Rec Elta® RL-S

Total Station for Reflectorless Measurement

Operating Instructions

SURVEYORS-EXPRESS™

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ZEISS

Contents:

Appendix

Introduction

This manual describes the use of the Rec Elta RL Electronic Tacheometer from Carl Zeiss. The most conspicuous peculiarity of this instrument type is that you are able to measure with as well as without reflector.

Chapter 1 describes the mode functions of the Rec Elta RL and some essential hardware components as well as the attributes of relectorless measurement, with chapter 2 giving an overview of the program structure.

Chapter 3 describes the measurement procedure for fast familiarization with the system.

Actions before instrument use, such as selecting the units to be used for measurement or setting definite switches and determining the instrument errors are described in chapter 4. A detailed description is given in chapter 8.

While chapter 5 describes the measurment of points in detail, chapters 6 and 7 show the possibilities of determination of coordinates and the special application with the Rec Elta RL.

Chapter 9 (data transfer) and 11 (description of interface) deal with data transfer from the Rec Elta RL to peripheral devices and vice-versa. Chapter 9 also gives a detailed description of the terminal modes.

Chapter 10 describes the editor functions for searching, displaying, editing and deleting the recorded data.

The Appendices give general information on instrument use, care, maintenance and adjustments.

The salient feature of the Rec Elta RL are:

Measurement sensor:

- incremental electronic scanning of the horizontal and vertical circles
- electro-optic rangefinder with and without prism in the infrared region using the impulse measurement (pulse delay measurement)
- Compensator for correction the vertical axis tilt in line of sighting
- Audible signal generator

Control and display unit:

- 24 single-function keys, colour coding the the key groups, alphanumeric input, variable soft keys with additional functions
- Graphics display (240x38 pixels) with 4 lines with 40 characters each, sizes of letters 5 x 5 and 5 x 7 pixels
- Convenient user interface with menu and interactive modes (display and keyboard assignment)
- Direct selection of important program parts regardless of the current program level
- Application-oriented programs
- RS 232 C (V.24) interface for data input and output (slip ring)

This instrument was produced with tested methods and quality materials. The mechanical, optical and electronic functions were checked thoroughly before delivery. Should any defect attributable to faulty materials or workmanship occure within the warrantly period, it will be recovered as a warrantly service.

This warranty does not cover defects attributable to operator errors or improper handling.

Any further liabilities, a. g. for indirect damage, cannot be assumed.

Subject to change without prior notice for further development.

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Important Note

This manual describes the operation of Rec Elta® RL-S and Rec Elta® RL, hereinafter referred to as Rec Elta® RL.

Please note:

For short range measurements of up to 400 m* this class of instruments is intended for use without a reflector, and from about50 m, for use with a reflector. Protect your measuring system by avoiding prism measurements under 50 m, using the foil reflector or measuring without reflector.

* depending on surface texture and reflectance

Rec Elta Version: 2.10 Status of June 1993 Enhancements

11. Coordinates

Re 11.4 Setting out

Call of setting-out points
After the setting-out points have been called from Mem, the menu of the setting-out elements (display of the wanted distance and direction angle) now provides the possibility of editing the P.I. of the setting-out point.

13. Set

Re 13.2.1 Defining your own marks

It helps to speed up the measuring process if, after completion of a measurement, the cursor automatically jumps to the position within the P.I. where the input for the next point should normally be made. This default position for the cursor can now be set by definition of the marks.

- The position can be set with the new softkey Cur (no. 3).
- The position is marked by two vertical lines in the tabulator line.
- The default position in the CZ standard marking is the first P.I. digit.
- The cursor default position and the tabulator stop may be placed in the same position.

Procedure:
- Set the desired position with the horizontal cursor keys.
- Press the softkey Cur.
- The position is now marked by vertical lines.

General:
The current mark number is permanently stored. As a result, the last marking selected is always offered after the system has been shut down and switched on again.

15. Editor

Re 15.2 Record display

Both horizontal cursor keys can now be used to alternate between P.I. and data display.

Re 15.3 (4) Recall with ?Pt

To facilitate the entry of point numbers after ?Pt, a column rule is displayed under the input field, which means that the input position of the first digit is now easy to find.

Re 15.5 Entry of coordinate records/reduced data E-Hz-h

After pressure of softkey Inp, the options for the entry of

- coordinates
- E-Hz-h

are now offered. This also permits the manual entry of polar setting-out data.

Special features:
- If softkey Inp is pressed during the standard call in an application program, coordinates can be directly entered.
- After selection of the E-Hz-h setting-out mode, setting-out points can be called up by directly entering the polar values.

Re 15.7 Record deletion

Renumbering in the data base
Version 2.00 permits the deletion of data lines according to different criteria. Afterwards, the lines are empty while the addresses are retained. If complete sectors in the Mem are free after deletion, this space is available for new recordings. In this case, addressing continues beyond 2000 until the Mem has been filled again.

Advantage: Addressing is retained (?Ad).
Drawback: Empty addresses exist when the data base is paged, or in printing or data transfer to the computer.

The possibility has now been provided of eliminating the empty lines by reorganization after the deletion process.

Procedure:
(1) Press **MEN** to leave the selection menu for deletion.
(2) Decision: renumber Mem addresses? **YES/NO**.
(3) **No:** addressing remains unchanged (as in previous versions). Jump to the EDITOR display.
Yes: define a start address for renumbering. The default displayed is the first address.
(4) After confirmation of the start address, renumbering is performed, followed by the jump to the EDITOR address.

16. Data transfer

Re 16.4 Update

A new feature included in this mode is the option of having the programming statusses displayed for:

- Elta
- Rec E
- Mem

1. Instrument Description

1.1 Introduction

Rec Elta RL = Measurement sensor + operating and displaying unit

(1) Measurement sensor:
- Measurement (D, HZ, V)
- Compensator sensing
- Measured data correction for:
  vertical axis tilt in the sighting axis direction
  meteorological conditions etc.

(2) Operating and displaying unit:
- Four lines with 40 characters each
- Graphics capability (240 x 38 pixels)
- Menu selection
- Dialogue information
- Program control
- Data editing and computing
- Displays measured and/or computed data and point identifications

Operating and displaying unit keyboard:
Hard keys:
- 24 single-function keys, colour coding of key groups
- Operation and control of program execution
- Input and editing of values and parameters, selection of functions and programs
- Alphanumeric input

Function keys (soft keys) :
- Functions which depend on the selected program
- Display in the bottom line

Power supply:
- NiCd battery pack (5) with 4.8 V and 2.4 Ah for about 6 to 8 hours of operation

Audible signal generator (13):
- Supports specific functions by audible signals

1.2 Rec Elta RL Controls

Fig. 1.2.1: Rec Elta RL Main operation side

Fig. 1.2.2: Rec Elta RL rear

1	Handle	2	Handle screws
3	Battery cartridge screw	4	Transmitter optics
5	Battery cartridge	6	Receiver optics
7	Focussing with indication of distance	8	Eyepiece mount
9	Eyepiece with diopters scale	10	Alidade level
11	Sighting collimator	12	Display
13	Audible signal generator	14	Keyboard
15	Tripod joint	16	Tribrach
17	Tilting axis height mark	18	Optical plummet
19	Vertical fine motion	20	Counter weight
21	Vertical clamp	22	Slip ring with interface
23	Horizontal fine motion	24	Tribrach screw
25	Horizontal clamp	26	Interface
27	Reticle illumination		

