Rec Elta®
C/CM/CMS
Computer Total Station

Operating Instructions

ZEISS

Contents

Annex:

Introduction

This manual describes the use of the Rec Elta ® 13C/15C/13CM/13CMS total stations from Carl Zeiss, referred to in the following as Rec Elta® C/CM/CMS. Any differences between these versions are specifically pointed out in the text.

The following subjects are dealt with in the individual chapters:

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❑ **Chapter 2: Program execution**

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The major features of the Rec Elta® total stations are:

❑ **Measuring sensor:**

- Incremental, electronic scanning of the horizontal and vertical circles
- Electro-optical distance meter operating in the infrared range according to the phase comparison method
- Compensator for correcting the vertical axis inclination in the sighting and trunnion axis directions
- Acoustic signal generator
- PCMCIA memory card as the data and program memory and for data interchange with DOS-compatible computers
- Rec Elta® C: mechanical clamps and tangent screws
- Rec Elta® CM/CMS: motorized drives for manual and automatic setting
- Rec Elta® CMS: target sensor for the detection, tracking and automatic setting of standard reflectors

❑ **Control and display unit:**

- 24 single-assignment keys, color coding of the key groups, alphanumeric entry, variable softkeys with additional functions
- Display screen with graphic capabilities (240x38 pixels) with 4 lines of 40 characters each, type sizes 5 x 5 and 5 x 7 pixels
- Convenient user interface due to menu and dialog techniques
- Direct selection of major program parts, irrespective of the current program level
- Dedicated application programs
- Rec Elta® C: RS 232 C (V 24) interface as data input and output port
- Rec Elta® CM/CMS: RS 232 C (V24) interface on the stationary base as data input and output port and for power supply

❑ Important Note:

The instrument was manufactured by tested methods and using quality materials. The mechanical, optical and electronic functions were carefully checked prior to delivery. Should any defect attributable to faulty material or workmanship occur within the warranty period, it will be repaired as a warranty service.

This warranty does not cover defects caused by operator errors or improper handling.

Any further liabilities, e.g. for indirect damages, cannot be accepted.

Subject to change.

Software status Rec Elta® C 3.00, Rec Elta® CM/CMS 2.00 Revision: July 1997

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1 Instrument Description

1.1 Overview

Rec Elta® = Measuring Sensor + Control and Display Unit

❑ **Measuring Sensor:**

- Measurement (D, Hz, V)
- Compensator pickup
- Correction of measured data for:
  - Vertical axis inclination in the sighting and trunnion axis directions
  - Index and collimation
  - Addition constant and scale
  - Projection and height reduction
  - Meteorological conditions etc.

❑ **Control and Display Unit:**

- 4 lines with 40 characters each
- Graphic capabilities (240 x 38 pixels)
- Menu selection
- Dialog prompts
- Program control
- Data editing and computation
- Display of measured and/or computed data and point identifications

❑ **Keyboard of the Control and Display Unit:**

- Keys:
  - 24 single-function keys, color coding of key groups
  - Operation and control of program execution
  - Entry and editing of values and parameters, selection of functions and programs
  - Alphanumeric entry
- Function keys (softkeys):
  - Functions depending on the selected program
  - Display in the bottom line of the screen

❑ **Power Supply:**

- Rec Elta® C: exchangeable NiCd battery pack (5) with 4.8 V and 2.0 Ah for approx. 6 to 8 hours of operation
- Rec Elta® C/CM/CMS: external NiCd battery pack with 6 V and 7 Ah for approx. 6 hours of operation

❑ **Acoustic Signal Generator**

- Support of specific functions by acoustic signals

❑ **Data Memory:**

- Rec Elta® C: Internal Mem
- Rec Elta® C/CM/CMS: PCMCIA memory cards Type 1, SRAM and FLASH

❑ **Interface:**

- RS 232 C / V24 interface

1.2 Rec Elta® 13C and 15C

1.2.1 General Instrument Description

The Rec Elta® 13C/15C total stations are based on the successful Rec Elta® 13/14/15 line and therefore offer all measurement, computation and storage functions of these instruments. In addition, the Elta® 13C/15C feature an integrated, DOS-compatible PC in which a standard PCMCIA memory card can be inserted. This on-board PC permits a significant extension of the program range available in the instruments and the flexible configuration of its type and scope. A number of additional programs are supplied by Carl Zeiss in the standard version, and various optional programs can also be used.
The on-board PC permits users with programming experience to write their own programs under the DOS operating system using a high-level language such as Turbo Pascal, C or Basic which can be executed and compiled on a PC.

1.2.2 Data Interfaces

The PCMCIA card is used as a data memory and additional program memory, permitting data to be stored in files for up to 99 different projects. Processing of any project can be interrupted and resumed later on, with the possibility of handling a different project in the meantime. Data interchange with an external PC featuring a PCMCIA drive can be performed directly via the memory card on a file basis, in accordance with the usual DOS rules and using the access possibilities provided, such as the EDIT editor. Alternatively, data can also be interchanged via the serial RS 232 C / V24 interfaces of the instrument and PC. At the PC end, we recommend the use of the **RECPCD.EXE** transmission program from Carl Zeiss.

1.3 Rec Elta® 13 CM

1.3.1 General Instrument Description

The Rec Elta® 13 CM is completely based on the Rec Elta®13 C in its design and operating functions. Compared with this latter instrument, however, it offers the following additional features:

- motors instead of mechanical clamps and tangent screws
- motor-supported measurement options
- additional servo-supported processes.

The programs of the Rec Elta® 13 CM are used in the same way as in the non-motorized instrument versions, but they have been supplemented by servo-supported functions where appropriate.

1.3.2 Motor-supported Coarse and Precision Setting

- The mechanical clamps and tangent screws have been replaced by knobs for motor control.
- Continuous coarse and slow motion of the instrument and telescope is now possible.
- The control knobs are conveniently located on the side of the upright.
- Coaxial arrangement of the large coarse-motion and the smaller slow-motion knobs, separately for Hz and V.
- The speed of horizontal and vertical coarse motion is continuously variable, depending on amount of rotation of the large knob.
- Manual rotation of the instrument for coarse setting in the conventional way remains possible, after pressure of the **FCT/MOT** hardkeys. This interrupts the electrical contact with the motors. A minor rotation of one of the control knobs reactivates the motors.
- The smaller knob permits extremely sensitive slow motion, both horizontally and vertically, due to high gear reduction.
- Slow motion is performed either by continuous adjustment or in increments with a resolution of 1" (0.3 mgrad).
- When turning the knob, your hand will feel the knob engaging at the individual increments.
- A high-precision gear converts the motor rotations into instrument and telescope movements.

1.4 Rec Elta 13® CMS

1.4.1 General Instrument Description

The Rec Elta® 13 CMS is in essence a Rec Elta® 13 CM with added internal upgrades and, in particular, a target sensor mounted on the telescope. This means that the full functionality of the motorized instrument has been retained and supplemented by sensor functions for all measuring processes and programs. These functions include:

- automatic sighting of a prism
- tracking of a moving prism
- search for a prism

All prisms available from Carl Zeiss or prisms from other manufacturers can be used as targets. There is no need to modify existing reflectors. The standard prism for the target sensor is the single prism, but multiple prisms can also be used from a distance of 100 m onwards.

In field use and in particular in the close range, it may happen that the light of the target sensor is reflected by other objects than the prism. No measurement, however, is performed in this case. The instrument stops the measurement in progress and displays an appropriate message.

If several reflectors are positioned in nearly the same sighting direction, this may affect the measurement, as the target sensor does not incorporate target recognition for several prisms.

The distances attainable with a single prism in good sighting conditions range from 1.7 m up to 400 m in automatic sighting, and up to 300 m in the tracking and search modes. Rain, humidity, fog, shimmering and other refraction influences may affect the measuring range that can be covered.

The target sensor uses visible laser light, which facilitates orientation in the field when working in the close range in good sighting conditions. The laser complies with laser safety class 1.

1.4.2 Operating Principle of the Target Sensor

With 1.5°, the field of view of the target sensor has the same aperture angle as the instrument telescope, corresponding to 2.6 m on a distance of 100 m. This means that the observer's human eye and the objective target sensor see virtually an identical section of the object space. There is only a minor vertical offset in the close range from the shortest sighting distance up to approx. 30 m, resulting from the relative positions of the telescope and the sensor mounted on top of it. However, this has no adverse effect on the measurement. The target sensor is therefore able to detect any prism which is located in the field of view, and can use it for target tracking or automatic target sighting. Should automatic tracking not be possible due to the extreme peripheral position of the prism, readiness for measurement can be obtained at any time by manual or motorized movement of the instrument and/or telescope.

The automatic sighting process comprises two parts. When the prism is detected in the field of view, the instrument first aligns itself approximately with the prism center. In the second step, any remaining deviation between the target and sensor axis is determined and corrected. This process runs until the target and axis coincide.

1.4.3 Automatic Sighting

Automatic sighting of a prism can be performed either in position 1 or 2. Due to the vertical offset between the target sensor and telescope axes, the telescope in position 1 sights a point below the prism, when the sensor axis has been aligned with the target. After measurement of the approximate prism distance, however, the vertical offset angle by which the telescope has to be tilted for centered sighting of the prism can be computed. Since the prism is not captured by the measuring cone on distances of less than approx. 30 m, the telescope is slowly tilted upward until close-range distance measurement is possible. This adjustment is part of the automatic sighting process and is independent of any distance measurement that may be required for the selected measuring mode.

Alternatively, the measurement can be performed in two positions. First, the target is automatically sighted in position 1, then in position 2. The bearings and zenith angles relative to the initial position are averaged, and the instrument is then pointed at the prism center. Measurement in two positions reduces the occurrence of errors, as it also eliminates the residual alignment errors within the scope of the measuring accuracy. This method can be used from a distance of 5 m onwards.

1.4.4 Prism Tracking

Prism tracking is only advisable from a distance of approx. 15 m onwards. It is always performed in position 1. Any interruption of the signal sent to the prism is displayed. The instrument stops and waits for manual or motorized pointing or for renewed contact with the prism. The search for a reflector can also be started from the tracking mode.
Prism tracking is always linked with automatic sighting. As soon as the prism has come to a stop, automatic sighting and the selected computation and storage operations etc. can be triggered by pressing the **ENT** key. After completion of this process, tracking is continued.

1.4.5 Prism Search

The prism search mode uses a definable search window which starts approx. 1.5° on the right (left) of the current telescope position and opens symmetrically with respect to the telescope position in all directions. Within this window, the search for the prism is optionally made in a horizontal or vertical search pattern.
The search is a self-contained process which may be successful or unsuccessful, or can be terminated by the operator. It can be used either independently, irrespective of the current measurement, or in combination with automatic sighting or tracking.

1.5 Rec Elta® Controls

❑ **Key for Figs. 1-1, 1-2 and 1-3:**

1	Handle	2	Handle screws
3	Battery cassette lock	4	Distance meter adjustment screw
5	Battery cassette of C Balancing weight of CM/CMS	6	Ring cap on reticle control
7	Focussing control	8	Eyepiece mount
9	Eyepiece with diopter scale	10	Sighting collimator
11	Alidade level	12	Display
13	Acoustic signal generator	14	Keyboard
15	RS 232C / V24 interface of C	16	Tribrach
17	Mark for trunnion axis height	18	Optical plummet
19	Vertical tangent screw	20	Vertical clamp
21	Horizontal tangent screw	22	Horizontal clamp
23	Counterweight	24	Tribrach screw
25	Tribrach tightening screw	26	Sensor attachment (of CMS)
27	Transmitter objective (of CMS)	28	Receiver objective (of CMS)
29	Cover of PCMCIA card	30	Lock of PCMCIA card
31	V coarse motion knob	32	V slow motion knob
33	Hz coarse motion knob	34	Hz slow motion knob

1.5.1 Rec Elta® C Main Control Side

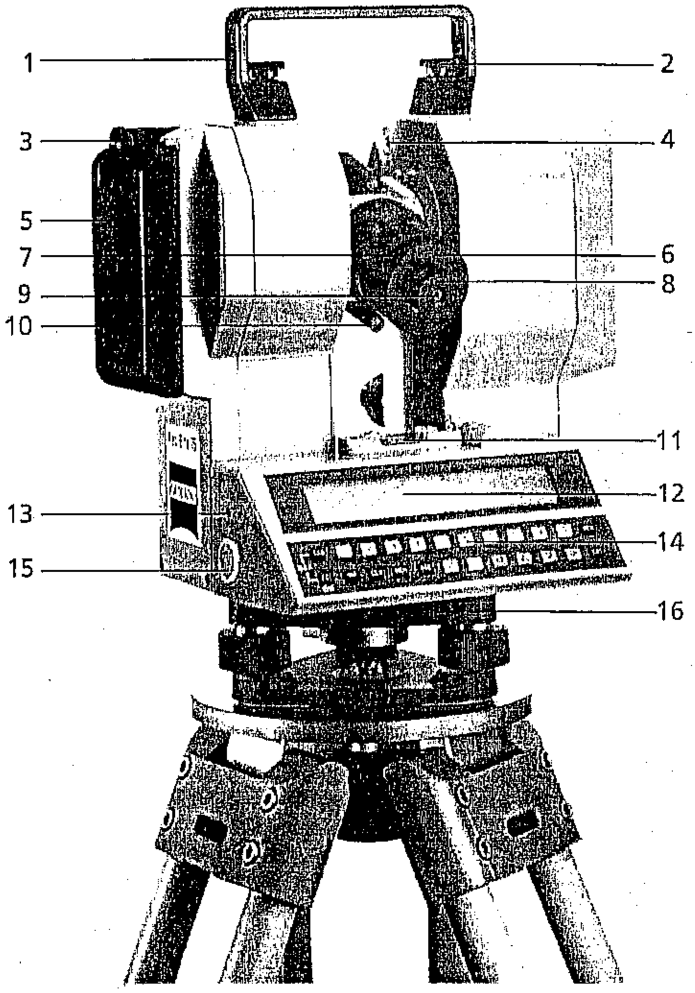


Fig. 1-1: Rec Elta® C main control side

1.5.2 Rec Elta® C Front View

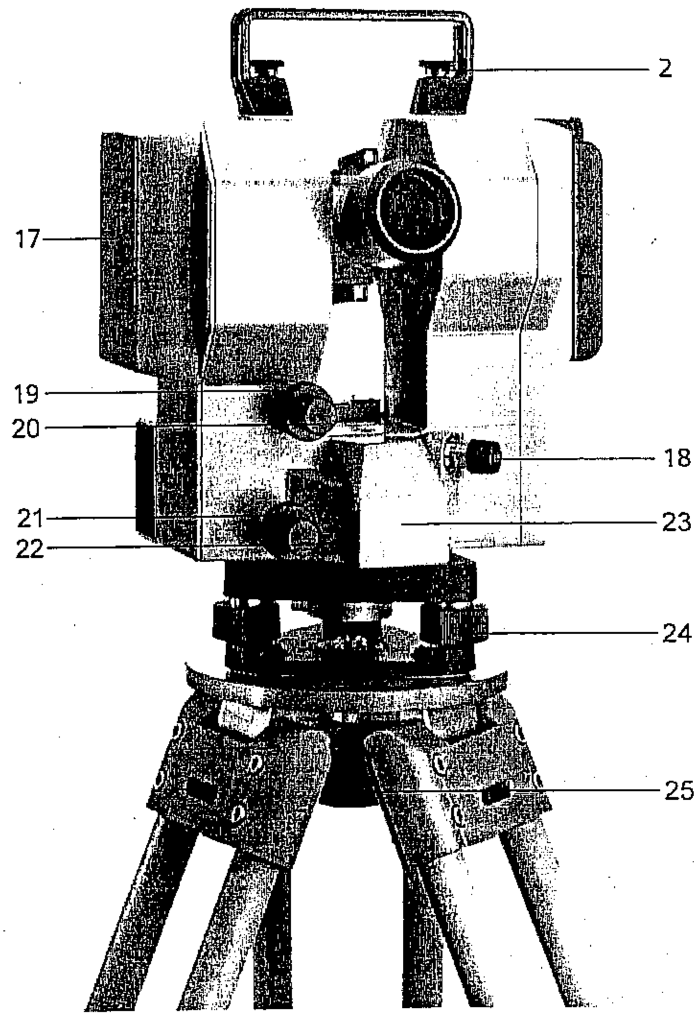


Fig. 1-2: Rec Elta® C front view

1.5.3 Rec Elta® CM/CMS Control Side

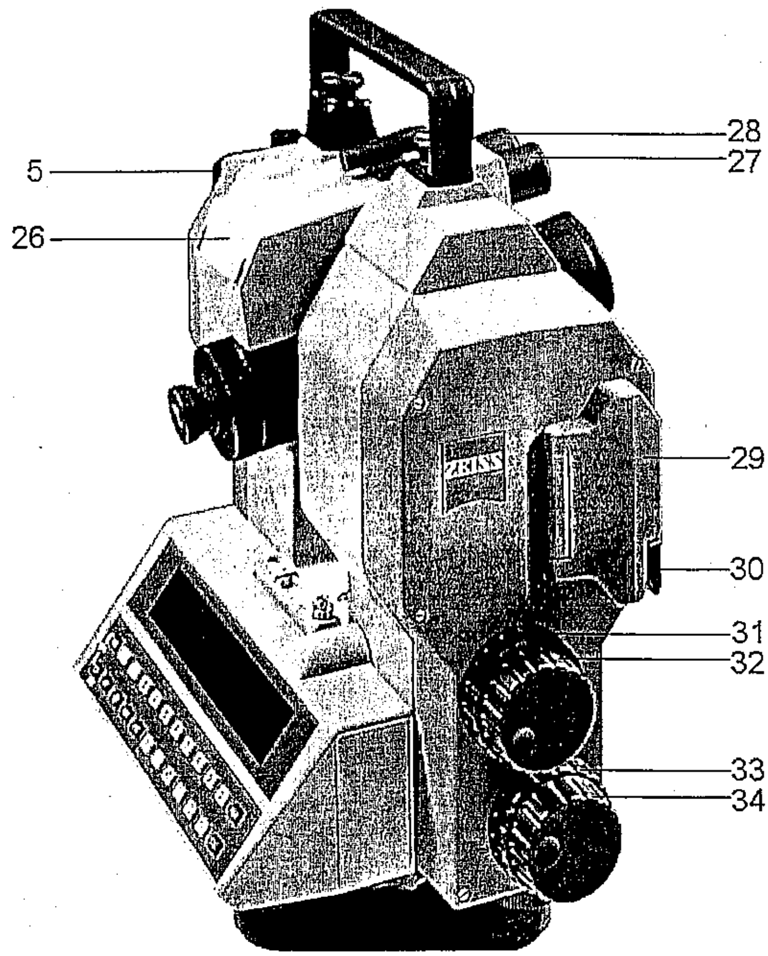


Fig. 1-3: Rec Elta® CM/CMS control side

1.6 Rec Elta® Components

1.6.1 Compensator

❑ **Purpose**

Determination of the current vertical axis inclinations in the sighting and transverse directions by a dual-axis compensator.

❑ **Function**

The effects of the vertical axis inclinations on the circle readings are automatically corrected. Levelling can be checked by means of the digital display of the inclinations.

❑ **Working range**

The working range of the compensator is ± 2'40" or 48 mgrads. If the compensator is out of range, the address and the last digits after the decimal point in the distance and angle readings are replaced by dashes in the display of the Rec Elta® C (this also happens during fast instrument rotation).

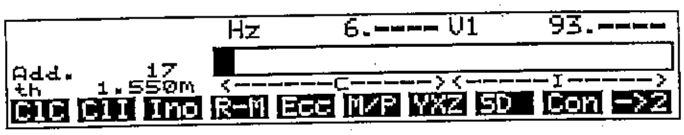


Fig. 1-4: Compensator out of range, Rec Elta® C

The Rec Elta® CM/CMS displays a message which permits levelling after pressing **MEN** or deactivating the compensation after pressing **ENT**.

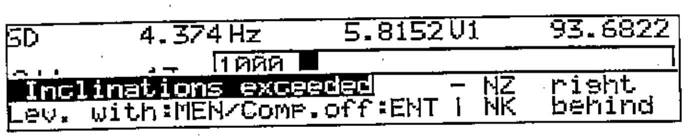


Fig. 1-5: Compensator out of range, Rec Elta® CM/CMS

❑ **Checking**

Checking the compensator at regular intervals is essential for its precise function. Checking is performed by run center determination using the **COMPENSATOR** mode in the **ADJUST/PREPARE/CALIBRATE** program.

☞ **This check is required for precise height measurements.**

❑ **Display**

For the display of the vertical axis inclinations, press function key **LEV** or ⊕ / **COMPENSATOR.**

❑ **Compensator activation/deactivation**

Activation or deactivation in all measuring programs using the **Con/Cno** softkey.

1.6.2 Acoustic Signal Generator

❑ Purpose

Confirmation of Rec Elta® functions by an acoustic signal.

❑ Function

Confirmation by a short signal:

- after each key pressure
- after successful initialization (capturing of zero pulses)
- after completion of a measurement
- during recording: distinction between the recording of one data line (measured data only or computed data only) and of two data lines (two short signals). A long signal sounds in the case of an operating error or if the zero pulse has not been captured.

❑ Activation/Deactivation

The acoustic signal can be activated or deactivated in the program **ADJUST/ PREPARE/SET/ACOUSTIC SIGNAL.**

1.6.3 MEM Memory of Rec Elta® C

The permanent memory of all Rec Elta® instruments stores computation constants, operating modes, measuring units etc., even after instrument shutoff.

In the Rec Elta® C, measured and computed data and additional information can be stored in the **MEM** internal memory with a capacity of more than 1200 data lines comprising the 27-digit point identification and 3 measured or computed values.

1.6.4 PCMCIA Memory Card

The Rec Elta® C/CM/CMS support Type 1 SRAM and FLASH memory cards with a storage capacity of 0.5 MB, 1 MB and 2 MB. For the general handling of these memory cards, we refer to the instructions and recommendations given by the card manufacturers. As regards the PC formatting of the cards and the checking of the buffer batteries used (in SRAM cards), please note the specifications made by the manufacturers of the PCMCIA drives and their supporting PC software.

1.6.5 Handling of the PCMCIA Memory Cards

Once the instrument has been switched on, it is always set for the use of the on-board PC and the PCMCIA memory card. Therefore make sure that a formatted PCMCIA memory card has been inserted. If the memory card is blank, a data file **NONAME.DAT** with a maximum of **500** data lines is created. After use, the card will normally contain several data files with the extension **.DAT.** Make sure that all files created externally with the extension **.DAT** and stored on the card have an identical structure as the files generated by the instrument itself. Each data file is associated with a configuration file which contains the control data and has the file name **CTL$$$xx.CFG,** with xx = 01 to 99. The control file of the current data file has the extension .000 instead of .CFG. The contents and structures of the data files and control files are described in the chapter Interface. The project manager of **PROJECT** is used for calling up and handling the data files.

If no memory card has been inserted either deliberately or by mistake, when the instrument is switched on, this is indicated by the message:

Fig. 1-6: Hint for insertion of PCMCIA card

If you do not insert a memory card now in the Rec Elta® C and answer with **NO**, the functionality of the on-board PC is not activated. All programs normally called up as PC PROGRAMS and project-based processing are not active. All other programs of the instruments, however, are usable without restriction and data is saved in the internal MEM of the instrument. This means that, even if no PCMCIA card is available, most programs of the instrument can be used and that data can be saved and interchanged via the RS 232 C / V 24 interface. The combination within the instrument of data stored in the internal MEM and on the memory card is not possible and has to be done during external processing.

☞ **This functionality does not apply to Rec Elta® CM/CMS where a memory card must always be inserted.**

A memory card can be removed and the same or a different card be reinserted while the instrument remains switched on. A message to this effect will be displayed. Proper operation, however is only ensured if the card remains inserted. Should it be necessary to exchange the card, the data and control files of the new card will become valid.

1.6.6 Interface

❑ Purpose

The RS 232 C / V24 interface permits the transfer of measured and/or computed data to peripheral instruments or the transfer of data from peripheral instruments to Rec Elta®.

❑ Capabilities

- On-line transfer via the Rec Elta® interface to peripheral instruments
- Instrument control via an external computer
- Data transfer between the internal **MEM** or the **PCMCIA** card and an external computer

1.6.7 Battery

❑ Service life

The liquid crystal display of the Rec Elta® uses very little energy. Depending on the age and condition of the battery and the type of measurement performed, a charged battery lasts for 6 to 8 hours of measurement.

❑ Battery change

If the battery voltage is no longer sufficient, the following message appears on the screen

```
BATTERY LOW !!!
```

Fig. 1-1: Battery display

and an acoustic signal consisting of three short beeps is emitted to request changing of the battery.

The batteries feature internal fusing to protect both the instrument and battery against short circuits.

☞ **If the Rec Elta® C is powered from a car battery, the battery cassette on the instrument must be replaced by a balancing weight.**

1.7 Operation and Control of Rec Elta®

1.7.1 Switching the Instrument On and Off

The Rec Elta® is switched on with the **FCT** function key, and it is switched off by simultaneous pressure of the **FCT** function key and the **TAB** tabulator key.

1.7.2 Triggering Measurement

ENT key of the keyboard

1.7.3 Keyboard of the Control and Display Unit (Hardkeys)

❑ **Keys grouped according to their functions:**

- Light grey:
  - Numeric keys **1,...,0**
  - **·/-** key
  - Spacebar
- Medium grey:
  - Vertical cursor keys ↑↓
  - Horizontal cursor keys ←→
- Dark grey:
  - Function keys **TAB, FCT, INP, LEV, MEM, ABC, MEN** and **ENT**
  - Rec Elta® CM/CMS ⊕ **, MOT**

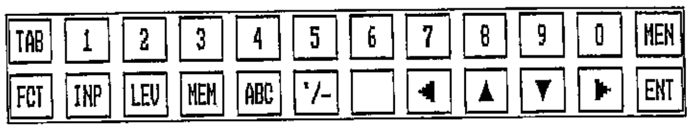


Fig. 1-7: Keyboard of the Rec Elta® C control and display unit

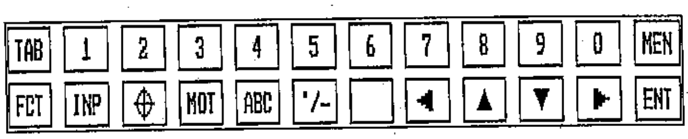


Fig. 1-8: Keyboard of the Rec Elta® CM/CMS control and display unit

Key	Function	Use
1,...,0	Numeric keys	• Entry of numbers • Softkey selection (together with **FCT** key) • Program selection
+/-	Minus sign (direct access)	• Sign for negative entries • Special characters, e.g. for point identification entries
.	Decimal point (together with **FCT** key)	• Special characters, e.g. for point identification entries • The decimal point is forcibly set in all numeric entries
☐	Spacebar	• For blanks in entries
ABC	Alpha key	• Function key for activating alphabetic and special character entries
FCT	Function key	• Activation of the softkeys in combination with numeric keys **1,...,0** • Shift key for the entry of decimal points and upper-case letters
TAB	Tab stop	• Support of point information entries
←→↑↓	Cursor	• Selection of the entry or editing position • Editing, incrementing and decrementing values • Scrolling in lists • Changing the input field
MEN	MENU function	• Quitting a function for the next higher menu • Return from a subroutine to the program where the call was made
ENT	ENTER function	• Continuing program execution (as displayed) • Triggering measurement
INP	Input menu	• Calling up the input menu from a function and subsequent return to the point where the call was made

Key	Function	Use
MEM	Memory assignment	• Display of the current memory assignment of the internal Mem or PCMCIA card and subsequent return to the point where the call was made, Rec Elta®C
LEV	Vert. axis inclination	• Display of the vertical axis inclination, Rec Elta®C
⊕	Sensor function	• Call of the sensor menu, Rec Elta® CM/CMS
MOT	Motor function	• Call of the motor menu, Rec Elta® CM/CMS

Repeat function: Continuous pressure of keys **1,...,0, TAB, spacebar, cursor keys.**

Single function: All other keys.

1.7.4 Softkeys

Softkeys are function keys to which different functions are assigned, depending on the program involved. The current functions are shown in the bottom line of the display in abbreviations comprising a maximum of 3 digits.

❑ **Three types of softkeys are provided:**

- Triggering of a function and return to the program part where the call was made (e.g. **Inf** = entry of an information line)
- Display and changing of a switch status (e.g. **Ino/Ion** incrementation on or off)
- Display of the next or previous operating mode in MEASURE

❑ **Selecting the softkeys:**

- Press the **FCT** key simultaneously with the numeric key below the softkey to be selected.

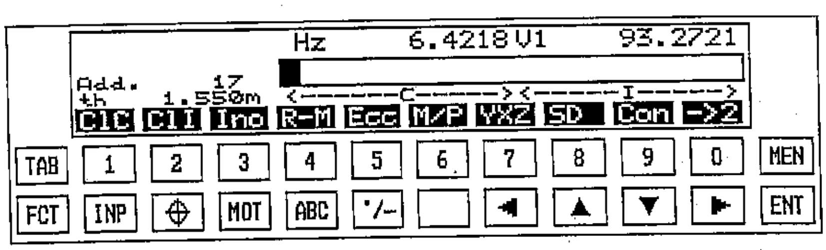


Fig. 1-10: Softkeys

2 Program Execution

2.1 User Guidance

The Rec Elta® guides the user through the programs by menu and dialog techniques. The measurement and computation options and the necessary entries are displayed on the screen. You can select and enter the option required.

❑ Selection menus

Where a choice can be made from several programs, modes or options, you only need to press the number below the appropriate **L** mark.

❑ Softkey menus

Softkeys are function keys to which different functions are assigned, depending on the program used. The current functions are displayed in the bottom line of the display in abbreviations comprising a maximum of 3 digits. This allows matching the measuring process to the task involved. To call up the function required, simultaneously press the **FCT** key and the appropriate numeric key.

❑ Shortcuts using hardkeys

Shortcuts are provided between the programs and modes to speed up program execution. This avoids the necessity of quitting a program to go via the relevant menu.

The function required in a different program part can be directly accessed from the current program level. After the relevant function has been completed, you can return to the point where the call was made.

❑ Dialog lines and dialog fields

The Rec Elta® program gives the user a large number of hints on what has to be done or can be done. These hints are displayed in negative type in the form of a dialog line or dialog field.

The dialog line usually appears in the first display line; the dialog fields are arranged on the right-hand side of the display (e.g. **INPUT** menu).

All entries are checked for plausibility, where possible. Faulty entries are not accepted and must be repeated.

2.2 Shortcuts Using Hardkeys

2.2.1 INP (Input Menu)

❑ Purpose

Display and modification of parameters required for the correction and reduction of measurements.

- For the computation of heights or height differences, the instrument and reflector heights or the station and target heights have to be entered.
- For the correction of distance measurements on the basis of the current atmospheric conditions, the temperature and air pressure can be entered and taken into account.
- The entries for pressure and barometric height are interlinked; changing one of the values also changes the other.
- For the correction of distance measurements, the scale and addition constants can be entered.
- The PPM correction (parts per million) is an additive specification for the scale; in surveying this means mm/km.
- The entries for scale and PPM correction are interlinked; changing one of the values also changes the other.

☞ **These parameters are permanently stored in the (non-volatile) NV-RAM and are retained after the Rec Elta® is shut off.**

❑ Selecting the program

- Direct call from any point of the program using the **INP** key:
- Display of the selection menu with the values currently stored in the NV - RAM.

REFL:	1.700m	TEMP.:	20°C	INPUT MENU
INST:	1.630m	PRESS:	944hP	SELECT:←↑↓→
ADCO:	0.000m	BAR.H:	597m	ENTER
SCLE:	1.000000	PPM :	0	

Fig. 2-1: Selection menu of the INPUT program

❑ Selecting the parameter to be edited

Move the input frame using the cursor keys:

- in the line: ← (to the left), → (to the right)
- in the column: ↑ (up) and ↓ (down)

❑ Activating the entry

Confirm the selection with **ENT**, which automatically activates the change menu.

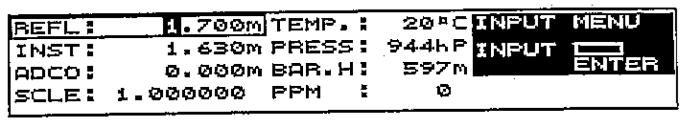


Fig. 2-2: Input/editing menu

❑ Editing the entry

The position of the item to be edited is indicated by the cursor. At the beginning, the cursor is positioned on the first allocated digit. The decimal point is fixed and cannot be changed.

Key	Function
→	The cursor moves one digit to the right, the figures remain unchanged.
←	The cursor moves one digit to the left, the figures remain unchanged. If no figures are present, zeroes are set.
0,1,...,9	Entry of the figures 0,1,...,9 at the appropriate positions, existing figures are overwritten. The digits before the decimal point are deleted with 0.
.	Effective for heights, addition constant, temperature, PPM and barometric height. Can be pressed at any position of the input field and causes the current sign to be changed.

❑ Ending editing

The editing of entries is ended with **ENT**. At the same time, the **input limits** are checked.

- Positive check:
  - Return to the selection menu, the previous value in NV-RAM is overwritten.
- Negative check:
  - The acoustic signal sounds, the previous value in NV-RAM is displayed again and the selected field remains active for further entries.

Change from the input/editing menu to the selection menu for editing further parameters, if necessary.

❑ Storage in the NV-RAM memory and quitting the INPUT program

Press the **MEN** key to return to the main menu or to the program part where the call was made. The edited values are forcibly stored in NV-RAM. There is also the option of saving the values on the **PCMCIA** card (or in the internal **MEM**) for the unambiguous assignment to the subsequent measurements.

❑ **Input limits**

Temperature	Celsius	from	-30°	C	to	+70°	C
	Fahrenheit	from	-22°	F	to	+158°	F
Air Pressure	Pascal	from	440	hPa	to	1460	hPa
	Torr	from	330	Torr	to	1095	Torr
	InchMercury	from	13.0	InMc	to	43.1	InMc
	Barom.Height	from	6400	m	to	-3200	m
Scale		from	0.995 000		to	1.005 000	
PPM		from	-5 000		to	5 000	
Addition constant		from	-0.128	m	to	+0.127	m
		from	-0.42	ft	to	+0.42	ft
Instrument/reflector height							
Heights and height differences		from	9999.999	m	to	-9999.999	m

2.2.2 LEV (Levelling), Rec Elta® C only

- Display of the vertical axis inclinations for the correction of levelling.
- Press **MEN** to return to the program part where the call was made.

2.2.3 MEM (Memory), Rec Elta® C only

- Display of the storage capacity of the internal **MEM** or **PCMCIA** card
- Press **MEN** to return to the program part where the call was made.

2.2.4 ABC (Alphanumeric Entry)

- Toggling between numeric and alphanumeric entry in the point identification

2.2.5 TAB (Tab Jump)

- Defined jump to the next tab stop in the point identification

2.2.6 MEN (Menu)

- Quitting a program, mode or function for the next higher menu.
- Return from a utility routine (e.g. softkey) to the program where the call was made.

2.2.7 MOT (Motor), Rec Elta® CM/CMS only

- Definition of the motor functions: measurement in two positions, setting and checking of a control point
- The **FCT/MOT** key combination deactivates the motor, ⇒ manual operation

2.2.8 ⊕ (Target Sensor), Rec Elta® CM/CMS only

- Calling up the vertical axis inclinations in Rec Elta® CM
- Definition of the target sensor functions in the sensor menu of Rec Elta® CMS (see ***2.5 Target Sensor Functions of Rec Elta® CMS***)

2.3 Motorized Operations and Measuring Processes in Rec Elta® CM/CMS

The following steps are executed automatically or supported by the servo motors:

2.3.1 After Instrument Startup

- Initialization of the Hz and V angle measuring systems

2.3.2 Determination of Collimation and Index Corrections

- Coarse and precision sighting in position 1
- Trigger the measurement with **ENT**
- Automatic sighting in position 2
- Precision sighting in this position
- Trigger the measurement with **ENT**
- Compuation and display of the corrections
- Automatic return to position 1

Run center determination is performed simultaneously in the background.

2.3.3 Stationing Programs

As soon as the (preliminary) station coordinates and the orientation are available, the next backsight point that has been called up is sighted automatically. If height computation has been selected, this is performed with allowance made for the heights of the station, backsight point, instrument and reflector. This is also a possibility of rapidly locating concealed backsight points.

2.3.4 Setting Out

After the option has been called up, the backsight point is sighted automatically. If height computation has been selected, this is performed with allowance made for the heights of the station, backsight point, instrument and reflector.
After measurement of the approximate point and assessment of the setting out result, the instrument turns back to the nominal Hz and V directions, if required.

2.4 Motorized Sighting and Measuring Functions in Rec Elta® CM/CMS

2.4.1 FCT/MOT Hardkey

When you press this key combination, the electrical contact of the motors is interrupted, and the instrument with the telescope can be manually rotated as required. If you move any of the setting knobs, the motors are reactivated.

2.4.2 MOT Hardkey

The following options are offered in each measurement program:

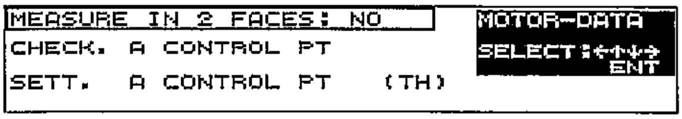


Fig. 2-3: MOT hardkey

2.4.2.1 Measurement in 2 Positions: NO/YES

Fig. 2-4: Measurement in both faces

NO: Measurement in any telescope position
YES: Measurement in both telescope positions and averaging

Fig. 2-5: Measurement in face 1 + 2

Procedure:

- Coarse and precision sighting in position 1
- Trigger the measurement with **ENT**
- Automatic sighting in position 2
- Precision sighting in this position
- Trigger the measurement with **ENT**
- Computation and storage of the mean values as referred to position 1
- Automatic return to position 1
- If you terminate the measurement in position 1 or 2 by pressing **MEN**, the instrument automatically returns to its initial position.

2.4.2.2 *Setting Control Points*

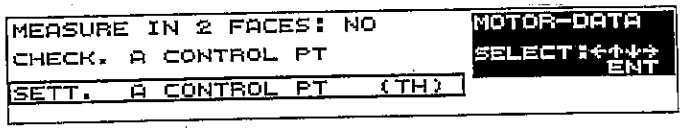


Fig. 2-6: Setting a control point

Measuring a control point for definition and checking of the orientation:

- Sight a clearly visible target
- Trigger angle measurement with **ENT**
- Storage and recording of the Hz/V readings
- Return to the superposed measurement menu

The Hz and V readings for this control point are retained as long as the instrument remains switched on, until stationing is performed again or a new control point is set.

2.4.2.3 *Checking Control Points*

This function is only active if a control point has previously been set.

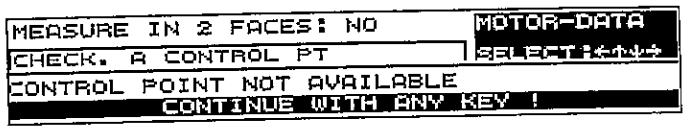


Fig. 2-7: Control point has not yet been set

- The instrument and telescope are automatically set to the stored Hz and V angle readings.
- Optical check as to whether the sighting of the control point ist still correct.
- If required, trigger an angle measurement to the control point by pressing **ENT**. Determination and recording of the deviations.

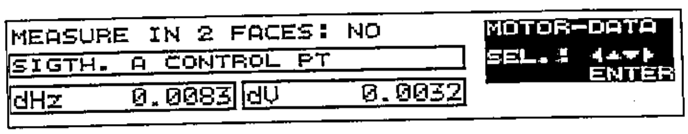


Fig. 2-8: Display of the measured deviations

- Press **MEN** to quit this program part and to return to the superposed menu.

2.5 Target Sensor Functions in Rec Elta® CMS

When you press the hardkey ⊕, the target sensor menu is displayed:

Fig. 2-9: Target sensor menu

MEN Quitting the menu and return to the measurement menu where the call was made; the preset target sensor parameters are active

2.5.1 Automatic Sighting: ON/OFF

OFF Optical sighting and manual setting
ON Automatic sighting and setting in one position, or in both positions if selected

2.5.2 Measurement in 2 Positions: ON/OFF

OFF Measurement in position 1 or 2
ON Measurement in both positions with averaging

2.5.3 Tracking: ON/OFF

OFF No prism tracking
ON Prism tracking in position 1, automatic sighting of the prism after **ENT**, followed by continued tracking

2.5.4 Status Display of Target Sensor Functions

Display of the selected functions for automatic sighting and tracking in the current measuring mode display:

	Measurement in position 1	Measurement in positions 1+2
Automatic sighting **ON**	**AUTO**	**AUTO (1+2)**
Tracking **ON**	**→ P ←**	**→ P ← (1+2)**

If automatic sighting or tracking is **OFF**, no status display appears.

