) |
| No. 3 | DATA2 | |
| No. 4 | DATA3 | (highest-value byte) |
| No. 5 | DATAY1 | (low value byte) |
| No. 6 | DATAY2 | |
| No. 7 | DATAY3 | (highest value byte) |
| No. 8 | ETX | (03 hex) |

The current data can be derived from this as follows:

$$\text{Data (sec)} = \frac{\text{DATA3} \cdot 256^2 + \text{DATA2} \cdot 256 + \text{DATA1}}{100} \text{ sec}$$

The data is a two's complement value, the zero point of which is the optical axis.

```

-----
      Program Example
-----
procedure ac_value(var X_Value, Y_value);
var temp: real; valid: boolean;
begin
  repeat
    repeat until (aux_data=$02);           { wait for STX }
    temp:=aux_data;
    temp:=temp +aux_data*256.0;
    X_Value:=(temp +aux_data*256.0*256.0)/100.0;
    temp:=aux_data;
    temp:=temp +aux_data*256.0;
    Y_Value:=(temp +aux_data*256.0*256.0)/100.0;
    valid:= (aux_data=$03);                { data valid if ETX }
    if not valid then repeat until (aux_data=$03); { synchronize to next data }
  until valid;
  if x_wert>10000.0 then x_wert:=x_wert-16777.216; { two's complement data }
  if y_wert>10000.0 then y_wert:=y_wert-16777.216; { two's complement data }
end;
-----

```

2.4 Data entry for remote control

The autocollimator can be remote controlled via the computer interface from the computer. For this purpose, the following sequence has to be sent by the computer:

| | | |
|-------|------|----------|
| No. 1 | STX | (02 hex) |
| No. 2 | DATA | |
| No. 3 | ETX | (03 hex) |

Depending on the contents of DATA, one or more keystrokes are simulated (simultaneously). One key is assigned to each bit of DATA, whereby a "1" means "key depressed".

| | | |
|-------|-------|----------|
| DATA: | Bit 7 | DISPLAY |
| | Bit 6 | COMPUTer |
| | Bit 5 | EDIT |
| | Bit 4 | MEASure |
| | Bit 3 | ALIGN |
| | Bit 2 | PRINT |
| | Bit 1 | LAST |
| | Bit 0 | NEXT |

Exceptions:

DATA = 00 hex (0000 0000 bin) —>
System reset of autocollimator, then wait min. 100msec.

DATA ≥ C0 hex (11xx xxxx bin) —>
inadmissible combination, reserved for company-internal functions;
improper use can cause damage.

2.5 Baud rate / data format of computer interface

The transmission is effected at

Baud rate: 300 bd, 600 bd, 1200 bd, 2400 bd
Format: 1 start bit
8 data bit
no parity bit
1 stop bit

The baud rate which is set is applicable for both directions and is factory-set to 2400 baud.

The baud rate can be changed in two ways:

- a) via DIP switch (resistant)
- b) via keyboard (non-resistant)

Procedure for a)

- Remove mains connector
- Remove equipment cover
- The Z-80 processor card (no. 219 514) accommodates a DIP switch -S1,1...8.
Switches S1,1/2 determine the baud rate.

| -S1,2 | -S1.1 | Baud rate |
|-------|-------|-----------|
| 0 | 0 | 2400 bd |
| 0 | 1 | 1200 bd |
| 1 | 0 | 600 bd |
| 1 | 1 | 300 bd |

0 = off/open
1 = on /closed

- Close unit again and switch on.

Procedure for b)

AC must be in main menu ("AUTOCOLLIMATOR select function"), then press the following keys:

| <u>Press key:</u> | <u>Effect / Display:</u> |
|------------------------------------|--|
| - ALIGN and EDIT simultaneously | Entry into test program ("TEST program select function") |
| - MEASURE (several times) till | ("set to: nnnn Baud") is displayed (only if option present!) |
| - NEXT (several times) | till desired baud rate is reached |
| - ALIGN (several times) | till main menu is reached again |

The baud rate is now maintained until the autocollimator is switched off or until changed again.

2.6 Cable connection

| <u>AK socket</u> | <u>Printer</u> | <u>Cable connector</u> | <u>Computer</u> | |
|--------------------------|------------------------|------------------------|--------------------|-----|
| 25-pin D-sub (female) | 25-pin D-sub (male) | | D-sub 9-pin 25-pin | |
| s. Pin | | | | |
| TxD 2 | --(===== | 2 | 3 | RxD |
| RxD 3 | --(===== | 3 | 2 | TxD |
| RTS 4 | --(===== | 8 | 5 | CTS |
| CTS 5 | --(===== | 7 | 4 | RTS |
| Gnd 7 | --(===== | 5 | 7 | Gnd |

The data communication from the computer to the auto collimator must in all cases be operated with handshake, as otherwise there may be disturbances in operation.

We recommend our MÖLLER PC toolbox for operation with IBM compatible computers.

3. AUTOCOLLIMATOR PC TOOLBOX

Contents:

- PROM with free-switched computer interface
- Cable from autocollimator direct to computer (9-pin / 25-pin)
- Diskette with:
 - Interrupt-controlled driver software for Turbo-Pascal 5.0 (UNIT), taking over from the user the work of interface control and data conversion.
 - Demo programs
 - Additional documentation