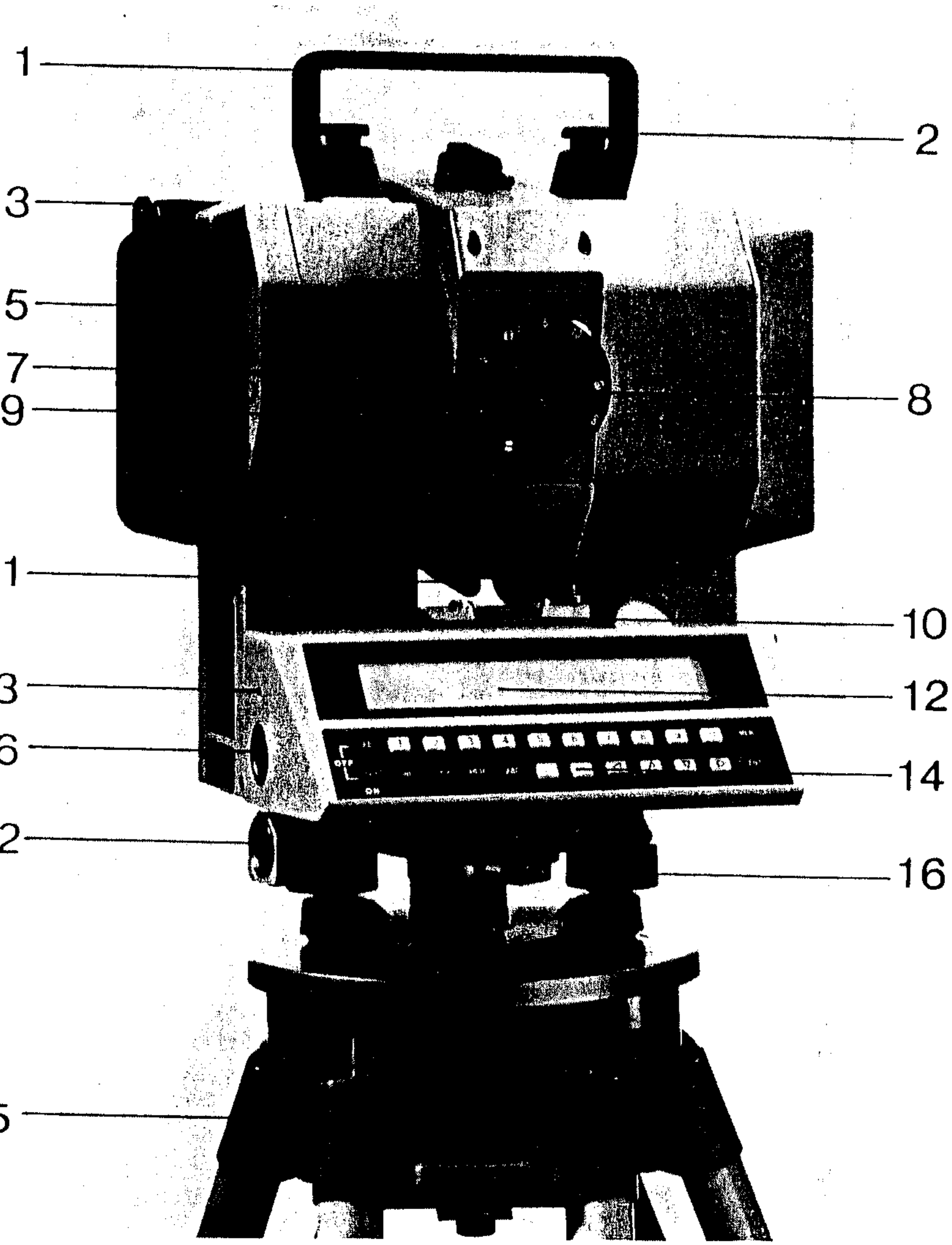


Abb. 1.2.1: Rec Elta RL Hauptbedienungsseite

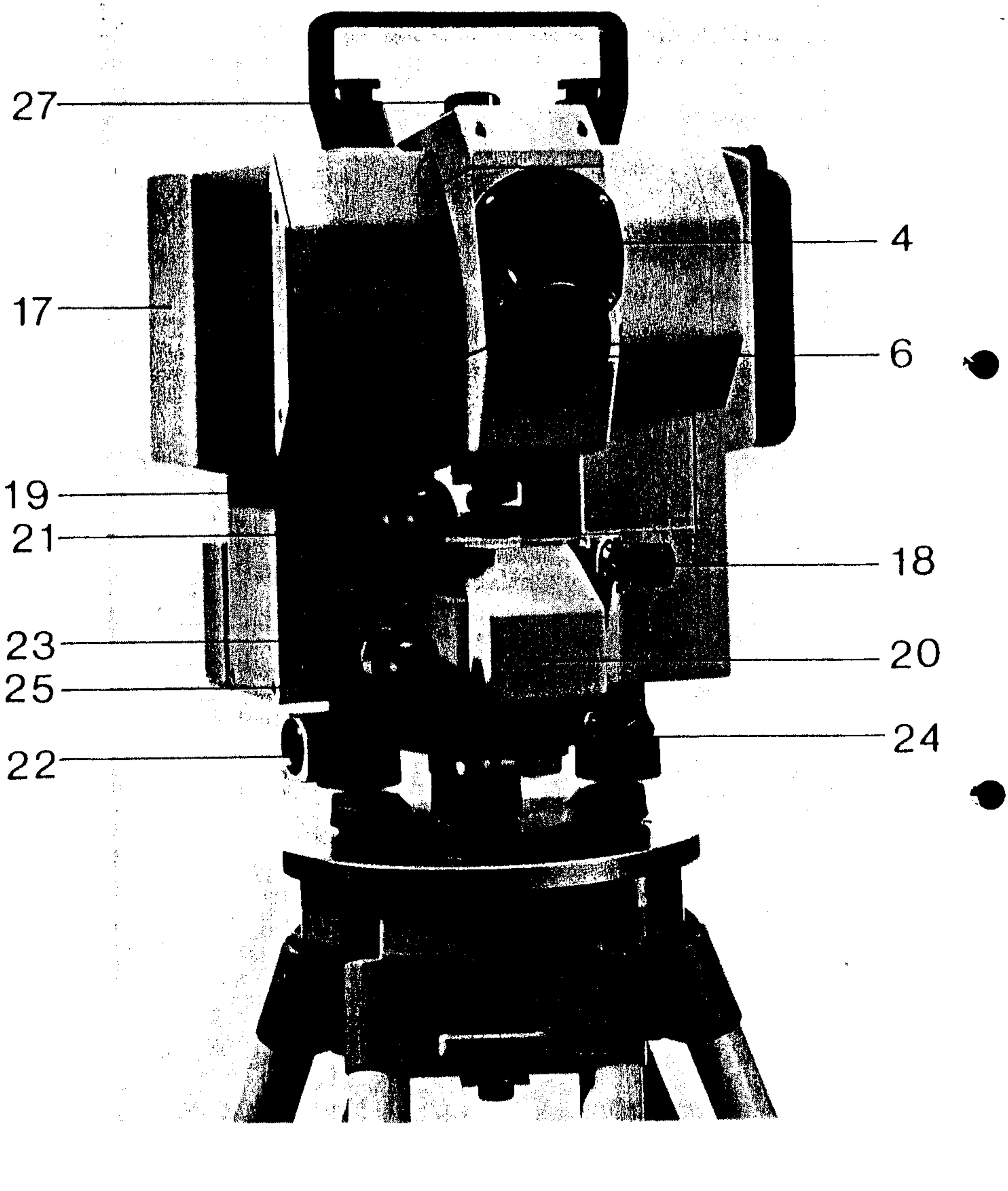


Abb. 1.2.2: Rec Elta RL Rückseite

1.3 Operation and control of Rec Elta RL

1.3.1 Turning on and off

The Rec Elta RL is turned on with the function key **FCT** and is turned off by simultaneously pressing the function key **FCT** and the tab function soft key **TAB**.