2.5.5 *Search Parameters*

Display and setting of the search parameters

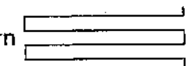
Fig. 2-10: Setting of the search parameters

HZ RANGE:	5°	10°	50°	100°	200°	window width
V RANGE:	2°	5°	10°	20°		window height

SEARCH: RIGHT/LEFT — search direction as referred to the current telescope position

PATTERN:

↑ vertical search pattern 

→ horizontal search pattern 

START SEARCH: Triggers the search in accordance with the preset parameters.

←↑↓→ Continuous movement of the instrument or telescope in the displayed direction; press any key to stop the movement.

MEN Quitting the menu without action, and return to the search menu.

2.5.6 *Start Search*

Triggers the search in accordance with the preset parameters.

- If a prism is found, the program returns to the measurement menu and continues with automatic sighting or tracking, if selected.
- If no prism is found or if you terminate the search in progress with **MEN**, a message to this effect is displayed, and the search can be continued, redefined or ended.

2.5.7 *Compensator*

Call of the compensator menu and display of the current vertical axis inclinations in the sighting direction | NZ and in the trunnion axis direction — NK.

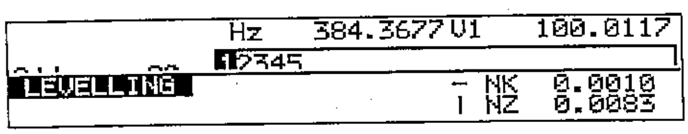


Fig. 2-11: Compensator menu

- If the compensator is within its working range, the inclination values are continuously displayed.
- If the calibrated working range of ± 48 mgrads (± 2′ 40″) exceeded, the display shows before/behind instead of the NZ values and left/right instead of the NK values, depending on the current position of the vertical axis.
- If the vertical axis is inclined to such an extent that the physical working range of the compensator is exceeded, both displays show ???????.

This compensator display can be used for precision levelling of the instrument. This, however, requires a run center determination, if possible at the beginning of the setup.

Press **MEN** to quit the compensator menu and to return to the menu where the call was made.

3 Measuring Process

3.1 Requirements

On the initial startup of the instrument, you can set various parameters and switches which are then applied to all measurements. These settings are:

- ☐ **Selection of the measuring unit and vertical reference system - e.g. meters, grads, zenith - (ADJUST/PREPARE/UNITS)**
- ☐ **Setting of the number of decimal places (ADJUST/PREPARE/SET)**
- ☐ **Setting of the marking or format of the point identification (ADJUST/PREPARE/SET)**
- ☐ **Setting of the switches as required - e.g. acoustic signal on or off - (ADJUST/PREPARE/SET)**
- ☐ **Selection of recording in MEM or on the PCMCIA card or in an external computer (DATA TRANSFER/RECORDING)**
- ☐ **Selection of the recording interface and setting of the transmission parameters (DATA TRANSFER/INTERFACE 1/2)**
- ☐ **Occasional check of the parallel alignment of the optical axis and distance meter axis (ADJUST/PREPARE/EDM-SIGNAL)**

3.2 Measurement Preparation

The preparation of the individual measurements comprises the following procedures:

- ☐ **Setting up the instrument**
- ☐ **Levelling, centering, telescope focussing (ANNEX A5 Measurement Preparation)**
- ☐ **Definition of a project file (ADJUST/PREPARE/SET/PROJECT)**
- ☐ **Entry or import of reference point data in the project file**
- ☐ **Entry of the parameters for projection and height reduction (ADJUST/PREPARE/PROJEC.REDUCTION)**
- ☐ **Entry of checking of instrument height, reflector height, scale, addition constant, pressure and temperature in the INP menu**

☞ **The following checks and calibrations should be made prior to all precision measurements, in particular height measurements:**

- ☐ **Determination of the compensator run center**
- ☐ **Determination of the index and collimation corrections**
- ☐ **Calibration of the target sensor (Rec Elta® CMS)**

3.3 Startup Routine

❑ **Switching the instrument on: Press the FCT key of the Rec Elta®.**

- The startup logo displays the instrument name, the program version and the copyright note.

ZEISS
Rec Elta 13 CMS

Version: 1.10E
(C) CARL ZEISS
1996-1997

Fig. 3-1: Startup logo

- This is followed by a system test and the display of the preset recording mode (internal or external via RS 232 C)

❑ **Initializing the V circle, Rec Elta® C**

Request for initialization (determination of the V circle zero point) by the display "Initialize V1" on the screen.

Initialize V1
Tilt the telescope

Fig. 3-2: V circle initialization

- Smoothly move the telescope up or down.
- Successful initialization is confirmed by an acoustic signal, and the display changes to "Initialize V2"
- The second V zero pulse is captured by changing the tilting direction.

❑ **Initializing the Hz circle**

The initialization is performed to determine the zero point of the horizontal circle. The circle orientation is retained even after the instrument is switched off and on again (quasi absolute orientation).

- Rotate the instrument about its vertical axis.
- Successful initialization is confirmed by an acoustic signal.
- The display changes to the main menu (3.4)

Initialize Hz
Turn the instrument

Fig. 3-3: Hz circle initialization

❑ **The initialization of Rec Elta® CM/CMS is performed by the motors.**

☐ Initialization error

An error message may appear if you rotate the instrument or tilt the telescope too slowly or too fast or in a jerky way. This is indicated by acoustic signals and a display on the screen:

- Slower:Tilt the telescope or rotate the instrument more slowly.
- Faster: Tilt the telescope or rotate the instrument more rapidly.

```
Initialize  V1
Tilt faster
```

Fig. 3-4: Operator message

☐ Switching off the instrument

Simultaneously press the **FCT** and **TAB** keys to switch off the instrument.

3.4 Main Menu

❑ Overview

List of programs available in Rec Elta®.

❑ Selecting the programs

Press the numeric key below the "**L**" mark which points to the program required.

```
SELECT PROGRAM:              PROJECT: POLYGON
 MEASURE                ADJUST/PREPARE
 |     COORDINATES     |     DATA TRANSFER
 |     |     SPECIAL   |     |     EDITOR    DOS-PC
 L     L     L         L     L     L         L
```

Fig. 3-5: Main menu

❑ List of programs and the appropriate keys

Key		Function
1	**Measure**	– Measurement of distances, bearings, height differences and local coordinates
2	**Coordinates**	– Stationing, measuring, computing and setting out coordinates, area computations
3	**Special**	– Programs for special applications
6	**Adjust/ Prepare**	– Definition and checking of calibration data – Definition of units (m, grad, YXZ etc.) – Setting of parameters
7	**Data Transfer**	– Data transmission via the interface – Selection of internal or external recording – Terminal mode – PC demo mode – Updating of the operating program
8	**Editor**	– Display and editing of the recorded data lines
9	**DOS-PC**	– Call of the application programs of the on-board DOS-PC (see chapter 7 Application Programs)

3.5 Measurement

❑ Selecting the program

Select the program by pressing the appropriate numeric key - here key **1** for **MEASURE** (see Fig. 3-5).

❑ Initial menu of the MEASURE program

- Display of the program and its options
- Display of the recording status, scale m and projection reduction PR
- Display of manual input, if selected

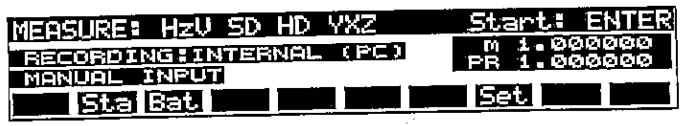


Fig. 3-6: Initial menu of the MEASURE program

ENT Changing to the input and measurement menu of the **MEASURE** program
MEN Return to the main menu

Sta Display of the current instrument status such as instrument parameters, input and correction data (e.g. index and trunnion axis correction, scale, addition constant, temperature and air pressure)
Bat Display of battery capacity
Set Setting of horizontal circle

❑ Input and measurement menu of the MEASURE program

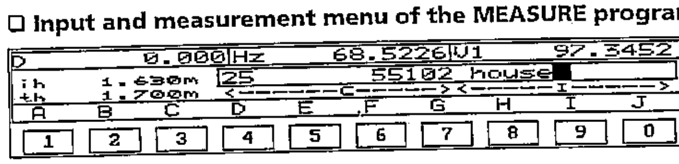


Fig. 3-7: Input and measurement menu

- Enter the point identification **P.I.**
- Select the cursor position
  - Use the cursor keys ← or → or the **TAB** key
- Numeric entry:
  - Press the appropriate numeric keys
- Alphanumeric entry:
  - When you press the **ABC** key, letters and special characters assigned to the numeric keys appear in the softkey line.
  - Changing the alphabetic line: backward in the alphabet with ↓ forward with↑. Upper-case letters: **FCT** + the numeric key assigned to the letter.
- Editing an entry
  - Move to the position to be corrected using the cursor keys ← and → and enter the correct character.

❑ Performing the measurement

- Sight the reflector - the intersection of the vertical and tilting axes of the reflector is defined by the intersection of the prism edges.
- Focus the target using the focussing control.
- Trigger the measurement by pressing the **ENT** key.
- The signal received by the distance meter is automatically controlled, and the signal intensity is displayed in the form of a bar graph on the screen.
  - Optimum: bar graph is in the middle.
  - Measurement not possible due to interruption of the measuring beam or insufficient signal intensity: bar graph on the left, measurement can be terminated with **MEN**.
  - Measurement not yet completed: bar graph oscillates in the entire range.
- Before being displayed, the measured data is automatically corrected for:
  - the influence of temperature and air pressure (distance D)
  - the preset prism or addition constant (D)
  - the preset scale (D)
  - the preset projection reduction (D)
  - the index correction (vertical angle V)
  - the collimation correction (horizontal angle Hz)
  - the components of vertical axis inclination (Hz, V)
  - the circle eccentricities (Hz, V)
  - the trunnion axis error (Hz)
- Off-center measurement with visual contact with the center
  - Centered sighting of the target for angle measurement.
  - Start measurement by pressing **ENT**; this triggers angle measurement.
  - Sight the off-center reflector, measure the distance.
    The off-center distance reading is subsequently treated like a centered distance. The heights of the center and off-center point are assumed to be identical.

❑ Recording

When measurement is completed, the point identification and measured data are automatically stored in a data line in the internal memory MEM, on the PCMCIA card or in an external computer.

☞ **Make sure the softkey for recording (FCT + 4) is set to R-M.**

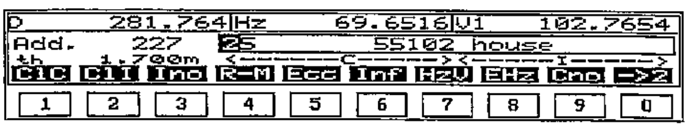


Fig. 3-8: Result menu

❑ Further measurements

You can now enter a new P.I. in the result menu (see Fig. 3-8) and measure the next point.

MEN : Quitting the mode and return to the main menu.

3.6 Off-Center Measurements

❑ **Purpose**

Points which are not directly visible from the instrument station can be measured by entering an eccentricity. Three different modes are available for this type of indirect point measurement:

- **ECCENTRICITY:**
  Measurement of an off-center point and computation of the center. The off-center point may be located horizontally in front of, behind, on the left or right of the center or spatially relative to it.

- **HIDDEN POINT:**
  Measurement of the prisms of a two-prism staff and computation of the measurement data as referred to the end of the staff.

- **3-D PLANE :**
  Measurement of points defining a plane in random position, and computation of this plane. Continuous determination of points in this plane by computation of the intersection of the instrument's sighting axis with the plane, or measurement of a point and computation of its distance from the plane.

❑ **Selecting, performing and ending an off-center measurement:**

If you press the **Ecc** function key, the type of eccentricity last selected for this measuring mode and the relevant parameters are displayed. If necessary, you can change the type of eccentricity. The duration of off-center measurement in the modes **ECCENTRICITY** and **HIDDEN POINT** depends on the selection of **ONCE** or **PERMANENT**, the default being **ONCE.** Measurement in the **3-D PLANE** mode is a continuous measurement. As long as an eccentricity is set, this is indicated in smaller type in the second and third lines in front of the input field of the point identification. In addition, the function key used for the eccentricity is set to **Eno,** indicating the option of terminating the off-center measurement by the pressure of this key. In this case, all references to the eccentricity mode will also disappear from the measurement menu.

Depending on the measuring mode and type of eccentricity used, some of the displayed function keys may be ineffective. When you press these keys, the message **'KEY LOCKED IN THIS CONFIGURATION'** is displayed for one second.

The recording switch for the **D-Hz-V** mode has been extended for the computed data **R** resulting from the off-center measurement. This means that the following recording options are now available.

- **Rno** no recording
- **R-M** original measurec data (D)-Hz-V of the measured point
- **R-C** computed data D-Hz-V of the computed point
- **RMC** includes R-M and R-C

For measurements not performed in the eccentricity mode, the content of **R-M** and **R-C** is identical.

☐ Overview of measuring modes and eccentricities:

Modes	Eccentr.	Hidden. Pt.	3-D PLANE
MEASURE			
Hz-V	-	-	-
D-Hz-V	☑	☑	☑
E-Hz-h	☑	☑	☑
Y-X-Z	☑	☑	☑
COORDINATES			
Stat. on known point	☑	-	-
Free stationing	☑	-	-
with height stat.	☑	-	-
Polar points	☑	☑	☑
Setting out			
SPECIAL			
Height stationing	☑	-	-
Point-line distance	☑	-	-
Connect. distance.	☑	-	-

3.6.1 Type: Eccentricity

The measurement of off-center points is also open to the **D-Hz-V** measuring mode. Depending on the position of the reflector relative to the center, the slope distance D, the bearing Hz and/or the zenith angle V are recomputed for the center. In height computation, the height of the off-center point is always adopted as the height of the center.

☞ **The entered instrument height ih and the reflector/target height th are ignored for height computation in D-Hz-V.**

Since the Hz and V readings are always continuously displayed in the **D-Hz-V** measuring mode, some of the angle readings recomputed for the center are briefly displayed after the off-center measurement. All data recomputed for the center can be saved as computed data using **R-C** or **RMC**.

When you scroll the measuring modes with the function keys 7 and 8, a preset eccentricity is retained, except in Hz-V where off-center measurement is not possible.

☐ Entering an eccentricity

```
TYPE   : ECCENTRICITY                  ECCENTR.
REFL.  :IN FRONT OF   CENTER           SELECT:←↑↓→
DIST.  :    1.000m                           ENTER
MODE   : ONCE        ELEV.  : YES
```

Fig. 3-9: Entry of an eccentricity

Depending on the position of the reflector relative to the center, different options are available:

Refl.: in front of the center
in a spatial position relative to the center (reflector on the sighting beam between station and target point
on the right of the center
behind the center
on the left of the center

Dist.: Amount of eccentricity

Mode: Off Permanent Once

Height: No Yes

Entering modifications:

↑↓: Selecting the option, scrolling through the options
ENT: Confirmation of the selection or modification
MEN: Return to the menu where the call was made

The bearing and horizontal distance of the center are computed (in EHz). If you have selected the local system (XYZ), the coordinates of the center are computed.

☞ **If you select Yes for the height, the height of the off-center point is also adopted for the center.**

☐ **Recording example:**

- **D-Hz-V** measuring mode: off-center point 2.00 m to the right of the center
  Recording switch **RMR**

```
Tr   2.000                                Identifier
SD   25.510  Hz  194.1759 V   92.0018  Off-center Point
SD   25.588  Hz  189.1555 V   92.0268  Center
```

The first recording line documents the type and amount of eccentricity. If the recording switch has been set to **M** , the measured data **D-Hz-V** of the off-center point is recorded. If the recording switch has been set to **R** , the computed data **D-Hz-V** of the center is recorded.

3.6.2 Type: Hidden Point

The purpose of this indirect measuring method is the surveying of points which do not permit centered or off-center sighting in the usual way by means of a perpendicular prism staff. The method uses a two-prism staff. First the prism **R1** at one end of the staff and then a further prism **R2** on the staff are measured. On this basis, the measured data of the other staff end **P** is extrapolated. This way, the two-prism staff provides a means for surveying hidden points using a random off-center target configuration.

```
TYPE   : HIDDEN POINT                    HIDDEN PT
R1-R2  :  0.800m                         SELECT:←↑↓→
R2-P   :  2.000m TOL: 0.003m                  ENTER
MODE   : ONCE     ELEV. : YES
```

Fig. 3-10: Parameters of the hidden point mode

Meaning of the display:

R1-R2: Spacing of reflectors R1 and R2 on the staff.
R2-P: Distance of reflector R2 from the staff end, the actual measuring point P.
TOL: Tolerance to be met between the specified parameter R1-R2 and the measurement of R1 and R2.
MODE: Determines whether single or continuous measurement is to be performed.
ELEV.: Determines whether an elevation computation is to be performed. This takes the following into account in

- **MEASURE:**
  - D-Hz-V no parameters
  - E-Hz-h instrument height ih and R1-R2-P
  - Y-X-Z instrument height ih and R1-R2-P
- **POLAR POINTS:**
  - Y-X-Z station height Z, instrument height ih and R1-R2-P

If all parameters of the eccentricity menu are correct, press **MEN** to return to the measurement menu.

```
SD        0.000 Hz    140.6431 V1    132.4044
HIDDEN PT
MEASURE R1
Add.     276   <-------C------><------I------>
C1C C1I Ino RMC Eno M/P HzV HD  Con ->2
```

Fig. 3-11: Measurement of hidden points

The references to off-center measurement in the lines 2 and 3 are:

HIDDEN PT.
MEASURE R1: request for measurement of reflector R1 and
MEASURE R2: request for measurement of reflector R2

After you have measured reflector **R2**, the measured data of point **P** is computed in accordance with the selected measuring mode, it is partially displayed and stored in the selected recording mode. In the **PERMANENT** mode, the request **MEASURE R1** then appears again.
If the specified tolerance **TOL** is exceeded, the following message is displayed

TOLERANCE EXCEEDED, PRESS ANY KEY TO CONTINUE

and you have to continue measurement by sighting **R1**.

☞ **When you scroll the measuring modes with the function keys 7 and 8, the HIDDEN POINT is retained, except in Hz-V where off-center measurement is not possible. In any new measuring mode, however, you are always requested to measure R1.**

Press the **Eno** softkey to end the measurement of the hidden point.

❑ **Recording example:**

- Measuring mode E-Hz-h
  R1-R2 = To = 1.000 m, R2-P = Tu = 1.500 m, TOL = ds = 0.003 m
  Recording switch **RMC**

```
         To    1.000   Tu    1.500  ds    0.003   Kennung
/2-P-S   D    25.882   Hz 196.7976  V   89.2907   Refl. R1
/2-P-S   D    25.731   Hz 196.7976  V   91.7220   Refl. R2
/2-P-S   E    25.509   Hz 196.7976  h     1.840   Punkt P
```

The first recording line documents the parameters of the two-prism staff.
If the recording switch has been set to **M**, the measured data **D-Hz-V** of the reflectors **R1** and **R2** is recorded.
If the recording switch has been set to **R** , the computed data of point **P** is recorded in the selected measuring mode.
The columns 22-27 of the point identification for measured and computed data include **/2-P-S** to identify the type of measurement involved.

3.6.3 Type: 3-D Plane

❑ Purpose

This function permits measuring surfaces, surface points and point in relation to surfaces if these surfaces can be defined as planes in any spatial position. This is a particular advantage in the measurement of planes, flatness checks and in the measurement of facades.

3 points are sufficient for the unambiguous definition of a plane in any spatial position; however, no redundancy in definition exists in this case. Every additional measuring point ensures such redundancy and stabilizes the plane and its accuracy. The plane parameters are computed in accordance with the rules of adjustment using the least square method. This also supplies the quantity sigma, i.e the standard deviation of the unit of weight, which provides easy-to-interpret information on the quality of the measured plane. If sigma is low, e.g. < 0.010 m, this indicates that the measurement is accurate and that the measured points are located in one plane. Up to 9 points can be included in the plane.

After definition of the plane, you can either perform measurements in the plane or measure points relative to the plane. The **MODE: IN THE PLANE (Th)** computes any points in this plane by pure angle measurement as an intersection of the sighting axis with the plane. In the **MODE: DISTANCE TO PLANE (DTh)** any points are measured using bearings and distances, and the point distances from the plane are determined. The specification of parallel distances permits the generation of planes parallel to the masuring plane, where measurements can also be performed in both modes.

```
TYPE    : 3-D-PLANE             3-D-PLANE
ELEV.   : YES                   SELECT:←↑↓→
MEASURE :   ENTER                     ENTER
Determination of plane using 3-9 pt.
```

Fig. 3-12: Selection of 3D plane

The following options are available in the eccentricity menu:

ELEV.: YES (NO)
MEASURE: ENTER

ELEVATION determines whether an elevation computation is to be performed. In the determination of the plane, this takes the following into account in:

- **MEASURE:**
  - D-Hz-V no parameters
  - E-Hz-h instrument height, reflector height th
  - Y-X-Z instrument height, reflector height th
- **POLAR POINTS:**
  - Y-X-Z station height Z, instrument height, reflector height th

To start the measurement of the plane, select and confirm **MEASURE.** For geometrical reasons, the first three points of the plane must not be positioned along one **line** and must be spaced at least **2 cm** apart. Otherwise the following message will be displayed

Plane points are identical Continue with any key

and the request for measurement of the current point will be repeated. If measurement is ended before the third point, the following message appears:

Determination of parameters impossible Continue with any key

From the third measuring point onwards, the plane is computed, and the test quantity sigma and distance D of the instrument from the plane are displayed.

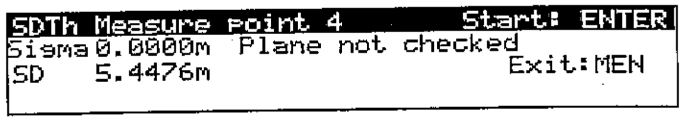


Fig. 3-13: Determination of the plane

After 3 points, sigma is equal to zero as no redundancy exists yet.

☐ Measuring within the plane

Press **MEN** to end the point measurement in the plane; the program returns to the measurement menu.

Fig. 3-14: Measuring in the plane

The references to the 3-D PLANE measurement in lines 2 and 3 are:
D: 0.000m
Pa: 0.000m

Now the mode **IN THE PLANE (Th)** is active. If you turn the instrument and/or tilt the telescope, the measurement data of the selected measuring mode are continuously computed. Press **ENT** for recording.

☐ Measuring outside the plane

Use the **M/P** function key for changing the measuring parameters of the 3D plane. It opens a menu which permits switching the mode between **IN THE PLANE (Th)** and **DISTANCE TO PLANE (SD).** Use the option **PARALLEL** to enter a parallel distance from the measuring plane. The sign of the parallel distance is positive if the parallel plane is located between the instrument and the measuring plane. The distance **D** between the instrument and the plane changes directly after this entry.

Fig. 3-15: Measuring parameters

Quit this menu with **MEN**; the program returns to the measurement menu.

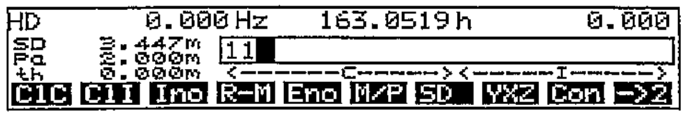


Fig. 3-16: Measuring outside the plane

If the mode **DISTANCE TO PLANE (SD)** has been selected and a parallel plane has been set, the references to 3-D PLANE measurement in lines 2 and 3 are, for example:

D: 5.462m instrument distance from parallel plane
Pa: 2.000m
All measurements are performed with bearings and distances and are displayed in the selected measuring mode. The distances of the measured points from the selected plane are displayed in line 2:

D: 0.002m the measured point is very close to the plane
D: -1.852m the measured point is located behind the plane

Switching of the **MODE** and entries in **PARALLEL** continue to be possible. Any change is automatically recorded.

☞ **The DTh mode can be used, for example, to determine the distance of a parallel plane from the original plane. This distance is entered. You can now measure further points in the new plane contact-free using Th.**

When you scroll the measuring modes with the function keys 7 and 8, **3-D-PLANE** is retained, except in Hz-V.

Press the **Eno** function key to end measurement in the 3-D-PLANE mode.

❑ Recording example:

- Measuring mode **Y-X-Z**
  Recording switch **RMR**

```
3-D-E POINT  1   D    25.947   Hz 175.3879  V  92.2679
3-D-E POINT  2   D    26.245   Hz 175.3879  V  87.7189
3-D-E POINT  3   D    26.759   Hz 179.5905  V  87.7185
3-D-E POINT  4   D    26.463   Hz 179.5902  V  92.1012
```

If recording has been set, all points of the plane are recorded with the code **3-D-E** in the point identification, with the consecutive point number and with the measured data **D-Hz-V**.

```
3-D-E (Th)   D    24.935   pa     0.000  Si    0.001
     /3-D-E                Hz 177.2916  V   90.0373
     /3-D-E  Y     9.067   X    -24.334  Z     4.097
```

The first line documents the mode **(Th)**, the distance **D** between the instrument and the plane, the parallel distance **pa** and sigma **Si**.
If the recording switch has been set to **M**, the second line shows the measured data **Hz** and **V**.
If the recording switch has been set to **R**, the third line shows the computed data **Y-X-Z** of the point sighted in the plane.

```
3-D-E (DTh)  D    22.935   pa     2.000  Si    0.001
     /3-D-E  D    22.030   Hz 166.5385  V   95.4600
     /3-D-E  Y    11.025   X    -19.007  Z     1.569
     /3-D-E  D     1.104   pa     2.000
```

The first line documents the mode **(DTh)**, the distance **D** between the instrument and the plane, the parallel distance **pa** and sigma **Si**.
If the recording switch has been set to **M**, the second line shows the measured data **D-Hz-V**.
If the recording switch has been set to **R**, the third line shows the computed data **Y-X-Z** of the sighted point and the fourth line the distance **D** of the point from the parallel plane.

The code **/3-D-E** is included in the columns 22-27 of the point identification for measured and computed data to mark the type of measurement involved.

4 Measurement

4.1 General

❑ Purpose

The **MEASURE** program offers four modes for the determination and display of the measuring elements which are useful in everyday practical work. Bearings, angles, distances, heights or height differences and local coordinates can be selected in different combinations. Use the **FCT + 7** or **FCT + 8** softkeys for selection. The next mode (**FCT+8**) and the preceding mode (**FCT+7**) are displayed. In addition, indirect heights can be measured in the **EHz** and **XYZ** modes.

If you are working in a coordinate system with a projection scale (e.g. Gauss-Krüger), you can enter the scale in the **ADJUST/PREPARE** mode.

❑ Calling up the program

Press numeric key **1** to select the **MEASURE** program in the main menu. The initial menu is now displayed.

In the initial menu (see FigFig. 4-14-11) any bearing can be set with the **Set** softkey.

If the height is also to be measured, you can enter the instrument height **ih** and the reflector height **th** using the **INP** key.

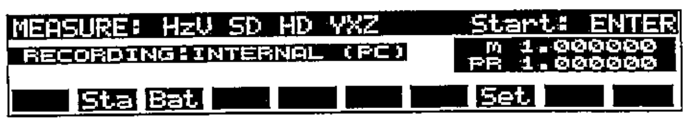


Fig. 4-1: Initial menu MEASURE

MEN: Return to the main menu.

❑ Entering the P.I.

ENT: Starts the program.
Enter the P.I. in line 2.
Select the measuring mode required (angle measurement or combined angle and distance measurement) using the **FCT + 7, 8** softkeys. The Hz and V displays always operate in the tracking mode.

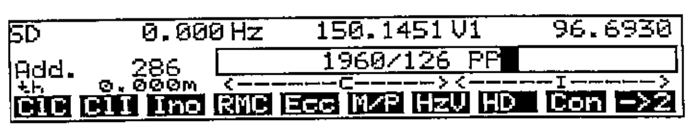


Fig. 4-2: Input and measurement menu

❑ Measurement

ENT: Triggers the measurement
The signal intensity is displayed by the bar graph in line 3. If the bar graph is in the middle, this indicates an optimum signal. If the bar graph is on the left, the signal received is inadequate. You can then terminate measurement with **MEN.**

❑ Result menu

After completion of the measurement, two or three measuring elements are displayed in line 1 (see Fig. 4-3). You can now enter a new P.I.

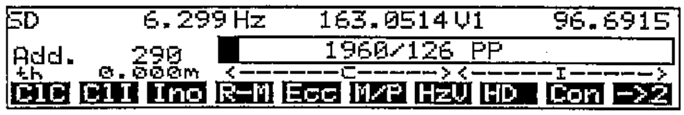


Fig. 4-3: Result menu

After measurement, the measured data is written to a buffer memory and recorded (if recording has been activated). The **FCT + 7, 8** softkeys can be used to display the data in the different modes. Since angle measurement runs in the tracking mode, the display is continuously updated.

☞ **The E and h values are not recomputed!**

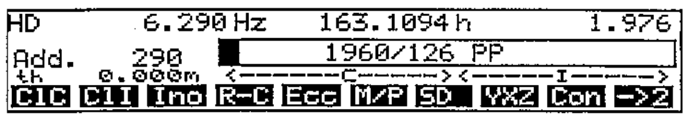


Fig. 4-4: Measuring elements

❑ Recording

If softkey 4 is not set to **Rno**, the data is automatically recorded after completion of the measurement (PCMCIA card, or in Rec Elta® C optionally in the INTERNAL MEM).
If an external storage medium has been connected, make sure the parameters are correctly set (see **DATA TRANSFER**). You will find the relevant information on the interface in chapter **11 INTERFACE DESCRIPTION.**

❑ Ending the measurement

MEN: Direct return to the main menu.

4.2 Initial Menu

☐ Menu Structure

Fig. 4-5: Initial menu

Line 1:	Display of the dialog line in negative type - Name of the program: **MEASURE** with measuring modes - Program start: **ENT**
Line 2:	Recording status, internal or external
Line 3:	Manual input, if selected. Display of the scale and projection reduction to be used for the subsequent distance measurements.
Line 4	Softkeys

Key		**Function**
Sta	**(FCT + 2)**	Current status of major instrument parameters
Bat	**(FCT + 3)**	Battery capacity
Set	**(FCT + 8)**	Setting a required bearing

☐ Display and storage of the instrument status (Sta)

Documentation of the instrument status at the moment of measurement. This permits an assessment of the measurement to be made at a later time. If you press this softkey, parameters determined or entered in several different menus are combined in a list (see Fig. 4-6).

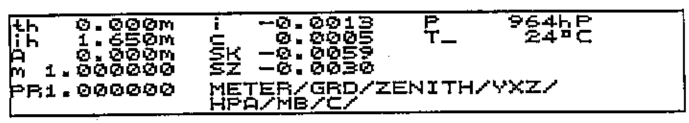


Fig. 4-6: Instrument status

☐ Input parameters (see also INPUT) and abbreviations

• Instrument height	ih
• Reflector height (target height)	th
• Temperature	C
• Air pressure	P
• Scale	M
• Addition constant	A
• Projection reduction	PR

❑ Instrument errors (see also ADJUST):

- Index error — i
- Collimation error — c
- Position of the compensator run center in the sighting direction — SZ
- Transverse direction — SK

❑ Units (see also UNITS):

- Distance measurement
- Angle measurement
- Vertical reference system
- Coordinate system
- Air pressure
- Temperature

You can quit the **Sta** function by pressing any key. An enquiry is automatically displayed as to whether the current status is to be recorded in the memory for documentation (see Fig. 4-7).

Fig. 4-7: Recording

YES: Recording of the data in the memory, return to the initial menu
NO: No recording of the data, return to the initial menu

❑ Battery capacity (Bat)

If you press the **Bat** softkey, the battery capacity is displayed on the screen in the form of a bar graph.

- Bar graph on the right: battery fully charged.
- Bar graph on the left: battery needs to be changed soon.

MEN : Return to the initial menu of the **MEASURE** program

❑ Setting a horizontal direction (Set)

The **Set** softkey permits setting the horizontal circle to zero or the entry of any given bearing using the numeric keys.

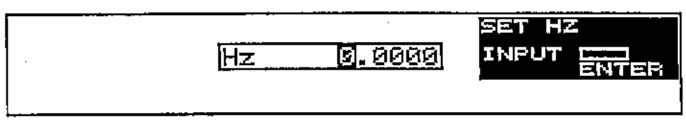


Fig. 4-8: Setting menu

Press **ENT** without any further entries to set the horizontal circle to zero. For the entry of any specific angle, use the following keys:

Keys	Function
Selecting the position:	
←	Cursor moves one digit to the left, figures remain unchanged. If no figure is present, zeroes are set.
→	Cursor moves one digit to the right, figures remain unchanged. Zeroes preceding the first figure before the decimal point are deleted.
Entry: **0,1,...,9**	Enter the figures 0,1,...,9 in the appropriate positions, any existing figures are overwritten. Enter 0 to delete figures before the decimal point.

End the entry with **ENT** and check whether the input limits are complied with:

- **Grad:** 0 - 399.9999
- **DMS:** 0 - 359°, 0 - 59', 0 - 59"
- **DEG:** 0 - 359.9999°
- **MIL:** 0 - 6399.99

An acoustic signal sounds if these ranges are exceeded. Correct the faulty entry.

For clear labelling of a point, you can enter a point identification (see Fig. 4-9). Sight the point and start the measurement with **ENT**.

Fig. 4-9: Measurement menu Set Hz

After storage, the display returns to the initial menu.

4.3 Input and Measurement Menu

Press **ENT** to change from the initial menu directly to the input and measurement menu.

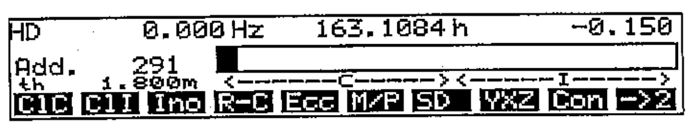


Fig. 4-10: Input and measurement menu

❑ Explanation of the display

Line 1: Display of the current angle readings Hz and V at the beginning ; later on, further measured or computed data is displayed, depending on the measuring mode selected.

Line 2: ih or Mem address, 27-digit display for the P.I. entry.

Line 3: th and format of the last marking selected

Line 4: Softkeys

❑ Entering the P.I.

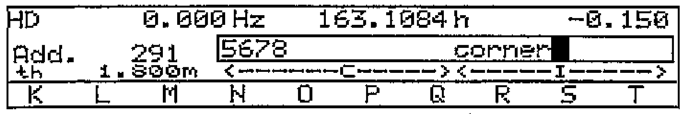


Fig. 4-11: P.I. entry.

To ensure clear assignment of the point and measurement, the point can be labelled and described prior to measurement by the entry of a point identification.

- Point information (P.I.) = point code (C) + additional information (I), comprising up to 27 alphanumeric digits (letters, figures, special characters and blanks).
- Point code = point number as a numeric and/or alphanumeric entry. The number of digits is variable and may range from a minimum of 3 to a maximum of 14; this is also the range used for incrementation (see 4.4.2). Unused digits are available for additional information or appear as blanks.
- Additional information = point description by an alphanumeric entry.

If you press the **ABC** key, the softkeys in the display are replaced by letters for alphanumeric entries.
A B C D E F G H I J
The vertical cursor keys ↑, ↓ permit the selection of all other letters and of special characters.

The entry is facilitated by:
(1) a framed input field (input window) and

(2) marks structuring the point identification (see below and **SET**).

❑ Marking

To support the entry and for easier reading, the P.I. field is graphically subdivided into blocks.
The format depends on the number of digits used for the point code and additional information.
Default marking: <-----C------><-----I----->

The **SET** mode offers an option for selecting the marking format. The following parameters can be set there:

- Tab function **TAB** (to facilitate the entry)
- Beginning and end of the point number block
- Blanks to be skipped in the P.I. entry

4.4 Function Keys and Softkeys

Function keys and softkeys offer greater flexibility in the measuring process and support the point entry.

4.4.1 Function Keys

These are:

TAB	Tab function in accordance with the parameters set in the SET mode.
FCT	Function key for selecting the softkeys in combination with the numeric keys **0,1,....,9**.
⊕	Rec Elta® C/CM, calling up the vertical axis inclinations Rec Elta® CMS, calling up the sensor menu
MEM	Rec Elta® C, calling up the memory status
MOT	Rec Elta® CM/CMS, calling up the motor menu
ABC	Function key for activating the alphabetic entry, i.e. the option of entering upper-case and lower-case letters and special characters using the softkey line 4.
1,...,0	Key for numeric entries and for activating the softkeys.
-	Negative entries or special character for P.I.
.	Special character for P.I.
Spacebar	Same function as a cursor movement to the right, with deletion of the existing entries.
←→	Cursor keys for selecting the digits to be entered or edited without deletion of the cursor position.

4.4.2 Softkeys

❑ **List of softkeys**

Softkey		Function
Page 1:		
ClC	(FCT + 1)	Deletion of the point code within the point identification
ClI	(FCT + 2)	Deletion of the additional information within the point identification
Ino	(FCT + 3)	Activation/deactivation of the point number incrementation
R-M	(FCT + 4)	Changing the recording mode (measured and/or computed data or no recording)
Ecc	(FCT + 5)	Entry of an eccentricity
Inf	(FCT + 6)	Entry of an information line
HzV	(FCT + 7)	Selection of previous measuring mode
HD	(FCT + 8)	Selection of next measuring mode – HzV original angle readings – DHz original measuring elements D, HZ and V – EHz computed measuring elements E, Hz and h – XYZ local coordinates
Con	(FCT + 9)	Activation/deactivation of compensation
→2	(FCT + 0)	Changing to page 2

Softkey		Function
Page 2:		
Ono	(FCT + 1)	Indirect object height measurement (EHz + XYZ only)
Tno	(FCT.+.2)	Distance tracking
Del	(FCT + 3)	Deletion of the last record
R-M	(FCT + 4)	See above
D:N	(FCT + 7)	Selection of the distance meter mode
HzV	(FCT + 7)	See above
EHz	(FCT + 8)	See above
Mk1	(FCT + 9)	Mark selection
→1	(FCT + 0)	Changing to page 1

❑ Deleting the point information with the ClC and ClI softkeys

Use the **ClC** softkey for complete deletion of the point code field and the **ClI** softkey to delete the additional information field. Both fields are then available for new entries. Individual digits are deleted with the spacebar.

❑ Activating/deactivating incrementation with the Ion/Ino softkey

This softkey permits the point number to be automatically incremented or decremented by a selected amount. When you call up the input and measurement menu, incrementation is deactivated (**Ino**).

- Use **FCT + 3** to activate incrementation. The display changes from the P.I. input menu to Fig. 4-12: Enter the increment. Confirm with **ENT**. The incrementation interval has been set to the default value 1.

```
INCREMENT:      1                INPUT  ENTER
```

Fig. 4-12: Entry of the increment

Enter the new increment starting at the cursor position ■. The input range from -9999 ≤ incr ≤ 99999 is checked automatically. A warning signal sounds if an incorrect entry is made.

- Ending of incrementation
  End the entry with the **ENT** key. The program returns to the entry of the point indentification in the measurement program from where you started. The **Ino** softkey changes to **Ion**, indicating that incrementation has been activated.

☞ **Only the numeric part on the outer right of the point code is incremented. The point number can only be incremented as long as blanks are available before the point number. Leading zeroes are deleted in the incrementation.**

`20 1.568---1234`	incrementation to 9 999 999

☐ Activating/deactivating recording with the Rno/R-M/R-C/RMC softkey

The **FCT + 4** softkey permits the selection of different switch settings for the type of recording. Depending on the measuring mode (**HzV**, **DHz**, **EHz** or **XYZ**) the following options are available:

Rno Measurement is not recorded.
R-M Original measured data (D, Hz, V) or (Hz, V) is recorded.
R-C Data computed from the measured data is recorded, e.g. E, Hz, h - X, Y, Z
RMC Measured and computed data is recorded
Line 1: measured data
Line 2: computed data

☞ **Recording successful:** **Address of the internal memory or "Ext. Rec." is displayed in line 3.**
Recording deactivated: **No display of the address or "Ext. Rec.".**

☐ Entering an information line with the Inf softkey

To record additional information on a measurement, an alphanumeric entry comprising up to 27 digits can be made with the **Inf** softkey.

Fig. 4-13: Entry of information

The cursor at the beginning of line 2 indicates readiness for the entry. Move to the entry position using the horizontal cursor keys ←, →. Enter figures directly, letters and special characters with the **ABC** key or directly with the vertical cursor keys ↑, ↓. For deletion of the complete information use the **Cll** (**FCT + 2**) softkey. Individual digits are deleted with the spacebar.
End the entry of information with:
MEN: Return to the input and measurement menu without saving
ENT: End of the entry and saving in an address

☐ Selecting the measuring mode with the HzV, DHz, EHz and YXZ softkeys

These two softkeys permit the selection of different measuring modes and, after measurement, the alternative display of the following measured and computed data.