1.3.2 Measurement initiation

- **ENT** key at the keyboard

1.3.3 Operating and displaying unit keyboard (hard keys)

Key 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, ABC, MEN** and **ENT**

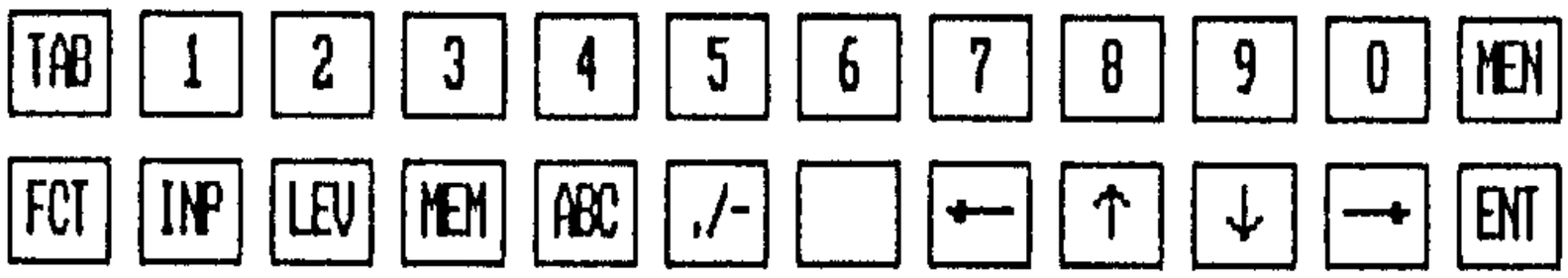


Fig. 1.3.3: Operating and displaying unit keyboard

Key	Function	Usage
1,...,0	Numeric keys:	- Number entry in the Rec Elta RL - Soft key selection (together with FCT key) - Program selection
·/-	Minus sign: (direct access)	- Sign for negative input - Special character, e.g. for point identification input
.	Decimal point: (with FCT key)	- Special character, e.g. for point identification input - For numeric input, the decimal point is set forcibly and cannot be changed
☐	Spacebar:	- For space input
ABC	Alpha key	- Function key for activating alphabetic and special characters input
FCT	Function key:	- Selection of soft keys together with numeric keys 1,...,0. - Shift key for entering decimal points and capitals
TAB	Tab function	- Supports point identification input
↑,↓,→,◄–	Cursor functions	- Selection of the entry or editing position - Editing and incrementing or decrementing values - Scrolling in lists - Change of input field
MEN	MENU function:	- Exit from a function to the next higher menu - Return from a subroutine to the calling program

Key	Function	Usage
ENT	ENTER function:	- Continues program execution (see display) - Measurement initiation
INP	Input menu:	- Input menu access from a function and later return to the calling point
MEM	Memory load	- Display of the current mem load and return to the calling point
LEV	Vertical axis tilt:	- Display of the vertical axis

Repeat function: Keys 1,...,0, TAB,the Spacebar and the cursor keys if pressed continuously.

Normal function: All other keys.

1.3.4 Soft keys

Soft keys are function keys that are assigned different functions in the different programs.
The current functions are displayed in the bottom display line using mnemonics up to 3 characters long.

There are two types of soft keys:
- Some initiate functions and then return to the calling program (e.g. Inf = input of an information record).
- Others display a switch setting and allow its modification (e.g. incrementing on and off)

Soft key selection:
- Press the FCT key and the numeric key below the soft key to be selected

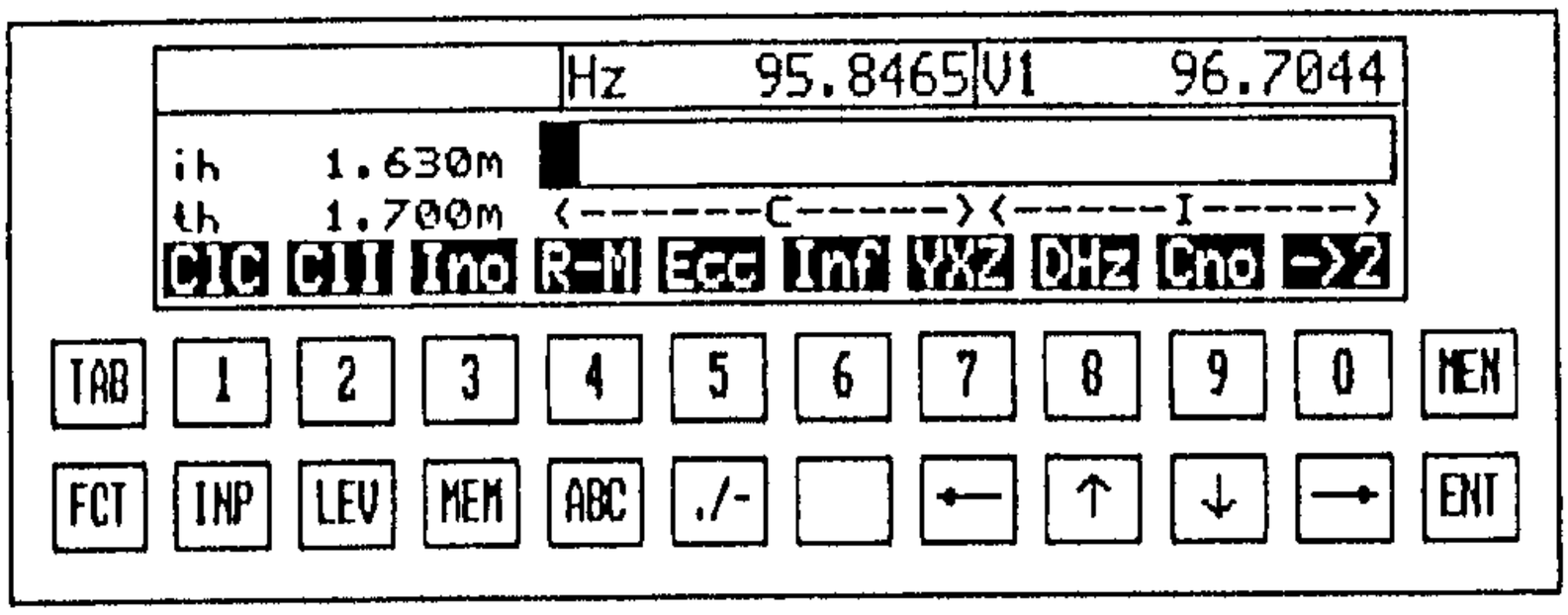


Fig. 1.3.4: Soft keys

1.4 Rec Elta RL Components

1.4.1 Compensator

(1) Purpose
Determination of the current vertical axis tilts in the sighting direction by a one-axis compensator.

(2) Function
The effects of the vertical axis tilt on the vertical circle readings are corrected automatically. The levelling of the Rec Elta RL can be checked by means of the digital display of the tilts.

(3) Operating range
The operation range of the compensator in both directions is ± 2'40" or 48 mgrads. If the compensator is out of range, the decimals of the angle displays in the display are replaced by dashes (also during fast instrument rotation).