HzV: Determination of the original angle readings
Hz = horizontal circle reading
V = vertical circle reading

DHzV: Determination of the original measuring elements D, Hz, and V
D = slope distance
Hz = horizontal circle reading
V = vertical circle reading

EHz: Determination of the horizontal distance, bearing and height difference

HD	=	horizontal distance
Hz	=	horizontal circle reading
h	=	height difference or target height

XYZ Determination of the local coordinates, station = origin, the zero direction of the circle is the X axis

Y	=	easting
X	=	northing
Z	=	height

The last mode set when you quit the **MEASURE** program is the default mode when you start again.

☐ Activating/deactivating compensation with the Con/Cno softkey

To permit angle readings e.g. even in the case of heavy ground vibrations, the compensation can be deactivated and reactivated later on.

Con: Compensation of the vertical axis inclinations by computational correction of the angle readings.
Cno: No correction.

☐ Object height measurement with the Ono/on softkey

Following distance measurement of a point in the **HD** and **XYZ** modes, the height can be indirectly determined by pure angle measurement.

☞ **If you also want to determine the lateral distances from the foot of the perpendicular, the projection of the line of sight and the vertical plane through the object must intersect at a right angle.**

Fig. 4-14: Object height measurement

The definitions in the **EHz** mode are as follows:
E: Horizontal distance between instrument and reflector/target
O: Transverse deviation from the line instrument - reflector
h: Height of the target

In the **XYZ** mode, the results refer to the local system, not to the line station-object. Press **Ono** to return to normal operation of the respective mode.

ENT: Saving the current measurement
MEN: Return to the main menu

☐ Tno/on softkey (distance tracking)

The **Tno/on** softkey permits toggling between single and continuous measurement. Use **ENT** to store individual measurements during tracking. For more effective utilization of this mode, we recommend the entry of a point number increment. Distance measurements are performed automatically in the special tracking mode with a measuring time of approx. 1 sec.
Press **Tno** to switch back to single measurement.

ENT: Saving the current measurement
MEN: Return to the main menu

☐ Deletion of the last address with the Del softkey

The **Del** softkey permits the deletion of the last measurement/address.

```
ADD.    294 100              tower
DELETE ?                            YES  NO
```

Fig. 4-15: Deletion

YES: Address is deleted, return to the input menu.
NO: Address is not deleted, "**NOTHING DELETED**" is displayed. Return to the input menu

☐ Selecting the distance meter mode with the D:N/D:L/D:R softkey

The **D:N** softkey offers three different options to meet different measuring requirements such as fast measurement or measurement of long distances.

D:N: Normal (default in the input menu of the MEASURE mode)
D:L: Long (option for long distances)
D:R: Rapid (option for higher measuring speed)
The selected option remains active within a measuring mode until it is changed.

☐ Selecting the marking with the Mk1 softkey

- Purpose
  Adaptation to different measuring tasks by the selection of different marking formats to support the P.I. entry.

- Selection
  When you call up the measuring mode, the last marking used is automatically displayed (line 3 of the input menu). Press the **Mk1** softkey to call up the mark formats defined in the **SET** mode. Repeatedly press the softkey until the marking required appears in the sequential display. The selected marking is retained in all programs until it is changed. The figure in the softkey indicates which marking has been selected.

4.5 Result Menu

After measurement, the measured data is written to a buffer memory and recorded (if recording has been activated). The softkeys 7 and 8 can be used to display the data in the different modes. Since angle measurement runs in the tracking mode, the display is continuously updated.

☞ **The values for E and h or XYZ are not recomputed! The computed horizontal distance refers to the station height, not to the reflector height (this is significant if major height differences exist). The height results are dependent on the type of entry for the instrument and reflector heights.**

- ih = th : h = height difference between the Rec Elta® trunnion axis and the reflector
- ih and th entered: h = height difference between the ground points of station and target
- H_S, ih, th entered: h = H_Z = height of target above the reference surface (Hs = known height of station above a reference surface)

4.6 Recording

Depending on the selected recording mode, the data is stored either internally or externally. If an external storage medium has been connected, make sure the parameters have been correctly set (see **DATA TRANSFER**). You will find the relevant information on the interface in the chapter **INTERFACE DESCRIPTION.** Depending on the setting of the **R-M** (**FCT + 4**) softkey, the following is recorded in the individual modes:

• Hz, V and D, Hz, V	**Rno**	recording off
	R-M	recording on
• E, Hz, h and X, Y, Z	**R-C**	recording of computed data
	RMC	recording of measured + computed data

If an off-center point is measured using the **Ecc** softkey option, the following data lines are recorded, depending on the selected recording option:

(1) Type and amount of eccentricity

(2) Original measured data D, Hz, V of the center (**R-M**, **RMC**)

(3) Reduced and centered measured data E, Hz, h or coordinates in relation to the center (**R-C**, **RMC**)

☞ **If a measurement is performed in position 2, the horizontal angle Hz displayed in the line of reduced measured data E, Hz, h or X, Y, Z is converted into position 1; otherwise position 2 would no longer be recognized in the subsequent evaluation. Measurements in the HzV and DHz modes are stored with their original values.**

5 Coordinates

5.1 General

A coordinate system constitutes the necessary framework for extensive surveys. When using the modes of the **MEASURE** program, the measured data is fitted into a coordinate system during data processing in the office.
For many applications, however, it is necessary or desirable to generate coordinates or work with coordinates directly in the field. The modes supporting these processes are combined in the **COORDINATES** program.
If you are working e.g. in a Gauss-Krüger coordinate system, you can enter the projection and height reduction in the **ADJUST/PREPARE** program.

❑ Purpose

The **COORDINATES** program offers five modes (see Fig. 5-1) for the determination, display and recording of coordinates obtained in different ways, such as stationing on a known or unknown point which is prerequisite for the determination of polar points, setting out or area computations. The **PC Program mode** is not active in this version.

❑ Selecting the measuring modes

Select the **COORDINATES** program in the main menu using numeric key 2. The Coordinates menu is displayed (Fig. 5-1). The modes can be directly selected using the numeric keys assigned to the programs by the **L** marks.

Fig. 5-1: Menu of the COORDINATES programs

❑ Comments on the modes

- **Mode 1 Stationing on a known point:**
  Stationing by measurement of known backsight points (max. 20) or by orientation using a given azimuth.
- **Mode 2 Free stationing:**
  Stationing by measurement of known backsight points (max. 20) if the station is unknown.
- **Mode 3 Polar points:**
  Determination of coordinates by measurement of D, Hz, and V after stationing.
- **Mode 4 Setting out:**
  Setting out using either coordinates or azimuth and distance; this must be preceded by a stationing procedure.
- **Mode 5 Area:**
  Computation of an area using coordinates.

5.2 Stationing on a Known Point

❑ **Purpose**

Preparatory measurement for the orientation of the set of directions or graduated circle in order to permit the determination of polar point coordinates or setting out coordinated points.

The coordinates of the station and backsight point or the azimuth relative to the backsight point are known.

If you also want to compute heights in further measurements and the station height is not available, you can perform a height stationing procedure. The height Z = 0.000 means no height.

The measurement of the known reference points (max. 20) orientates the instrument in the national coordinate system involved; the bearing between the station and reference point and the scale are derived from the measurements (Fig 5-2).

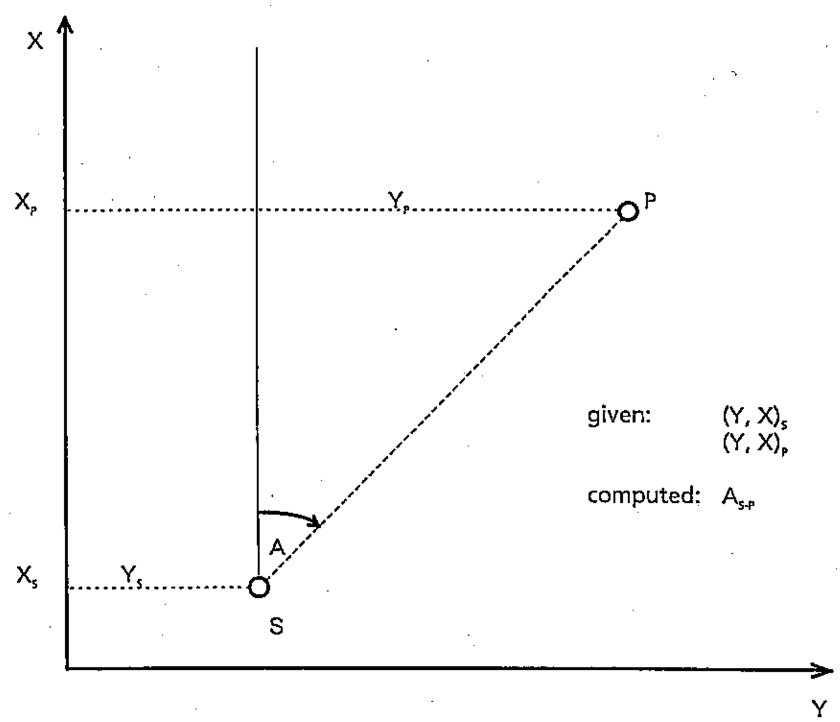


Fig. 5-2: Stationing on a known pointt

☐ Selecting the mode

Call up stationing with numeric key 1 in the **COORDINATES** program (Fig. 5-1), the display changes automatically to the initial menu of this measuring mode (see Fig. 5-5).

Fig. 5-3: Initial menu for stationing

☐ Calling up the known station

ENT: Starts the mode (Fig. 5-4).
The station can either be called up with softkeys 5 to 8 or entered manually using softkey 3.

Fig. 5-4: Calling up the station

Key		Function
FCT + 3	Softkey **Inp**	Manual entry of the station P.I. and coordinates, in the same way as in the **EDITOR** program.
FCT + 5	Softkey **LAd**	Calling up the last address in line 2.
FCT + 6	Softkey **?Ad**	Calling up the station using its address
FCT + 7	Softkey **?Pt**	Calling up the station using its point number
FCT + 8	Softkey **?PI**	Calling up the station using a point identification
↑↓		Scrolling the data lines
←→		Toggling between the display of coordinates and the point identification P.I.

The address found is displayed in line 2 of Fig. 5-5.

Fig. 5-5: Calling up the station "1500 PP"

ENT: Confirms the point selection, the program changes to the display in Fig. 5-5.

☞ **If the called address contains no coordinates, a message to this effect is displayed.**

❑ Type of orientation

The orientation can be performed in two different ways. Use numeric key 1 or 2 in Fig. 5-6 for selection.

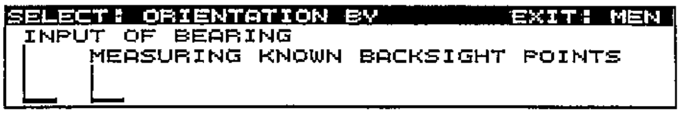


Fig. 5-6: Orientation options

Key 1: Distance measurement of the backsight point is not possible, but the azimuth between the station and backsight point is known (e.g. computed from coordinates) and can be entered.

Key 2: Coordinates of the backsight points are known (available in the memory or to be subsequently entered manually).

Case 1: Orientation using known azimuth

❑ SET HZ menu

If you press key 1 in Fig. 5-6, you are requested to enter the azimuth (Fig. 5-7).

ENT: Ends the entry, change to the P.I. entry in the measurement menu.

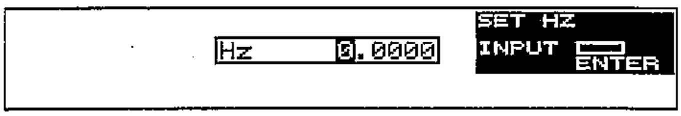


Fig. 5-7: Azimuth entry

❑ Entering P.I. in the measurement menu

ENT: Calling up the measurement menu (see Fig. 5-8) and entry of the point identification in line 2

Fig. 5-8: P.I. entry in the measurement menu

❑ Measurement

ENT: Sight the backsight point and trigger measurement.

❑ Recording

Recording of the set azimuth, the scale (M = 1) and the station coordinates. Return to the main menu (see Fig. 5-1).

Case 2: Orientation using backsight points

☐ Calling up the backsight points

If you press key 2 in Fig. 5-6, the display changes to Fig. 5-9 for calling up the backsight points for stationing from the PCMCIA card or MEM. A maximum of 20 backsight points can be measured.

Fig. 5-9: Calling up the backsight points

Call up the backsight points in the same way as **Calling up the station** using the softkeys **Inp**, **LAd** or **?Ad** or with the vertical cursor keys.

ENT: Confirms the correct point selection, the program changes to the measurement menu (Fig 5-11).

If the station and backsight point are identical, this is indicated in Fig. 5-10.

ENT :Continues the measurement.

Fig. 5-10: Identical points

☐ Measurement

Sight the reflector on the backsight point and trigger the measurement with **ENT**. Change to the measuring mode DTh or Th by pressing the DTh softkey, i.e. select the mode suitable for the measurement configuration.

DTh: Measurement is performed by the distance meter and theodolite. If you measured the target without a prism by mistake, interrupt the measurement with **MEN** and set the softkey to **Th**.

Th: Measurement can only be performed with the theodolite.

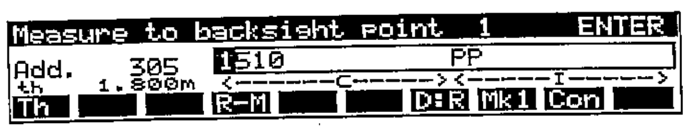


Fig. 5-11: Measurement menu

☐ Result of the backsight measurement

After completion of the backsight measurement, line 1 displays the deviations between the measured data and the data computed from the coordinates (Fig. 5-12). The following is displayed:

- dl: longitudinal deviation, if measurement was performed with DTh
- dq: transverse deviation, which is always 0.000 for a backsight point
- dz: height deviation, if the station height and the height of the backsight point are known

```
dl   -0.002m    dq    0.003m    dz   -0.002m
 RESIDUALS EXCEEDED, NEW MEASUREMENT
      NEXT BACKSIGHT POINT
           ADJUSTMENT
```

Fig. 5-12: Result menu

It is decisive for continued measurement whether the specified limits have been exceeded or not. The display means the following:

Residuals exceeded, new measurement
- The last measurement is not used, change to **Next backsight point**

Next backsight point
- Call up further backsight points

Adjustment
Computation of the orientation

Repeat the steps **Next backsight points** and **Measurement** for all backsight points.

☐ Adjustment

If you select the adjustment option, the program computes the orientation and scale, and displays the residuals in the longitudinal, transverse and radial directions. Averaging for orientation is performed without weighting.

```
dl          0.000 dq          0.001 dr        0.001
1520              PP                  SELECT:↑↓
NO. 2         ALL RESIDUALS CORRECT: ENTER
Del       Add  R-C
```

Fig. 5-13: Display of residuals

The cursor keys ↑ and ↓ permit calling up the individual residuals for assessment. You can use the **Del** and **Add** softkeys to delete or add individual measurements.

ENT: All residuals are O.K., change to the scale menu

☐ Scale menu

After completion of stationing, you can select the scale to be used for further measurements. The selected scale is:

- filed in the input menu
- stored
- used for all subsequent computations

Fig. 5-14: Scale menu

Key 1: Scale is adopted from the input menu (**INP**)
Key 2: Scale resulting from the stationing measurement is used
Key 3: Scale is set to M = 1.000 000

☐ Editing the station

After confirming the stationing, you can edit the station P.I.

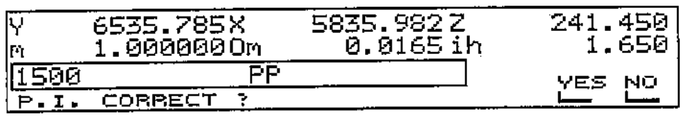


Fig. 5-15: Request for station P.I.

YES: Storage and change to the coordinates menu
NO:

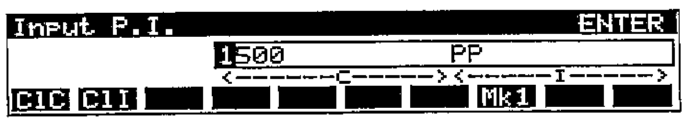


Fig. 5-16: Editing the station P.I.

If the height of the station is unknown, it can be computed on the basis of the backsight points. In addition, further spot heights can be measured.

☞ **After this stationing procedure, the horizontal circle of the instrument is rotated through the orientation angle omega. As a result, bearings are now displayed under Hz.**

☞ **If the measurement for stationing is terminated with MEN, this must be confirmed for safety's sake. A terminated stationing process cannot be resumed**

```
Terminate program
ARE YOU SURE ?
                                  YES NO
```

Fig. 5-17: Termination of measurement?

YES: Return to the coordinates menu
NO: Stationing is continued

5.3 Polar Point Determination

☐ Purpose

Determination of the coordinates and heights of new points by distance and angle measurement; display and recording of the computed values.
The coordinates can be computed in a higher-order coordinate system. Local coordinates can be determined in the **MEASURE** program.

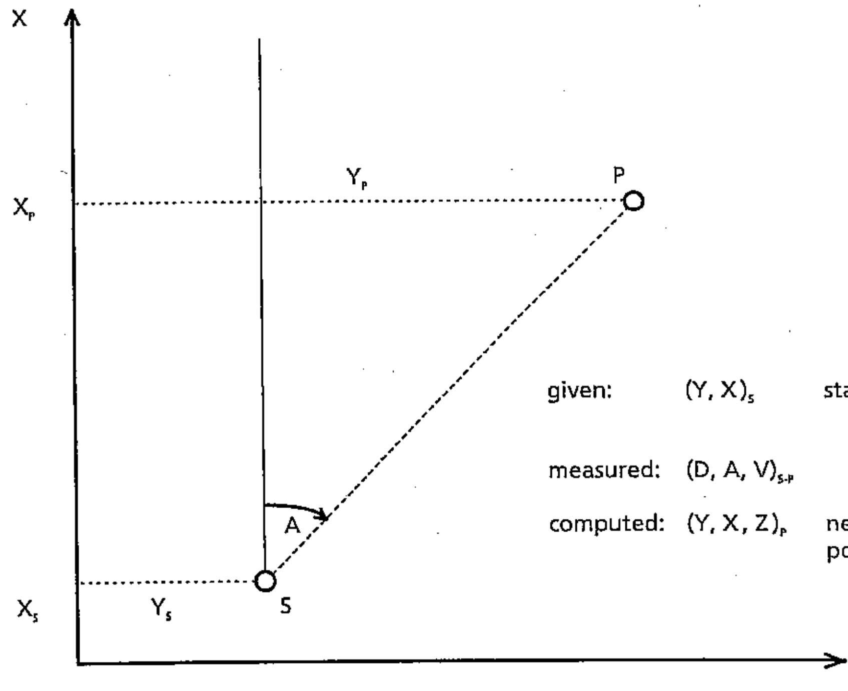


Fig. 5-18: Determination of new point coordinates

☐ Selecting the mode

Call up polar point determination with numeric key 7 in the **COORDINATES** program (Fig. 5-1); the program automatically changes to the initial menu of this measuring mode.

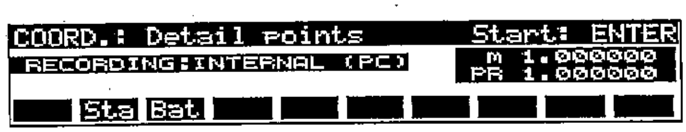


Fig. 5-19: Initial menu for polar point determination

ENT: Display of the last stationing

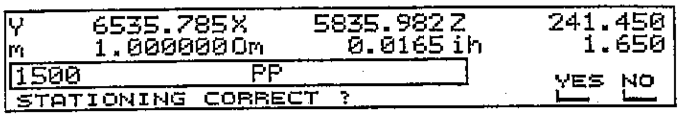


Fig. 5-20: Stationing selection

YES: Stationing is valid for this station; change to the measurement menu (Fig. 5-21) for the P.I. entry of the new point

NO: Stationing is not valid for this station; change to the coordinates menu (Fig. 5-1), for performing a stationing procedure.

❑ P.I. entry in the measurement menu

Enter the point identification of the new point in line 2.

Fig. 5-21: P.I.-entry in the measurement menu

❑ Measurement

ENT: Triggers the measurement of the new point.

Fig. 5-22: Measurement

❑ Result menu

After completion of the measurement, line 1 displays all three coordinate values (Fig. 5-23).
The cursor in line 2 in the input field requests the entry of the new P.I. For further measurements, proceed as described in **Input** and **Measurement.**

Fig. 5-23: Result menu

❑ Recording

Recording completed: an address is displayed in line 2 before the P.I. input field. The recording of measuring elements or coordinates is dependent on the setting of softkey 4:

- **R-M:** measured data
- **R-C:** coordinates
- **RMC:** measured data and coordinates

❑ Checking for double measurements

If function key '?on' has been set, the current project is searched for coordinated points with the same point code after measurement. If no such point is found, the data is recorded in accordance with the selected recording option. If a point is found, the following options are available:

- Function key 'OLD': The first measurement is used; instead of the second measurement, PI, dY, dX, (dZ) are recorded to indicate the double measurement.
- Function key 'NEW': The second measurement is used; the first measurement is overwritten with PI, dY, dX, (dZ) to indicate the double measurement.
- Function key 'MIT': The first measurement is overwritten with the mean values and 'M' is inserted at digit 27 of the PI; instead of the second measurement, PI, dY, dX, (dZ) are recorded.
- Function key 'USG': Display and entry of the lower threshold for the search within the project; normally this is address 1.
- Function key '? ↓': Continuation of point search.

5.4 Setting Out

❑ Purpose

Search for or setting-out of coordinated points. Stationing on a known or unknown point and the storage of the coordinates of the points to be set out in the internal memory are prerequisitie for setting out points on the basis of coordinates.

After you have entered the point to be set out or called it up from the memory and after measurement of the approximate point, the Rec Elta® displays the result in the form of the longitudinal deviation **dl**, the transverse deviation **dq**, the angle **dR** between the approximate point and the nominal point, the radial deviation **dr** and the deviations of the coordinates **dx**, **dy** and **dz**.

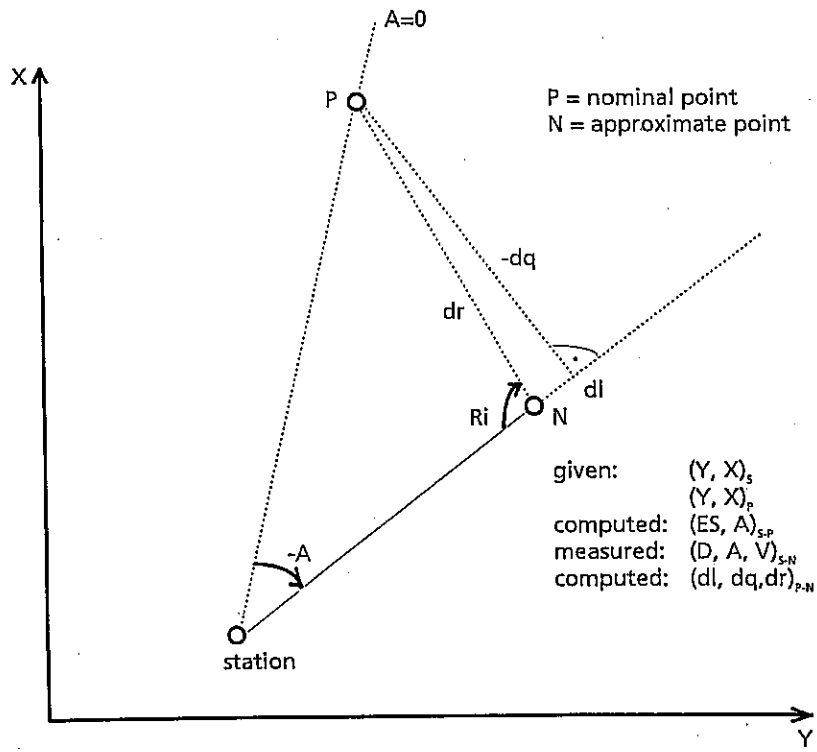


Fig. 5-24: Setting out

☐ **Selecting the mode**

Call up the setting out mode with numeric key 7 in the **COORDINATES** program (see Fig 5-25); the program changes automatically to the initial menu of this mode.

Fig. 5-25: Initial menu for setting out

ENT: Change to selection of the setting-out method

☐ **Selecting the setting-out method**

Two different setting-out methods can be selected as shown in Fig. 5-27.

Key 1 Setting out using given coordinates Y, X, Z with orthogonal corrections dl, dq and dr or coordinate corrections dy, dx and dz; change to the station enquiry.

Key 2 Polar setting out using the given distance E, bearing HZ and height difference h, if these values were computed beforehand from the station and setting-out coordinates.
Change to the entry of an azimuth (see ***5.2 Set***) followed by the change to ***6.4.5 Calling up the setting-out points***

Fig. 5-26: Selection of the setting out method

☐ **Stationing enquiry**

The results of the last stationing (coordinates, scale and orientation) are displayed for checking.

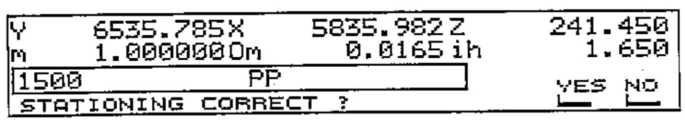


Fig. 5-27: Stationing enquiry

YES: Stationing is valid for this station; change to the menu for calling up the setting-out points (see Fig. 6-28).

NO: Stationing is not valid for this station; change to the coordinates menu (Fig. 5-1), for performing a stationing procedure.

☐ Calling up the setting-out points

When you select the setting-out method, the menu for calling up the setting-out points is displayed (Fig. 5-28). The setting-out point can either be called up with softkeys 5 to 8 or manually entered using softkey 3.
For setting out by coordinates, a search is made for data lines with Y, X, (Z) values whereas for polar setting out, the elements E, HZ, (h) are required.

```
Recall point to be set out          ENTER
Add.    320  5504            house
Add.      1  100             Anfangspkt.
        Inp      LAd ?Ad ?Pt ?PI ?↓
```

Fig. 5-28: Calling up the setting-out points

Key		Function
FCT + 3	Softkey **Inp**	Manual entry of the station P.I. and coordinates, in the same way as in 10.3 of the **EDITOR** program.
FCT + 5	Softkey **LAd**	Calling up the last address in line 2.
FCT + 6	Softkey **?Ad**	Calling up the station using its address
FCT + 7	Softkey **?Pt**	Calling up the station using its point number
FCT + 8	Softkey **?PI**	Calling up the station using a point identification
↑↓		Scrolling the data lines
←→		Toggling between the display of coordinates and the point identification P.I.

ENT: Confirms the point selection, the prog. changes to the display in Fig. 5-30.

If the called address contains no coordinates or polar setting-out elements, a message to this effect is displayed.

A check is made as to whether the setting-out point and the station are identical. If they are identical, this is indicated as in Fig. 5-29.

ENT : Continued measurement, followed by: **Calling up the setting-out points**

```
Recall point to be set out          ENTER
Add.    295  1500            PP
POINT TO BE SET = STATION
         CONTINUE WITH ANY KEY !
```

Fig. 5-29: Identical points

☐ Setting-out elements

The Rec Elta ® uses the known station and target point coordinates to compute the setting-out elements E (nominal horizontal distance) and Hz (bearing of the setting-out point). This data is displayed (see Fig. 5-30). In this process, Hz = 0.000 is internally set for each setting-out point. Now turn the instrument until Hz = 0.000 appears in the display.

Fig. 5-30: Setting-out elements

❑ Measurement and result

ENT: Triggers the measurement of the approximate point

Fig. 5-31: Result menu

After completion of the measurement, the setting-out corrections are displayed, depending on the setting of softkey **dlq**. The following options are available: the orthogonal corrections dy, dx, dz as the coordinate differences between the new point and the approximate point, or the polar corrections dl (longitudinal deviation) and dq (transverse deviation), or dR (angle relative to approximate point) and dr (radial deviation), or the actual coordinates XYZ of the setting-out point. If you select **ALL**, all types of setting-out corrections are recorded.

- dl positive: measured distance is too short
- dq positive: approximate point on the left of the nominal point

The transverse deviation (Hz) is displayed in the tracking mode. Repeat the measurement of the approximate points with **ENT** until the deviations no longer exceed the specified limits.

Use the **Tno/Ton** softkey to activate or deactivate the tracking mode for distance measurement and computation of the setting-out data.

❑ Ending the measurement and recording

MEN: Ends the measurement after setting out.
Brief display of the address under which the final setting-out elements are stored. The display changes to the enquiry whether further points are to be set out.

Fig. 5-32: Setting out further points

YES: Change to calling up the setting-out points
NO: Return to the coordinates menu

The recording of measuring elements or coordinates is dependent on the setting of softkeys 4 and 5:

- **R-M:** measured data D, HZ, V
- **R-C:** computed data, depending on the setting of softkey 5:
  - dlq: longitudinal, transverse and height differences
  - dyx: coordinate differences (coordinates only)
  - drR: angle relative to approximate point and radial deviation
  - ALL: all
- **RMC:** measured and computed data

☞ **For clear identification which point has been set out, the address of the setting-out point is filed right-flush in the P.I. Any information previously entered in this position is overwritten.**

5.5 Free Stationing

❑ **Purpose**

Free stationing permits the coordinates and height of an unknown station to be determined in any coordinate system. Depending on the measuring mode, you can use either bearings (Hz-V), distances and bearingss (SD-Hz-V) or a combination of both as measurement data. The option to be used is either stipulated (Helmert transformation) or can be selected as required (single point adjustment).

Backsight measurements of a maximum of 20 reference points are possible, Planimetric and height adjustment is performed separately.

```
SELECT                                    EXIT: MEN
 SINGLE POINT ADJUSTMENT
     HELMERT:SCALE FREE
          HELMERT:SC=1.00
```

Fig. 5-33: Mode selection

MEN: Return to the **COORDINATES** menu

❑ **Three methods are available for free planimetric stationing:**

The method of single point adjustment uses bearings and bearings plus distances in any combination as measurement data. It computes the station coordinates X and Y, scale M and the orientation unknown omega. On the basis of a selectable bearing accuracy (default is 0.0005 grad) and a selectable distance accuracy (default is 0.005 m), the weight ratio for bearings and distances is computed in accordance with the error propagation law. All bearing measurements in the adjustment process are assigned weight 1, while the computed weight (default 0.01) is applied to all distance measurements. The adjustment is performed on the basis of unequally weighted observations.

The Helmert transformation always uses bearings and distances. The same unknowns as in single point adjustment are determined. Bearings and distances are identically weighted in the Helmert transformation. The Helmert transformation offers the option of retaining scale 1.000000.

Height adjustment of the station is always performed according to the method of free point adjustment, but with height measurements being weighted inversely proportional to the square of the distance, just as in the standard approach.

As soon as it is geometrically possible, preliminary station parameters are computed in the stationing process either by transformation after two bearing plus distance measurements or by resection after three measurements. A corresponding procedure is applied to the station height Z.

☞ **If single point adjustment is performed on the basis of 3 bearing measurements, the only problem caused by geometry in this mode may occur if the station and the three backsight points are located on a circle. In such rare cases, the inadequacy of the method can be avoided by performing at least one measurement including a distance.**

The following description of free stationing uses the single point adjustment option, the process of which is identical to both versions of the Helmert transformation. In the case of any differences, an appropriate cross reference is made.

- In single point adjustment only:

Fig. 5-34: Entry of the standard deviations

- Enter the standard deviation for angles, range 0.0001 grad to 0.0100 grad
- Enter the standard deviation for distances, range 0.001 m to 0.100 m

Continue with **MEN**

Fig. 5-35: Start of single point adjustment

The measuring mode for single point adjustment is bearing measurement (HzV) or distance plus bearing measurement (DHz) and can be changed during measurement, if necessary. The only measuring mode for the Helmert transformation is distance plus bearing measurement (DHz).

The initial menu indicates that all distance measurements during stationing are performed with a scale of 1.000 000, irrespective of any other setting in the input mode (**INP**).

ENT: Starts the mode; change to the input menu for the station identification.

Fig. 5-36: Station entry

ENT: Confirms the entry; change to the menu for selection of the backsight points.

❑ Calling up the backsight points

In the menu, you can either call up backsight points from the PCMCIA card or MEM using the softkeys 3 to 8 (see Program 10. **EDITOR**) or you can enter them.

Fig. 5-37: Calling up the backsight points

☞ **If the station height (Z) is also to be computed, you have to enter or change the instrument and target heights using the INP key.**

☐ Measuring the backsight points

Measure the backsight point selected. After two measurements of bearing plus distance or three bearing measurements, the program computes the approximate coordinates. As long as these coordinates have not been computed, multiple measurements are not possible. After you have measured the 2nd or 3rd and all subsequent points, the following selection menu is displayed::

```
dl    0.001m    dq     0.000m    dz   -0.000m
 RESIDUALS EXCEEDED, NEW MEASUREMENT
 |     NEXT BACKSIGHT POINT
 |     |     ADJUSTMENT
 |__   |__   |__
```

Fig. 5-38: Selection after backsight measurement

The display means:

- dl= longitudinal deviation (for distance measurement only)
- dq= transverse deviation
- dz= height deviation (Z), if the backsight point includes a height.

- Residuals exceeded, new measurement
  - the last measurement is overwritten, change to **calling up backsight points**
  - this function also permits the search for backsight points
- Next backsight point
  - calling up further backsight points, change to **calling up backsight points**
- Adjustment
  - adjustment is performed

Repeat the steps for all backsight points.

❑ Adjustment

If you select the adjustment option, the program computes the planimetric coordinates, the circle orientation and the scale, and displays the residuals in relation to the backsight points.

Fig. 5-39: Display of residuals

Use the upward ↑ and downward ↓ cursor keys to call up the individual residuals for assessment.

ENT: All residuals are O.K., change to **height computation**

If the residuals are not O.K., you can delete or add individual measurements.

- Result of the Helmert transformation:

Fig. 5-40: Helmert results

The display shows the transformation parameters o and a, the offsets in Y and X, the scale and the angle of rotation.

The longitudinal and transverse residuals are displayed for each backsight point; in the Helmert transformation, the coordinate differences dy and dx are displayed.

❑ Deleting and Adding

If the residuals are not O.K., the measurements concerned can be deleted with the **Del** softkey.

Fig. 5-41: Deletion enquiry

NO: Return to **Adjustment**
YES: Deletion of the measurement

Fig. 5-42: Deletion of a measurement

If you have deleted individual measurements, the adjustment is automatically repeated after **ENT**. The deleted measurements are retained on the PCMCIA card and in the MEM; they are identified by **DEL** in the P.I.

To add further measurements, use the **Add** softkey. The program changes to **calling up backsight points.**

❑ Height computation

If heights are required for further measurements in the polar points or setting-out programs, these heights have to be computed.

```
Compute elevation ?                          YES  NO
```

Fig. 5-43: Height computation

NO: no computation of the station height
no computation of heights in the polar points mode
no computation of height differences in setting out
Change to the **result menu**

YES:

Case 1:
The measured backsight points include heights. The program uses the backsight measurements to compute the station height. The process is the same as in planimetric adjustment.

Case 2:
The measured backsight points do not include heights. Additional points have to be called up for height stationing. The process is the same as in planimetric adjustment.

❑ Result

After completion of stationing, the complete result is displayed.

```
Y      6535.784X     5835.981Z        241.450
my        0.000mx       0.000mz         0.000
m      1.0002890m      0.0067         YES  NO
 STATIONING CORRECT ?
```

Fig. 5-44: Ergebnis der Stationierung

JA: Abspeichern der Stationierung **Registrierung**
NEIN: Sprung ins Hauptmenü, alte Stationierung bleibt erhalten

❑ Recording

Recording depends on the selected softkey.
Softkey **RMR** stores both measured and computed data:

(1) Measured data D, HZ, V (directly after measurement). The measurements used for height computation are stored once again in a separate block. This permits a clear assignment of the measurement and computation, if any measurements should be deleted or additional measurements be performed.

(2) Computed data dl, dq, dr, dz (dl, dq, dr after orientation computation, dz after height computation).

(3) Coordinates X, Y, Z of the backsight point

(4) Scale M and heights ih (instrument) and th (reflector).
- Softkey **R-C** stores items 2 to 4
- Softkey **R-M** stores items 1, 3 and 4.
- 3 and 4 are always stored, even with **Rno**.

☞ **After this stationing procedure, the horizontal circle of the instrument is rotated through the orientation angle omega. As a result, bearings are now displayed under Hz.**

☞ **If the measurement for stationing is terminated with MEN, this must be confirmed for safety's sake. A terminated stationing process cannot be resumed.**

```
Terminate program
ARE YOU SURE ?
                                YES  NO
```

Fig. 5-45: Termination of measurement?

YES: Return to the coordinates menu
NO: Stationing is continued

5.6 Area

❑ Purpose

Computation of areas on the basis of coordinates. The coordinates can either be determined by measurement with the total station, manually entered, or imported to the PCMCIA card or MEM by data transfer. The coordinates must be called up in a uniform sense of rotation. The first point need **not** be entered again.

❑ Selecting the mode

Call up the **Area** mode with numeric key 8 in the **COORDINATES** program, the program changes to the initial menu of this computation mode.

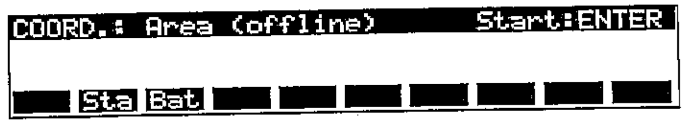


Fig. 5-46: Initial menu for Area

ENT: Change to entry of the area designation

Fig. 5-47: Entry of an area designation

The **NAr** softkey permits the entry of a known nominal area. The computation result is then compared with this area. The entry is optional.

ENT: Change to the menu for area corners

❑ Calling up the area corners

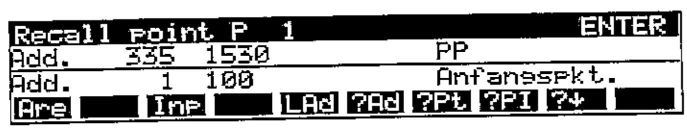


Fig. 5-48: Calling up the area corners

Definition:

Key		Function
FCT + 1	Softkey **Ar**	Starts the area computation
FCT + 3	Softkey **INP**	Manual entry of the coordinates
FCT + 5	Softkey **LAd**	Calling up the last address
FCT + 6	Softkey **?Ad**	Call using the address
FCT + 7	Softkey **?Pt**	Call using the point number
FCT + 8	Softkey **?PI**	Call using a point identification P.I.
FCT + 9	Softkey **?↓**	Continued search using an entered P.I.
↑↓		Scrolling the data lines
←→		Toggling between the display of coordinates and P.I.

For a detailed description of the search routines see chapter **10. Editor.**

ENT: Confirms the selection

You can enter a maximum of 60 points.

❑ Computing the area

Start the computation with the **Ar** softkey. For a clearer overview, the points with their P.I., planimetric coordinates and connecting distances to the next point are displayed again in the sequence of their entry. Use the cursor keys ↑ und ↓ for the selection of individual entries.

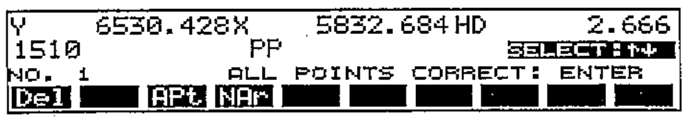


Fig. 5-49: Entry check

Points entered incorrectly can be deleted with the **Del** softkey.

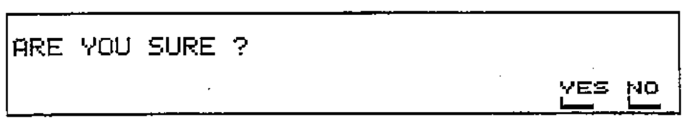


Fig. 5-50: Deletion of a point

YES: Point is deleted; change to **Area computation**
NO: Change to **Area computation**

For the entry of additional points, use the **APt** softkey. Make sure the sequence is correct. Use the cursor keys to display the point in front of which an additional point is to be inserted (see Fig. 5-51).

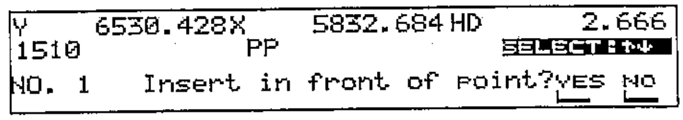


Fig. 5-51: Additional points

YES: Change to point selection
NO: Change to **Area computation**

☐ Result

If you have correctly selected and entered all points, confirm with **ENT**. The result is displayed.

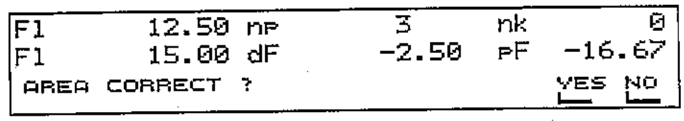


Fig. 5-52: Result of area computation

The display means:

- **Fl:** area in m^2
- **np:** number of corner points
- **nk:** not active

If you have entered a nominal area, the following is additionally displayed in line 2:

- **Fl:** nominal area in m^2
- **dF:** difference of area (nominal/actual)
- **pF:** difference in percent (dF / nominal area)

YES: Area is recorded; return to the coordinates menu.
NO: Change to the check menu

6 Special

6.1 General

☐ Purpose

The **SPECIAL** program offers two modes (see Fig. 6-1) for the solution of problems frequently encountered in surveying. On the basis of the original measured data D, Hz, V, the values required for the task on hand are computed, displayed and stored. Before starting the individual programs, you can run a height stationing procedure for which you can also use points without planimetric coordinates; however, you have to measure the distance in this case. The process is identical to **Free Stationing** (see 5.5). The **PC Program Mode** calls up the application programs of the DOS PC.

If you are working e.g. in a Gauss-Krüger coordinate system, you can enter the projection and height reduction in the **ADJUST/PREPARE** program.

☐ Selecting the mode

Select the **SPECIAL** program with numeric key 3 in the main menu. The display changes to the menu of the special programs (see Fig. 6-1). The modes can be directly selected using the numeric keys assigned by the **L** marks.

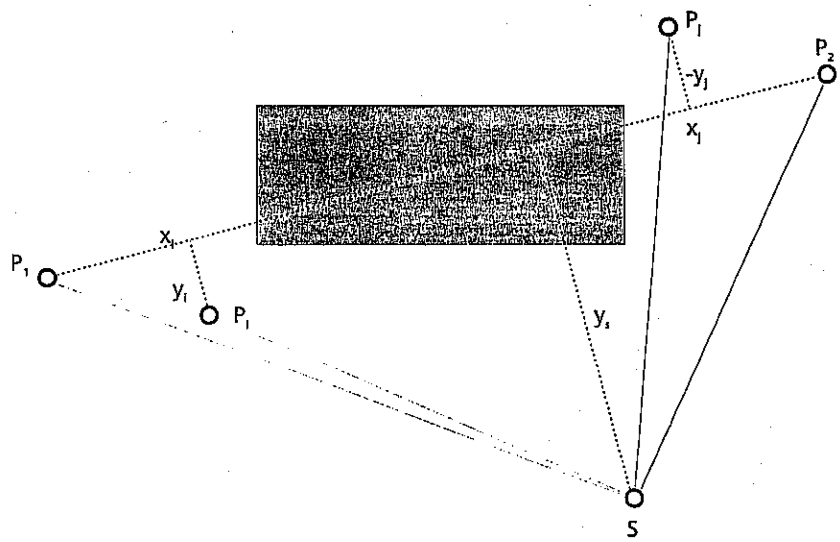
Fig. 6-1: Menu of special programs

❑ Comments on the modes

Mode 1: Point-to-line distance

Determination of

- x= Distance of the foot of perpendicular from starting point P1
- y= Orthogonal distance of the point from line P1-P2
- h= Height difference between P1 and P2
- Z= Height of target Pi



measured: (D, A, V)
computed: (x, y, Z)

Fig. 6-2: Point-to-line distance

Mode 2: Connecting distances

Determination of

- D= Slope distance
- E= Horizontal distance
- h= Height difference

between

- the first point sighted and subsequent points (function **1→P**, softkey 5)
- two points sighted successively (function **P→P**, softkey 5).
-

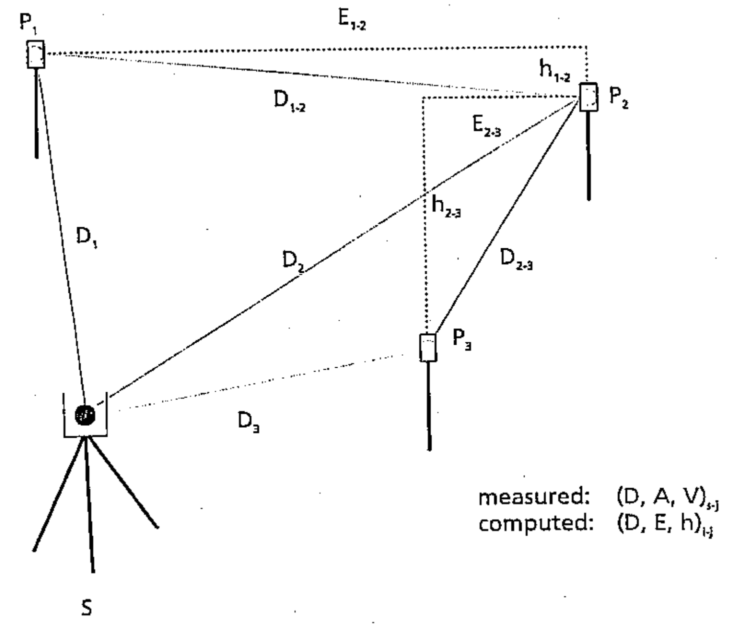


Fig. 6-3: Connecting distances

6.2 Point-to-Line Distance Mode

☐ Purpose

Determination of point distances from a reference line defined by angle and distance measurement of the two points P1 and P2.
The mode facilitates orthogonal surveys on aligning bases, utility lines, road axes, sight rail and profile surveys. If the instrument station is freely selected, you have to measure the points P1 and P2. If the station is known in a coordinate system, the points can be called up from the data memory.

☐ Selecting the mode

Call up the point-to-line distance mode with numeric key 1 in the **SPECIAL** program (see Fig. 6-1); the program automatically changes to the initial menu of this measuring mode (Fig. 6-4).

Fig. 6-4: Initial menu for point-to-line distance

☐ Selecting the coordinate system

Fig. 6-5: Selection of the coordinate system

1. Local system
In the local system, you measure the two points of the line P1 and P2. The height can be determined either by measuring the first point of the line or by separate height stationing.

ENT: Starts the mode

☐ Entering the P.I.

Enter the point identification in line 2 of Fig. 6-6.

Fig. 6-6: Input menu for local system

❑ Measuring the first point of the line

Sight the reflector of the first point and trigger the measurement with **ENT**.

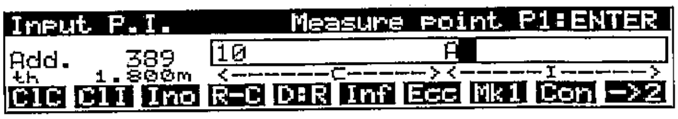


Fig. 6-7: Measurement of the 1st point of the line

After measurement, the readings are recorded in accordance with the setting of softkey 4 -**R-M**, **R-C** or **RMC**.

❑ Measuring the second point of the line

Enter the point identification for the second point in line 2. Sight the reflector of the second point and trigger the measurement with **ENT**. Recording and display as for the first point.

❑ Result menu

Result after measurement of the two points of the line (Fig. 6-8).

Line 2: Local coordinates y (easting), x (northing) and h (height difference) of the second point of the line as referred to the axis P1-P2.

Line 3: Local coordinates of the station as referred to the line P1-P2.

ENT: Storage in two data lines, if the recording mode has been activated.

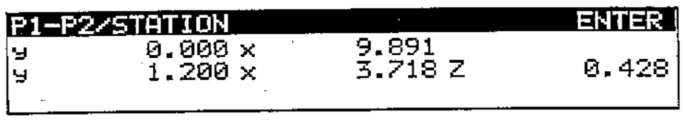


Fig. 6-8: Result menu for point-to-line distance

If P1 and P2 are identical, a message to this effect is displayed (see Fig. 6-9). Continue the measurement with **ENT**, followed by **P.I. Entry**.

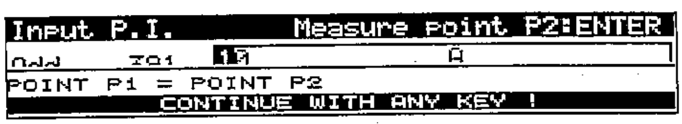


Fig. 6-9: Identical points

❑ Measurement of lateral points

Press **ENT** to change from the result menu to the input menu for the measurement of detail points (points not located on the line). The cursor in line 2 in the input field requests the entry of a new P.I. Perform further measurements as described in the items **P.I. entry** and **Measuring the first point of the line.** The local coordinates y, x and z as referred to the line are displayed and recorded (Fig. 6-10).

Fig. 6-10: Lateral points

The **x/y** function key indicates that local coordinates were computed. It can also be set to **Y/X** for recording of coordinates in the higher-order system, or to **All** for recording of coordinates in both the local and higher-order systems.

❑ Recording

Measurements are automatically recorded if softkey 4 is set to **R-M, R-C** or **RMC.** Recording completed: the address is displayed in line 2 before the P.I. input field.

☞ **If softkey 4 is set to Rno, recording is deactivated and no address is displayed in line 2.**

❑ Ending the measurement

MEN: Direct return to the **SPECIAL** program.

2. Coordinate system

The stationing last performed is displayed.

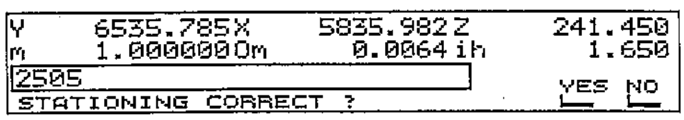


Fig. 6-11: Display of last stationing

Is this stationing O.K.?
YES: Continue with **Calling up P1**
NO: Return to the **SPECIAL** main menu (Fig. 6-1)

☐ Calling up P1

The coordinates of points P1 and P2 can either be selected from the memory using the softkeys 3-8, or they can be entered.

```
Recall point P  1                          ENTER
Add.    396  15              tree
Add.      1  100             Anfangspkt.
          Inp       LAd ?Ad ?Pt ?PI ?↓
```

Fig. 6-12: Selection of points P1 and P2

ENT: Confirms the selection

☐ Result menu

If the points P1 and P2 have been correctly called up, the result is displayed.

```
P1-P2/STATION                              ENTER
y       0.000 x       9.895
Y    6535.785 X    5835.982 Z        241.450
```

Fig. 6-13: Result menu for point-to-line distance

The display means:

Line 2: Local coordinates y and x of the second point of the line as referred to the axis P1-P2.

Line 3: Coordinates Y, X and Z of the station in the higher-order coordinate system.

ENT: The result is stored. Continue with **Measuring lateral points.**

If the two points are identical, a message to this effect is displayed (see Fig. 6-9).

6.3 Connecting Distances Mode

☐ Purpose

Distance and angle measurement from a station to two points supplies the connecting distance in the form of slope distance (D), horizontal distance (E) and height difference (h) between:

- the sighted point and the first point (softkey **1→P**)
- points sighted successively (softkey **P→P**).

☐ Selecting the mode

Call up the connecting distances mode with numeric key 2 in the **SPECIAL** program (see Fig. 6-1); the program changes automatically to the initial menu of this measuring mode (Fig. 6-14).

Fig. 6-14: Initial menu for connecting distances

ENT: Starts the mode

☐ Selecting the coordinate system

Fig. 6-15: Selection of the coordinate system

MEN: Return to the **SPECIAL** menu

1. Local system (key 1)
In the local system, you can directly measure the starting points for the determination of connecting distances.

☐ P.I. entry

Enter the point identification in line 2 of Fig. 6-16.

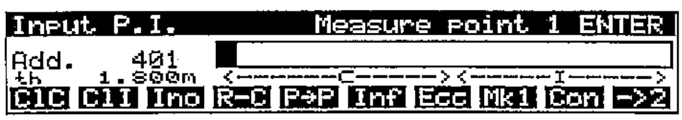


Fig. 6-16: Input menu for connecting distances

❑ Measuring the first point

Sight the reflector of the first point and trigger the measurement with **ENT**.

```
Input P.I.              Measure point 1 ENTER
Add.    401  1451
th      1.800m  <-------C------><------I------>
C1C C1I Ino R-C P>P Inf Ecc Mk1 Con ->2
```

Fig. 6-17: Measurement of connecting distances

After measurement, the readings are recorded in accordance with the setting of softkey 4 -**R-M**, **R-C** or **RMC**. Continue with **Measuring the next point.**

❑ Measuring the next point

Enter the point identification for the next point in line 2. Sight the reflector of the second point and trigger the measurement with **ENT**.

❑ Result menu

After measurement of the first two points, line 1 displays all three elements determined (Fig 6-18). The cursor in line 2 in the input field requests the entry of the new P.I. For further measurements, proceed as described in the items **P.I. entry** and **Measuring the next point**.

```
SD        2.676 HD        2.665 h         -0.245
Add.    404  1452
th      1.800m  <-------C------><------I------>
C1C C1I Ino R-C P>P Inf Ecc Mk1 Con ->2
```

Fig. 6-18: Result menu for connecting distances

❑ Recording

Measurements are automatically recorded if softkey 4 is set to **R-M**, **R-C** or **RMC**. Recording completed: the address is displayed in line 2 before the P.I. input field.

☞ **If softkey 4 is set to Rno, recording is deactivated and no address is displayed in line 2.**

2. Coordinate system (Key **2**)
Connecting distances can be determined in a higher-order coordinate system. In this case, you can call up the first point from the memory or enter it. There is no need to measure this point.
The stationing last performed is displayed.

```
Y     6535.785X     5835.982Z      241.450
m     1.0000000m       0.0064ih      1.650
2505                               YES  NO
 STATIONING CORRECT ?
```

Fig. 6-19: Display of last stationing

YES: Continue with **Calling up P1**
NO: Return to the **SPECIAL** main menu (Fig. 6-1)

☐ Calling up P1

The coordinates of point P1 can either be called up from the memory using the softkeys 3-8, or they can be entered.

Fig. 6-20: Calling up P1

If the station and P1 are identical, the display shows:

POINT P1 = STATION !!

If the points have been correctly selected, the program changes to **Measuring the next point**.

☐ Ending the measurement and quitting the mode

MEN: Direct return to the **SPECIAL** program.

7 Application Programs

7.1 Project Management

❑ **Main menu:**

```
SELECT PROGRAM:          PROJECT: ABCDE
 MEASURE                 ADJUST/PREPARE
      COORDINATES              DATA TRANSFER
            SPECIAL                  EDITOR    DOS-PC
```

Fig. 7-1: Main menu

The heading line of the main menu indicates the name of the current project, in this case **NONAME**. The associated data file on the PCMCIA card is **NONAME.DAT.**

❑ **Project manager:**

In the **ADJUST/PREPARE/SET** menu, the current project is also displayed under **PROJECT: ABCDEFGH.**

```
SET:                               EXIT: MEN
 MARKING                     INITIALIZE MEM
      PROJECT:ABCDEFGH             SOUND/MAN.INP.
            DEC. DIGITS
```

Fig. 7-2: Current project

This menu item calls up the project manager.

```
PROJECT:ABCDEFGH.DAT              EXIT: MEN
 SELECT PROJECT              DATA FROM OTH. PRJ.
      NEW PROJECT                 RENAME PROJECT
            DEL. PROJECT               UPDATE PC
```

Fig. 7-3: Project manager

The following options are offered:

```
SELECT PROJECT:                    EXIT: MEN
ABCDEFGH.DAT                     SEARCH:  ↑↓
USED:          30 LINES          SELECT: ENT
MAX:          500 LINES
```

Fig. 7-4: Selecting a project

You can scroll through all projects stored on the PCMCIA card, with the number of lines used and the maximum number of lines being displayed for each project.

ENT: Confirms the selected project.

```
NEW PROJECT:                          EXIT: MEN
NAME:           .DAT                SELECT: ↑↓
MAX. LINES      5524                INPUT:  ENT
PROJECT DATA
```

Fig. 7-5: New project

Enter the file name of a new project in accordance with the usual DOS rules, the file extension **.DAT** is set automatically. **MAX. LINES** indicates the number of unused data lines on the PCMCIA card. You can specify a maximum number of lines for the project here. In **PROJECT DATA**, you can enter alphanumeric information comprising up to 10 lines of 27 digits each, and save it at the beginning of the new project.

```
DELETE PROJECT:                       EXIT: MEN
ABCDEFGH.DAT                        SEARCH: ↑↓
USED:         30 LINES              DELETE: ENT
MAX:         500 LINES
```

Fig. 7-6: Deleting a project

You can scroll through all projects stored on the PCMCIA card, with the number of lines used and the maximum number of lines being displayed for each project. If you press **ENT** to delete the project no longer required, the following enquiry is displayed:

```
LAST WARNING:
 ABCDEFGH.DAT  DELETE, ARE YOU SURE ?
                                YES NO
```

Fig. 7-7: Check for deletion

YES: Deletes the project file and the associated data file on the PCMCIA card.
NO: Return to menu.

```
DATA FROM OTHER PROJECT               EXIT: MEN
AAAA.DAT                            SEARCH: ↑↓
                                    SELECT: ENT
```

Fig. 7-8: Data import

Any type of data from another project, e.g. reference point coordinates, can be imported to the current project. Select the other project with the cursor keys and activate it with **ENT**.

```
PROJECT:AAAA.DAT                      EXIT: MEN

ADR      A-A
```

Fig. 7-9: Data selection

Select the data to be imported either by calling it up individually via the address and point identification, or by calling up groups using a starting and end address, a starting and end point identification or a combination of these methods. The point marking can be changed and wildcards can be used in the search mask.

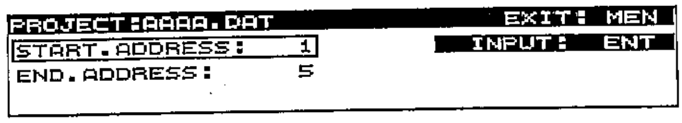


Fig. 7-10: Starting and end addresses

The selected single line or the starting and end lines of the selected group are displayed for checking:

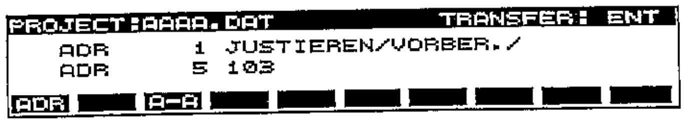


Fig. 7-11: Display for checking

The horizontal cursor keys permit you to toggle between the display of the point identification and of the measured or computed data

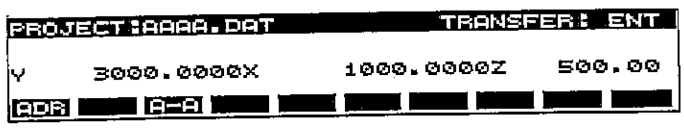


Fig. 7-12: Data display

ENT: Acceptance of the selected data in the current project

The selection and import procedure can be repeated as often as required.

A project can be renamed, if necessary. You can also vary the maximum number of lines in the range between the last line used in the project and the number of lines that can be stored on the card.

Fig. 7-13: Change of project name and number of lines

If a new operating or application program for the on-board PC is supplied by Carl Zeiss, it can be loaded from a PCMCIA card using UPDATE DOS. Separate instructions are supplied for this process. In normal operation, the following message is displayed:

```
NO UPDATE FILES AVAILABLE
CONTINUE WITH ANY KEY
```

Fig. 7-14: Update

7.2 Basic Tasks and Transformations

❑ **Purpose**

This section summarizes various programs which permit partial computations to be performed right in the field. This does not mean, however, that the entire computation work should be transferred to the field. Instead, the Coordinates programs are intended to enable the user to perform all computations he considers useful for checking the measurement or as intermediate steps between different measuring routines, thus contributing to smooth field work. Traverse is an on-line program permitting the generation of adjusted coordinates in the field.

You can call up these programs in the **COORDINATES** menu, the **SPECIAL** menu or directly from the **DOS-PC** main menu:

```
SPECIAL:                                     EXIT: MEN
 STATIONING (ELEV.)   PC-PROGRAM
      STATION + OFFSET
            CONN. DIST.
```

Fig. 7-15: PC Programs

7.2.1 *Basic Tasks*

```
TO RECT/TO POLAR                             EXIT: MEN
 BEARING + DISTANCE
      POLAR POINTS
```

Fig. 7-16: Selection of basic tasks

Call up the option required.

MEN: End and return to the menu.

❑ **Bearing, distance (and height difference):**

```
SEQUENCE OF COMPUTATION:                     EXIT: MEN
 1-2,1-3,1-4
      1-2-3-4-5-6
```

Fig. 7-17: Sequence of computation

Select the sequence of computation

MEN: End and return to the basic tasks menu

```
Recall/PI of point P1                      ENT
Adr     3        100
Y      1000.000 X        2000.000 Z     500.000
          Inp        LAd ?Ad        ?PI
```

Fig. 7-18: Calling up P1

ENT: Call up point 1 using the point identification or address.
MEN: End and return to the menu.

```
Recall/PI (next) point P2                  ENT
Adr     4        101
Y      1000.000 X        1000.000 Z     500.000
          Inp        LAd ?Ad        ?PI +?
```

Fig. 7-19: Calling up P2

ENT: Call up point 2 using the point identification or address.
MEN: End and return to the menu.

Check whether points P1 and P2 are identical; if so, both points can be re-entered.

```
From P1 to P2
Bearing:                200.0000 grad
Hor. distance:          1000.000 m
Diff. of elev:             0.000 m       -> ENT
```

Fig. 7-20: Result

Display: Bearing, horizontal distance from P1 to P2 and, if both heights are known, height difference Z(2)-Z(1).

ENT: Proceed with the entry of the next point P3 and computation using the same starting point P1.

In the case of continuous computation, entry of the next point P3 and computation using point P2.

❑ Polar connection of point P2 to P1:

```
Recall/PI of point P1                      ENT
Adr     3        100
Y      1000.000 X        2000.000 Z     500.000
          Inp        LAd ?Ad        ?PI
```

Fig. 7-21: Calling up P1

ENT: Call up point 1 using the point identification or address.
MEN: End and return to the menu.

```
From  P1 = 100
Bearing:              250.0000 grad
Hor. distance:        1000.000 m
                                      YES NO
```

Fig. 7-22: Entry of data

Enter the bearing angle P1→P2
Enter the horizontal distance P1→P2

NO: Repeat the entry of the bearing angle and horizontal distance
YES: Computation of the coordinates

```
Recall/PI of point P2                    ENT
                 12345abcde
                 <------C------><-----I----->
  A    B    C    D    E    F    G    H    I    J
```

Fig. 7-23: Entry of P2

ENT: Confirms the entry of the point identification for point P2
MEN: End and return to the menu.

```
Adr 31           12345abcde
Y      292.893 X      1292.893 Z        0.000

Next polar point ?                    YES NO
```

Fig. 7-24: Result

Display of the new computed point including its memory address

YES: Entry and computation of the next point
NO: Return to the basic tasks menu

7.2.2 Transformations

The Transformations menu offers the following options:

```
TRANSFORMATION:                     EXIT: MEN
HELMERT S = 1.000000           SUB->MAIN
    HELMERT S = FREE                MAIN->SUB
        DOCUMENTAT.YES
```

Fig. 7-25: Selection of transformation

Call up the option required.

For both Helmert transformations, the coordinates of identical points in the superordinate and subordinate systems can be documented by selecting **YES.** The computation of detail points and the transformation to a line are always documented.

MEN: End and return to the menu

☐ Helmert Transformations

In the option **S=1.000000**, the Helmert transformation computes the shifts of coordinates in Y and X and the angle of rotation; in the option **S=FREE**, it also computes the scale as an unknown. The procedure in both programs is identical.

```
Reading of identical points
of MAIN system  Y/X ?

                                YES NO
```

Fig. 7-26: Reading in identical points

YES: Reading in identical points of the superordinate system Y/X
NO: Return to the transformation menu

```
Selection of data lines, Transfer

All Adr A-A ?PI P-P     LAd
```

Fig. 7-27: Selection of data lines

Select data lines using the active function keys.

```
Selection or Transfer with ENT
Adr      3     100
Adr      6     107
All Adr A-A ?PI P-P     LAd
```

Fig. 7-28: Display of addresses

```
Selection or Transfer with ENT
Y     1000.000 X        2000.000 Z    500.000
Y     3000.000 X        2000.000 Z    500.000
All Adr A-A ?PI P-P     LAd
```

Fig. 7-29: Display of coordinates

After selection, the data lines are displayed as follows:

- with **All, A-A, P-P** the first and last lines,
- with **Adr, ?PI, LAd** the selected line.

If the selection was not correct, use the function keys or, for single lines, the cursor keys to make a new selection.

If the selection is correct, press **ENT** to transfer the data to the program for further computation. Several selection and transfer cycles can be performed successively. However, only a maximum of **20 points** can be transferred.

After reading in all points of the superordinate system, end the selection with **MEN.**

```
Identical points in MAIN system Y/X
Adr      6     107
Y     3000.000 X       2000.000 Z     500.000
Points transferred o.k. ?             YES NO
```

Fig. 7-30: Checking of transferred points

For checking, all transferred points are displayed in rapid succession.

YES: The correct points have been transferred.
NO: Return for reentry.

```
Reading of identical points
of SUB system  y/x ?
Attention: use same sequence
than with Y/X-system                  YES NO
```

Fig. 7-31: Reading in points of the y/x system

Read in the identical points of the subordinate system y/x.

☞ **The procedure is the same as described for the superordinate system. Make sure to read in the corresponding points in the same sequence as in the superordinate system.**

(1) Check whether the number of identical points is the same.

(2) Check the transformation result

NO: Terminates incorrect computation

```
Result of Helmert-Transf. S = free
 o =    0.000008        a =   0.999992
dy =       -0.021 m    dx =        0.003 m
                                   -> ENT
```

```
Result of Helmert-Transf. S = free
 S =    0.999992      ep =      0.0005 grad
Mean square error    m0 =       0.009 m
                                   -> ENT
```

Fig. 7-32: Transformation result

Display of the transformation parameters o, a, the shifts in Y and X, the scale, the angle of rotation and the mean error of weight unit m0. If only 2 identical points are available, the distance deviation is displayed:

ds = S(Y/X) - s(y/x)

Continue with **ENT**

```
Check residuals              all o.k. ENT
 1     dY  0.003 m   dX  0.011 m 100

Del      new add      Com
```

Fig. 7-33: Checking of residuals

Display of residuals in Y und X, possibility of scrolling.

Active funciton keys:

Del: Deleting points
new: Repeating the complete transformation
add: Reading in additional identical points
Com: Recomputing the transformation parameters, e.g. after deletions
ENT: Confirms that the transformation is OK

```
Transformation of more points
of SUB system y/x ?

                                  YES NO
```

Fig. 7-34: Transformation of further points

YES: Proceed with the selection of further points
NO: Return to the transformation menu

```
Not ident. points in SUB system y/x
Adr     11     103
Y    3000.030 X      1000.030 Z    500.030
Points transferred o.k. ?         YES NO
```

Fig. 7-35: Selection of further points

For the selection, transfer, display and confirmation of the points to be transformed, proceed as for the selection in the superordinate and subordinate systems.

```
Transformation with consideration
of the weighted best fit ?
                                   YES NO
```

Fig. 7-36: Best-fit adjustment

NO: No best-fit adjustment
YES: The residuals of identical points are set to zero. Additional corrections derived by weighted averaging from the residuals of the identical points are applied to the transformed non-identical points.

weight: p = 1/(s*sqr(s))

with s = distance between identical and non-identical points.

Display of the transformed points with their addresses, point identifications, coordinates and corrections obtained by best-fit adjustment (if selected). The point identifications remain unchanged. The type identifiers (YT, XT, Z) of the coordinates indicate the transformation.

❑ Detail point computation

```
Recall/PI PB (Coordinates)           ENT
Adr    4      101
Y     1000.000 X      1000.000 Z   500.000
         Inp      LAd ?Ad      ?PI
```

Fig. 7-37: Calling up the starting point

Call up the starting point in the superordinate system using the point identification or address.

```
Recall/PI PB (Coordinates)           ENT
Adr    5      103
Y     3000.000 X      1000.000 Z   500.000
         Inp      LAd ?Ad      ?PI
```

Fig. 7-38: Calling up the end point

Call up the end point in the superordinate system using the point identification or address.

Fig. 7-39: Entry of PB

Enter the orthogonal distances for starting point PB.

Active function keys:

ClC: Deleting the point code
ClI: Deleting the additional information
???: No orthogonal distances are known
Mk1: Changing the PI marking
MEN: Return to the transformation menu

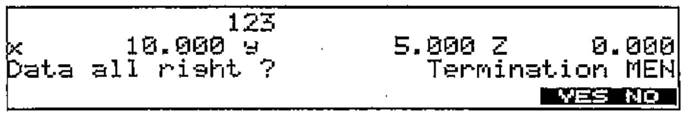


Fig. 7-40: Checking the entry

YES: Confirms the selection
NO: Repetition of the selection
MEN: Cancels the entry

Fig. 7-41: Entry of PE

Enter the orthogonal distances for end point PE.

Active function keys:

ClC: Deleting the point code
ClI: Deleting the additional information
???: No orthogonal distances are known
Mk1: Changing the PI marking
MEN: Return to the transformation menu

Fig. 7-42: Checking the entry

YES: Confirms the selection
NO: Repetition of the selection
MEN: Cancels the entry

```
Comparison of distances:          o.k. ?
D(comp) =     2000.000 m
D(meas) =     2000.200 m
ds      =       -0.200 m          YES NO
```

Fig. 7-43: Comparison of distances

Display of the computed and measured distances

Display of the difference (comp. - meas. distance) for assessment

YES: Continue the computation
NO: Return to the transformation menu

The transformation parameters are computed.

```
Input of next SUB point                ENT
               789
               <------C------><------I------>
C1C C1I                       Mk1
```

Fig. 7-44: Next detail point

```
                   789
x       500.000 y          2.500 Z      0.000
Data all right ?             Termination MEN
                                      YES NO
```

Fig. 7-45: Display of local coordinates

Enter the point identification and the orthogonal distances of a detail point to be transformed.

MEN: Return to the transformation menu

```
Adr 63          789
Y     1489.950 X       1002.598 Z       0.000

                                       -> ENT
```

Fig. 7-46: Result

Display of the address, point identification and transformed coordinates Y, X and Z of the detail point.

ENT: Enter the next detail point.

7.2.3 Transformation to the Aligning Base

Fig. 7-47: Calling up the starting point

Call up the starting point in the superordinate system using the point identification or address.

Fig. 7-48: Calling up the end point

Call up the end point in the superordinate system using the point identification or address.

Fig. 7-49: Entry of the orthogonal distances for starting point PB

Active function keys:

ClC: Deleting the point code
ClI: Deleting the additional information
???: No orthogonal distances are known
Mk1: Changing the PI marking
MEN: Return to the transformation menu

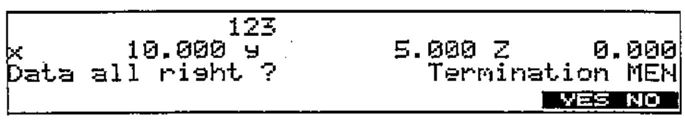


Fig. 7-50: Checking the record

YES: Confirms the selection
NO: Repetition of the selection
MEN: Cancels the entry

```
Input Point PE  (Orthog. values)  ENT
            456
            <-------C----><------I------>
ClC ClI     ???                Mk1
```

Fig. 7-51: Entry of the orthogonal distances for end point PE

Active function keys:

ClC: Deleting the point code
ClI: Deleting the additional information
???: No orthogonal distances are known
Mk1: Changing the PI marking
MEN: Return to the transformation menu

```
               456
x     2010.200 y         5.400 Z       0.000
Data all right ?           Termination MEN
                                      YES NO
```

Fig. 7-52: Checking the record

YES: Confirms the selection
NO: Repetition of the selection
MEN: Cancels the entry

```
Comparison of distances:              o.k. ?
D(comp) =    2000.000 m
D(meas) =    2000.200 m
ds      =      -0.200 m                YES NO
```

Fig. 7-53: Display of the computed and measured distances

Display of the difference (comp. - meas. distance) for assessment

YES: Continue the computation
NO: Return to the transformation menu

The transformation parameters are computed.

```
Selection of data lines, Trafo line

All Adr A-A ?PI P-P     LAd
```

Fig. 7-54: Selection of data lines using the active function keys

```
Selection or Trafo line with ENT
Adr       3      100
Adr       6      107
All  Adr  A-A  ?PI  P-P       LAd
```

```
Selection or Trafo line with ENT
Y      1000.000 X        2000.000 Z    500.000
Y      3000.000 X        2000.000 Z    500.000
All  Adr  A-A  ?PI  P-P       LAd
```

Fig. 7-55: Display of selected lines

If the selection was not correct, use the function keys or, for single lines, the cursor keys to make a new selection.

If the selection is correct, press **ENT** to transfer the data to the program for further computation. Several selection and transfer cycles can be performed successively.

```
Adr 73          100
x        10.200 y       -995.100 Z     500.000

Next point ?                             YES  NO
```

Fig. 7-56: Further points?

YES: Select the next point to be transformed
NO: Ends the transformation

7.3 Computation of Intersections

❑ **Line and arc intersections:**

```
XSECTIONS:                                 EXIT: MEN
LINES
     ARCS + LINES
          DOCUMENTATION YES
```

Fig. 7-57: Menu for computation of intersections

Calling up line intersection
Calling up arc intersection
Documentation of the initial values for line and arc intersection **YES** or **NO**

MEN Return to the menu of PC coordinates programs

7.3.1 Line intersection

```
LINE INTERSECTIONS:                        EXIT: MEN
LINE-LINE                       LINE-ORTH/PT
     PAR-PAR/PTS                     2 ORTH/PTS
          PAR-PAR/DIST
```

Fig. 7-58: Selection of the option required

MEN: End and return to the menu of PC coordinates programs

Each line is defined by 2 coordinated points. If only 1 point and the bearing are available, an auxiliary point must first be computed as a polar point (basic tasks program). The entry is always supported by a graphic display of the selected type of intersection. This display can be called up at any time during the entry using the **Gph** function key.

❑ **Standard case:**

Fig. 7-59: Graphic support

Display of the graphics for the selected option and of the first point to be called up: P1.

ENT: Starts the computation
MEN: Return to the line intersection menu

```
Recall/PI of point P1                  ENT
Adr      3       100
Y    1000.000 X      2000.000 Z   500.000
Gph      Inp      LAd ?Ad      ?PI
```

Fig. 7-60: Calling up point P1 using the point identification or address

Active function keys:

Gph: Calling up the graphics for the selected intersection type
Inp: Entry of the point
LAd: Calling up the point via the last address used
?Ad: Calling up the point via the address
?PI: Calling up the point via the point identification
MEN: Return to the line intersection menu.

Call up points P2, P3 and P4 in the same way.

☞ **Error and system messages:**

- Points 1 and 2 on the line are identical
- Points 3 and 4 on the line are identical
- Lines are parallel or identical
- Grazing intersection angle
- Check whether the points on the line are identical, i.e. whether the differences in the X and Y coordinates of the points amount to < 0.1 m
- Check whether the lines are parallel or identical
- Check the intesection angle < +- 5 grads

```
Intersection S:                Recording ?
YS=      2000.000 XS=      1500.000 inside
1-S      1118.034 3-S      1118.034
2-S      1118.034 4-S      1118.034 YES NO
```

Fig. 7-61: Display of intersection point coordinates YS and XS

Display of the distances between points 1 to 4 on the line and intersection point S.

NO: No storage of intersection point
YES: Storage of intersection point

```
Input of point identification          ENT
              123456
              <------C------><------I------>
                                  Mk1
```

Fig. 7-62: Entry of the point identification

ENT: Saves the point
Line 1 is retained, a new line 2 can be selected.

❑ **Parallel lines through 2 points:**

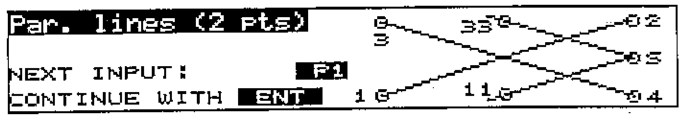


Fig. 7-63: Display of the graphics for the selected option

MEN: Return to the line intersection menu.

Enter the points P1 and P2 of line 1 and the points P3 and P4 of line 2 as in the standard case.

Fig. 7-64: Calling up point P11 on the line parallel to line 1

Call up point P33 on the line parallel to line 2

Display of the computed intersection point, possibility of entering the point identification and saving.

Line 1 is retained, a new selection can be made for line 2 and the points of the parallel lines.

❑ **Parallel lines with distances:**

Fig. 7-65: Display of the graphics for the selected option

MEN: Return to the line intersection menu.

Enter the points P1 and P2 of line 1 and the points P3 and P4 of line 2 as in the standard case.

Fig. 7-66: Entry of distances

ENT: Enter the distance a11 from line 1-2
ENT: Enter the distance a33 from line 3-4

Enter **positive** values for distances located on the right when viewed from P1 (P3) in the direction of P2 (P4).

Display of the computed intersection point, possibility of entering the point identification and saving.

Line 1 is retained, a new selection can be made for line 2 and the distances of the parallel lines.

❑ Line with perpendicular through 3rd point

Fig. 7-67: Display of the graphics for the selected option

MEN: Return to the line intersection menu.

Enter the points P1 and P2 of line 1 and point P3 as in the standard case.

Computation of the foot of the perpendicular from P3 on line 1 and display of the intersection point coordinates YS and YS

Display of the distances of points 1 to 3 on the line from intersection point s, possibility of entering the point identification and saving.

Line 1 is retained, a new point P3 can be selected.

❑ Perpendicular lines through 2 points

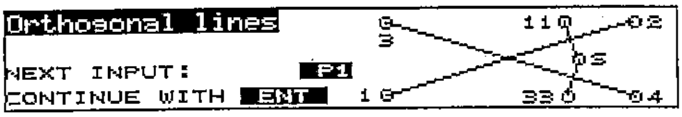


Fig. 7-68: Display of the graphics for the selected option

MEN: Return to the line intersection menu.

Enter the points P1 and P2 of line 1 and the points P3 and P4 of line 2 as in the standard case.

Call up point P11 of the perpendicular to line 1.

Call up point P33 of the perpendicular to line 2.

Display of the computed intersection point of the perpendicular lines, possibility of entering the point identification and saving.

Line 1 is retained, a new selection can be made for line 2 and the points for the perpendicular lines.

7.3.2 Arc Intersection

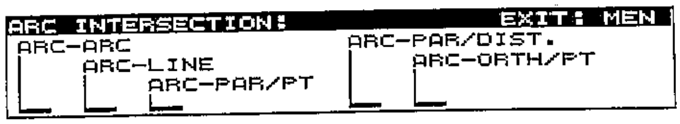


Fig. 7-69: Calling up the option required

MEN: End and return to the arc intersection menu.

The entry is always supported by a graphic display of the selected type of intersection. This display can be called up at any time during the entry using the **Gph** function key.

As described in the chapter on line intersection, the lines are defined by 2 points and, if applicable, by a third point for parallel or perpendicular lines or by a specified distance.

Fig. 7-70: Options for arc definition

❑ Center and radius

Fig. 7-71: Display of the graphics for the selected option and of the first point to be called up: M1.

ENT: Start
MEN: Return to the arc intersection menu

Fig. 7-72: Calling up point M1 using the point identification or address

Active function keys:

Gph: Calling up the graphics for the selected intersection type
Inp: Entry of the point
LAd: Calling up the point via the last address used
?Ad: Calling up the point via the address
?PI: Calling up the point via the PI
MEN: Return to the arc intersection menu

Request for the entry of radius R1.

MEN: Return to the arc intersection menu.

❑ Center and point on the circle

Call up center M1 as described above.

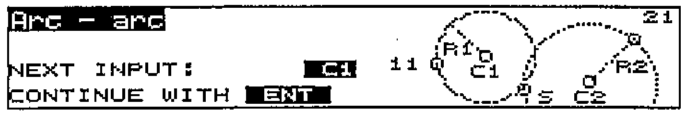


Fig. 7-73: Display of the graphics for the selected option

Request for the entry of point P11.

MEN: Return to the arc intersection menu.

Call up point P11 as described above.

❑ Center, point on the circle and parallel distance dR

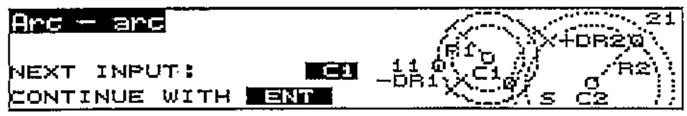


Fig. 7-74: Graphic support

Call up the center and the point on the circle as described above.

Request for the entry of parallel distance dR1.

MEN: Return to the arc intersection menu.