(4) Check
Periodical compensator checking is required for precise operation. Checking is by center-point determination in the **COMPENSATOR** mode in the **ADJUSTMENT/PREPARATION** program.

This check is required for precise height measurement.

(5) Display
Vertical axis tilt display with function key **LEV**.

(6) Turning on and off
Turning on and off the compensation:
- in the MEASURE and SETTING OUT programs with soft key **Con/Cno**

1.4.2 Audible signal generator

(1) Purpose
Rec Elta RL function confirmation by an audible signal.

(2) Function
Confirmation by a short signal:
- of any key stroke
- after successful initialization (zero-pulse capture)
- after measuring termination
- During recording: Difference between recording of only one data line (only measured or computed values) or of two data lines (two short beeps). A long beep sounds if an operating error occurs or the zero pulse is not captured.

(3) Turning on and off
The audible signal can be enabled and disabled in the ADJUSTMENT/PREPARATION program.

1.4.3 Memory

The non-volatile memory of the Rec Elta RL contains computing constants, operating conditions, measuring units etc. even when the Rec Elta RL is turned off.

Data and additional informations are stored in the internal memory or they are transferred via the interface to an external memory.

1.4.4 Interface

(1) Purpose
The RS 232 C interface enables transfer of measured and/or computed data to peripheral devices or data from periphal devices to the Rec Elta RL. The instrument has got two interfaces. The first one is at the the display, the second one is at the slip ring.

(2) Options
Online transfer over the RS 232 C interface of the Rec Elta RL to peripheral devices. In the terminal mode you can connect an external computer at the slip ring. The cable doesn't move then when rotating the instrument.

1.4.5 Battery

(1) Operation time

The liquid crystal display of the Rec Elta RL needs very little power. A fully charged battery lasts for 6 to 8 hours of operation depending on the age and condition of the battery and on the type of measurement work.

(2) Battery change

The "!!! **Battery empty** !!!" message appears in the display and an audible signal consisting of three short beeps sounds when the battery is low to request a battery change in the Rec Elta RL.

The batteries supplied with the instruments contain an internal fuse protecting the instrument and the battery against shorts.

Note:
If Rec Elta RL is supplied by a car battery or an external battery you have to replace the battery box of the instrument by a battery box of equalizing weight.

(3) Instruction of the correct change of the power supply when using an external battery

Important!
Never connect the battery at the instrument and the external battery at the same time.

Case 1: The battery at the instrument is low, an accordingmessage appears in the display. The low battery is to be changed for the external battery.

1. Take out the low battery
2. Connect the external battery and press ENT
3. Attach the equalizing weight to the battery pack

Case 2: The external battery is low and is to be changed for a battery cartridge.

1. Take off the the equalizing weight
2. Jam off the external battery
3. Put in the battery cartridge and press ENT

The battery change has to be carried out in the given sequence, otherwise the instrument may be damaged. Any claim to warranty ceases when neglecting these instructions.

2. Program Execution

2.1 User Guidance

The Rec Elta RL guides the user through the programs with menus and by interactive means. The measurement and computation options and the required entries are displayed. You can select and enter the desired option.

- Selection menus

Where there is a choice between several programs, modes or options, only the digit below the applicable mark (L) has to be pressed.

- Soft key menus

Soft keys are functions keys which have different functions corresponding to different programs. The current functions are indicated in the bottom display line by abbreviations consisting of up to 3 characters.
This allows matching the measurement procedure to the application.
The functions can be called by simultaneously pressing the FCT key and the applicable numeric key.

- Dialogue lines or dialogue fields

The Rec Elta RL program gives many hints to the user on what has to be done or can be done. These hints are displayed in inverted form in a dialogue line or a dialogue field.

The 1st display line is generally used as dialogue line. The dialogue fields are arranged at the right-hand side of the display(e.g. INPUT - menu)

All entries are checked for plausibility where possible. Errored entries are rejected and must be repeated.

2.2 Short cuts

Short cuts are provided between the programs and modes to speed up program execution. These short cuts avoid the long route through the different menus and the associated forced program exits.

A function in another program part can be accessed directly from the current program level After function completion, the calling function is returned to.

2.2.1 Hard keys

2.2.1.1 INP (input menu)

(1) Purpose
Display and editing of parameters required for correction and reduction measurements.
- Entry of the instrument and reflector heights or af the station and target heights for computing elevation or level differences.
- Entry of the temperature and the atmospheric pressure for correcting distance measurements based on the current atmospheric conditions.
- Entry of the scale and the addition constant for the correction of distance measurement.
- Switching over between the measurement with and without reflector. If measurement with prism is chosen, the prism constant is used. See also **A 1.5 Prism- and addition constant.**

These parameters are stored permanently in the internal memory NV-RAM (non-volatile), e.g. they are not lost when you turn off the Rec Elta RL.

(2) Program selection
- Direct call with the **INP** key from any program part:
  Display of the selection menu (Fig. 2.2.1.1) with the values currently stored in the NV-RAM

```
REFL:      0.000m TEMP.:    20°C INPUT MENU
INST:      0.000m PRESS:   944hP SELECT:←↑↓→
ADCO:      0.000m BAR.H:    597m       ENTER
SCLE: 1.000000    PPM  :       0 PRISM:    NO
```

Fig. 2.2.1.1.1: Selection menu of the INPUT program

(3) Selection of the parameters to be edited
Go to the input field with the cursor keys:
- horizontally : ◄– (left), → (right)
- vertically : ↑ (up) und ↓ (down)

(4) Input activation
Confirm correct selection with **ENT**; simultaneous change to the editing menu.

REFL:	0.000m	TEMP.:	20°C	INPUT MENU
INST:	0.000m	PRESS:	944hP	SELECT:←↑↓→ ENTER
ADCO:	0.000m	BAR.H:	597m	
SCLE:	1.000000	PPM :	0	PRISM: NO

Fig. 2.2.1.1.2: Input/editing menu

(5) Entry editing
The editing position is indicated by the cursor. The cursor is at the first significant position.
The decimal point is fixed and cannot be changed.

Key	Function
→	Cursor moves right one place, digits are not modified.
◄–	Cursor moves left one place, digits are not modified. Is there no digit, a zero is set.
0,1,...,9	Input of the digits 0,1,...,9 in the corresponding places, existing digits are overwritten. Deletion of the digits preceding the decimal point by 0.
-	Effective for heights, addition constant, temperature, ppm and barometric height. Can be pressed anywhere in the input field and causes the current sign to be changed.

(6) Editing termination

Terminate input with ENT. The input bounds are checked (see (8) below).

- Result positive:
  Jump back to the selection menu (Fig. 2.2.1.1.1), the current value is overwritten in the NV-RAM.
- Result negative:
  An audible signal sounds, the current value in the NV-RAM is displayed again, the selectd field remains active for further input.

Changing from the input/editing to the selection menu (Fig. 2.2.1.1.1) in order to edit more parameters if necessary.

(7) Storage in the internal memory and exit from the INPUT program

MEN :Jump back to that point where the input menu was called.
The edited values are stored forcibly internally. Additionally you have got the possibility of writing the values into the Mem in order to ensure an unambiguous assignment to the measurement procedure.

Fig. 2.2.1.1.3: Storage in the Mem

YES: The values are stored in the Mem. Jump to the calling point
NO: The values are not stored in the Mem. Jump to the calling point.

(8) Input bounds

Temperature	Celsius	:	from	-30° C	to	+70° C
	Fahrenheit	:	from	-22° F	to	+158° F
Pressure	Pascal	:	from	440 hPa	to	1460 hPa
	Torr	:	from	330 Torr	to	1095 Torr
	InchMercury:		from	13.0 InMc	to	43.1 InMc
	Elevation	:	from	6400 m	to	-3200 m
Scale			from	0.995 000	to	1.005 00
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 level differences			from	-9999.999m	to	9999.999m

LEV
- Displays the vertical axis tilts for correcting the levelling
- Return to the calling program part with **MEN**

MEN
- Exit form a program, mode or function to the next higher menu
- Return from a utility routine (e.g. soft key) to the calling program

2.2.2 Soft keys

HzV	Option of a measurement mode
Set	Setting of a horizontal direction

Switches
Some soft keys serve as switches in all modes. The switch condition is displayed and can be changed by the soft key itself:

Ino, Ion	Incrementing mode
Con, Cno	Compensator

2.3 *Main Menu and Program Levels*

The tree structure of the programs and the short cuts with the function keys provide clear program control.
The top level of the user interface is the main menu with the 6 programs that can be called directly with numeric keys.

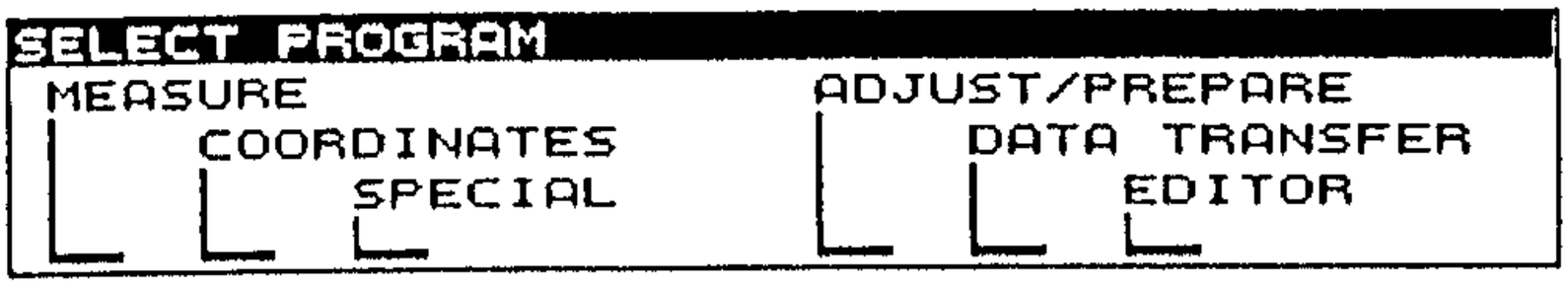


Fig. 2.3.1: Main menu

Survey of the programs and the associated keys

Key	Function
1 Measure	Measurement of directions, distances and height differences.
2 Special	Programs for special applications.
3 Coordinates	Stationing, measurement, computation and setting-out of coordinates, computation of area
6 Adjusting/ Preparing	Determination and checking of instrument parameters. Entry of units(m, grad, YXZ etc.). Setting of parameters.
7 Data transfer	Data transfer. Option between internal or external recording. Terminal mode
8 Editor	Display and editing of the recorded data.

In the SPECIAL, COORDINATES ADJUSTMENT/ PREPARATION, and TRANSFER programs there are several submenus which form the middle level of the user interface.

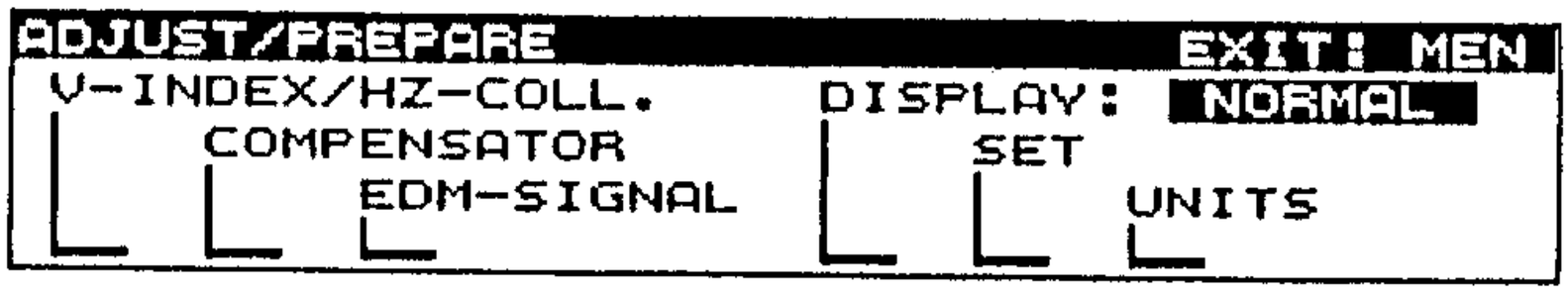


Fig. 2.3.2: Middle program level: ADJUSTMENT/PREPARATION

Within these subprograms, the soft keys (function keys) allow calling a large number of different utility routines that serve to match program execution to your requirements.

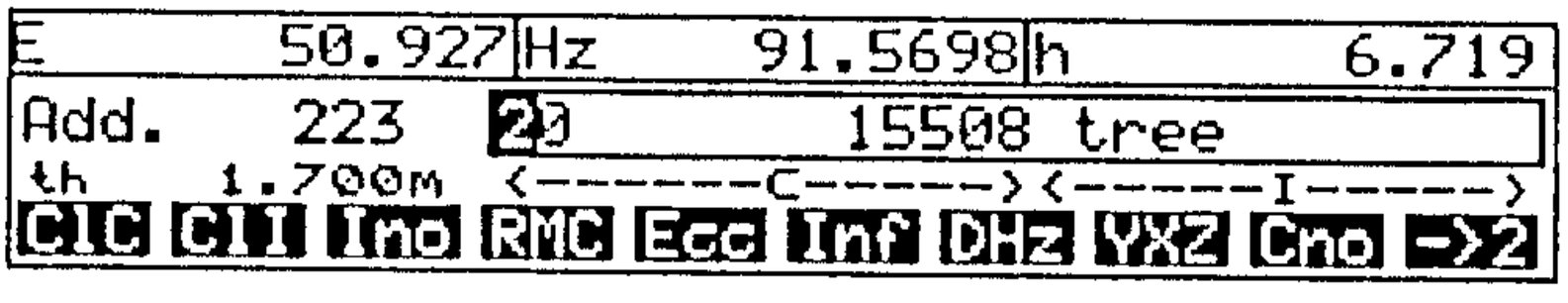


Fig 2.3.3: Lower program level: Result menu with soft keys

From the modes, functions and submenus you can always return to the next higher menu with the hard key **MEN** (menu) (normal and emergency exit).

Soft keys and tables form the lower level of the user interface.

2.4 Menu Types

The sequence for calling menus and their structure are almost identical.

When you call a measurement mode, the initial menu appears first so that you can check the instrument condition with specific soft keys.