The entry of a parallel distance dR permits the introduction of a parallel circle into the computation:

- dR is positive if located outside when viewed from the center.
- dR is negative if located inside when viewed from the center.

❑ 2 points on the circle and radius:

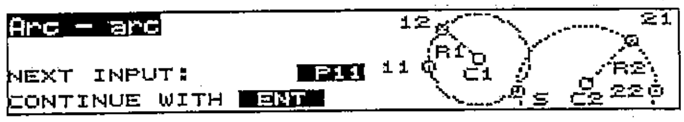


Fig. 7-75: Display of the graphics for the selected option

Request for the entry of point P11.

MEN: Return to the arc intersection menu.

Call up points P11 and P12 as described above.

Call up the radius as described above.

❑ 2 points on the circle, radius and parallel distance dR:

Call up the two points on the circle, the radius and the parallel distance as described above.

❑ Unambiguousness of the geometrical solution:

To ensure an unambiguous solution in arc intersection, note the following rules for point definition and entry:

Circle definition: If two points are given on the circle, make sure to define them in such a way that the center M1 (M2) is located on the right-hand side when you look from P11 (P21) to P12 (P22).

❑ Error and system messages:

- **ATTENTION**
- No intersection possible
- Circles touch each other
- Line touches the circle
- Tangent point is computed
- Bad intersection
- No computation of intersection

ENT: Continue

❑ **Work cycle for circle-circle intersection:**

Fig. 7-76: Graphic support

- Define and enter the first circle.
- Define and enter the second circle.
- The intersection point located to the right of line M1 --> M2 is computed.
- Possibility of entering the point identification and saving.
- Change to the entry of a new, second intersection element.

❑ **Work cycle for circle-line intersection:**

- Define and enter the circle.
- Enter the line.
- The program computes the intersection point located in the direction of P1 when viewed from the foot of the perpendicular (M onf P1-P2).
- Possibility of entering the point identification and saving.
- Change to the entry of a new, second intersection element.

❑ **Work cycle for circle-parallel line intersection:**

- Define and enter the circle.
- Enter the line and the distance or the point of the parallel line.
- The program computes the intersection point located in the direction of P1 when viewed from the foot of the perpendicular (M on P1-P2).
- Possibility of entering the point identification and saving.
- Change to the entry of a new, second intersection element.

❑ **Work cycle for circle-perpendicular intersection:**

- Define and enter the circle.
- Enter the line and the point of the perpendicular.
- M left of P1-->P2:
  - S is located in the direction of line P1--P2 when viewed from the foot of the perpendicular (M on perpendicular).
- M right of P1-->P2:
  - S is located in the opposite direction of line P1--P2 when viewed from the foot of the perpendicular (M on perpendicular).
- M on P1--P2:
  - S is located on the right when viewed from P1-->P2.
- Possibility of entering the point identification and saving.
- Change to the entry of a new, second intersection element.

7.4 Traversing

❑ **Purpose**

The traverse program permits you to measure and optionally adjust the coordinates of traverse points right during field work. You can also record polar points during the measuring process and correct them after the adjustment of the traverse. As a result, coordinates which do not require any postprocessing in the office are available for further measurements.

Each project may include one current - i.e. uncompleted - traverse. Up to 20 traverse points can be determined in addition to the starting point and end point. Measurements can be performed in both telescope positions 1 and 2. Multiple foresight and backsight measurements are possible.

Several options for the starting and end points are available for defining the type of traverse.

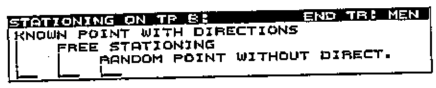


Fig. 7-77: Starting point

Fig. 7-78: End point

The traverse can either be connected to a given point and bearing using the options **KNOWN POINT WITH DIRECTIONS** and **FREE STATIONING**, or it can be started as a free traverse from any point using **RANDOM POINT WITHOUT DIRECTION**.

The traverse with a connected starting point can either be closed with given coordinates and bearing using **KNOWN POINT WITH DIRECTIONS** and **FREE STATIONING**, or only with given coordinates using **KNOWN POINT WITHOUT DIRECTIONS**.

You can run each traverse **WITHOUT END**, with the option of measuring the last traverse point in foresight only, or of using it to measure backsight and polar points, if required.

Depending on the job involved, the options available also permit you to create closed traverses.

During polar point measurement, you can check the distance and/or bearing using known points outside the traverse.

Traverses can be measured and computed both with or without heights. If the height of the starting point is known or determined by free stationing, heights are included in the computation of the traverse.

Two adjustment methods are available:

```
BALANCE OF TRAVERSE:          TR MENUE: MEN
DIFF. OF ANGLES AND COORDINATES
    TRANSFORMATION TP B - TP E
```

Fig. 7-79: Balancing of the traverse

(1) Classical method including the adjustment of angles and distribution of the closing error in proportion with the distances of the traverse.

(2) Two-point transformation using the nominal and actual coordinates of the starting and end points.

If the traverse is measured with heights, the height closing error is distributed in proportion with the distances of the traverse.

The following describes a classical traverse with known starting and end points and with given connecting directions at the beginning and end.

7.4.1 Starting the Traverse

To start a traverse, press key 6 in the PC coordinates menu. The display shows:

INITIALIZATION OF TRAVERSE!

If a traverse already exists, the following enquiry appears:

```
Shall the existing traverse
be deleted ?
                                    YES NO
```

Fig. 7-80: Check for existing traverse

YES: Further warning regarding the deletion of marks in the starting and end records of the traverse
NO: Marks are not deleted

If a traverse has been interrupted, it can be resumed at the appropriate point.

Before starting the actual measurement, the program automatically changes to the input menu for the entry of **ih**, **th** etc.

```
REFL:      1.500m TEMP. :   20°C INPUT MENU
INST:      1.500m PRESS:  944hP SELECT:←↑↓→
ADCO:      0.000m BAR.H:   597m        ENTER
SCLE: 1.000000   PPM   :     0
```

Fig. 7-81: Input menu

MEN: Confirms the entry; change to the selection menu for the starting point

```
STATIONING ON TP B:                END TR: MEN
KNOWN POINT WITH DIRECTIONS
     FREE STATIONING
          RANDOM POINT WITHOUT DIRECT.
```

Fig. 7-82: Selection of the starting point

Meaning of the options:

- Known point with directions:
  The station coordinates are known.
  Connection in direction using coordinates or entry of an azimuth.
  (see chapter **6.2 Stationing on a Known Point**)
- Free stationing:
  The station coordinates are unknown and are computed by measuring known points.
  (see chapter **6.5 Free Stationing**)
- Random point without directions:
  Any point can be entered; connection in direction is not possible.

After successful stationing, change to foresight measurement.

```
Foresight1         TP B - TP 1      End: MEN
ADR       83    101
th     0.000m   <-------C------><------I------>
C1C C1I         R-M RfH              Mk1  SD add
```

Fig. 7-83: Foresight to TP1

Make sure to enter the reflector height (when measuring with heights) and a new point number; otherwise an error message will be displayed.

```
Refl.-/Target height is missing !
                                   => ENT
```

```
Change point identification !
                                   => ENT
```

Fig. 7-84: Error messages

Enter the correct reflector height using softkey **RfH**.

```
Reflector height:
Input or confirmation,        ENT
old    1.500 m          new
```

Fig. 7-85: Entry of the reflector height

Foresight measurement:

```
Foresight1         TP B - TP 1      End: MEN
ADR       83    101
th     1.500m   <-------C------><------I------>
C1C C1I         R-M RfH              Mk1  SD add
```

Fig. 7-86: Foresight measurement of TP1

The softkey **add** permits you to call up additional functions:

- Entry of an information line
- Display of data
- Compensator ON/OFF

Foresight is only possible in the DTh mode, distance and angle measurement.

The measurement can be repeated as often as required and in both telescope positions. In this case, the deviation of the current measurement from the first measurement is displayed for assessment.

After completion of the foresight measurement, the menu **MEASUREMENT ON PP** is displayed for the selection of the next steps.

MEN: End of foresight measurement

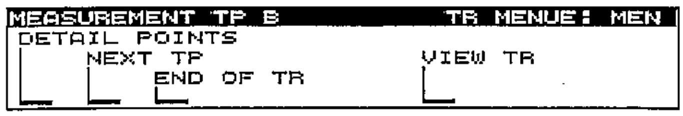


Fig. 7-87: Selection menu after foresight measurement

7.4.2 Polar Point Measurement

Even during the traverse measurement, any number of polar points can be measured and will be corrected after the adjustment of the traverse.

An additional orientation can be performed for polar point measurement. This is particularly useful if you had to interrupt the traverse measurement and have resumed it at a later time. The following reference points are offered automatically:

- On TP A: the foresight to the first traverse point TP 1
- On TP n: the backsight to traverse point TP n-1
- On PP E: the backsight to the last traverse point TP I

Fig. 7-88: New orientation

Before starting the orientation measurement, you can set the current instrument height.

Fig. 7-89: Orientation measurement

After completion of the measurement, the program changes to the menu in Fig. 7-88, and you can start the polar point measurement with key 1.

```
Y      1707.107 X        1707.107 Z    500.068
                 1556
ADR       93
th     1.500m   <--------C------><------I----->
C1C  C1I  Ino  R-C  RfH       OrC  Mk1   SD  add
```

Fig. 7-90: Polar points

During polar point measurement, you can use softkey **OrC** to sight known points for an orientation check. If distances and bearings are measured, the following data is displayed:

```
Adr 3             100
dY      -0.016   dX        -0.020   dZ   -0.021
d1      -0.020   dq        -0.016   dr    0.025
LSB             Rec                     +?
```

Fig. 7-91: Orientation check

LSB: Lower search threshold for control points
Rec Recording of the measurement
+?: Continued search using the same criterion

If the bearing is measured, only the transverse deviation dq is computed and displayed.

☞ **These measurements are only used for checking purposes and have no influence on traversing!**

Select **MEN** to terminate polar point measurement.

You can continue traversing with **NEXT TP** (s. Fig. 7-87). The following request for changing the station is displayed:

```
Change the traverse station !
                                        -> ENT
```

Fig. 7-92: Change of station

ENT: Display of the computed coordinates of TP 1

```
Next traverse point: TP 1
                  102
Y      2000.010 X        1000.000 Z    500.005
                                        -> ENT
```

Fig. 7-93: Coordinates of TP 1

7.4.3 Backsight Measurement

ENT: Change to entry or confirmation of the instrument height.

```
Instrumental height:
Input or confirmation,        ENT
old   1.500 m          new █
```

Fig. 7-94: Instrument height

A request for backsight measurement is now displayed. The backsight point number is offered automatically.

```
Backsight  1     TP 1 - TP A     End: MEN
ADR        95    101
th    1.500m  <-------C------><------I------>
C1C C1I     R-M RfH         Mk1  Th add
```

Fig. 7-95: Backsight measurement

Backsight measurement has been set by default to pure angle measurement, but you can switch it to angle and distance measurement **(DTh)** using softkey **Th.** After measurement, the differences between the foresight and backsight measurements are displayed.

```
Diff. to average of foresight
        on beginning point
ds =   0.010                dh =    0.010
Measurement o.k. ?                 YES NO
```

Fig. 7-96: Differences of measurements

YES: Acceptance of the measurement and display of the corrected coordinates
NO: Measurement is repeated

```
Improved traverse point TP 1:
                102
Y     2000.005 X      1000.000 Z    500.000
                                    -> ENT
```

Fig. 7-97: Corrected coordinates

ENT: Request for foresight measurement of the next traverse point

Repeat the procedures of backsight, foresight and - if necessary - polar point measurement for all traverse points.

After completeion of each backsight and foresight measurement, you can check the current status of the traverse using VIEW TR (for selection see Fig. 7-98).

```
TP 1:           102
Y     2000.005 X        1000.000 Z    500.000
ih       1.500 tr          1.500 tv     1.500
Scroll with    ◄▲▼►                 End: MEN
```

Fig. 7-98: Status of traverse

↑↓: Selection of the station and measurement data
←→: Toggling between the data blocks

```
TP A:    HD   1000.010 Hz    100.0000
TP 1:    HD   1000.000 Hz    300.0000
TP 1:    HD   1000.000 Hz    100.0000
TP 2:
```

```
TP A:                          h      0.005
TP 1:                          h      0.005
TP 1:                          h      0.005
TP 2:
```

Fig. 7-99: Measured data

The display shows the averaged, reduced and oriented measurement data for backsight and foresight at each station.

7.4.4 Ending the Traverse

After the foresight measurement of the last point of the traverse, you can select the type of closing measurement using **END OF TR** (see Fig. 7-100).

```
STATIONING ON TP E:              END TR: MEN
KNOWN PT WITH DIRECT.
      KNOWN PT WITHOUT DIRECT.
            FREE STATIONING        WITHOUT END
```

Fig. 7-100: Options for closing measurement

The stationing types **KNOWN POINT WITH DIRECTIONS** and **FREE STATIONING** correspond to those of stationing at the starting point. The option **KNOWN POINT WITHOUT DIRECTIONS** ends on a point with known coordinates, but without a connecting direction. **WITHOUT END** means that the end of the traverse is open, with the option of occupying the last traverse point or not.

In the following example, **KNOWN POINT WITH DIRECTIONS** has been selected. After stationing on the closing point, a request for backsight measurement of the last traverse point is displayed.

```
Backsight  1     TP E - TP 1     End: MEN
                102
ADR    112
th   1.500m   <-------C------><------I------>
C1C C1I      R-M RfH              Mk1   Th add
```

Fig. 7-101: Backsight to last TP

When measurement is completed, the closing error is displayed.

```
Error of closure:
               Error of closure coordinat.
dY    -0.005 dX       0.000 dZ     -0.005
                                    -> ENT
```

```
Closure error:
              Lons.-/late.-/ansle closure
dl      -0.005 dq         0.000 db   0.0010
                                     -> ENT
```

Fig. 7-102: Closing error

ENT: Confirms the closing error

Before the traverse is adjusted, you have the option of measuring polar points.

```
MEASUREMENT TP E                TR MENUE: MEN
 DETAIL POINTS             BALANCE
                                VIEW TR
```

Fig. 7-103: Measurement on end point

If you select the option BALANCE, an enquiry is displayed as to whether all measurements have been completed.

```
Are all sightings for traversing and
detail points finished ?
                                    YES NO
```

Fig. 7-104: Check on end pointt

YES: Selection of the balance option
NO: Change to Fig. 7-103 **Measurement on end point**

```
BALANCE OF TRAVERSE:            TR MENUE: MEN
 DIFF. OF ANGLES AND COORDINATES
      TRANSFORMATION TP B - TP E
```

Fig. 7-105: Adjustment

If you select one of the two options, the traverse and polar points are adjusted accordingly and the existing coordinates in the memory are overwritten.

The traverse is now completed. The relevant database in the current project is marked and the program control returns to the PC coordinates menu.

7.5 CURVE LAYOUT

❑ Purpose

After the entry of any arc parameters, the program part **ARC COMPUTATION** computes the remaining principal points and elements of the arc, as soon as this is geometrically possible. It therefore provides very flexible support in any type of arc computation.

The program parts **ARC**, **LINE**, **SPIRAL** and **SPIRAL (PRT)** permit the computation of the curve layout for the selected element. The prerequisites are the beginning and end of the arc as principal points and further parameters defining the element. The stationing computation can either be preset for single stations or for a stationing interval. The program computes the planimetric coordinates of the axial points and the points on the left and right of the axis, if selected. The computed points can be directly used for further computations.

```
CURVE LAYOUT:                                     EXIT: MEN
ARC COMPUTATION               LINE
    ARC                           SPIRAL
                                      SPIRAL(PRT)
```

Fig. 7-106: Curve layout menu

7.5.1 Principal Points of the Arc

A graphic display supports the entry and computation of the principal points of the arc.

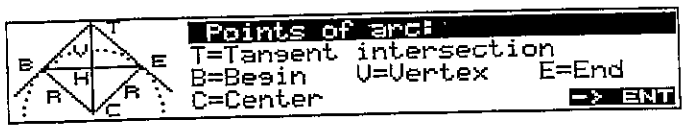


Fig. 7-107: Principal points of the arc

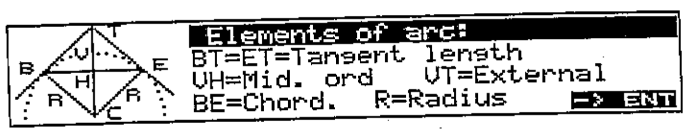


Fig. 7-108: Elements of the arc

ENT: Confirms the graphic support

```
1 BEGIN ARC Y      0.000   X      0.000
2 END     ARC Y    0.000   X      0.000
3 T INTERS.   Y    0.000   X      0.000
4 CENTER PT   Y    0.000   X      0.000
RECALL PT: (1-4)   GRPH=0        O.K. ENT
```

Fig. 7-109: Entry of the principal points of the arc

Enter the existing principal points of the arc, as far as known. For example:

```
Recall: Begin of arc                              ENT
Adr    22       201
Y    1000.000 X       1000.000 Z    500.000
Gph     Inp     LAd ?Ad       ?PI  +?
```

Fig. 7-110: Calling up the beginning of the arc

After the entry of the end point of the arc:

```
1  BEGIN ARC  Y       1000.000    X        1000.000
2  END    ARC  Y      2000.000    X        1000.000
3  T  INTERS.  Y         0.000    X           0.000
4  CENTER  PT  Y         0.000    X           0.000
RECALL  PT:  (1-4)        GRPH=0          O.K.  ENT
```

Fig. 7-111: Status of principal point entry

After you have entered all known principal points, select **ENT** to call up the input menu of the arc elements.

```
1  TANGENT          0.000   5  CHORD       1000.000
2  RADIUS           0.000   6  EXTERNAL       0.000
3  ARC              0.000   7  MID  ORD.      0.000
4  DELTA           0.0000   8  TI  ANGLE     0.0000
ELEMENT  NO:  (1-8)        GRPH=0          O.K.  ENT
```

Fig. 7-112: Menu of arc elements

For example, entry of the radius:

```
Input or confirmation                            ENT
Radius   (old) =     1000.000
Radius   (new) =                 █
```

Fig. 7-113: Entry of the radius

After all necessary entries have been made, the computation of the missing parameters can be started. All entries are checked for plausibility, if this is geometrically possible. In the event of an error, a plaintext message indicating the cause is displayed.

```
1  TANGENT        577.350   5  CHORD       1000.000
2  RADIUS        1000.000   6  EXTERNAL     154.701
3  ARC           1047.198   7  MID  ORD.    133.975
4  DELTA          66.6667   8  TI  ANGLE   133.3333
ELEMENT  NO:  (1-8)        GRPH=0          O.K.  ENT
```

Fig. 7-114: Computed arc elements

Select the bend direction as seen from the beginning of the arc:

```
BEND RIGHT OR LEFT:              EXIT: MEN

BEND RIGHT
     BEND LEFT
```

Fig. 7-115: Selection of the bend direction

The computation of the principal points of the arc is now completed. The principal points and parameters are saved, and the program returns to the PC program menu.

7.5.2 Arc Layout

For arc layout, start with the entry and computation of the principal points and elements of the arc as described in ***7.5.1***. When this data has been saved, start the layout computation processes described in ***7.5.6***.

7.5.3 Line Layout

For line layout, you first have to call up the starting point BC and the end point EC.

```
Recall of point BC                      ENT
Adr   23       202
Y     2000.000 X      1000.000 Z   500.000
          Inp        LAd ?Ad      ?PI  +?
```

Fig. 7-116: Calling up BC

```
Recall of point EC                      ENT
Adr   24       205
Y     3000.000 X      1500.000 Z   500.000
          Inp        LAd ?Ad      ?PI  +?
```

Fig. 7-117: Calling up EC

After saving these points, start the layout computation by one of the methods described in ***7.5.6***.

7.5.4 Spiral Layout

For spiral layout, you first have to call up the starting point BC and the end point EC.

```
Recall of point BC                         ENT
Adr    23       202
Y     2000.000 X        1000.000 Z    500.000
          Inp       LAd ?Ad       ?PI  +?
```

Fig. 7-118: Calling up BC

```
Recall of point EC                         ENT
Adr    24       205
Y     3000.000 X        1500.000 Z    500.000
          Inp       LAd ?Ad       ?PI  +?
```

Fig. 7-119: Calling up EC

You can now enter the known parameters of the spiral.

```
PARAMETER OF SPIRAL:               EXIT: MEN
1   PARAMETER     A        0.000
2   LENGTH        L        0.000
3   RADIUS        R        0.000
4   TANG. ANGLE            0.0000
INPUT: (1 - 4)            NPAR=0        O.K. ENT
```

Fig. 7-120: Input menu for the spiral parameters

For example, the entry of parameter A and length L:

```
Input or confirmation                  ENT
Negative if begin at end of spiral
Parameter A  (old) =   1000.000
Parameter A  (new) =
```

Fig. 7-121: Entry of A

```
Input or confirmation                  ENT

Length L   (old) =   1150.000
Length L   (new) =
```

Fig. 7-122: Entry of L

The remaining parameters can now be computed.

```
PARAMETER OF SPIRAL:               EXIT: MEN
1   PARAMETER     A   1000.000
2   LENGTH        L   1150.000
3   RADIUS        R    869.565
4   TANG. ANGLE         42.0965
INPUT: (1 - 4)        NPAR=0        O.K. ENT
```

Fig. 7-123: Parameters of the spiral

Select the bend direction of the spiral as seen from the origin (R=infinite):

```
BEND RIGHT OR LEFT:                    EXIT: MEN
SEEN FROM BEGIN OF SPIRAL
 BEND RIGHT
 |    BEND LEFT
 L__  L_
```

Fig. 7-124: Selection of the bend direction

After saving the principal points and parameters of the spiral, start the layout computation by one of the methods described in ***7.5.6***.

7.5.5 Layout of Spiral Parts

For the layout of a spiral part, you first have to call up the starting point BC and the end point EC.

```
Recall of point BC                        ENT
Adr    23      202
Y    2000.000 X       1000.000 Z    500.000
          Inp      LAd ?Ad      ?PI  +?
```

Fig. 7-125: Calling up BC

```
Recall of point EC                        ENT
Adr    24      205
Y    3000.000 X       1500.000 Z    500.000
          Inp      LAd ?Ad      ?PI  +?
```

Fig. 7-126: Calling up EC

You can now enter the known parameters of the spiral part.

```
PARAM. OF PART OF SPIRAL           EXIT: MEN
1   PARAMETER          A          0.000
2   RADIUS (LARGE)     R1         0.000
3   RADIUS (SMALL)     R2         0.000
INPUT: (1 - 3)                   O.K.  ENT
```

Fig. 7-127: Parameters of the spiral part

Enter parameter A:

```
Input or confirmation                     ENT
Negative if begin at end of spiral
Parameter A  (old) =   2000.000
Parameter A  (new) =
```

Fig. 7-128: Entry of parameter A

```
PARAM. OF PART OF SPIRAL          EXIT: MEN
1  PARAMETER              A     2000.000
2  RADIUS (LARGE)         R1       0.000
3  RADIUS (SMALL)         R2       0.000
INPUT: (1 - 3)                   O.K. ENT
```

Fig. 7-129: Parameters of the spiral part elements

Enter the semimajor and semiminor axes:

```
Input or confirmation                   ENT

Radius large  (old) = 10000.000
Radius large  (new) =
```

Fig. 7-130: Entry of the semimajor axis

All parameters of the spiral part are now known:

```
PARAM. OF PART OF SPIRAL          EXIT: MEN
1  PARAMETER              A     2000.000
2  RADIUS (LARGE)         R1   10000.000
3  RADIUS (SMALL)         R2    2500.000
4  LENGTH           L(R1-R2)    1200.000
INPUT: (1 - 3)                   O.K. ENT
```

Fig. 7-131: Parameters of spiral part

Select the bend direction of the spiral part as seen from the origin.

```
BEND RIGHT OR LEFT:               EXIT: MEN
SEEN FROM BEGIN OF SPIRAL
 BEND RIGHT
      BEND LEFT
```

Fig. 7-132: Selection of bend direction

After saving the principal points and parameters of the spiral part, start the layout computation by one of the methods described in ***7.5.6.***

7.5.6 Layout of Single Points or Point Sequences

After the entry or computation of the element parameters, the computation process for single points or point sequences located on and laterally to the axis is identical for arcs, lines, spirals and spiral parts.

```
MODE OF STATIONING:      TERMINATION: MEN
 SINGLE POINTS
      GIVEN INTERVAL
```

Fig. 7-133: Selection of the stationing sequence

7.5.6.1 *Layout of Single Points*

Select the computation sequence in the cross profile

```
COMPUTATION IN CROSS PROFILE:              ENT
NO CROSS PROFILE POINT
   RIGHT HAND SIDE     0.000 m
       LEFT HAND SIDE     0.000 m
```

Fig. 7-134: Computation sequence in cross profile

Enter the distances of lateral points from the axis.

```
Distance to axis, pt. right hand side:

old  50.000 m          new █
```

Fig. 7-135: Entry of distance from the axis

Selected computation sequence in the cross profile.

```
COMPUTATION IN CROSS PROFILE:              ENT
NO CROSS PROFILE POINT
   RIGHT HAND SIDE   50.000 m
       LEFT HAND SIDE   35.000 m
```

Fig. 7-136: : Computation sequence in cross profile

Enter the station of the beginning of the arc:

```
Input or confirmation                      ENT
Station of beginning of curve
old          0.000 m        new █
```

Fig. 7-137: Station of beginning of the arc

Enter the station of the cross profile to be computed:

```
Input or confirmation                      ENT
Station of point Pi
old         50.000 m        new █
```

Fig. 7-138: Station of cross profile point Pi

Enter the point identification of the cross profile point. The station is automatically included in the point identification.

```
Point number for station point          ENT
                  123          0+050.000
                  <------C------><------I------>
                                   Mk1
```

Fig. 7-139: Point identification of the cross profile point

Display of the computed points of the cross profile. In our example, this is the point marked R located on the right of the axis at a distance of 50.000 m.

```
Adr 41          123             R      50.000
Y    1050.000 X        950.000 Z        0.000

Cross=1           End=MEN       Continue ENT
```

Fig. 7-140: Computed point

Select button 1 if you want to use a different computation sequence for the next cross profile; select **ENT** to continue with the next cross profile or **MEN** to end the computation and to return to the curve layout menu.

7.5.6.2 Layout of Point Sequences

Enter the station of the beginning of the arc:

```
Input or confirmation                   ENT
Station of beginning of curve
old         0.000 m         new
```

Fig. 7-141: Station of beginning of the arc

Enter the station interval.

```
Input or confirmation                   ENT
Stationing interval
old        20.000 m         new
```

Fig. 7-142: Station interval

Select the computation sequence in the cross profile.

```
COMPUTATION IN CROSS PROFILE:           ENT
 NO CROSS PROFILE POINT
      RIGHT HAND SIDE    0.000 m
           LEFT HAND SIDE    0.000 m
```

Fig. 7-143: Computation sequence in cross profile

Select the computation mode: continuous computation or stop after each station.

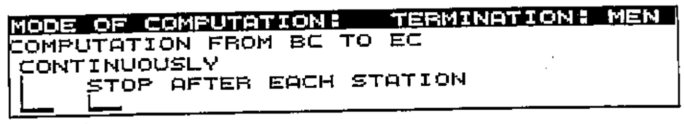


Fig. 7-144: Computation mode

Enter the point identification for the first station. The stationing of the point on the axis and the position L/R and distance of any lateral points are set automatically.

Fig. 7-145: Point number of first station

Display and saving of the computed points of the cross profile, depending on the computation mode selected. This computation sequence also determines the midpoint and end point of the arc.

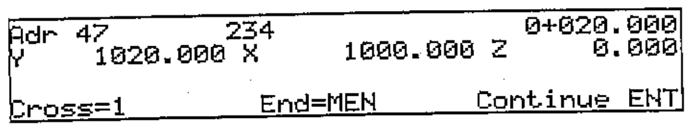


Fig. 7-146: Computed point

After completion of this computation sequence, you have the possibility of computing single points. After completion, the program returns to the curve layout menu.

8 Adjust/Prepare

8.1 General

❑ **Purpose**

Increased strain placed on the instrument by extreme measuring conditions, transportation, prolonged storage and major changes in temperature may lead to misalignment of the instrument and faulty measuring results. Such errors can be eliminated by adjustment of the instrument or by specific measuring methods. The manual alignment of the instrument is described in detail in the annex.

❑ **Selecting the adjustment mode**

Call up the **ADJUST/PREPARE** program with key 6 in the main menu; the menu of the program with its modes is displayed (see Figs. 8-1 and 8-2).

Fig. 8-1: Menu of the ADJUST/PREPARE program in Rec Elta® C

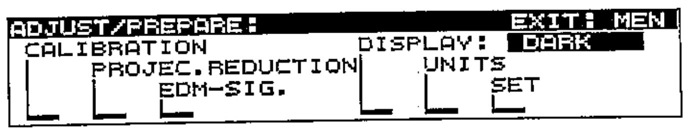


Fig. 8-2: Menu of the ADJUST/PREPARE program in Rec Elta® CM/CMS

❑ **Comments on the mode**

V INDEX/HZ COLLIMATION:
Zenith angle or bearing measurements in both telescope positions can be used to compute the correction values for index and collimation correction. These correction values are determined in our works and stored in the Rec Elta® prior to delivery. They are taken into account in all measurements, which means that measurements are only required in one telescope position.
However, these correction values can be redetermined and stored at any time using the **V INDEX/HZ COLLIMATION** programs of the adjustment menu. Prior to precise height measurements or precision measurements of targets involving major height differences, in particular, it is essential that these errors be redetermined and checked.

During execution of this mode, the compensator is also automatically aligned. There is no need, therefore, to repeat the mode for this purpose.

The trunnion axis error is determined at the works and the correction is stored in the instrument.

COMPENSATOR:
Just as it is advisable to determine the run center in the alidade level, the Rec Elta® compensator also requires checking at regular intervals by run center determination. It is particularly important that you perform this procedure in the **COMPENSATOR** program prior to precise height measurement.

EDM SIGNAL:
The optical axis of the distance meter and the collimation line of the theodolite telescope must coincide. Only then will the maximum energy be reflected when the reflector is sighted with the telescope crosslines. The **EDM SIGNAL** program permits checking the parallel alignment and making any adjustments required.

DISPLAY:
Variation of the display brightness to adapt it to the local conditions.

UNITS:
Definition of the measuring units to be used for measurement

PROJECTION CORRECTION:
Entry of the parameters for the Gauss-Krüger and height reduction.

❑ Options in SET mode

MARKING:
To identify and describe a measurement or point, a point identification (P.I.) comprising a point code and additional information with a maximum total of 27 digits has to be entered before measurement is started. For better readability of the 27 characters and to support the P.I. entry, you can mark subblocks in the input field to suit your specific requirements.

DECIMAL DIGITS:
The number of decimal digits for the different measurement and computation elements such as bearings, angles, distances, coordinates and heights is freely selectable depending on the task involved.

INITIALIZE FILE:
Eliminates problems in the internal memory. All data is lost.

MANUAL INPUT/SOUND:
The automatic measurement of D - Hz - V is replaced by the manual input of the values.
Activation or deactivation of the acoustic signal.

8.2 V INDEX/HZ COLLIMATION

❑ **Purpose**

The determination of the index correction should be performed after prolonged storage or transportation of the instrument, after major changes in temperature and prior to precise height measurements.

❑ **Selecting the initial menu**

The vertical and horizontal circle corrections can be checked in the **V-INDEX/HZ-COLL.** mode. Press key 1 (Fig. 8-1) to call up the initial menu (see Fig. 8-2) which shows the value last determined.

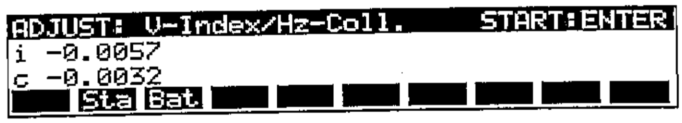


Fig. 8-3: Initial menu for V Index/Hz Coll.

❑ **Input and measurement menu**

Press **ENT** to change from the initial menu to the menu for P.I. entry and measurement. For subsequent identification of the procedure, you can enter a point identification before starting the measurement in the first telescope position (see Fig. 8-4).

Fig. 8-4: Input and measurement menu for position 1

☞ **In Rec Elta® CM/CMS, the measurement is supported by motors. The instrument is automatically turned to the other telescope position.**

❑ **Measurement**

The zenith angle and bearing measurements in both telescope positions permit the computation of the correction in the Rec Elta® and its storage together with the two angle/bearing values. The measurement menu (see Fig. 8-4) requests sighting in position 1. Trigger the measurement with the **ENT** key. After completion of the measurement in the first telescope position, the measurement menu requests measurement in position 2 (Fig. 8-5).

```
V-Index/Hz-Coll.   Measure pos. 2: ENTER
          120893
```

Fig. 8-5: Measurement menu for position 2

☐ Result of the determination

The old and new corrections are displayed in the result menu for comparison (Fig. 8-6). You have to decide which of the two should be applied to the subsequent measurements.

```
V-INDEX/HZ-COLL.                      EXIT: MEN
 OLD         i    -0.0057     c    -0.0032
       NEW   i    -0.0092     c    -0.0005
             i     0.0000     c     0.0000
```

Fig. 8-6: Result of the determination

Key	Function
1	Old correction is retained (e.g. in the case of incorrect determination), no storage
2	New correction is taken into account in subsequent measurements, storage with angles/bearings in both positions
3	Corrections are set to zero, storage without angles/bearings
MEN	Quitting the menu, old value is retained, return to the program part where the call was made

☐ Error

If the correction exceeds the amount of 2'40" or 49.5 mgrads, no new correction is computed and an acoustic warning signal sounds.

```
ERROR: LIMIT EXCEEDED
          PRESS ANY KEY TO CONTINUE !
```

Fig. 8-7: Error message

MEN: Quitting the error display. Continue with **input and measurement menu.**

8.3 Compensator

☐ Purpose

Just as it is advisable to determine the run center in the alidade level, the Rec Elta® compensator also requires checking at regular intervals by run center determination. It is particularly important that you perform this procedure in the **COMPENSATOR** program prior to precise height measurement. The Rec Elta® instruments feature a dual-axis compensator.

☐ Selecting the initial menu

The run center determination of the compensator can be checked using the **COMPENSATOR** option. Press key 2 (Fig. 8-1) to call up the initial menu (see Fig. 8-8), which displays the run center components in the sighting axis direction (SZ) and trunnion axis direction (SK).

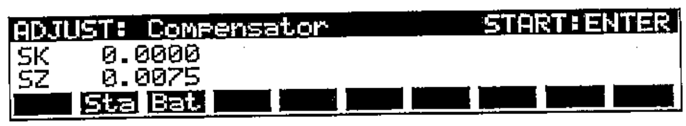


Fig. 8-8: Initial menu for run center determination and levelling

☐ Run center determination

If you level the Rec Elta® using the level, the compensator reaches its working range and then automatically compensates any residual vertical axis inclination in the sighting and trunnion axis directions. For the exact run center determination, it is essential that you allow the liquid of the compensator to settle. Therefore lock the Rec Elta® with the Hz clamp (22) before starting the measurement.

☞ **In Rec Elta® CM/CMS, the run center determination is supported by motors. All you have to do is start the measurement in position 1; the process is then performed automatically.**

Press the **ENT** key to trigger compensator measurement in position 1 (see Fig. 8-9).

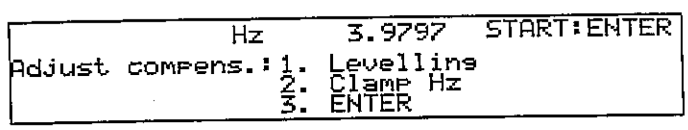


Fig. 8-9: Compensator measurement in position 1

As in the run center determination of the alidade level, you have to turn the Rec Elta® through 180° or 200 grads ± 5 grads. Lock the instrument again with the Hz clamp and trigger the compensator measurement in position 2 by pressing the **ENT** key.

```
                Hz        0.5596   START:ENTER
Adjust compens.:1.  Turn Hz →0 (+5/-5)
                2.  Clamp Hz
                3.  ENTER
```

Fig. 8-10: Compensator measurement in position 2

❑ Result

After computation, the run center components and the vertical axis inclinations in the sighting and trunnion axis directions are displayed (see Fig. 8-11). If the instrument has not been properly levelled, an error message appears.

```
 LEVELLING                          Exit: MEN
SK    0.0000          - NK   0.0000
SZ    0.0045          | NZ  -0.0027
```

Fig. 8-11: Run center components

Meaning of the display:

SK	0.0012	Run center component in the trunnion axis direction
SZ	-0.0004	Run center component in the sighting direction
-NK	-0.0008	Inclination in the trunnion axis direction
|NZ	0.0014	Inclination in the sighting direction
positive value		Inclination to the right or front
negative value		Inclination to the left or back

If no determination error occurred, the SK and SZ values are automatically recorded.

❑ Error

If the run center values exceed the limits of :

- SZ = ± 25.5 mgrads = 82.6"
- SK = ± 51.5 mgrads = 165.6"

an error message is displayed as shown in Fig. 8-12.

```
                Hz    200.0000     Wait
Adjust compens.:1.  Turn Hz →0 (+5/-5)
ERROR: LIMIT EXCEEDED
            PRESS ANY KEY TO CONTINUE !
```

Fig. 8-12: Error message

MEN: Previously determined run center values are retained
Return to the **ADJUST/PREPARE** menu

❑ Levelling with the compensator

The digital compensator display in this program permits a higher levelling accuracy than the alidade level of the instrument. You can also use the compensator display to adjust the alidade level.

Precise levelling using the tribrach screws (24) has been achieved when approximately zero is displayed for both inclinations. If the compensator is activated, a higher levelling accuracy is not necessarily required, as the relevant correction values of the vertical axis inclinations are automatically applied to the horizontal and vertical circle readings. Precise levelling may be advisable, however, if the compensator has to be deactivated for the subsequent measurements, due to vibrations.

```
LEVELLING                              Exit: MEN
SK   0.0000          - NK  0.0000
SZ   0.0045          | NZ -0.0027
```

Fig. 8-13: Use of the digital display for levelling

If the compensator working range of ± 2'40" is exceeded during levelling, this is indicated in the display.

```
LEVELLING                              Exit: MEN
SK   0.0000          - NK  0.0000
SZ   0.0045          |   behind
```

Fig. 8-14: Inclination direction

Explanation of Fig. 8-14:

Inclination to the left	_	Display "left"
Inclination to the right	_	Display "right"
Inclination to the back	_	Display "back"
Inclination to the front	_	Display "front"

☞ **The digital display of the vertical axis inclination can be called up in any program using the LEV key or ⊕ / COMPENSATOR**

MEN: Return to the program part where the call was made or to the **ADJUST/ PREPARE** menu

8.4 Target Sensor Calibration in Rec Elta® CMS

To calibrate the target sensor for automatic sighting, use a clearly visible reflector at a distance or approx. 50 m. The procedure comprises three steps:

- Determination of index and collimation correction
- Determination of the compensator run center in a background process
- Calibration of the sensor optics in relation to the telescope optics

After you have called up the calibration option, the first two steps are performed with motor support.

```
ADJUST: V-Index/Hz-Coll.    Start:   ENT
i    0.0060   Before sensor calib. do
c    0.0007   V-Index/Hz-Collimation
     Sta Bat
```

Fig. 8-15: Start of the target sensor calibration

```
CALIBRATION SENSOR           Measure:  ENT
        Sight prism exactly
              in 100 m or 300 ft
```

Fig. 8-16: Request for sighting of the prism

The actual target sensor calibration comprises the exact manual focussing of the prism followed by three automatic sightings performed by the target sensor. In this process, the horizontal and vertical angular deviations between the target sensor axis and the optical axis are determined. These corrections are stored in the instrument and taken into account in subsequent automatic sighting.

```
CALIBRATION SENSOR                EXIT: MEN
 OLD       HZ -0.0019       V1   0.0138
      NEW  HZ  0.0010       V1   0.0169
```

Fig. 8-17: Result of the target sensor calibration

8.5 EDM Signal

❑ Purpose

The optical axis of the distance meter and the collimation line of the telescope must coincide to ensure that a maximum of energy is reflected when the reflector is sighted with the telescope crosslines.

❑ Selecting the mode

Press numeric key 3 to call up the mode.

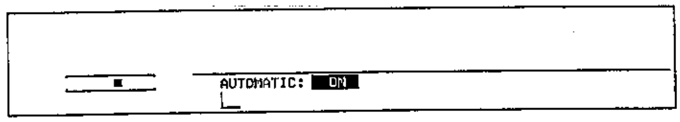


Fig. 8-18: Automatic signal control - activated

❑ Check

Sight a reflector from a distance of at least 200 m ; the signal control is activated (Fig. 8-18).