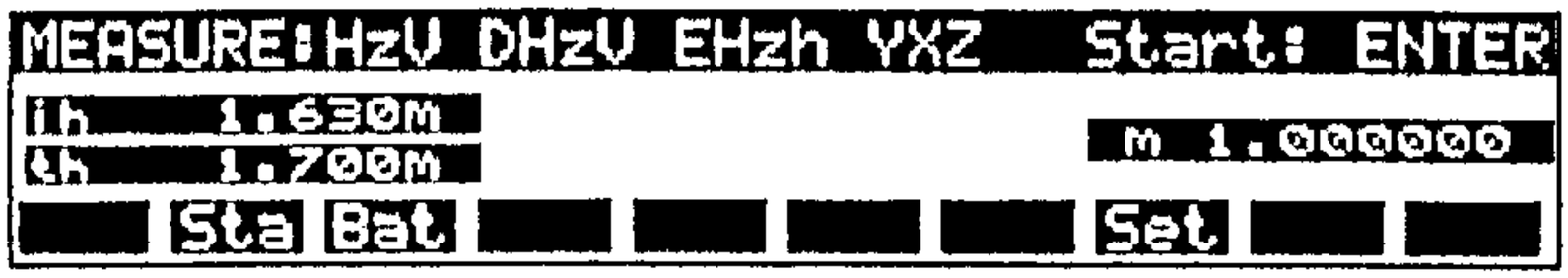


Fig 2.4.1: Initial menu

In the following input and measurement menu (Fig. 2.4.2) a request appears to enter the point identification and to initiate measurement.

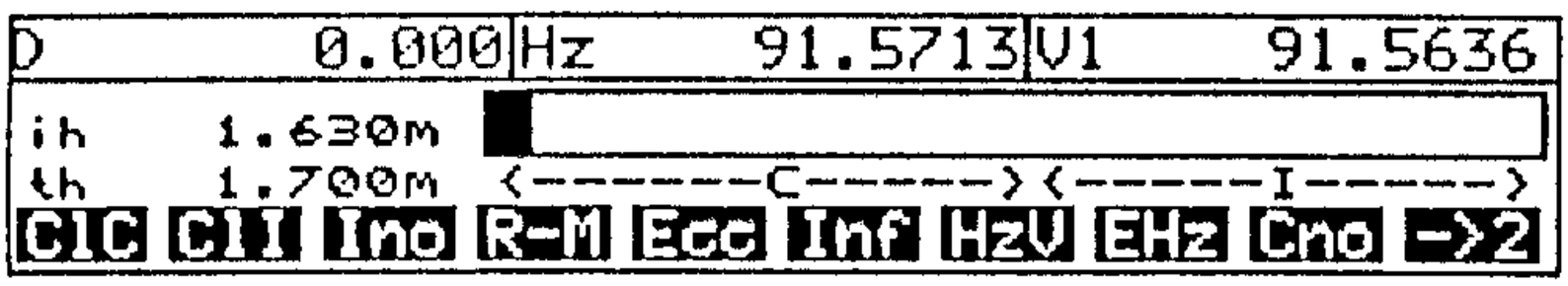


Fig. 2.4.2: Input and measurement menu

After measurement completion, the result is displayed in the result menu (Fig. 2.4.3).

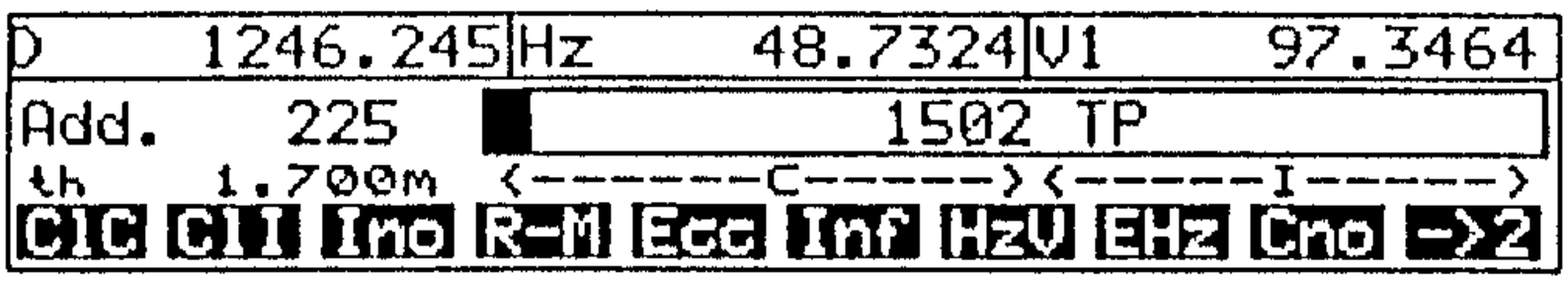


Fig.2.4.3: Result menu

3. Measurememt Procedure

3.1 Requirements

- Instrument start up
  Levelling, centering, telescope adjustment
  (see APPENDIX A 5 Measurement Preparation).
  - Selection of the required measuring units and reference systems - e.g. meter, grad, zenith (see ADJUSTMENT/PREPARATION program).
  - Setting of the desired switches, e.g. audible signal on or off (see ADJUSTMENT/PREPARATION program).

3.2 Turn-on routine

(1) Turning on the instrument:
- Press the FCT key at the Rec Elta RL.
- The display shows shortly the program version and the copyright.

```
Z  E  I  S  S          Version: 1.01 E

                       (c) Carl Zeiss
REC ELTA RL                Germany  1993
```

Fig. 3.2.1: Initial display

- Now the system test is performed showing also the recording mode (internally or externally via RS 232 C)

(2) V circle initialization
Request to initialize (determine the zero point of the vertical circle) by display "zero pulse V1" on the display.

```
Initialize  V 1
Tilt the telescope
```

Fig.: 3.2.2: V circle initialization

- Swing the telescope up and down smoothly.
- The successful initialization will be confirmed by an audible signal and the display changes to "zero pulse V2".
- The 2nd zero pulse will be captured by another tilting direction change.

(3) HZ circle initialization

Initialization is required to determine the zero point of the horizontal circle. The circle orientation is also retained after turning off and on again (quasi absolute orientation).

- Turn the instrument around the vertical axis.
- The successful initialization will be confirmed by an audible signal.
- The display changes to the main menu (3.3).

```
Initialize  Hz
Turn the instrument
```

Fig.: 3.2.3: Hz circle initialization

(4) Initialization error

An error message may appear if you tilt the telescope too slowly or too fast or not smoothly enough. Audible signals and remarks in the display indicate this:

- Slower : Turn more slowly
- Faster : Tilt faster

```
Initialize  V 1
Tilt faster
```

Fig. 3.2.4: Operator message

(5) Turning off the instrument

To turn off the instrument, press the **TAB** - and the **FCT** key simultaneously.

3.3 Main Menu

(1) Survey
Survey of the Rec Elta RL programs.

(2) Program selection
Press the numeric key below the **"L"** mark that points to the program.

Fig. 3.3.1: Main menu

3.4 Measurement

(1) Program selection
Select the program with the appropriate numeric key - here key 1 for MEASURE (see fig. 3.4.1).