To check the adjustment, set the signal control to AUTOMATIC: OFF. Move the crosslines away from the reflector center using the horizontal and vertical slow-motion controls (21 and 19 or 32 and 34). If the alignment is correct, the signal must now decrease. If no signal is displayed or if the signal intensity increases, the distance meter is misaligned

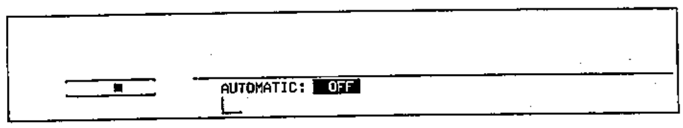


Fig. 8-19: Fig. 8-1: Automatic signal control - deactivated

❑ Alignment

Move the telescope with the slow-motion controls until a signal is displayed.

Loosen the two outer lock screws (internal thread rings) of the distance meter (4) with a hex socket wrench and turn the inner screws until a maximum signal is obtained (do not loosen the adjacent slotted screws).

Use the lower adjustment screw (4) for vertical shifting of the distance meter beam and the upper adjustment screw for horizonal shifting.

Move the telescope crosslines closer to the reflector center until just a minimum signal is displayed and continue the alignment.
If the signal display (bar graph) is outside the range on the right during this procedure, set the signal control to AUTOMATIC: ON (Fig. 8-18) until the signal display is in the middle. Then deactivate the automatic signal control again and continue the alignment.

Repeat this procedure until a maximum signal is displayed when the reflector center is sighted. Then tighten the lock screws (4) again.

MEN: Return to the menu of the adjustment programs (Fig. 8-1).

8.6 Display

❑ Purpose

The variation of the display brightness permits you to adapt the display to the local light conditions.

❑ Changing the mode

Use numeric key 6 to select **NORMAL**, **DARK** or **BRIGHT**. The change has a direct effect on the display.

Fig. 8-20: Display variation

8.7 Set

8.7.1 General

❑ **Purpose**

To be able to identify a point or measurement for subsequent evaluation, you have to label it or describe it in more detail. The **SET** mode permits the user-defined structuring of the point identification and, in addition, the setting of a freely selectable subdivision to support the entry.

Depending on the task involved, it may be advisable to select the number of decimal digits required in the measurement and computation elements.

❑ **Selecting the setting mode**

Press key 7 to directly call up the **SET** mode. The menu of setting programs with its options is displayed (Fig. 8-21). Use keys 1, 2, 3, 6 and 7 for direct selection of the modes.

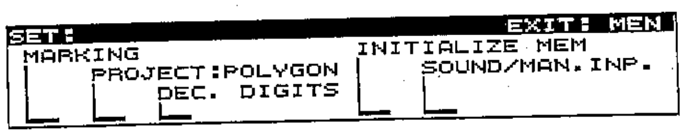


Fig. 8-21: Initial menu of the SET program

❑ **Comments on the modes**

Mode : MARKING
To identify and describe a measurement or point, a point identification (P.I.) comprising a point code and additional information with a maximum total of 27 digits has to be entered before measurement is started.
For better readability of the 27 characters and to support the P.I. entry, you can mark subblocks in the input field to suit your specific requirements.

Mode : DECIMAL DIGITS
The number of decimal digits for the different measurement and computation elements such as bearings, angles, distances, coordinates and heights is freely selectable depending on the task involved.

Mode : MANUAL INPUT/SOUND
Activation or deactivation of the automatic measurement of D - Hz - V.
Activation or deactivation of the acoustic signal.

Mode : INITIALIZE FILE
If problems occur in the storage in MEM, the MEM needs to be reinitialized.

Mode : PROJECT calls up the project manager.
Management of the projects stored on the PCMCIA card and use for software updates (see **7.1 Project manager).**

8.7.2 Marking

❑ Purpose

For better readability of the 27 characters and to facilitate the P.I. entry, you can mark freely selectable subblocks in the input field to suit your specific requirements. Up to 7 different marking formats can be specified.

❑ Selecting the marking option

Press numeric key 1 to call up the **Marking** option in the **SET** program (see Fig. 8-21); the program changes automatically to the marking selection menu (see Fig. 8-22)

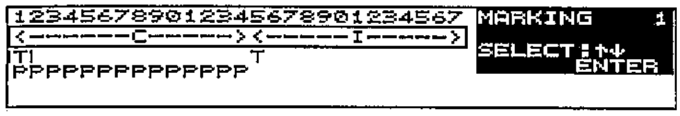


Fig. 8-22: Marking selection menu

☞ **The marking information is stored on the PCMCIA card or in the internal MEM. On delivery, they contain one default marking format. The other marking options have not been allocated. New marking formats are automatically stored. No data is lost in this process.**

Description of marking 1: Default marking - Rec 500 format

Line	Content	Function
1	Layout gage digits 1 - 27	Facilitates the precise definition of a digit within the P.I.
2	Marking line	Subdivision of the P.I. into point code (C) and additional information (I). Supports the entry in the P.I. field which can be marked by freely selectable characters. Blank marks are always skipped in the P.I. entry (not included in the default marking).
3	Tab stops ENTER	Default tab stops in positions 1 and 15 Activation of the entry routine
4	Point number field	Definition of the point number field (default 1 to 14), marked by 14 Ps.
5	Softkeys	This line is unused when you call up the option or select a marking format. When you press the **ENT** key, softkeys permitting the modification of the tab stops and point number field are allocated to this line.

8.7.3 Defining Your Own Marking Formats

❑ Purpose

The graphical representation provided by user-defined marking facilitates the point identification entry.

In addition to the default marking, up to 6 different marking formats can be specified. On delivery of the instrument, the default format has been assigned to Marking 1. All marking lines are freely available for your own entries.

If you call up a marking line with the cursor keys and activate the entry with the **ENT** key, the default marking is loaded as a basis for your modifications.

❑ Selecting the marking lines

Key	Function
↑,↓	Scrolling through all (assigned or blank) marking lines.
MEN	Quitting the default marking menu and calling the **MARKING** selection menu (Fig. 8-22).
ENTER	Activates the entry routine for the selected marking line which can now be edited.

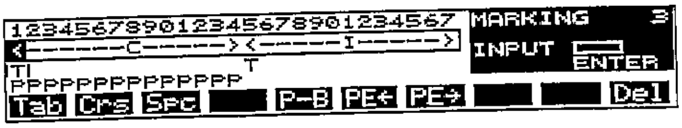


Fig. 8-23: Input menu for marking modification

You can now modify this default format to meet your own requirements.

❑ Entry of your own marking format

The following hardkeys and softkeys support the setting of your own marking format:

Key	Function
ABC	Activates the alphabetic entry for the definition of a marking line, the softkeys in line 5 are replaced by the letters of the alphabet.
←,→	Selecting a specific position in the input field using the horizontal cursor keys
1, 2, ...,0	Entry of the marking letters and special characters using the numeric keys.

☐ Setting tab stops (optional)

Any number of tab stops can be set.

Key	Function
←,→	Selecting the desired position.
Tab softkey	**T** (for tab stop) is written in this position in line 3. The same softkey can be used to delete the tab stop.

☐ Setting a cursor position

To speed up the measuring process, it is useful if - after measurement - the cursor is automatically set to the position within the P.I. where the entry for the next point is normally to be made.

Key	Function
←,→	Selecting the desired position.
Crs softkey	The position is marked in the third line by two vertical bars. The cursor and tab stops may be set in the same position.

☐ Setting a blank (optional)

This position is not accessible during P.I. entry; it is skipped automatically. The blank is only effective in the point information, not in the point number.

Key	Function
←,→	Selecting the desired position.
Spc softkey	The character "☐" appears in the appropriate position in the marking line. Any existing character is overwritten. You can delete this definition by overwriting it with a different character.

☐ Setting the point number field

The point number field must always be defined. It is used for:

- incrementation
- search for point numbers using **?Pt**.

Use the softkeys **P-B** for defining the beginning of the field and **PE→** or **PE←** for defining the end. The following limitations apply to the number of digits in the point number:

- minimum size of the point number field: 3 digits
- maximum size of the point number field: 14 digits

Values below or above these limits are not accepted.

Key	Function
←,→	Selecting the desired position.
P-B softkey	A 3-digit point number field begins at this position.
PE softkey **←**	Reducing the field by one digit.
PE softkey **→**	Increasing the field by one digit.

The defined field is marked in line 4 by at least 3 Ps up to a maximum of 14 Ps.

☞ **It is advisable to also enter the number of the selected marking, e.g. in the point information. Otherwise it will no longer be visible when you call up the input menus. The entry of a figure does not restrict the entry of information (s. Fig. 8-24).**

Fig. 8-24: User-defined marking with number

❑ Restrictions

The following entries are not admissible:

- Blanks in the point number field
  - Blanks in the point number field are automatically deleted after **ENTER**.
- Alphanumeric characters in the point number field
  - Alphanumeric characters in the point number field limit the range for the point number.

❑ Saving the entry or modification

Press the **ENT** key to include the entry or modification in the marking list. As in all other menus, the **MEN** key permits quitting before saving the entry.

Key	Function
ENTER	Quitting the editor mode. The modification is saved. Calling the selection menu (Fig. 8-22) for selecting the next marking line.
MEN	Quitting the editor mode. The modification is not saved. The old marking is retained. Continue with Fig. 8-22.

☐ Deleting a marking format

If a marking format is no longer required, you can delete it with the **Del** softkey.

Key	Function
←,→	Selecting the marking
ENTER	Activates the marking entry
Del softkey	Fig. 8-23 is displayed.

Fig. 8-25: Deletion of marking

NO: The marking concerned is displayed again.

YES: Marking is deleted, change to Fig. 8-26

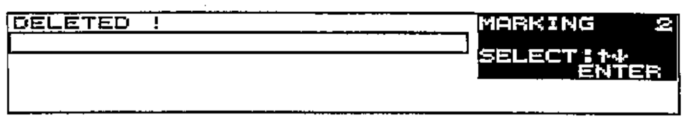


Fig. 8-26: Marking deleted

←,→: If no new marking entry is made, this display appears as long as the cursor keys are pressed.

ENTER: The deleted marking line is loaded with the default marking as a basis for your own entry.

8.7.4 *Decimal Digits*

❑ Purpose

You have the possibility of setting the number of digits after the decimal point for angle and distance readings.

❑ Selecting the mode

Call up the **DECIMAL DIGITS** option in the **SET** mode with numeric key 2 (see Fig 8-27).

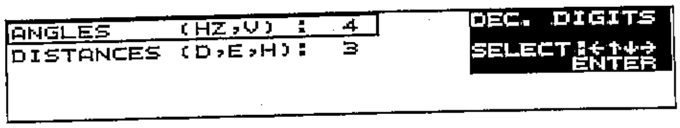


Fig. 8-27: Decimal digits mode

❑ Selecting angles or distances

Use the cursor keys ↑ (up) and ↓ (down) to select angles or distances for the setting of the decimal digits.

MEN: Change to the **SET** program.
ENT: Activates the mode.

❑ Modification

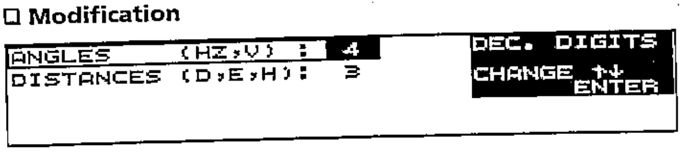


Fig. 8-28: Mode selection

Use the cursor keys ↑ (up) and ↓ (down) to select 3 to 5 decimal digits in the angle mode and 2 to 4 decimal digits in the distance mode (see Fig. 8-29).

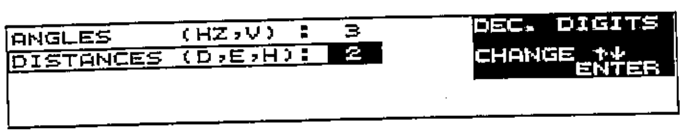


Fig. 8-29: Entry

ENT: Saving the modification

❑ Ending the modification

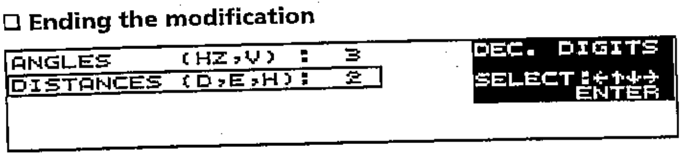


Fig. 8-30: Modified decimal digits

8.7.5 INITIALIZE FILE

☐ Purpose

If recording in the MEM is no longer possible, this is indicated by the error message 4WR. The MEM has to be reinitialized in this case. Before initialization, make sure to transfer all data stored in the MEM to a different storage medium as all data will be lost in this process.

☐ Calling up the mode

Call up the mode with numeric key 6.

```
ALL DATA TO BE DELETED ?
ARE YOU SURE ?
                                   YES  NO
```

Fig. 8-31: MEM initialization

YES: MEM is initialized; all data is lost. Change to the **SET** menu.
NO: Change to the **SET** menu.

8.7.6 Manual Input / Sound

```
MANUAL INPUT/SOUND:                 EXIT: MEN
 MAN. INP.: ON
      SOUND: ON
```

Fig. 8-32: Manual input/sound ON OFF

☐ Manual input

In the manual input mode, the angle and distance measurement by the instrument is replaced by the manual entry of D-Hz-V. This permits you to familiarize yourself with the system without the need to perform measurements. In addition, it offers the possibility of checking and repeating previous measurements.
If you press **ENT**, the following input mask is displayed in the relevant measurement menus of the programs:

```
SD        0.000Hz    291.3080V1    179.0121
```

Fig. 8-33: Manual entry

The data is entered in the same way as in the **Inp** option of the **EDITOR** menu.

MEN: Ends the entry. The measured data is converted in accordance with the measuring program selected and stored, if recording has beem activated.

❑ **Sound**

The acoustic signal can be directly activated and deactivated using numeric key 2 (see also **1.4.2 Acoustic Signal Generator**).

8.7.7 Units

❑ **Purpose**

Definition of the measuring units to be used for measurement.

❑ **Selecting the program.**

Use numeric key **8** to call up the units menu.

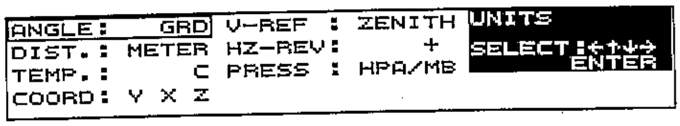


Fig. 8-34: UNITS selection menu

❑ **Selecting the unit to be changed**

Move the input field with the cursor keys ← (to the left), → (to the right), ↑ (up) and ↓ (down).

MEN: Quitting the units menu.
Storage of the selected new unit in the permanent memory.
Return to the main menu.

❑ **Activating the entry**

Confirm the correct selection with **ENT**; this brings you to the change menu.

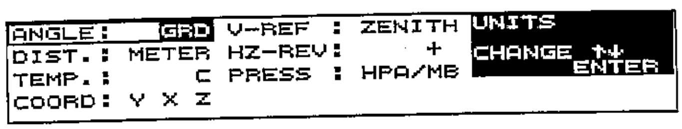


Fig. 8-35: Change menu

❑ **Changing the entry**

Move the vertical cursor keys ↑, ↓ until the unit required appears in the input field.

ENT: The new unit is stored in the Elta NV - RAM. Change to the selection menu (see Fig. 8-34).
MEN: Resetting to the old unit. Change to the selection menu (see Fig. 8-34).

❑ **Unit options**

Horizontal and vertical angle measurement HZ and V:
- Grad (400.0000)
- DMS (360°00'00")
- DEG (360.0000°)
- Mil (6400 mils)

Distance measurement SD:
- Meters (m) or feet (ft)

Temperature T:
- C or °F

Pressure P:
- hPa/mb (hectopascal or millibar)
- Torr
- InMerc

Vertical reference system V-Ref:
- Zenith angle
- Vertical angle
- Height angle
- Slope in %

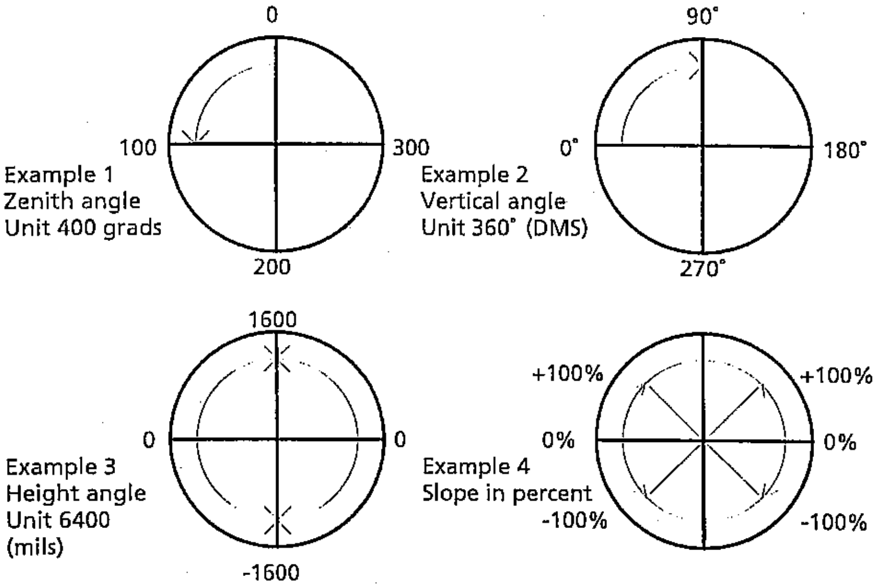


Fig. 8-36: Vertical reference systems

8.8 Projection Reduction PR

❑ **Purpose**

Projection reduction **PR** is used for fitting an observation into a Gauss-Krüger coordinate system and for height reduction from the measurement horizon to the reference horizon. This factor has a parallel effect to the existing scale factor **m**, which now only determines network tensions and measurement inaccuracies, or can be used as a calibration scale. Scale **m** and projection reduction **PR** are displayed together in all measuring programs and are applied to all distance measurements.

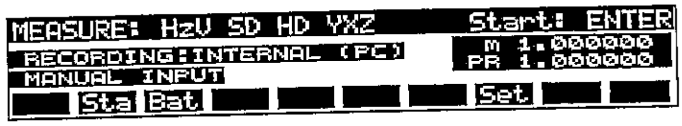


Fig. 8-37: PR display in the initial menu

As previously, scale **m** is directly entered via **INP** or determined after stationing on the basis of distances. It should therefore be close to 1.000 assuming a homogeneous network configuration, error-free point position and measurement within the measuring accuracy range.

❑ **Selecting the mode**

Call up projection reduction in the **ADJUST/PREPARE** menu using **PR-COR.** :

Fig. 8-38: Calling up projection reduction

Projection distortion and height reduction are determined by the projection reduction factor **PR** which can be preset to a value typical of the measurement area involved. For this, you require the mean easting or Y value and the mean height of the measurement area:

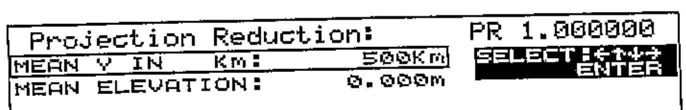


Fig. 8-39: Entries

☞ **Mean easting mY is the approximate Y coordinate of the center of the measurement area in the GK system excluding the zone number.**

Example: Y value = 35 78 600.71 entry: mY = 579Km

☞ **The mean height mH is the approximate height of the center of the measurement area in the height reference system.**

Example: height = 536.55 mH = 537m

☐ **The projection reduction is computed as follows:**

PR = 1 + ((**mY** - 500)² / (2*6370*6370) - **mH** / 6370000)

Enter **mY** in km, enter **mH** in m

If the effect of projection distortion is to be excluded, e.g. in a Soldner system network or local network, enter the value 500 for **mY.**

If the effect of height reduction is to be excluded, e.g. in a local network, enter 0 for **mH.**

☞ **If the vertical reference point is not identical with mean sea level, enter the difference between the actual height and the reference point height for mH for height reduction.**

9 Data Transfer

9.1 General

☐ **Purpose**

The data measured in the field and stored in the internal Mem memory or on the PCMCIA card can be transferred to a computer for further processing in the office or can be output on a printer for documentation. If a PCMCIA card is used, the data can be directly transferred to the appropriate PC drive, or via the interface of the instrument using the program parts **INTERFACE 1** and **INTERFACE 2**. The instruments connected to the Rec Elta® are usually called peripheral units.

Data transfer from peripheral units to the Rec Elta® is necessary e.g. for setting out, to ensure that the coordinates determined by the office computer can be used to compute the setting-out elements in the field. Apart from data transfer via the interface, direct data interchange is also recommended here, if the PCMCIA card is available. Since the memory card always uses the Rec E M5 record format, the data in the PC must be provided in a suitable format. If, for example, the data is provided in the Rec 500 format, the **CZCONVD.EXE** program from Carl Zeiss can be used for conversion. If required, the program also creates the necessary control file CTL$$$xx.CFG.

Instead of data recording in the internal Mem or on the PCMCIA card, you can also connect a computer to the RS 232 C interface for external recording and/or computation. The recording mode is selected in the program part **RECORDING**:

Communication between the Rec Elta® and the peripheral unit is only possible if the data transfer parameters have been correctly set in the relevant program part.

The program part **PC-DEMO** establishes the communication with an external PC, permitting the Rec Elta® control unit with the keyboard and display screen to be displayed on the PC using the **REC_TRM** program. This offers the possibility of making all program runs in the Rec Elta® visible on a PC screen for demonstration, projection or documentation.

In combination with an external computer, the **TERMINAL** program offers the option of running your own specific software which guides the instrument through your programs via a self-programmed user interface.

The program part **UPDATE** permits future software updates of the Rec Elta®.

☐ Selecting the transfer mode

Select the **DATA TRANSFER** program with numeric key 7. The selection menu is displayed (Fig. 9-1).

```
DATA TRANSFER                              EXIT: MEN
 INTERFACE 1: PRINT.          PC – DEMO
       INTERFACE 2: COMP.1          TERMINAL
             RECORDING                    UPDATE
```

Fig. 9-1: DATA TRANSFER selection menu

9.2 Preparation for Data Transfer

Prior to data transfer, you have to connect the peripheral unit to the Rec Elta® and prepare it appropriately. For passive peripherals such as printers, this means that identical transmission parameters, paper feed etc. need to be set. In active peripherals such as PCs, you have to call up and start the data transfer program.

9.3 Selecting and Calling up INTERFACE 1, 2

❑ Purpose

INTERFACE 1 and **INTERFACE 2** can be predefined by setting the transmission parameters and can be called up for data transfer between the internal Mem or PCMCIA card and the periphery.

❑ Calling up INTERFACE 1, 2

The handling of the two interfaces is identical, and only a description for **Interface 1** will therefore be given here. It is advisable to configure the interfaces for different peripheral units, e.g.:

- **Interface 1:** Standard interface for printers for line-controlled transmission
- **Interface 2:** Standard interface for computers for software-controlled transmission

Call up the interfaces with numeric key 1 (**Interface 1**) or 2 (**Interface 2**), see Fig. 9-1. The display changes to Fig. 9-2, where you select the data transfer direction or define the parameters.

Fig. 9-2: Selection of the data transfer direction

❑ Selecting the data transfer direction

Before starting the data transfer, make sure the peripheral unit has been connected to the Rec Elta® and appropriately prepared.
The bidirectional data communication of the Rec Elta® allows data transfer as shown in Fig. 9-2 using

- Numeric key 1: from Rec Elta® to a peripheral unit
- Numeric key 2: from a peripheral unit to Rec Elta®

Case 1: Data transfer from Rec Elta® to a peripheral unit

❑ Data selection

Softkeys are used for a targeted selection of the data to be transferred (Fig. 9-3).

All: all lines
Adr: one line (enter address)
A→A: from a starting address to an end address (enter addresses)
LAd: last address
Pt.: one line (enter point number)
P→P: from a starting point to an end point
?PI: one line (point identification)

MEN: Cancelling the data selection

```
SELECTION FOR DATA TRANSFER

All      Adr A→A LAd      Pt. P→P ?PI
```

Fig. 9-3: Selection of data lines

❑ Data transfer

After selection of the data lines, you can start the data transfer (see Fig. 9-4).

```
ADDRESSES
ADD.      1  METER/GRD/ZENITH/YXZ/
ADD.    300
START DATA TRANSFER ?          YES NO
```

Fig. 9-4: Start of the data transfer

YES: Data transfer runs and the transferred addresses are continuously displayed.
NO: Return to the data line selection menu (Fig. 9-3).

A data transfer in progress can be terminated at any time using **MEN.**

Case 2: Data transfer from a peripheral unit to Rec Elta®

❑ Connection of the peripheral unit and data transfer

To check, an enquiry is displayed (Fig. 9-5) as to whether the peripheral unit has been connected.

```
PERIPHERAL DEVICE CONNECTED ?
                               YES NO
```

Fig. 9-5: Connection of the peripheral unit

YES: Rec Elta® displays "**READY TO RECEIVE DATA**", to indicate that the data transfer can be started.
NO: Quitting and change to Fig. 9-2.

A data transfer in progress can be terminated at any time using **MEN.**

9.4 Setting Parameters

❑ **Purpose**

Specific configuration of the interface by parameter setting to permit communication with the peripheral units.

❑ **Selecting the setting menu**

Use numeric key 3 in Fig. 9-3 to call up the selection menu for setting the transfer parameters.

Fig. 9-6: Setting of transfer parameters

❑ **Selecting the parameters to be changed**

Move the input field to the parameter to be changed using the cursor keys 🡐 (to the left), 🡒 (to the right), 🡑 (upward) and 🡓 (downward).

❑ **Activating the entry:**

ENT: Confirms the correct selection, the display changes to the editing menu (Fig. 9-7).

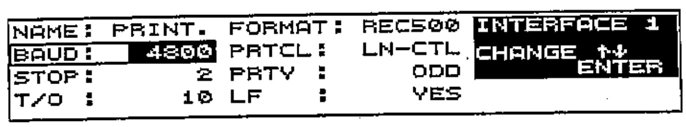


Fig. 9-7: Editing menu

❑ **Editing the entry:**

Press the vertical cursor keys 🡑, 🡓 until the parameter required appeared in the input field.

ENT: Saves the selected parameter; the input field is available for the selection of further parameters.

MEN: Return to the program part where the call was made (Fig. 9-2).

❑ **Editing options**

Editing:
Names or values for the selected parameter can be selected from a list.

- **NAME:** Mode 1 - Mode 2 - Printer - Comp.1 - Comp.2 - Cass.- Acoust. - Modem - Buffer
- **BAUD RATE:** 300 - 600 - 1200 - 2400 - 4800 - 9600
- **STOP:** 1 or 2 bits
- **T/0 (Time Out):** 0 - 10 - 20 - ... - 90 sec.
- **FORMAT:** Rec 500 or Rec E
- **PRTCL (Protocol):** Rec 500 - XON/OFF+E - XON/OFF - LN-CTL+E - LN-CTL - Modem
- **PTY (Parity):** even - odd - none
- **LF (Line Feed):** Yes - No

Note:
Detailed information on the parameters is included in chapter **11. INTERFACE DESCRIPTION.**

9.5 Recording

❑ Purpose

If you want to store the data in an external storage medium (e.g. Rec 500) instead of the internal Mem or the PCMCIA card, you have to activate external recording. The recording mode currently set can be read in the system test after instrument startup:

- INTERNAL (FILE)
- EXTERNAL (RS232 C)

An indication is also included in the initial menu of each measuring mode.

❑ Call

Use numeric key 3 to call up the **RECORDING** mode in the **DATA TRANSFER** program.

Fig. 9-8: Recording

❑ Parameters

To ensure smooth data transfer between the two instruments, make sure that the parameter settings are identical.

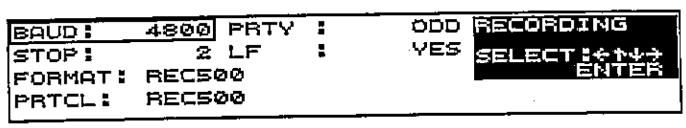


Fig. 9-9: Parameters

Changes:
Names or values for the current parameter can be selected from a list.

• **NAME:**	Mode 1 - Mode 2 - Printer - Comp.1 - Comp.2 - Cass.-Acoust. - Modem - Buffer
• **BAUD RATE:**	300 - 600 - 1200 - 2400 - 4800 - 9600
• **STOP:**	1 or 2 bits
• **T/0 (Time Out):**	0 - 10 - 20 - ... - 90 sec.
• **FORMAT:**	Rec 500 or Rec E
• **PRTCL (Protocol):**	Rec 500 - XON/OFF+E - XON/OFF - LN-CTL+E - LN-CTL - Modem
• **PTY (Parity):**	even - odd - none
• **LF (Line Feed):**	Yes - No

❑ Changing the recording mode

Numeric key 2 (see Fig.: 9-8) permits direct toggling between:

- INTERNAL (FILE) and
- EXTERNAL (RS 232-C)

The setting is retained until it is changed.

MEN: Return to the **TRANSFER** menu.

9.6 PC-DEMO

❑ Purpose

The current display content of the Rec Elta® can be displayed on a PC monitor. This permits demonstrating the system to a larger group of interested persons.

❑ Selecting the mode

For demonstration, connect the Rec Elta® to a DOS-compatible computer using e.g. the cable 708177-9270 (see also 11.3.3). Start the Carl Zeiss program **RECE_TRM.EXE** on the PC.

Now press numeric key 7 of the **TRANSFER** menu.

```
PC CONNECTED FOR PC-DEMO ?

                                    YES  NO
```

Fig. 9-10: PC-DEMO enquiry

NO: Return to menu 9-1

YES: All display contents of the Rec Elta® program are not displayed on the PC monitor. In the Rec Elta® keyboard, which is also displayed, the key last pressed lights briefly up.

☞ **Press the YES button only if a PC has been connected and the RECE_TRM program has already been started. Otherwise, there will be a program crash in the Rec Elta®. In this case, the instrument can only be shut off by disconnecting it from the power supply.**

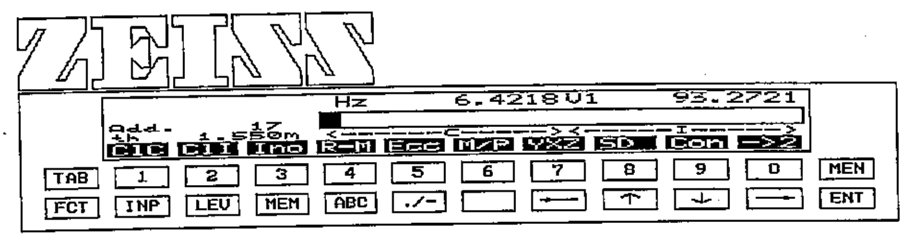


Fig. 9-11: PC monitor display after the start of PC-DEMO

During a demonstration with **PC-DEMO**, the response times of the Rec Elta® are significantly longer than usual, as the display contents and key pressures have to be transmitted to the PC. Operation at the usual speed is therefore not possible.

❑ Ending PC-DEMO

The **PC-DEMO** mode can be ended in different ways:

(1) Switch the Rec Elta® off and on again. The Rec Elta® now operates again without **PC-DEMO.**

(2) Select the **PC-DEMO** mode during demonstration. Press the **NO** button in the enquiry (Fig. 9-10). The Rec Elta® now continues to operate in the normal mode.

❑ Additional Information

Further information on the **PC-DEMO** software at the PC end can be called up by entering **RECE_TRM -H.**

9.7 Terminal

❑ Purpose

The terminal mode of the Rec Elta® offers the possibility of combining the instrument with a computer to create a personalized system. You can install your own programs tailored to your specific requirements on the computer. Clearly structured system commands control the communication between the instrument and the computer. The Rec Elta® keyboard and display screen can be used as input and output units for the system.

❑ Capabilities

In the terminal mode, the user is no longer bound by the given user interface of the Rec Elta®.

The following can now be freely used:

- keyboard
- display screen
- control commands
- function requests
- graphics commands

This enables the user to program

- user interface
- entries
- measuring process
- computation
- storage

in the connected computer to meet his own specific requirements.

The interaction principle between the Rec Elta® and a computer in the terminal mode is as follows:
Each key pressure on the Rec Elta® transmits a key code via the interface to the computer, where the code is interpreted by the program for the specific process involved. It may either

- transmit a function request to the Rec Elta® or
- write the Rec Elta® display screen or
- trigger an action in the computer.

❑ Calling up the program

Call up the program with numeric key 8 in the **DATA TRANSFER** program.

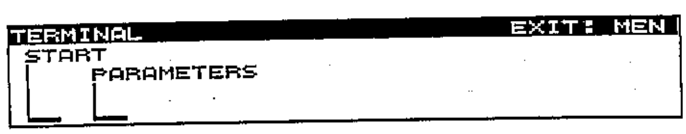


Fig. 9-12: Terminal mode

Start the terminal mode with numeric key 1.

This starts the following actions:

- The display screen is deleted.
- The terminal mode is activated.
- The connected computer assumes program control.

FCT+MEN: Ends the terminal mode at any point.

☐ Setting parameters

To ensure that the Rec Elta® and the connected computer work together smoothly, it is essential that the parameters correspond with each other. Press numeric key 2 to open the display and editing menu.

Fig. 9-13: Parameters

☐ Editing options

BAUD: 300.....9600
STOP: 1 or 2
FORMAT: REC - E, REC 500
PRTCL: REC 500, REC 500 + LN, LN - CTL, LN - CTL +E, XON/XOFF, XON/OFF + E, MODEM
PTY: ODD, EVEN, NONE
LF: YES/NO
T/O: set permanently to 10 sec.

MEN: Return to the Terminal Mode program

☞ **We recommend that you select either LN - CTL or XON/XOFF as the transmission protocol in the terminal mode in order to obtain a direct enquiry-response cycle.**

A detailed description of the commands is given in chapter **11 Interface Description.**

9.8 Update

This menu permits loading new updates for the Rec Elta® operating program.

☞ **When performing an update, note the specific instructions enclosed with each update.**

The Rec Elta® CM/CMS can be updated with two different operating programs:

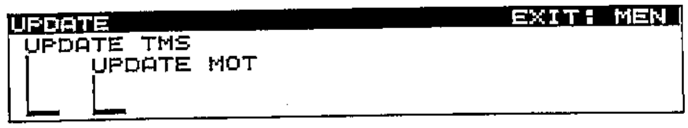


Fig. 9-14: Update options in CM/CMS

Call up the update program on the computer and run it under menu guidance up to the stage where the update can be started on the Rec Elta®.

☞ **Before starting the update, make sure that the instrument battery is sufficiently charged. Any interruption of the update process may make it necessary for you to call our service staff.**

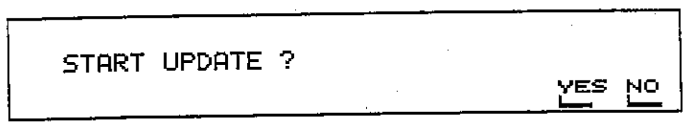


Fig. 9-15: Update selection menu

YES: Start update, duration approx. 5 minutes

NO: Return to the transfer menu.

10 Editor

10.1 General

❑ Purpose

Entry, call and display, editing and deletion of data lines.

❑ Selecting the editor functions

Select the EDITOR program by pressing numeric key 8. The selection menu is displayed.

```
SELECT DISPLAY:  ↑↓  DATA: →
Add.      1  METER/GRD/ZENITH/YXZ/
Add.      2  HPA/MB/C/
Del Edt Inp ACd LAd ?Ad ?Pt ?PI ?↓  Inf
```

Fig. 10-1: EDITOR selection menu

❑ Options available

The softkeys in line 4 permit the entry, the call and display, the editing and deletion of data lines in accordance with different criteria.

Key		Function
←, →, ↑, ↓		Scrolling through the database and toggling between the display of measured or computed data and P.I.
FCT + 1	Softkey **Del**	Deletion of data lines with various options (softkeys 5 to 8)
FCT + 2	Softkey **Edt**	Editing data lines
FCT + 3	Softkey **Inp**	Entry of coordinates or polar elements
FCT + 4	Softkey **ACd**	Additional coding of a number of data lines
FCT + 5	Softkey **LAd**	Display of the last address
FCT + 6	Softkey **?Ad**	Search for a specific address in the memory
FCT + 7	Softkey **?Pt**	Search for a specific point number in the memory
FCT + 8	Softkey **?PI**	Search for a specific point identification in the memory
FCT + 0	Softkey **Inf**	Recording of an information line

10.2 Display of Data Lines

❑ **Purpose**

- Overview of the data recorded so far
- Checking of data lines before editing or deletion
- Search for specific data lines

❑ **Search for data lines using the cursor keys**

The vertical cursor keys ↑, ↓ permit scrolling through the database (Fig. 10-2).
The horizontal cursor keys ←, →- can be used to toggle between the display of the P.I. and the associated coordinates or measured data (Figs. 10-2 and 10-3).
The display window remains fixed on line 2, the row of softkeys remains visible during all operations. The dialog prompt in the first line is replaced by a third data line.

Key	Function
↑	Upward scrolling in the data file. From the first memory line, the display jumps directly to the last address.
↓	Downward scrolling in the data file. From the last memory line, the display jumps directly to the first address.
→	Shifting the display field to the right, coordinates or measured data become visible.
←	Shifting the display field to the left, P.I. becomes visible.

```
SELECT DISPLAY:  ↑↓  DATA: →
Add.    245  1960/129      PP
Add.    246  1960/130      PP
Del Edt Inp ACd LAd ?Ad ?Pt ?PI ?↓  Inf
```

Fig. 10-2: Left side of the data line: address + point identification

```
SELECT DISPLAY:  ↑↓  P.I.: ←
Y   30732.214|X   30688.633|Z      546.827
Y   31054.371|X   29322.131|Z      502.936
Del Edt Inp ACd LAd ?Ad ?Pt ?PI ?↓  Inf
```

Fig. 10-3: Right side of the data line: coordinates or measured data

10.3 Search for Data Lines using the Softkeys

❑ **Purpose**

There are different methods of searching for data lines, depending on what you know about the point number, address or point identification. The search starts from the current address (in the frame in line 2, see Fig. 10-2).

☞ **If data lines are stored several times under the same point number or point information, use the ?↓ softkey to continue the search for the data line required.**

❑ **Call with the Lad softkey**

If you press the **LAd** softkey, the last address in line 2 is displayed (see Fig. 10-1). The vertical cursor keys bring you directly to the first address (↓) or to the last address but one (↑).

❑ **Call with the ?Ad softkey**

The **?Ad** directly calls up and displays a specific address. A maximum of 4 digits can be entered. Entry of the address as described in the **INPUT** program. The data line found is displayed in a frame in line 2 (see Fig. 10-2). The preceding and the next line are also displayed (see Fig. 10-2).

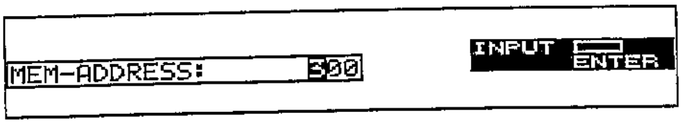


Fig. 10-4: Call using the address

❑ **Call with ?Pt**

The **?Pt** softkey permits calling up a specific point number (see Fig. 10-5).

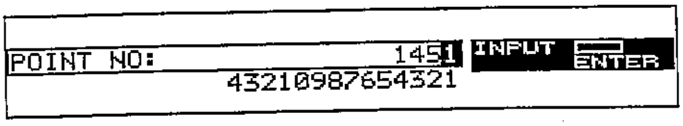


Fig. 10-5: Call using the point number

The data line found is displayed in a frame in line 2 (see Fig. 10-2). The preceding and the next line are also displayed.

☐ **Call with ?PI**

If you only know part of the point identification, you can use the **?PI** softkey to search for it within a specific mark configuration (see Fig. 10-6).

Fig. 10-6: Search for partial point identification

The search is supported by 3 softkeys.

Mrk: Selection of the mark configuration required

-■-: Dummy variable entered at digits of unknown content (formatted entry). Digits with this entry may include any type of text which is ignored during the search.

-◆-: Wildcard, stands for a range of unknown content (unformatted entry). Dummy variables and wildcards may be used in different combinations.

10.4 Additional Code

The **ACd** softkey permits the fast addition of further information to any data lines or overwriting any information entered by mistake. When you call up this option, the complete P.I. shows dummy variables.

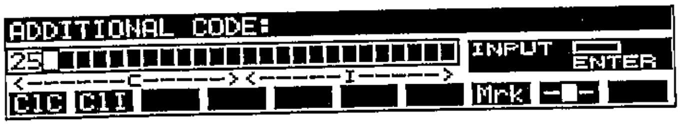


Fig. 10-7: Additional code

After you have selected the appropriate mark configuration using the **Mrk** softkey, you can make the changes required by overwriting the dummies. Any dummies overwritten by mistake can be reset using the -■- softkey. Press **ENT** to change to the selection menu of data lines to be edited (see Fig.: 10-8).