(2) Initial menu
- Informations on instrument parameters and correction values (e.g. index and collimation errors, scale, addition constant temperature and atmospheric pressure) can be accessed directly with soft key Sta (FCT + numeric key 2) in the initial menu (fig. 3.4.2).
- Display of the battery condition (soft key Bat)
- Setting of the horizontal circle (soft key Set)

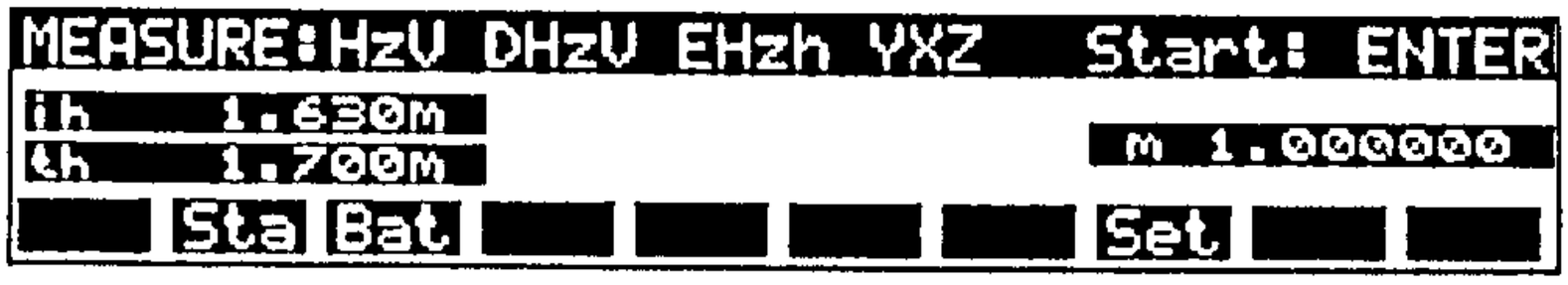


Fig. 3.4.1: Initial menu of the MEASUREMENT program

ENT : Change to the input and measurement menu of the MEASUREMENT program

MEN : Return to the main menu

(3) Input and measurement menu of the MEASURE program

- Enter the point identification

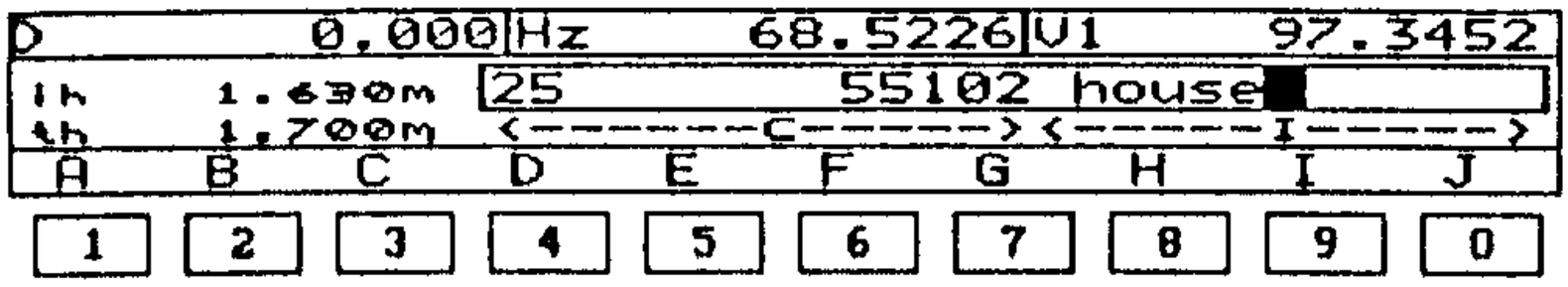


Fig. 3.4.2: Input and measurement menu

- Select the position
  Cursor keys → or. ◄– or **TAB** key (tab stop setting ind the SET mode)

- Numeric input:
  Press the desired numeric key
- Alphanumeric input:
  By pressing the **ABC** key letters and special characters appear in the soft key line that are assigned to the numeric keys.
  Letters line change: Down in the alphabet with ↓ and up with ↑.
  Capitalization: FCT + numeric key assigned to the letter.
- Input editing
  Go to the errored position with one of the two cursor keys → and ◄– and enter the correct digit; the errored digit will be overwritten then.

(4) Measurement procedure

- 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
- In some cases you need not necessarily sight an object exactly (e.g. measurement of an interior room, quarry etc.), if you are measuring reflectorless. In this case you have to set the approximate distance with the focussing ring.
- Initiate measurement with the **ENT** key
- Receiving signal: Is controlled automatically and the signal quality in indicated by the bar graph in the display
  . Optimum: Bar graph is in the middle
  . Measurement not possible: The measurement beam is interrupted or the signal amplitude is too low:
  Bar graph left, termination possible with **MEN**
  . Measurement not completed: Bar graph oscillates within the whole range

- The measured values are corrected automatically before display for:
  . the effect of temperature and pressure (distance D)
  . the set prism or addition constant (D)
  . the set scale (D)
  . the index correction (vertical angle V)
  . the collimation correction (horizontal angle Hz)
  . the component of the vertical axis tilt in the sighting axis direction for V
  . the circle eccentricities (Hz, V)
  . the tilting axis error (Hz,V)

(5) Recording

Ater measurement completion the point identification and the measured values are automatically stored in one record internally or externally.

Important:
The soft key for recording (FCT + 4) must be R-M, not Rno.

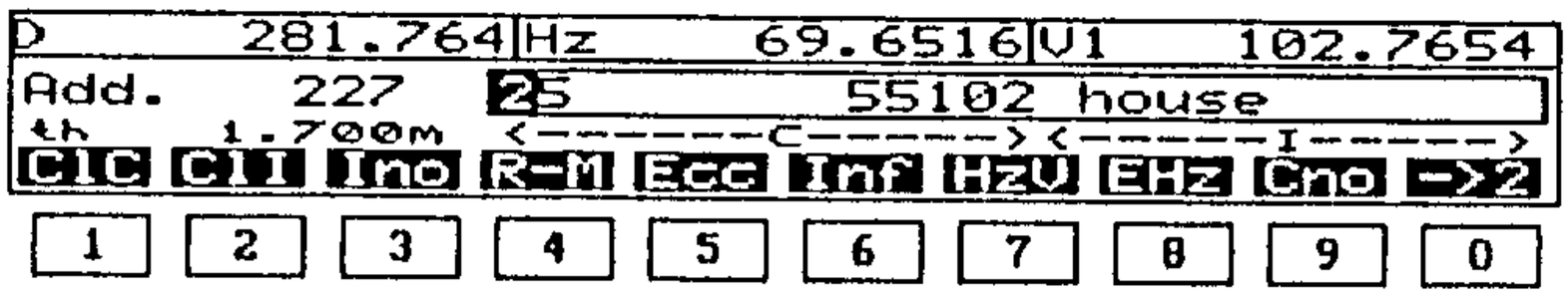


Fig. 3.4.3: Result menu

(6) Further measurement

A new P.I. can now be entered (see (3)) in the result menu (see fig. 3.4.4) and the next point can be measured (see (4)).

MEN : Exit from the mode.

4. Actions before instrument use

Before using a new instrument for the first time or after an observer or project change, we recommend you check the instrument settings.
The different programs and modes and their default options are described below. Detailed information is given in the mode descriptions further down in this manual.
The current values in the INPUT (INP) and ADJUSTMENT/ PREPARATION programs can also be checked in the initial menu of each measurement mode with the soft key **Sta** (initial instrument condition).

4.1 INP (Input menu)

(1) Purpose

Entry of parameters for the correction and reduction of measurements.
The input of the different parameters is realized exclusively with the INP hard key.

(2) Factory default settings

REFL:	0.000m	TEMP.:	20°C	INPUT MENU
INST:	0.000m	PRESS:	944hP	SELECT:←↑↓→ ENTER
ADCO:	0.000m	BAR.H:	597m	
SCLE:	1.000000	PPM :	0	PRISM: NO

Fig. 4.1.1: Default settings

A detailed description is given in 2.2.1.1 INP (INPUT MENU).

4.2 Adjustment/Preparation

4.2.1 Adjustment

(1) Purpose

Determination and check of the instrument error corrections.