Fig. 10-8: Selection of data lines

The selection is supported by 6 softkeys:

Adr: Information of a specific address is edited
A→A: Editing in a range from address to address
Lad: The last address is edited
Pt.: Information of a specific point number is edited. If the point number exists several times, the point required can be found in a program-controlled search (see Fig. 10-9).
P→P: Editing of all data in a range from a specific point number to a specific point number
?PI: The data lines to be edited can also be selected according to the criteria described in **Call with ?PI.**

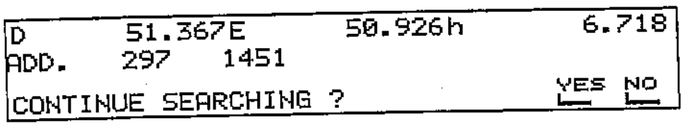


Fig. 10-9: Continued search

YES: The search is continued.

NO:

```
ADDRESSES
ADD.     297 1451
ADD.     298 1452
WRITE ADD. CODE ?              YES  NO
```

Fig. 10-10: Overwriting

YES: Brief display of the edited data line and return to the selection of further data lines.
NO: The data line is not overwritten (brief display: **Nothing overwritten!**). Return to the selection of further data lines.
MEN: Return to the program **SELECT DISPLAY**.

For the description of further softkeys, see 4.4 and 10.3.

10.5 Entry of Coordinate Lines /Polar Elements

❑ **Purpose**

Manual entry of coordinate records and polar elements E-Hz-h which are not available in the memory, but are required for measurements and computations. For the entry of these records, use the **Inp** softkey (not to be confused with the **INP** key for calling up the **INPUT** program!). Since the entry of coordinates and polar elements is basically identical, only the entry of coordinates is described here.

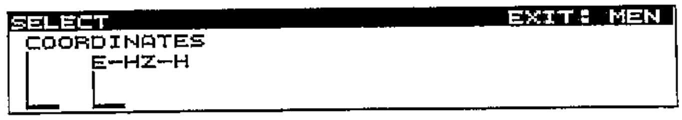


Fig. 10-11: Coordinates/E-HZ-H

❑ **Input menu**

Key 1: Changing to the coordinates input menu

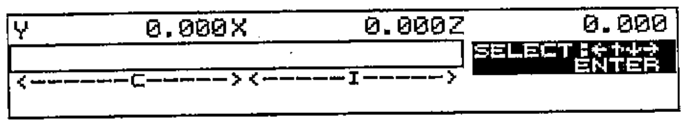


Fig. 10-12: Input selection menu

❑ **Selecting the input field**

The vertical and horizontal cursor keys move the input field to the coordinate or P.I. to be entered.

❑ **Activating the entry**

ENT: Activates the entry in the display field for the point identification (see. Fig. 10-13) or for coordinates (see Fig. 10-14). The entry is supported by the softkeys in line 4. In the PI columns 24 to 27, the entry /MAN is made to identify the manual input.

❑ **Entering the P.I.**

Entry of figures, letters or special characters for the P.I. in accordance with the input menu of the measuring mode. The input field with the mark configuration last selected is highlighted (see Fig. 10-12). A different mark configuration can be selected with the **Mrk** softkey.

Further softkeys support the entry. The **Inf** softkey (see Annex A 2) interrupts the P.I. entry for the entry of an information line which is then stored first.
The **ABC** key causes the softkey line to be overwritten with the alphabetic assignment.
ENT ends the entry. Return to the selection menu (see Fig. 10-12).

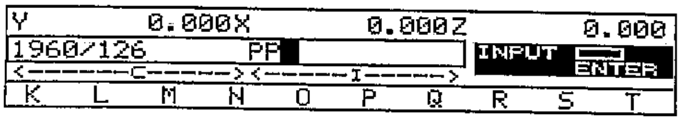


Fig. 10-13: P.I. input menu

❑ Entry of coordinates

The items **Selecting the input field** and **Activating the entry** also apply here. Numeric entries are made as in the **INPUT** program (2.2.1.1) - (see Fig. 10-14).

ENT: Ends the entry.

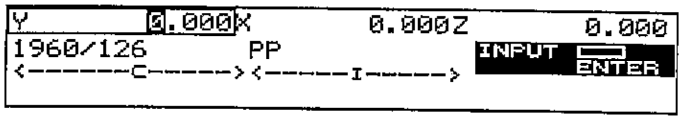


Fig. 10-14: Coordinates input menu

❑ Ending the entries

MEN: Ends the entries in the selection menu (see Fig. 10-12), the display changes to Fig. 10-15 with the enquiry whether the data is to be recorded.

YES: Display of the address of the saved data and change to the input selection menu of the next record (see Fig. 10-12). The entries of the last record are offered and only need to be edited.

NO: Change to the display in **EDITOR** (see Fig. 10.1.1).

Fig. 10-15: Data recording

10.6 Editing Data Lines

☐ **Purpose**

Correction of faulty point identifications or coordinates. In all other lines, only the P.I. area can be edited; the other input fields are blocked for entries.

☐ **Selecting the line to be edited**

Call up the line to be edited using the cursor keys or the **LAd**, **?Ad**, **?Pt** or **?PI** softkeys. The line to be edited is in line 2 of the display.
Call up the editing routine with the **Edt** softkey; the display changes to Fig. 10-11.
In the PI columns 24 to 27, the entry /EDT is made to mark the modification. Edit the line as described in Entry of coordinate lines.

☐ **Note:**

During editing of the P.I., the **Ino** and **Inf** softkeys are inactive.
ENT: Saves the record under its old address.

10.7 Deleting Data Lines

☐ **Purpose**

Creation of free storage capacity by deleting the complete memory or by the targeted deletion of individual measurements/data for specific reasons.
Following the deletion of data lines, the memory content can be renumbered, see the relevant description at the end of this chapter under **Renumbering**.

☐ **Selecting the data lines**

The following softkeys are used to select data lines for deletion (Fig. 10-16):
All: all lines
Adr: one line
A→A: from a starting address to an end address
LAd: last address
Pt.: point number
P→P: from a starting point to an end point
?PI: point identification

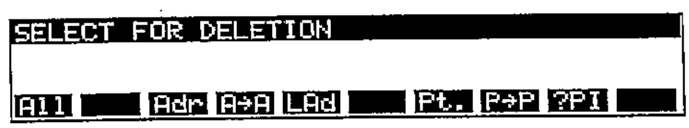


Fig. 10-16: Selection of data lines

❑ ALL softkey

If you press the **All** softkey, the display changes to Fig. 10-17 with the enquiry whether all data should be deleted.

```
ALL DATA TO BE DELETED ?

                                YES NO
```

Fig. 10-17: Deletion of all data

YES: The enquiry is repeated for safety's sake to avoid inadvertent deletion (see Fig. 10-18).
NO: Brief display : **NOTHING DELETED!**
Change to the selection menu for data lines (see Fig. 10-16)

```
ALL DATA TO BE DELETED ?
ARE YOU SURE ?
                                YES NO
```

Fig. 10-18: Repeated enquiry for deletion

YES: All lines are deleted.
NO: Brief display : **NOTHING DELETED!**
Change to the selection menu for data lines (see Fig. 10-16)

❑ A→A softkey

If you press the **A→A** softkey, the display changes to Fig. 10-19 for the selection of the starting and end addresses.

```
DELETION
START ADDRESS :        1      SELECT :←↑↓→
END ADDRESS   :      300             ENTER
```

Fig. 10-19: Selection

↑, ↓: Selection of the starting and end addresses
ENT: Confirms the selection, change to the input menu (see Fig. 10-20).
MEN: Change to **Deletion** (see Fig. 10-24).

```
DELETION
START ADDRESS :        1      INPUT
END ADDRESS   :      300             ENTER
```

Fig. 10-20: Entry of the address

MEN: Resets to previous values
ENT: Confirms the entry, change to the selection menu (see Fig. 10-19).
Repeat the procedure for the end address.
MEN: Change to **Deletion** (see Fig. 10-24).

❑ P→P softkey

The **P→P** softkey permits the deletion of addresses from a specific point number up to a specific point number. If the point numbers exist several times, the correct numbers can be selected by program-controlled search.

Fig. 10-21: Entry of the 1st point no.

MEN: Brief display : **NOTHING DELETED!**
Change to data line selection (see Fig. 10-16)
ENT: Start of the search and display of the following enquiry:

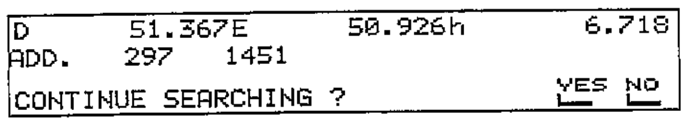


Fig. 10-22: Continued search

YES: Search is continued
NO: Entry of the 2nd point number (see Fig. 10-23)

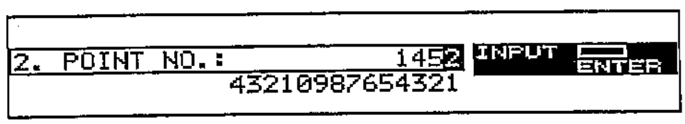


Fig. 10-23: Entry of the 2nd point no.

MEN : Brief display : **NOTHING DELETED!**
Change to data line selection (see Fig. 10-16)
ENT : Change to 10-22 Continued search

If the second point number has been found:
NO : Change to **Deletion.**

❑ Deleting the lines

The P.I. found and the associated addresses are automatically displayed.

Fig. 10-24: Deletion

YES: Brief display of the deleted data lines. Return to the selection menu (see Fig. 10-16).

NO: Brief display: **NOTHING DELETED!**
Return to the selection menu (see Fig. 10-16).

For the description of the other softkeys, see **10.3 Search for Data Lines.**

❑ Renumbering

If you quit the menu with **MEN** after deletion, the renumbering menu is automatically displayed. After renumbering of the memory, the data is available again without any gaps in the memory. To speed up this process or to ensure that specific addresses remain unchanged, you can enter a starting address for renumbering.

Fig. 10-25: Renumbering

NO: Return to the selection menu (s. Fig. 10-16).
YES: Change to the entry of a starting address

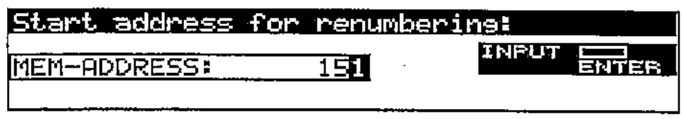


Fig. 10-26: Entry of a starting address

From the entered address onwards, the data lines are rearranged. The data lines preceding this address remain unchanged. Default is 1.

ENT: Entry of an address and renumbering. Return to the selection menu (see Fig. 10-16).

MEN: Return to the selection menu (see Fig. 10-16) without renumbering.

11 Interface Description

11.1 What is an Interface?

An interface is the point of contact between two systems or system areas, i.e. the point where information is interchanged. To ensure that it is understood by both the transmitting and receiving unit, specific rules must be defined for the transmission of signals and data. Since the conditions existing in communicating systems are usually not identical, it is of paramount importance for the interface definition that the differences involved be compensated.
Generally speaking, 3 types of interface can be distinguished: hardware, software and user interfaces.

❑ Hardware interfaces

Hardware interfaces are a physical connection between functional units such as measuring instruments, computers or printers. The following factors, for example, are of significance for the user:

- Shape and pin assignment of the connectors on the functional units and connecting cables. This is described in more detail in chapter 11.3.
- The data transmission method. The parameters and protocols for transmission control are described in chapter 11.4.

❑ Software interfaces

Software interfaces establish the link between programs or program modules.

The data to be transmitted must conform to a defined structure: the record format. The record formats generally used by Carl Zeiss are described in more detail in chapter 11.5.

If the two programs use different internal record formats, reformatting (data conversion) is required at one end.

❑ User interfaces

A further interface which is of particular importance for the handling of a system is the user interface. Interfaces between the user and the system are the monitor, the keyboard and the options for user guidance provided by the software. In the Rec Elta® concept, special emphasis has been placed on the design of the user interface. A general introduction is given in chapter 2.

11.2 Hardware Interfaces in Rec Elta®

The Rec Elta® comprises the functional units Elta and the display and control unit. An interface for peripheral instruments (e.g. computer, printer) is located on the left-hand side of the display and control unit or is provided as a slip ring contact on the stationary base of the instrument.
The interface for the peripheral equipment is of the asynchronous, serial type and conforms to DIN 66020 standard (V 24 / RS 232 C). The pin assignment is shown in chapter 11.3.1.

In the Rec Elta® concept, this interface has two functions:

(1) Data transmission:
Direct transmission of measured data between Rec Elta® and the connected peripheral instrument (computer, printer,...).
A series of transmission parameters and protocols are available for the control of this process (see chapters 9.2 and 11.4).

(2) Software updates:
Software for the Rec Elta® can be loaded via this interface (see chapter 9.4).

11.3 Connectors

11.3.1 8-pin Interface Connector

The interface connector is an 8-pin (female) stereo connector as per DIN 41524.

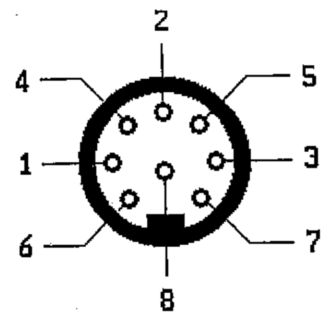


Fig. 11-1: Pin assignment (exterior view of connector)

Pin	Signal	Direction	Designation	Meaning
1	RTS	Out	RTS	RTS=1 means: Rec Elta® is ready for reception RTS=0 means: Rec Elta® is not ready
2	GND		Ground	
3	CTS	In	CTS	CTS=1 means: periphery is ready for reception CTS=0 means: periphery is not ready
4	TD	Out	Transmitted Data	Transmitted Data
5	RD	In	Received Data	Received Data
6			NC	Not assigned
7			NC	Not assigned
8			NC	Not assigned

If the interface is provided on the stationary base of the instrument, the assignment of pins 6 to 8 is as follows:

Pin	Signal	Direction	Designation	Meaning
6	VCC	In		External supply
7	VCC	In		External supply
8	GND		Ground	Not assigned

11.3.2 Cables

The following table lists the catalog numbers for various standard cables.

Peripheral Instrument	Rec Elta® 8-pin
DOS-PC, 9,25-pin	708177 - 9470
EPSON printer	708177 - 9300
Adapter cable Rec 500, 25-pin *)	708177 - 9290

*) The adapter cable connects the Rec Elta® (8-pin circular connector) with all existing Rec 500 cables (25-pin DB connector) used for software-controlled data transfer to computers (see 11.4.3.1). The cable therefore permits the following:

- users who have already connected a Rec 500 to a computer can connect a Rec Elta® to the existing Rec 500 cable and thus to the computer,
- all existing software-controlled connections of Rec 500 to computers can also be used for Rec Elta®.

11.4 Transmission Parameters and Protocols

The Rec Elta® offers various options for data transfer synchronization. The interface settings, for example, make it advisable to use control lines for communication with printers and a software dialog for communication with computers. The XON/OFF dialog, however, can also be recommended for printers or computers.

11.4.1 Selectable transmission parameters

(1)	Baud rates	300, 600, 1200, 2400, 4800, 9600, 19200	
(2)	Stop bits	1, 2	
(3)	Time out	00, 10, 20, 30, ... , 90 seconds (00 = time out deactivated)	
(4)	Formats	Rec 500, Rec E	
(5)	Protocols	Rec 500	software dialog
		MODEM	Rec 500 dialog + line control
		LN-CTL	line control
		LN-CTL+E	line control + end byte *)
		XON/OFF	XON/XOFF + protocol
		XON/OFF+E	XON/XOFF + end byte *)
(6)	Parity	odd, even, none	
(7)	Line feed	YES, NO	Output of CR LF or only CR to end a data line

*) End byte: Some computers require a special end byte to end the data transfer. By default, the Rec Elta® uses the end byte EOT = ASCII dec. 4. It is transmitted as an additional end character EOT.

11.4.2 Default Parameter Settings

Parameter	Rec Elta®
BAUD	4800
FORMAT	REC500
PRTCL	REC 500
STOP	2
PRTY	ODD
T/O	10
LF	YES

11.4.3 Control Diagrams of the Protocols

❑ Definition of the terms used:

The transmitted data line is an output port on the Rec Elta®, the received data line is an input port on the Rec Elta®.

The following ASCII characters are used:

Text character A = ASCII character dec. 65
Text character B = ASCII character dec. 66
Text character Z = ASCII character dec. 90
< stands for CR = ASCII character dec. 13 (carriage return)
= stands for LF = ASCII character dec. 10 (line feed)
Control character XOFF =ASCII character dec. 19
Control character XON = ASCII character dec. 17

11.4.3.1 Rec 500 Software Dialog

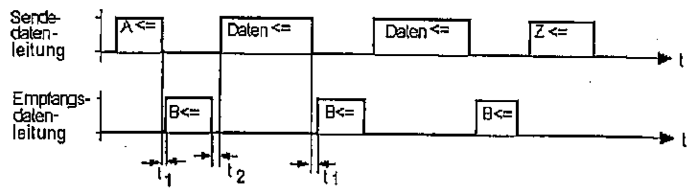


Fig. 11-2: Control diagram of the protocol 'Rec 500 software dialog'

❑ The following definitions apply to the time values entered in the control diagram:

- **t_1:**
  Interval between signal A from Rec Elta® and the response from the recording unit with signal B, and interval between the end of data transfer and the acknowledgement with signal B.

$$0 > t_1 < t_{(timeout)}$$

The recording unit may respond without delay to the recording request from the Rec Elta®. However, the selected time-out $t_{(timeout)}$ must not be exceeded; otherwise an error message is displayed and external recording is deactivated. The Rec Elta® assumes that no external recording unit has been connected.

- **t_2:**
  Interval between the acknowledgement of the reception of a data line by the connected recording unit with signal B and the transmission of a further data line. Depending on the type of recording line involved, this amounts to

$$10ms > t_2 < 100ms$$

The Rec 500 software dialog is also suited for data transmission to the Rec Elta®. The control diagram is identical to the one shown in Fig. 11-2, with the designations of the transmitted data line and received data line being interchanged, as data is now transmitted by the peripheral unit.

11.4.3.2 Rec 500 Software Dialog with Modem Control

For data transfer via a modem (dial-line modem), the Rec 500 software dialog with additional active control lines can be used. This protocol does not make any sense in the recording mode and is therefore not available there. It has only been installed in the data transfer mode and is suitable for bidirectional transfer. Make sure to use a cable with correct wiring as specified below:

Rec Elta® connector (8-pin plug)		Modem (25-pin plug)	
1	RTS	4	RTS
2	Ground	7	Ground
3	CTS	5	CTS
4	TD	2	TD
5	RD	3	RD

In addition, it may be necessary to implement a bridge from DTR to DSR in the modem. If there are still any problems, contact the customer advice department of the Surveying Division.

☞ **Make sure that the interface parameters such as the baud rate and parity between the Rec Elta® and the modem and, at the other end, between the computer and the modem correspond to each other.**

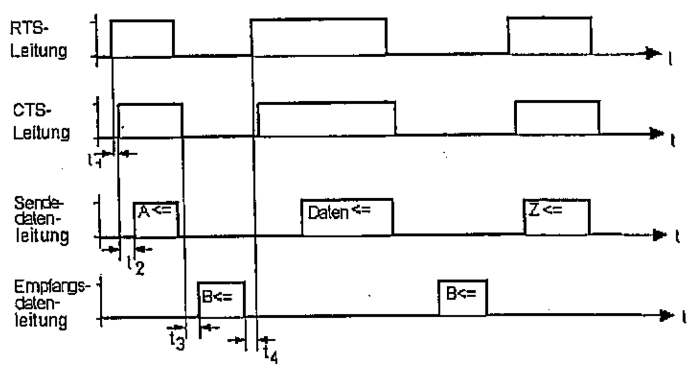


Fig. 11-3: Control diagram of Rec 500 protocol, software dialog with modem control

☐ **Description of the process and explanation of the time values:**

Once the transfer process has been started, the RTS line switches to the 'Log 1' status, thus signalling the transfer request to the modem. As soon as a connection exists between the modem and the opposite station, this is indicated by a 0/1 status change in the CTS line.
The **time t_1** of this process is typically 80 ms. If no connection can be established or if the time required for this process exceeds the selected time-out, an error message is displayed.
Time t_2 is the interval between a 0/1 status change of CTS (ready to receive status) and the transmission of a character string by Rec Elta®. Depending on the type of string to be transmitted (control character or recording line), this interval is

$$1\text{ms ms} > t_2 < 100\text{ ms}$$

Time t_3 is the time required for the switchover of the transfer direction. Since a modem link normally transmits data only in semiduplex operation, this time is required after the end of the RTS-CTS transmission request to also allow the opposite station to signal a transmission request.

$$80\text{ ms} > t_3 < t_{(\text{timeout})}$$

Time t_4 is 10 ms to 100 ms depending on the type of recording line involved.

11.4.3.3 XON/XOFF Protocol

The **XON/XOFF** protocol is a very simple, but efficient and frequently used data transfer protocol. It should preferably be employed for so-called terminal programs (e.g. terminal under Windows or Xtalk) and can be used for both data recording and data transfer from Mem E or the PCMCIA card to a computer. For data transfer to the Rec Elta®, the same control diagram applies, but the designations of the transmitted data line and received data line need to be interchanged, as the Rec Elta® is now the data receiver.

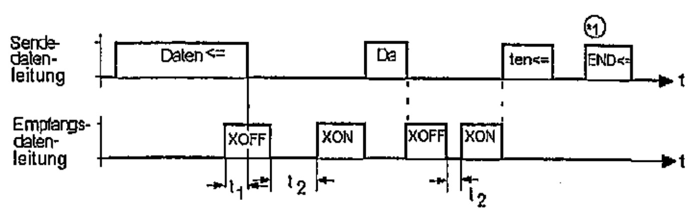


Fig. 11-4: Control diagram of XON/XOFF protocol

❑ **The following definitions apply to the time values shown in the control diagram:**

Time t_1 is dependent on the baud rate setting. On reception of an XOFF signal, the character transmission in progress is always completed. A further character may follow, especially if a high baud rate has been set.

Time t_2 is dependent on the time-out setting. If time-out has been set e.g. to 20 sec, the XON signal must arrive at the Rec Elta® transmission line not later than after these 20 sec in order to permit the transfer to be continued. Otherwise, the error message Timeout will be displayed (see error messages in the Annex of the Rec Elta® manual).

☞ **If the XON/XOFF protocol is used in data transfer (data transmission from the memory via the serial interface to the periphery), the additional character string 'END CR/LF' is output at the end of the transfer. This does not happen in the recording mode.**

11.4.3.4 XON/XOFF Control + End-Byte

This protocol corresponds to that of XON/XOFF control. In addition, however, the ASCII character 'EOT' is transmitted with the last record. Some operating systems (e.g. UNIX) recognize the end of data transmission this way.

11.4.3.5 Line Control (LN-CTL)

This line handshake widely employed in the past can be used both in the recording mode and for data transfer. In the recording mode, preference should be given to the protocols XON/XOFF or Rec 500 control. For data output on a printer, however, the line control protocol is very frequently used.

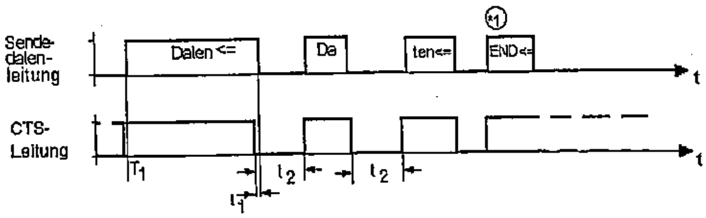


Fig. 11-5: Control diagram of the line control protocol in data output

❑ **The following definitions apply to the time values shown in the control diagram:**

At the moment T_1, i.e. prior to the output of the first data record, the CTS line must have been switched to the status 'Log 1' by the connected peripheral instrument. If the

CTS line is set to the `Log 0´ status when transmission is started, the counting for time-out is initiated. After the end of time-out, the error message Timeout is displayed before any data is output.

☞ **If data transfer using the line control protocol is not possible, this may be due to incorrect or defective wiring of the connecting cable.**

Time t_1 is dependent on the baud rate setting. When the CTS line status changes from 1 to 0, the character transmission in progress is always completed. A further character may follow, especially if a high baud rate has been set.

Time t_2 is dependent on the time-out setting. If time-out has been set e.g. to 20 sec, the CTS line status must change from 0 to 1 not later than after these 20 sec in order to permit the transfer to be continued. Otherwise, the error message Timeout will be displayed (see error messages in the Annex of the Rec Elta® manual).

☞ **If the line control protocol is used in data transfer (data transmission from the Mem E via the serial interface to the periphery), the additional character string `END CR/LF´ is output at the end of the transfer. This does not happen in the recording mode.**

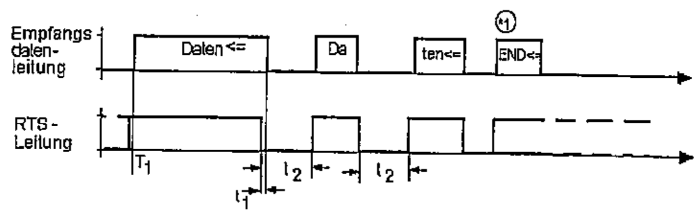


Fig. 11-6: Control diagram of the line control protocol in data reception

In the transfer direction `Transmit data to Rec Elta®´, the data transfer is controlled by the RTS line. The Rec Elta® is only ready to receive data if the RTS line (output port on Rec Elta®) switches to the `Log. 1´ status.
If the RTS setting is reversed, (1 / 0 status change), **time t_1** allows the current byte to be completely transmitted by the periphery.
With the RTS line switched to the `Log 1´ status, characters are expected within the selected time-out. Otherwise the error message I/O Timeout is displayed.
This transfer direction can only be used in the data transfer mode, not in the recording mode.

11.5 Data Record Formats

Two data record formats are provided by default for data transfer between Rec Elta® and peripheral instruments: the Rec 500 format (11.5.1) and the Rec E format M5 (11.5.2).
In addition to the time-tested Rec 500 record format, the new Rec E M5 format offers an even more detailed record description.
The data line starts with a format information which may be useful for external evaluation. All data blocks are preceded by a type identifier and succeeded by the measuring units. The numeric data fields have all been configured for 14 digits and may include the decimal point and sign, plus numeric values with the preset number of decimal digits.

11.5.1 Rec 500 Record Format

```
Position:
0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

Field:
<-><-->-<-------------><----------->-<><----------->-<><----------->-<><------->--

Example:
   1122 12345678901234ASDFGHJKLZXCV SD     2500.941 Hz      256.5224 V1 102.1234

Blanks:
LLL   L                            L              L                L            <=

Meaning:
     ADR    Identifier K    Add. Info. Z T1     Distance   T2  Bearing   T3 Zen. Angle

Number of Digits:
 3   4 1           27                 1 2   12       1 2       13       1 2     9   11
```

Abbr.	Designation	Digits	Num/Alpha	Meaning
L	Blank	1		
ADR	Address	4	num	Consecutive number of memory line (addr.) or blank
P	Point identification	27	num/alpha	Point identifier K and additional information Z
T1	Type ident. 1st value	2	num/alpha	e.g. D = slope distance E = horizontal distance
W1	1st value	12	num	
T2	Type ident. 2nd value	2	num/alpha	e.g. Hz = bearing
W2	2nd value	1	num	
T3	Type ident. 3rd value	2	num/alpha	e.g. V1 = zenith angle, h = height difference
W3	3rd value	9	num	
<	CR	1		Control character: CARRIAGE RETURN
=	LF	1		Control character: LINE FEED

11.5.2 Rec E M5 Record Format

```
            1         2         3         4
1234567890123456789012345678901234567890123456789
For_M5|Adr_12345|T2a_123456789012345678901234567|
            Value 1     <---------Value 2--------->

5         6         7         8         9
0123456789012345678901234567890123456789012345
T3_12345678901234_dim3|T4_12345678901234_dim4|
   <--Value 3--->          <--Value 4--->

    1         1         1
    0         1         2
6789012345678901234567890 1
T5_12345678901234_dim5|?<=
   <--Value 5--->
```

Abbr.	Designation	Digits	Num/Alpha	Meaning
For_	Identifier	4	alpha	Rec E format
M5	Format type	2	alpha	Measured data, 5 blocks
Adr_	Identifier	4		
	Value 1	5	num	Memory address
T2	Type identifier	2	alpha	Value 2
a	Marking	1	num	a=1-7
	Value 2	27	alpha	Point identification
T3	Type identifier	2	alpha	Value 3
	Value 3	14	num	14-digit value
dim3	Unit	4	alpha	4-digit unit
T4	Type identifier	2	alpha	Value 4
	Value 4	14	num	14-digit value
dim4	Unit	4	alpha	4-digit unit
T5	Type identifier	2	alpha	Value 5
	Value 5	14	num	14-digit value
dim5	Unit	4	alpha	4-digit unit
?	Identifier	1	alpha	? with errors, otherwise _

Special characters:

|	Separator	1		ASCII 124
_	Blank	1		ASCII 32
<	CR	1		ASCII 13
=	LF	1		ASCII 10 (can be set)

11.6 Interface Commands

A uniform input/output parameter format is used in order to ensure convenient and easy-to-read data interchange for all instrument parameters and constants in a process which is valid for all parameters types.

Due to their contents, commands used for identification, checking, error enquiries, keyboard enquiries and assignments, function requests an graphic display differ from this structure.

These commands are usually admissible in all program runs; they are blocked when e.g. distance measurement or compensator pickup is in progress. If these commands are used outside the terminal mode, the interface parameters of **RECORDING** apply, within the terminal mode those of **TERMINAL**. Exceptions are the format and the transmission protocol which are defined in the parameter format.

Any deviations are specifically mentioned in the following.

11.6.1 General Structure of the Parameter Format

Call:	Response:
`?ITYP<`	`!ITYP""|xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx"unit<`

Setting:	Response:
`!ITYP""|xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx"unit<`	`Q< or E<`

❑ **Key:**

?	fixed character for calling up information
!	fixed character as response and for transmitting information
I	variable character for the type of information
TYP	variable type identifier of the parameters, also used for display and data transfer
"	blank (ASCII dec. 32)
|	separator (ASCII dec. 124)
xxx..xxx	requested or transmitted information, 32 characters
unit	unit of the information, 4 characters
Q	response is correct
E	response is not correct
<	carriage return (ASCII dec. 13)

☐ Units:

'¨¨¨¨'	no unit
'm¨¨¨'	meters
'ft¨¨'	feet
'grad¨'	400 grads
'mil¨'	6400 mils
'deg¨'	360 degrees, decimal
'DMS¨'	360 degrees, minutes, seconds
'Torr'	torr
'inHg'	inches of mercury
'hPa¨'	hectopascal
'F¨¨¨'	° Fahrenheit
'C¨¨¨'	° Celsius
'm^2¨'	square meters
'ft^2'	square feet
'%¨¨¨'	% slope
'Bit¨'	bits

The command strings for reading and writing the information must be structured precisely as shown above. This also includes the correct syntax of the units.

☐ Examples of information types:

```
8 bit information   |¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨xxxxxxxx¨Bit¨<
Integer constant    |¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨255¨¨¨¨¨<
Real constant       |¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨123.4567890¨m¨¨¨<
```

11.6.2 Numeric Constants (Read/Write)

☐ Example Instrument Height ih:

```
?Kih¨<
!Kih¨¨¨|¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨¨1.5430¨m¨¨¨<
```

```
?Kih¨<          Instrument height
?Kth¨<          Reflector/target height

?Km¨¨<          Scale
?KPR¨<          Scale from projection reduction (read only)
?KA¨¨<          Addition constant
?KP¨¨<          Atmospheric pressure
?KT_¨<          Temperature

?KSZ¨<          Compensator run center, sighting direction
?KSK¨<          Compensator run center, transverse direction
```

```
?Ki""<        Index correction
?Kc""<        Collimation correction

?KHV"<        Rotational angle of bearing
?KHz"<        Current bearing
!KHz....      Setting of Hz circle to a given value

!Khz"....     Setting of Hz bearing for CM/CMS
!Kv1"....     Setting of zenith angle V1 for CM/CMS

!KDh"....     Setting of Hz window for CM/CMS
!KDv"....     Setting of V1 window for CM/CMS

?KTv"<        Eccentricity in front of the center
?KTl"<        Eccentricity left of the center
?KTh"<        Eccentricity behind the center
?KTr"<        Eccentricity right of the center
?KTs"<        Eccentricity spatial relative to the center

?KPI"<        Point identification
?KY""<        Coordinate
?KX""<        Coordinate
?KZ""<        Coordinate
?KE_"<        Coordinate
?KN_"<        Coordinate

?KPs"<        Point identification of the station
?KY"S<        Station coordinate
?KX"S<        Station coordinate
?KZ"S<        Station coordinate
?KE_S<        Station coordinate
?KN_S<        Station coordinate

?KPz"<        Point identification of the target
?KY"Z<        Target coordinate
?KX"Z<        Target coordinate
?KZ"Z<        Target coordinate
?KE_Z<        Target coordinate
?KN_Z<        Target coordinate

?KmY"<        Mean easting in km, projection reduction
?KmH"<        Mean elevation in m, projection reduction
```

11.6.3 Internal Instrument Settings (Read/Write)

❑ **Units:**

```
?SP01<
!SP01""|"""""""""""""""""""""""""""""dd0c0baa"Bit"<

          aa = 00 - mil            aa = 10 - DMS
          aa = 01 - grad           aa = 11 - deg
          b  =  0 - m              b  = 1  - ft
          c  =  0 - C              c  = 1  - F
          dd = 00 - hPa            dd = 01 - Torr
          dd = 10 - inHg
```

❑ **Vertical Reference System and Coordinate System:**

```
?SP02<
!SP02""|""""""""""""""""""""""""""""000ff0ee"Bit"<

        ee = 00 - Zen. Angle      ee = 10 - Height Angle
        ee = 01 - Vert. Angle     ee = 11 - % Slope
        ff = 00 - Y X Z           ff = 01 - X Y Z
        ff = 10 - E N Z           ff = 11 - N E Z
```

❑ **Display Illumination (Option):**

```
?SP05<
!SP05""|""""""""""""""""""""""""""""0000000n"Bit"<

        n  =  0 - Ill. Off        n  =  1 - Ill. On
```

❑ **Distance Measuring Mode:**

```
?SP19<
!SP19""|""""""""""""""""""""""""""""000000gg"Bit"<

        gg = 00 - D:N             gg = 01 - D:R
        gg = 10 - D:L (13-15)     gg = 10 - D:S (RL)
```

❑ **Compensator On/Off:**

```
?SP20<
!SP20""|""""""""""""""""""""""""""""0000000h"Bit"<

        h  =  0 - Comp. Off       h  =  1 - Comp. On
```

❑ **Clockwise or Counterclockwise Hz Display:**

```
?SP21<
!SP21""|""""""""""""""""""""""""""""0000i000"Bit"<

        i  =  0 - Hz +            i  =  1 - Hz -
```

❑ **Manual Entry On/Off:**

```
?SP23<
!SP23""|""""""""""""""""""""""""""""0000000j"Bit"<

        j  =  0 - Man. Entry Off  j  =  1 - Man. Entry On
```

❑ **Number of Decimal Digits for Distances, Heights and Coordinates:**

```
?SP24<
!SP24""|""""""""""""""""""""""""""""00000kkk"Bit"<

        kkk=001 - 1 Digit         kkk=010 - 2 Digits
        kkk=011 - 3 Digits        kkk=100 - 4 Digits
```

❑ **Number of Decimal Digits for Angles:**

```
?SP25<
!SP25""|""""""""""""""""""""""""""""00000lll"Bit"<

        lll=011 - 3 Digits        kkk=100 - 4 Digits
        lll=101 - 5 Digits
```

☐ Number of Current Marks of the Point Identification:

```
?SP26<
!SP26""|"""""""""""""""""""""""""""00000mmm"Bit"<

        mmm=001 - Mark 1        mmm=010 - Mark 2
        mmm=011 - Mark 3        mmm=100 - Mark 4
        mmm=101 - Mark 5        mmm=110 - Mark 6
        mmm=111 - Mark 7
```

11.6.4 Identification Commands (Read Only)

Call	Response	Meaning
?0000<	....	Instrument identification number
?0100<	....	Instrument serial number
?0300<	....	Instrument designation

11.6.5 Control Commands

Call	Response	Meaning
SEC<	Q<	CR is end of command
SEL<	Q<	CR+LF is end of command
SEO<	Q<	Instrument shutoff

11.6.6 Call of Error Numbers (Read Only)

Call	Response	Meaning
?E000<	!xxx<	xxx = Error number or 000

11.6.7 Function Requests

The following function requests are answered with allowance made for the selected format and protocol:

Call	Response
FKO<	Compensator readings, transverse SQa and longitudinal SZa
FD0<	Slope distance SD (with scale, add. constant and projection reduction)
FW1<	Angle readings Hz V
FMO<	Measured data SD Hz V (without scale, add. constant and projection reduction)
FMS<	Measured data SD Hz V (with scale, add. constant and projection reduction)
FMR<	Reduced data HD Hz h (with scale, add. constant and projection reduction)

☞ **If a function request which includes a distance measurement is cancelled with MEN, e.g. because no prism is available or the signal intensity returning from the prism is insufficient, the instrument transmits 'T' CR instead of the data record.**

The following function requests are answered with special menus. Press **MEN** to return to the program where the call was made.

FIN<	Call of the input menu and possibility of entering all values
FGZ<	Display of all initial status values
FTB<	Display of the battery condition
FTC<	Display of the EDM signal
FLV<	Display of the compensator data
FZI<	Call of the sensor menu and possibility of selecting all menu items in CMS
FAP<	Setting to nominal Hz and V (!Khz.., !Kv1..) and deletion of the screen in CM/CMS
FAC<	Setting to nominal Hz and V (!Khz.., !Kv1..) without deletion of the screen in CM/CMS
FLO<	Measurement in positions 1 and 2 in CM/CMS
FLN<	Measurement in position 1 or 2, set on instrument startup
FZO<	Automatic sighting in CMS
FZN<	Automatic sighting deactivated
FAZ<	Automatic sighting without setting to prism center in CMS
FTO<	Target tracking on in CMS
FTN<	Target tracking off in CMS
FEM<	Reads in a character string via RS 232 C and transfers it to the on-board DOS-PC

FSR/FSL<	Search for prism on the right/left in the preset search window (!Kdh.., !Kdv..) in CMS
Fhz(sxxxx)<	Continuous rotation of CM/CMS s=+ clockwise s=- counterclockwise xxxx= 1000 - 5000 speed xxxx= 0 end of movement
Fv1(sxxxx)<	Continuous tilting of the telescope in CM/CMS s=+ downward s=- upward xxxx= 1000 - 5000 speed xxxx= 0 end of movement
FSE(TEXT)<	Transmits the string TEXT from the on-board DOS PC via RS 232 C to an external instrument

In the case of FAZ, FSR, FSL, successful search is acknowledged with 'Q', unsuccessful search with 'E' and termination by MEN with 'T'.

11.6.8 Calling up Programs

The following commands are used to call up the Rec Elta® programs from the on-board PC. They can be executed in the usual way and then quitted with MEN. The program control then returns to the PC program where the call was made.

Call	Program
FME<	MEASURE
FBP<	STATIONING ON A KNOWN POINT
FEZ<	FREE STATIONING, SINGLE POINT ADJUSTMENT
FHT<	FREE STATIONING, HELMERT 1.000
FHF<	FREE STATIONING, HELMERT FREI
FPO<	POLAR POINT MEASUREMENT
FAS<	SETTING OUT
FFA<	AREA COMPUTATION
FHS<	HEIGHT STATIONING (SPECIAL PROGRAMS)
FSP<	CONNECTING DISTANCE
FPG<	POINT TO LINE DISTANCE
FMH<	PROJECTION REDUCTION

The sequence of operations for a call in the on-board PC program has to be programmed as follows:

- Transmission of the program call string.
- Closing of all files, including the interface.
- SHELL"MDIALOGD.EXE".
- Calling and execution of the program required; after quitting with MEN, return to the program of the on-board PC where the call was made, to the program stage after the SHELL command
- Before any further command, setting of the COM1 interface of the on-board PC.
- All variables of the on-board PC program are retained.

11.6.9 Key Codes

Outside the terminal mode, the corresponding key code for each key pressure can be entered on an external computer. This means that the complete operating cycle can be controlled on an external computer.

In the terminal mode, each key pressure sends a key code to the external computer, where it has to be individually processed. The transmission of key codes to the Rec Elta is not possible here.

The response to a key code is 'Q' CR or, in the case of an error, 'E' CR.

Key	Code	Dec.	Key	Code	dec.	Meaning
TAB	T09<	9	FCT/TAB	T19<	25	Shutoff
1	T31<	49	FCT/1	T21<	33	
2	T32<	50	FCT/2	T22<	34	
3	T33<	51	FCT/3	T23<	35	

Key	Code	Dec.	Key	Code	dec.	Meaning
4	T34<	52	FCT/4	T24<	36	
5	T35<	53	FCT/5	T25<	37	
6	T36<	54	FCT/6	T26<	38	
7	T37<	55	FCT/7	T27<	39	
8	T38<	56	FCT/8	T28<	40	
9	T39<	57	FCT/9	T29<	41	
0	T30<	48	FCT/0	T3D<	61	
MEN	T01<	1	FCT/MEN	T11<	17	Quitting the terminal mode
INP	T02<	2	FCT/INP	T12<	18	
LEV	T03<	3	FCT/LEV	T13<	19	
MEM	T04<	4	FCT/MEM	T14<	20	
ABC	T05<	5	FCT/ABC	T15<	21	
'/-	T2D<	45	FCT/'/-	T2E<	46	
SPC	T20<	32	FCT/SPC	T10<	16	
<	T06<	6	FCT/<	T16<	22	
^	T07<	7	FCT/_	T17<	23	
v	T08<	8	FCT/_	T18<	24	
>	T0A<	10	FCT/>	T1A<	26	
ENT	T0D<	13	FCT/ENT	T1D<	29	

After each key pressure, the keyboard is blocked and is only released again for the next key pressure after the transmission of 'Q' CR. This is necessary to avoid any unpredictable actions and reactions between the instrument and the on-board PC.

11.6.10 Graphics Commands

Graphics commands entered on the external computer are only effective in the terminal mode. They are answered with 'Q' CR or, in the case of an error, with 'E' CR.

- The screen size is 240*38 pixels.
- The origin of the pixel coordinate system is located in the upper left corner of the display.
- Entries of pixel values higher than 239 in x and higher than 37 in y are set to 239 and 37 respectively.
- Negative pixel values or values higher than 255, are acknowledged with 'E'.
- All character positions have 2 digits, all pixel positions have 3 digits. Leading zeroes must be set.
- The default character set uses 5*7 Pixel, the smaller type font 5*5 pixels per character.
- When the instrument is switched on, the pixel size is set to 5*7.
- To ensure that the complete graphic information is displayed immediately after transmission of the appropriate graphics command, GSO' should be sent before the first transmission of any graphics command.

Command	Response
G5O<	Activation of 5 pixel character height
G5F<	Deactivation of 5 pixel character height
GIO<	Display of characters in negative type

GIF<	Display of normal characters
GBO<	Activation of acoustic signal
GBF<	Deactivation of acoustic signal
GBL<	Generation of a long BEEP
GBS<	Generation of a long BEEP
GDC<	Deletion of the display
GSO<	Activation of immediate display, everything is displayed directly after the entry
GSF<	Deactivation of immediate display, everything is displayed after GDO
GDO<	Display of previously entered character strings
GXY(xxxlyyy)<	Setting the text pointer
GPR(TEXT)<	TEXT display in the position defined by GXY. Text pointer is positioned after the last character.
GCC<	Deletion of the cursor
GCS(xxxlyyy)<	Setting the cursor to pixel position, the pevious cursor is deleted
GCL<	Setting the cursor 1 digit to the left
GCL(xx)<	Setting the cursor xx digits to the left
GCR<	Setting the cursor 1 digit to the right
GCR(xx)<	Setting the cursor xx digits to the right
GCB(xx)<	Setting the cursor xx digits to the left and deletion of the digits crossed by the cursor
GTC(TEXT)<	TEXT display starting at the defined cursor position; cursor is positioned after the last character, text pointer remains unchanged

Command	**Response**
GPS(xxxlyyy)<	Setting a pixel
GPC(xxxlyyy)<	Deletion of a pixel
GFG(n)<	Moving a pixel from the GXY-defined position by one digit through an angle of (n-1)*50 grads, (n=1-8)
GHL<	Display of a heading line
GHL(TEXT)<	TEXT display in a heading line
GFR(xxxlyyyllllhhh)<	Frame from the lower left corner with length l and height h
GLV(xxxlyyyllll)<	Straight line upward
GLR(xxxlyyyllll)<	Straight line upward and to the right
GLH(xxxlyyyllll)<	Straight line to the right
GLF(xxxlyyyllll)<	Straight line to the right and downward
GKY(xxxlyyy)<	Menu hook, the position is stored for the text pointer and can be used for GPR
GSW<	Deletion of the display and display of an hour-glass
GFU(aaal...ljjj)<	Setting of 10 function keys
GFU()<	Deletion of all function keys
GSR<	Saving the current display
GSV<	Saving the current display and deletion of the entire screen
GHO<	Restoring the current display
GSU<	Saving and deletion of the lower half of the screen
GSH<	Restoring the lower half of the screen
GF1(xxxlyyy)<	Display of D

GF2(xxxlyyy)<	Hz tracking and display
GF3(xxxlyyy)<	V tracking and display
GF6(xxxlyyy)<	Hz/V tracking and display
GF7(xxxlyyy)<	Hz/V tracking and display of D/Hz/V
GAF<	Deactivation of the tracking display
GAO<	Activation of the tracking display
GF0<	End of tracking, deletion of the display line for GF6 or GF7

11.7 List of all Type Identifiers

The following table gives an overview of the type identifiers included in the data records described above. The type identifiers always comprise two digits, the second digit being usually a blank.

TI	Meaning	Digits after Decimal Point
a, o	Helmert transformation parameters	6
ep	Rotation of Helmert transformation	6
c	Collimation correction	3, 4, 5
dl	Longitudinal residual	2, 3, 4
dq	Transverse residual	2, 3, 4
dr	Radial deviation in setting out	2, 3, 4
Ri	Angle to approximate point	3, 4, 5
dx, dn	Residual in X direction	2, 3, 4
dy, de	Residual in Y direction	2, 3, 4
dz	Residual in Z (height)	2, 3, 4
dX, dN	Residual in Helmert transformation	2, 3, 4
dY, dE	Residual in Helmert transformation	2, 3, 4
h	Height difference	2, 3, 4
i	Index correction	3, 4, 5
ih	Instrument height	2, 3, 4
m	Scale (e.g. stationing)	6
mx, mn	Mean error in X	2, 3, 4
my, me	Mean error in Y	2, 3, 4
mz	Mean error in Z	2, 3, 4
m0	Mean point error in Helmert	2, 3, 4
pa	Parallel distance in 3-D plane	2, 3, 4
Si	Sigma in 3-D plane	3
pr	Weighting of bearings	3, 4, 5
ps	Weighting of distances	2, 3, 4
th	Target or reflector height	2, 3, 4
A	Addition constant	2, 3, 4
SD	Slope distance	2, 3, 4
E	Horizontal distance	2, 3, 4
Fl	Area	2
dF	Difference of nominal/actual area	2
np	Number of area corner points	0
nK	Number of circle segments	0
pF	Deviation of area in %	2
Hz	Bearing	3, 4, 5
HV	Hz rotation	3, 4, 5
NK	Compensator reading, transverse	3, 4, 5
NZ	Compensator reading, sighting direction	3, 4, 5
O	Transverse distance (indirect height determination)	2, 3, 4
Om	Orientation (stationing)	3, 4, 5

TI	Meaning	Digits after Decimal Point
P	Air pressure	
	• hPa/mb	0
	• Torr	0
	• InMerc	1
PI	Point identification	0
PR	Projection reduction	6
mY	Mean easting in km for PR	
mH	Mean height in m for PR	
Ps	Point identification of station	0
Pz	Point identification of target	0
Ri	Angle to approximate point	3, 4, 5
Ra	Radial deviation	2, 3, 4
SK	Compensator run center: component in trunnion axis direction	3, 4, 5
SZ	Compensator run center: component in line of sight direction	3, 4, 5
To	Hidden point : upper reflector	2, 3, 4
Tu	Hidden point : lower reflector	2, 3, 4
ds	Tolerance of hidden point	
T	Type of target eccentricity	2, 3, 4
	• Tv: in front of	
	• Tl: left of	
	• Th: behind the center	
	• Tr: right of	
	• Ts: spatial relative to	
	The eccentricity amount is stored in the associated value	
TI	Information line	0
TG	Text in instrument status	0
T_	Temperature in degrees Celsius / Fahrenheit	0
V	Vertical angle	3, 4, 5
	• V1 zenith angle	
	• V2 vertical angle	
	• V3 height angle	
	• V4 slope in %	
X, x, N_, n	Northing coordinates	2, 3, 4
Y, y, E_, e	Easting coordinates	2, 3, 4
Z	Height with selection: E = easting, N = northing	2, 3, 4
Z_	Barometric height	0

11.8 Carl Zeiss Data Transfer Programs

Data transfer programs from Carl Zeiss are available for various computer types:

Computer	Name	Language	Cat. No.
DOS-comp. PC	RECPCD	German	708044
	RECPCE	English	708045
Siemens MX-Series	CZMX	German	708058
VAX/MicroVAX	REC500VAX	English	708059

For more information, please consult the current price list.

11.9 Connection to Office Software

After data transmission, the field survey data is available in an ASCII file in the office computer, e.g. a PC. A generally accepted data interchange format - such as the DXF format for CAD systems or the RINEX format in the GPS world - does not yet exist for field survey systems. Therefore, the data usually needs to be converted from the manufacturer's format (in this case the Rec 500 or Rec E formats) into the user format required.
This is the approach used by most leading software companies operating on a national and international level. Carl Zeiss offers the CZCONVE.EXE program for this purpose, which converts data between the Zeiss formats.

In external conversion programs, the process is usually performed in two steps:

(1) Only the information of interest for further processing is filtered from the data records.

(2) The selected information is grouped in such a way that it can be recognized and processed by the subsequent software.

The search criteria for the filtering process are the type identifiers of the Carl Zeiss. data records. To select all coordinate records of a measurement, for example, a check is made after reading a record from the source file as to whether the type identifiers Y, X, Z actually exist at the appropriate positions of the data string. If not, the next record is read. If yes, the data string is rearranged as required and stored in the destination file.

A similar process is used if only the original measured data SD, Hz, V or Hz, V or other data types is to be transmitted. In this case, it may be necessary to assign e.g. the target height, addition constant, temperature, air pressure etc. to each record. These parameters are stored in the source file either at the beginning of a new program section or whenever they have been changed. In the data conversion program, such records can then also be recognized by their type identifiers and can be stored and added to the subsequent records of measured data in the format required. If a new data line with the relevant parameters is detected in the source file, these new values are assigned to the subsequent measured data.

Illustrations:

Annex

A 1 Formulae

A 1.1 Correction and Computation Formulae for Angle Measurement

❑ **V angle measurement**

$$V_k = V_0 + i + SZ_a$$

where:

V_0 = uncorrected V circle reading
i = index correction
SZ_a = current vertical axis inclination in the sighting direction

❑ **Hz bearing measurement**

$$Hz_k = Hz_0 + Hz_1 + A$$

where:

Hz_0 = uncorrected Hz circle reading
Hz_1 = c/sin(Vk) - collimation correction
A = circle adjustment for orientation, e.g. Hz setting

A 1.2 Basic Formula for Distance Measurement

The following basic components are used for the computation of all distances:

$$D_k = (D_0 + D_i + A) * M_i$$

where:

D_k = corrected distance
D_0 = uncorrected distance
D_i = internal corrections
A = addition constant
M_i = influence of meteorological data

The influence of the meteorological data M_i is computed as follows:

$$M_i = (1 + (n_0 - n) * 10^{-6}) * (1 + (a * T * T) * 10^{-6})$$

where:

n = (79.146 * P) / (272.479 + T) = current refractive index
n_0 = 255 = reference refractive index
P = air pressure in hPa or mbar
T = temperature in degrees Celsius
a = 0.001 = coefficient for vapour pressure correction

carrier wavelength	0.86 microns
modulation wavelength	20 m
precision scale	10 m

A 1.3 Computation of Distances and Reduction in Rec Elta®

The slope distance displayed in the Rec Elta® is the distance between the instrument's trunnion axis and the prism. It is computed from the measured slope distance and the entered scale:

$$D = D_k * M$$

where:

D	=	displayed slope distance
D_k	=	basic distance according to 1.2
M	=	scale

The height difference and the horizontal distance are computed as follows:

$$dh = dh_1 + dh_2$$

where:

dh_1	=	$Dk * \cos(Z)$
dh_2	=	$(Dk * \sin(Z)) * (Dk * \sin(Z)) * 6.8 * 10^{-8}$ influence of earth curvature and refraction (k = 0.13)

$$E = (E_1 + E_2) * M$$

where:

E_1	=	$D_k * \sin(Z + R)$	
R	=	$6.5 * 10^{-7} * D_k * \sin(Z)$	influence of refraction
E_2	=	$-1.57\ 10^{-7} * dh * D_k * \sin(Z)$	influence of earth curvature

with:

D_k	=	corrected slope distance
Z	=	measured zenith angle [grads]
M	=	scale
dh	=	computed difference in elevation
E	=	computed horizontal distance

Scale computation for reduction to MSL:

m	=	R / (R + h)	R	=	earth radius (6370 Km)
			h	=	elevation above MSL (Km)
S_2	=	S_1 * m	S_1	=	distance measured at elevation h
			S_2	=	reduced distance at MSL

This computation formula applies to all earth radii.

Note:
If a scale is computed in connection with a stationing routine, the preceding entry of a projection scale **PR** ensures that any effects of network tensions and measurement tolerances are clearly separated from the projection effect (e.g. Gauß-Krüger).

A 1.4 Testing the Rec Elta® on Calibrated Distances

All measured distances are corrected in the Rec Elta® for:

- the entered scale (see **INPUT** program)
- the entered addition constant (see **INPUT** program)
- projection reduction (see **PROJECTION RED.** program)
- the influence of pressure and temperature (see **INPUT** program)
- internal influences

The current values of the parameters scale, addition constant, pressure and temperature must therefore be entered in the Rec Elta® prior to the performance of the calibration measurement. The value to be used for projection reduction is usually 1.000000, as the test distances are normally not referred to MSL. These entries ensure that all corrections are completely and correctly applied in the Rec Elta®, and also permit a direct actual/nominal comparison on specified distances.
For an external correction of the atmospheric influences, set the temperature to 20°C and the air pressure to 944 hPa in the Rec Elta®. The internal correction then becomes zero.
For a Rec Elta® frequency test by measurement of the frequency in the sighting beam, the following should be noted:
If the ambient temperature of the Rec Elta® differs from the calibration temperature of 20°C, the emitted frequency no longer corresponds to the nominal frequency of 14 985 800 Hz. The Rec Elta® applies the resulting difference as a computational correction to all measured distances.

A 1.5 Prism and Addition Constants

All Zeiss distance meters have been matched to the Zeiss reflectors in such a way that the addition constant is 0.
If reflectors from other manufacturers are used, any existing addition constant can be determined by measurement and entered in the Rec Elta®.
Alternatively, the addition constant can be computed from the known prism constant of the reflector used and can then be entered in the Rec Elta®. The prism constant is computed on the basis of the geometrical size of the prism, the type of glass and the position of the mechanical reference point. The prism constant determined by this method for Zeiss reflectors is **35 mm.**
The following correlation exists between the addition constant Acz for Zeiss instruments, the prism constant Pcz for Zeiss reflectors and the prism constant Pf for reflectors from other manufacturers:

$$A_{cz} = P_{cz} - P_f$$

Example:

Zeiss reflector	prism constant	P_{cz}	= 35 mm
Other reflector	prism constant	P_f	= 30 mm

Addition constant for Zeiss instruments in combination with this other reflector

$$A_{cz} = +5 \text{ mm}$$

Either the prism constant of 30 mm or the addition constant of + 0.005 m can be set on the Rec Elta® in this case (see **INP** input menu).

A 2 List of Softkeys

The table below gives a brief overview of all softkeys. For details, please see the relevant chapters on the programs. Basically, 3 types of softkey can be distinguished:

(1) Softkeys triggering a function with or without return to the initial mode.

(2) Softkeys indicating a switch status, with the option of changing the switch setting.

(3) Softkeys indicating the previous or the next status (modes HzV/DHzV/EHzh/YXZ in MEASURE only).

❑ Alphabetic Order

Softkey	Function
A→A	Deletion, transfer or applying an additional code from address i to address j:
Adr	Deletion or transfer of or applying an additional code to a specific address
?Ad	Search for an address in the memory
All	Deletion or transfer of or applying an additional code to all data lines
Bat	Display of the battery capacity
ClC	Deletion of the point code within the point identification
Cll	Deletion of the additional information within the point identification (P.I.)
Crs	Setting a cursor
D:N,D:L,D:R	Selection of the distance meter measuring mode
dlq, dxy, drR	Saving deviations in the longitudinal and transverse directions, coordinate differences, angle to the approximate point.
YXZ, ALL	Saving nominal coordinates or all elements
DTh, Th	Switch for changing the measuring mode from D-Hz-V to Hz-V
Edt	Editing data lines in the editor
Ecc	Entry of an eccentricity
Sta	Display and optional storage of the current instrument status (units, input data, corr. for instr. errors)
HzV, DHz	
Ehz, YXZ	Measuring modes in the MEASURE program
Inf	Entry of an information line
Ino, Ion	Switch for point number incrementation
Inp	Entry of coordinate sets/polar elements
CSp	Change from the input menu to compensator run center determination, with subsequent return
Con, Cno	Switch for compensation
LAd	Display of the last address. Deletion or transfer of last address only
Mrk	Scrolling a predefined table with marks for supporting the P.I. entry

Softkey	Function
M/P	Changing the measuring mode for 3-D plane
Ono, Oon	Object height measurement
P-B	Setting a point number block
PE→	Incrementing the point number
PE←	Decrementing the point number
Pt.	Deletion or transfer of a specific point number
?Pt	Search for a point number in the memory
↓?	Continued search
P→P, 1→P	Switch for type of connecting distance
P→P	Deletion or transfer from point number i to point number j
?Pl	Search in the memory for lines with a specific partial point identification
	Deletion or transfer of all lines with a specific partial point identification
Rno, R-M	
R-C, RMC	Switch for recording
Set	Setting a direction
Spc	Setting a blank
Del	Deletion of data lines. Deletion of the last recording in Mem
Tab	Setting a tab stop
Tno, Ton	Tracking mode for distance measurement
ACd	Applying an additional code to a number of data lines in the editor
→2, 1→	Calling up the next (preceding) softkey line
-■-	Dummy variable
-◆-	Wildcard

A 3 *Rec Elta*® *Technical Data*

	Rec Elta® 13	Rec Elta® 15
Accuracy as per DIN 18723		
Horizontal angle measurement	0.5 mgrad/1.5"	1.0 mgrad /3.0"
Vertical angle measurement	0.5 mgrad /1.5"	1.0 mgrad /3.0"
Distance measurement	2 mm+2 ppm	3 mm+2 ppm
Telescope		
Aperture	45 mm	35 mm
Length	170 mm	170 mm
Field of view at 100 m	2.6 m	3.3 m
Shortest sighting distance	1.7 m	1.9 m
Magnification	30 x	22 x
Angle measurement		
Hz and V circles	electronic, incremental, zero encoder for V and Hz	
Measuring units	360° (DMS), 360° (DEG), 400 grads, 6400 mils	
Vertical reference systems	Zenitn angle, height angle, vertical angle, slope in percent	
Resolution	0.2 mgrad/0.6" selectable	
Compensator		
Type	dual-axis	dual-axis
Range	± 2' 40" bzw. 48.0 mgrad	
Distance measurement		
Method	electro-optical, modulated infrared light	
Transmitter/receiver optics	coaxial, in telescope	
Measuring range		
with 1 prism	2.0 km	1.5 km
with 3 prisms	2.5 km	2.0 km
Measuring time		
Standard	2.0 seconds	
Tracking	less than 1 second	
Levelling		
Circular level	10'/2 mm on tribrach	
Tubular level	30"/2mm	
Clamps and tangent screws	coaxial, with parallel axes	
Centering		
	Zeiss centering system Wild centering system	
Optical plummet		
Magnification	2x	
Shortest sighting distance	0.5 m	
Display screen		
	4 lines with 40 characters each, full graphic capabilities (240 x 8 pixels), type sizes of 5 x 5 and 5 x 7 pixels, normal and negative type fonts, automatic contrast adjustment	

	Rec Elta® 13 / Rec Elta® 15
Keyboard	
	2 rows with 12 keys each for instrument control, numeric and alphanumeric entry, direct assignment of 10 keys to the bottom line of the display as variable softkeys
Recording	
Internal MEM (in C version only)	non-volatile memory, data security for a minimum of 1 year, capacity 1200 data lines
PCMCIA card	SRAM, FLASH 0.5, 1.2 MB
External	via RS 232 C/V 24
On-board programs	
	Stationing on a known or unknown point (up to 20 points), height stationing (up to 20 points), determination of coordinates in the local or national system, setting out using coordinates or bearing and distance, area computation, point-to-line distance, connecting distance determination, concealed point, convenient search and editing functions
Program control	
	via keyboard and display, user guidance via menus, terminal mode
Interface	
	RS 232 C/V 24 on the instrument or via slip ring
Power supply	
Rec Elta® C	NiCd battery pack, 4.8 V, 2.0 Ah, approx 6-8 hrs
Rec Elta® CM/CMS	NiCd battery pack, 6 V, 7.0 Ah, approx 6 hrs of angle and distance measurement, external via slip ring with 6.0 V, 7.0 Ah
Temperature range	- 20 °C to + 50 °C
Dimensions	
W / H / D	232 x 270 x 182 mm
Trunnion axis height	158 mm (DIN centering spigot) 196 mm (WILD centering)
Weights	
Instrument incl. batt. C version	5.2 kg
Instrument CM version	6.0 kg
Instrument CMS version	6.3 kg
Case	2.5 kg

A 4 Error Displays

The following error messages may appear in the display:

BATTERY EMPTY	Charge condition of the battery is not sufficient. Change or charge battery.
Error 01	ROM error
Error 02	RAM error
Error 03	NV-RAM error
Error 04	NV-RAM error
Error 05	NV-RAM error
Error 06	NV-RAM error
Error 40	Error in distance meter
Error 41	Error in distance meter
Error 42	Error in distance meter
Error 43	Error in distance meter
Error 44	Error in distance meter
Error 47	Error in distance meter
Error 50	Error in distance meter
Error 51	Error in distance meter
Error 52	Error in distance meter
Error 53	Error in distance meter
Error 54	Error in distance meter
Error 60	Error in V measuring system
Error 61	Error in V measuring system
Error 80	Compensator error
Error 81	Data transmission error
Error 82	Data transmission error

If errors 01 - 06 occur, call the service.

Errors with number 40 and higher can usually be eliminated with **ENT**. If the error display appears constantly, call the service.

☞ **If the instrument no longer responds to key pressure in any of the operating modes, it can be shut off by disconnecting it from the power supply.**

Further messages:

Error 202	Compensator range exceeded
Error 203	Inclination range exceeded
Error 205	Limit value exceeded
Error 230	Termination of measurement
Error 231	Termination of automatic sighting
Error 232	Termination of prism search
Error 240	Point number overflow
Error 4xx	Error in storage
Error 480	File is empty
Error 4MV	File is is full
Error 490	No PCMCIA card inserted
Error 491	PCMCIA card is write-protected
Error 492	PCMCIA card exchanged
Error 501 - 509	Error in the control and display unit (call service)
Error 550	Termination of dialog with PC
Error 581	I - O receiving error (PARITY, FRAMING,OVERRUN)
Error 584	TIME - OUT, no CTS/XON
Error 585	TIME OUT in data transmission
Error 586	Error in opening of dialog (software dialog only)
Error 587	TIME OUT in data reception
Error 588	Dialog error
Error 589	Format error in data string from computer
Error 590	Faulty character in data string from computer
Error 591	Non-alphanum. characters in PID
Error 593	No decimal points in data string
Error 595	I - O format error
Error 599	Data transmission aborted by computer
Error 621	Setting-out point = station
Error 622	Setting out to be performed in position 1
Error 623	Record includes no coordinates
Error 624	Record includes no E/Hz values
Error 625	Backsight point = station
Error 626	Scale out of tolerance
Error 627	Coordinates of station and point I are identical
Error 628	Point P1 = P2
Error 629	Error in backsight points
Error 630	Record includes no reference height
Error 631	Hz setting to be performed in position 1
Error 632	Identical backsight points
Error 633	Point(s) deleted, additional measurement(s)
Error 634	No distance measured
Error 636	Tolerance exceeded
Error 637	Measurement to be performed in position 1

Error 638	No control point available
Error 640	Reaching maximum point number
Error 641	Area computation not possible
Error 642	Parameter determination not possible
Error 643	Points in the plane are identical
Error 660	Key blocked in this configuration
Error 661	Motor key blocked! Eccentricity has been set
Error 709	I2C Bus is open, call service
Error 710	Controller error, call service
Error 711	Error in control PCB, call service
Error 712	Axis does not reach sighting position
Error 713	Automatic sighting not possible
Error 714	Compensator not ready
Error 715	Prism not found
Error 721	Hz axis blocked
Error 722	V axis blocked

A 5 Measurement Preparation

A 5.1 Transportation

Switch off the instrument for transportation and protect it against heavy shocks and sudden temperature changes.

- Short distances: instrument on tripod
- Longer distances: instrument in its case

Allow sufficient time for the instrument to adjust to the ambient temperature. A difference in temperature of 1° C requires 1 minute of adjustment.

A 5.2 Setting up the Instrument

Extend the tripod legs to a convenient height and firmly tighten the tripod clamps. Secure the instrument at the center of the tripod head plate; the tribrach screws should be in mid-position.

❑ **Centering and levelling:**

Set up the tripod roughly above the ground mark and slightly push the tripod legs into the ground; the tripod head plate should be approximately horizontal.

- Coarse centering:
  - Center the circular mark of the optical plummet (22) above the ground mark using the tribrach screws (19) .
  - To focus the circular mark, turn the eyepiece.
  - To focus the ground mark, draw out or push in the eyepiece of the optical plummet.

- Coarse levelling:
  - Center the circular level by varying the length of the tripod legs.

- Precision levelling:
  Center the tubular level by determination of the run center..
  Run center determination:
  - Align the axis of the tubular level parallel with the connecting line between twotwo tribrach screws,
  - use these two tribrach screws to center the level
  - turn the instrument through 180 ° or 200 grads,
  - eliminate one half of the departure of the bubble level from the center by means f the tribrach screws (run center),
  - turn the instrument through 90° or 100 grads and adjust the level to the run center using the third tribrach screw,
  - turn the instrument about the vertical axis; the run center must remain stable in this process, otherwise repeat the run center determination.

- Precision centering:
  - Shift the tribrach on the tripod head until the image of the ground mark is in coincidence with the circular mark of the optical plummet. Tighten the clamping screw (25) of the tribrach.
  - If necessary, repeat the precision levelling and precision centering processes until the tubular level always returns to its initial position after rotation of the instrument and the ground mark remains constantly inside the circular mark.

❑ **Humid weather and rain:**

- Protect the instrument with the plastic cover during prolonged breaks.
- Wipe the instrument with an absorbent cloth and let it dry completely in a warm room , with the case open.

❑ **Sun:**

- In intense sun radiation, place the instrument under a field umbrella for measurement.

A 5.3 Telescope Focussing and Sighting

❑ **Focussing the crosslines:**

- sight a bright, evenly coloured surface (sky, white paper),
- turn the eyepiece (9) until the line pattern is sharply defined.

❑ **Focussing the target point:**

- Turn the focussing control (7) until the target point is sharply defined.
  - Checking for parallax:
    If you slightly move your head in front of the eyepiece, there must be no relative movement between the crosslines and the target; otherwise, check the focussing.

☞ **Sighting of the sun or strong light sources must by all means be avoided. This may cause irreparable damage to your eyes.**

A 6 Power Supply

A 6.1 Instructions for Use of the LG 91 High-speed Battery Charger

The Rec Elta® C total stations are powered by the NiCd batteries (70 81 55, 4.8 V, 2.0 Ah) which can be recharged with the LG 91 battery charger (70 81 50 - 9912/13). For Rec Elta® CM/CMS, you use the external battery 708145-9901 and the LG 20 battery charger (70 81 00).

☐ **Note the following instructions before starting the charging process (to ensure optimum battery service life):**

- Protect the LG 91 against humidity.
- When charging is started, the temperature of the battery must not be less than +10°C and higher than 35°C.
- A battery heated up by charging should not immediately be charged again; wait until it is lukewarm (35°C).
- Before the first use, check the voltage setting of the slide switch on the underside of the LG 91. It can be set to 115 V and 230 V mains voltage.

☐ **Charging process**

- Insert the battery cassette in the recess of the LG 91 and fasten it with screws.
- Connect the LG 91 to the mains.
- The red pilot lamp indicates that the chage current is flowing.
- Charging of an empty 2.0 Ah battery takes approx. 3 to 3.5 hours.
- After power failure in the mains. the LG 91 automatically resumes charging; the overall charging time of approx. 3 hours is not exceeded.

☐ **End of charging process**

- Flashing of the red pilot lamp indicates the end of the charging process.
- A trickle current continues to flow.
- Batteries cannot be overcharged.

☐ **Technical data**

- Input: 230 V or 115 V ± 10 % A.C.
- Output: 4.8 V, 1800 mA D.C.

A 6.2 Instructions for External Power Supply from a Car Battery

The external power pack for Rec Elta® comprises a DC/DC converter (mobile power adapter CPA 20 WR 05) which converts the voltage of the car battery from 12V to 6V. The plug for connection to the cigarette lighter is a standard plug which fits into all normal car cigarette lighters. At the other end, an 8-pin circular plug is provided for connection to a Rec Elta®.

❑ **Fusing:**

The converter is protected at its input by a 5A fuse (slow-blow fuse) which is installed in the cigarette lighter plug and is accessible by simply removing the pin.

The pin of the cigarette lighter plug is the positive pole (+), the lateral contacts must be connected with the negative pole (vehicle chassis).
The converter is protected against confusion of the poles. To reliably avoid any damage, however, the polarity in the car should be checked beforehand.

❑ **Accessories:**

When using the converter, replace the battery pack on the Rec Elta® by a balancing weight, cat. no. 708186 - 9500.

The cable length of the DC/DC converter totals 1.6 m. Since this is usually not sufficient to connect the cigarette lighter in the car with the socket on the Rec Elta® without obstructing measurement, Zeiss offers two additional cables:

1. Combined power/data cable for Rec Elta® (70 81 77 - 9350) with:
   - 8-pin circular plug for Rec Elta®,
   - 25-pin connector (female) for Rec 500,
   - 8-ping circular plug for power supply (DC/DC converter), total cable length 1.6m.

One end of this cable is plugged into the Rec Elta®. At the other end, two plugs are provided, a circular plug for power supply and a 25-pin plug for data output, used here for Rec 500.

2. Extension cable for power supply (70 81 77 - 9360), 8-pin plugs at both ends, 10 m long.

A 7 Alignment

A 7.1 Eliminating the Collimation Error

A collimation error exists if the line of sight of the telescope is not perpendicular to the tilting axis of the telescope. This error affects angle measurement performed only in one telescope position.

The error is usually measured in the **ADJUST** program and is then automatically taken into account if it does not exceed ± 2'40".

If it exceeds ± 2'40", set the collimation correction in the **ADJUST** program to 0 and adjust the telescope reticle manually.

For this, remove the ring cap (6), sight a well-defined target with an approximately level line of sight in both telescope positions, and determine the corresponding directions in the HZ-V mode of the **MEASURE** program. Average the directions and set the average with the Hz tangent screw. Then use the adjustment screws to shift the reticle until it is in coincidence with the target again.

Before tightening an adjustment screw, loosen the opposite one. Make sure that both adjustment screws are tightened after completion of the alignment.

☞ **Do not change the alignment in the vertical direction. Mechanical elimination of the index error can only be performed by the service staff.**

A 7.2 Aligning the Alidade Level

An absolutely stable setup of the instrument is essential here, i.e. make sure the instrument is fastened in the tribrach with the clamp and the tribrach is secured on a stable tripod with screw (25).

For the alignment, turn the instrument in such a way that the alidade level (11) is parallel to the line connecting two footscrews. Center the bubble using one of the two footscrews.

Then turn the instrument through a right angle so that the level points to the third footscrew. Use this footscrew to center the level as precisely as possible.

Turn the instrument in the opposite direction, and eliminate one half of the bubble error with the third footscrew and the other half with the level adjustment screw.

❑ **Note the following for alignment:**

- Avoid any one-sided heating of the level.
- Before tightening an adjustment screw, loosen the opposite adjustment screw.
- After completion of the alignment, both adjustment screws must be firmly tightened.
- After the alignment, the level must be properly centered in any sighting direction of the instrumetn.

Align the alidade level with utmost care and regularly check the alignment.

A 7.3 Aligning the Optical Plummet

Optical plummets are either installed in the vertical axis of the instrument or mounted on the tribrach (EWL type), or they are available as insertion plummets with a vertical eyepiece for ground points (V or VW), with a horizontal eyepiece (NZ or NW) or for ground and roof points (NZ or NZW).

The line of sight of the optical plummet is the optical extension of the vertical axis.

The optical plummets in the instrument and those for insertion in the tribrach require the same alignment procedure and are identical with regard to testing and realignment.

First check the levels, see section 3.4. Then shift the reticle in the plummet telescope using the adjustment screws until the image of the same target point remains centered when the plummet in the vertical axis is reversed through 180°.

If you use an optical plummet permanently mounted on the tribrach, you can determine the nominal lighe of sight by means of the plumb bob. You can also turn the complete tribrach on the tripod head through 2 x 120° , depending on the shape of its base plate. Mark the initial position on the tripod head to ensure that the center of the tribrach can be returned to the same position after the rotation. Level again after the rotation.

A 7.4 Aligning the Levels on Accessories

Levels are used to align instruments or instrument components in relation to the direction of gravity, e.g.:

- Vertical alignment of vertical axes
- Vertical alignment of optical plummet line of sight
- Horizontal alignment of centering systems
- Horizontal alingment of telescope line of sight
- Vertical alignment of prism staffs

Checking the alignment and its correction are extremely easy with levels mounted on a tribrach, with tubular and circular levels of instruments and with insertion plummets. After precise centering of the bubble using the scale or centering circle of the level, and 180° rotation in the vertical axis, the bubble error amounts to twice the alignment error. Eliminate half the error using the level adjustment screws and the residual error using the tribrach levelling screws.

The circular level on the centering rod can also be "reversed" and can be checked and aligned as described. Instead of adjusting the tilt with the tribrach screws, align the perpendicular position of the centering rod by shifting the tribrach on the tripod head.

A 8.2 Catalog Numbers

❑ Power Supply

708155	Battery pack 4.8V, 2.0 Ah
708146-9901	External battery 6 V, 7 Ah
708150-9912/13	LG 91 battery charger 90-120V,185-264V, 50/60Hz for 708151 - 52 -54 and 55
708100	LG 20 battery charger for 708146-9901
708157 - 9360	Extension cable for power supply, 10 m long, 8-pin plugs at both ends
708177 - 9350	Combined power and data cable for Elta/ RecElta® with 8 - pin circular plug for Elta/Rec Elta 25 - pin connector for Rec 500 8 - pin circular plug for power supply, 1.6 m long
708186 - 9500	Battery cassette with balancing weight for use with external power supply

❑ Tripods

707227	S 27 tripod
707270	Prism staff with graduation
707287	Extension (1m) for prism staff
707288	Tripod for prism staff
706128	Centering and height measuring rod (height-invariant)

❑ Tribrachs

707125	ED tribrach for Zeiss centering system
701725/9001	ED tribrach for centering rod
707126	EW tribrach for Wild centering system
707127	EWL tribrach with attached optical plummet

❑ Optical plummets

706137	V optical plummet for ground points, vertical eyepiece, for insertion in ED tribrach
706138 - 9901	N optical plummet for ground points, horizontal eyepiece, for insertion in ED tribrach
706139 - 9901	NZ optical plummet for ground and roof points, horizontal eyepiece, (in ED tribrach)
706141	VW optical plummet for ground points, vertical eyepiece, for insertion in EW tribrach
706142	NW optical plummet for ground points, horizontal eyepiece, for insertion in EW tribrach
706143	NZW optical plummet for ground and roof points, horizontal eyepiece (EW tribrach)

☐ Sighting targets

706704	Sighting target for Zeiss centering system
706705	Sighting target E
706706	Sighting target for use on KTR 1
706814	Sighting target E with adapter for use in Zeiss centering system
706815	Sighting target E with adapter for use in Wild centering system

☐ Reflectors

706765	KTR 1 N reflector, tiltable (incl. 1 prism) for mounting on prism staff 707286, extension 707287 or center spigot 706767 or Wild adapter 704538
706767	Adapter for insertion of KTR 1 in tribrachs with Zeiss centering system
704538	Adapter for insertion of KTR in tribrachs with Wild centering system
706762	ETR 1 N reflector, rigid (incl. 1 prism) for mounting on prism staff 707286 or extension 707287
706763	ETR 1 S reflector, rigid (incl. 1 prism) for mounting on prism staff 707286 or extension 707287
706824	Corner sighting reflector, complete, comprising: ETR 1 N, corner sighting staff and sighting collimator
706769	T 3 crossbeam for extending KTR 1 into a triple reflector
706770	T 7 crossbeam for extending KTR 1 into a 7x reflector
706816	T 19 crossbeam for extending KTR 1 into a 19x reflector

☐ Special accessories

708186 - 9100	Slip ring option
704116	Ninety-degree eyepiece
704105 - 9901	Zenith eyepiece F
704137	Objective filter for sun observation
706334	Reticle illumination (for sighting reflectors in adverse light conditions)
706776	ETR 1 adapter 106 mm for mounting ETR 1 on prism staff 707281 (not included in E Series)
707264	KTR 1 adapter 6 mm for mounting KTR 1 on prism staff 707281 (not included in E Series)
706768	Adapter 181 mm for mounting KTR 1 in Zeiss tribrach system

☐ Cases

709617	Accessory case accommodating: two ED or EW tribrachs, two adapters for DIN or Wild centering system, three KTR 1 reflectors, four ETR reflectors, two T 3 crossbeams, one T 7 cross beam
708566	Case for Rec Elta

The level on the tribrach which cannot be "reversed" can be aligned after a device with a vertical axis has been inserted in the centering system. When the level of this device is centered, eliminate the complete bubble error of the tribrach level using its adjustment screws.

The circular level on the prism staff can be checked and aligned after the staff has been vertically aligned by different means, e.g. by setting up the staff in a tripod or by using a plumb bob or theodolite for perpendicular alignment.

If a staff tripod with three legs is available "alignment by reversal" as described above is possible by rotation in the tripod.

A telescope level can be aligned by vertical circle readings and circle setting. This must be preceded by the determination of the vertical index error. If the V circle readings obtained by sighting the same target in telescope positions I and II add up to precisely 360°, the telescope line of sight is horizontal for the V circle reading of 90° and the telescope level is centered; otherwise center it on the scale using its adjustment screws.

A 8 Accessories

A 8.1 Description

The entire system features an identical height of the trunnion axes above the supporting surface of the tribrach:

- 158 mm with DIN center spigot
- 196 mm with Wild centering system

The height of the trunnion axes of KTR or the sighting target above the mounting surface is 100 mm.

❑ Tripod

The S 25 tripod (cat. no. 70 72 25) is supplied with the instrument.

During use, make sure that its wooden parts are tight; the upper joints and the tips are fitted with adjustable screws.

The friction of the leg joints can also be adjusted using the 6 hex socket screws directly below the axes. When you lift the tripod by its head, the legs should fold together slowly.

❑ Tribrach

The equipment includes the ED or EW tribrach. The only different between them is the centering system: DIN center spigot (ED) or Wild centering system (EW).

The footscrews are self-adjusting, i.e. adjustment is not required. The circular level can be aligned using two capstan screws, see section 3.4.

❑ Reflectors

The reflectors for distance measurement have been designed on a modular principle.

❑ Prism staff

The prism staff for setting up tiltable reflectors features an adapter. The 5/8" threaded top of the telescopic staff with graduation can be removed and turned. Then an M 8 thread for a non-tiltable reflector is available at the top.

In both cases, the graduation indicates the height of the prism above the staff tip. The extension can be screwed in between the telescopic staff and the adapter. One meter then has to be added to the height read from the scale.

The removable top of the prism staff also permits attaching an extension at the lower end of the prism staff.

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