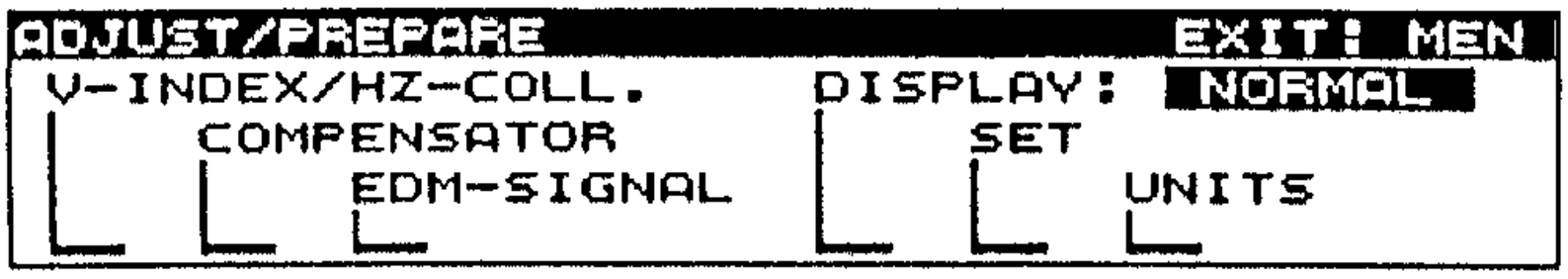


Fig. 4.2.1.1: Adjustment options

Note:
The V index, the HZ collimation and the compensator have to be adjusted before every precision measurement.

4.2.2 Units

(1) Purpose

Specification of the measuring units.

(2) Factory default settings

Fig. 4.2.2.1: Default settings

4.2.3 Set

In the SET program, individual entries can be made for the different modes.

Marks mode:
Entry of your own symbols or formats for the 27-character point identification.

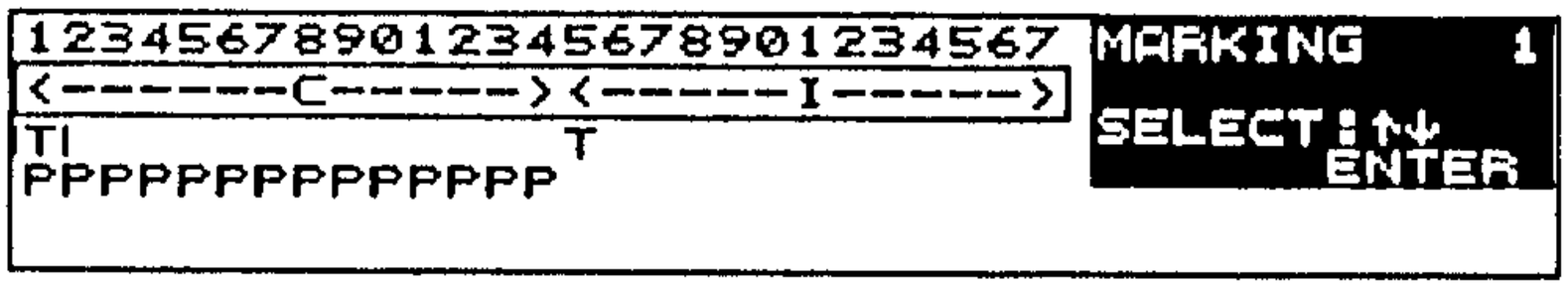


Fig. 4.2.3.1: Default mark

Decimal places
Entry of the number of decimal places for the following measurements.

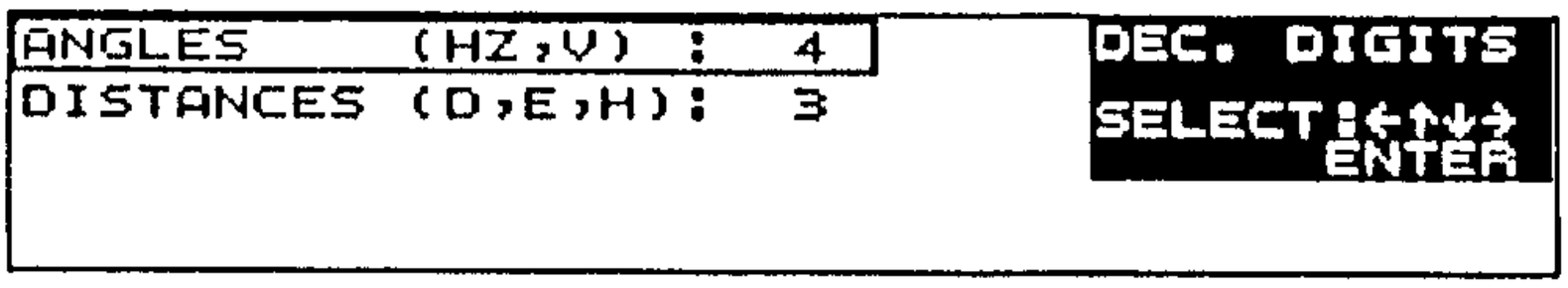


Fig. 4.2.3.2: Defaults

A detailed description of the specified options is given in chapter 8. ADJUSTMENT/ PREPARATION.

5. MEASURE program

5.1 Overview

(1) Purpose

The MEASURE program provides four modes for determination and displaying the measurement elements that are common in daily work. Directions, angles, distances and heights or height differences and local coordinates can be selected in different combinations. The selection is done with the soft keys FCT + 7 or FCT + 8 which show the next possible modes. In the modes EHz and XYZ you can measure additional remote object elevations. Independent of the chosen mode you can measure with or without reflector. You only have to take care of the correct setting in the INP menu.

Note:
For precise measurements you should measure reflectorless with a distance shorter than 5 m.

(2) Recall of the program

Select the MEASURE program with numeric key 1 in the main menu. Change to the initial menu. An optional direction can be set with the Set soft key (fig. 5.1.1) in the initial menu.

If the height is to be measured, too, you can enter the instrument height ih as well as the reflector height th with the INP soft key.

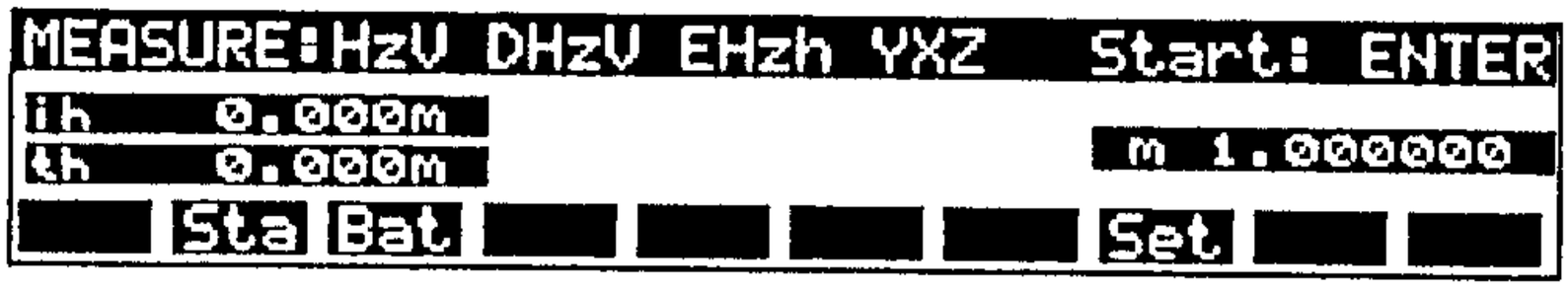


Fig. 5.1.1: Initial menu MEASURE

MEN: Return to the main menu

(3) P.I. input

ENT : Starts the program
Enter the P.I. in line 2.
Selection of the desired measurement mode (measurement of angles or of angles and distances) with the soft key FCT + 7, 8 - see 5.4 (8).
The current values for Hz and V are always displayed in the tracking mode.

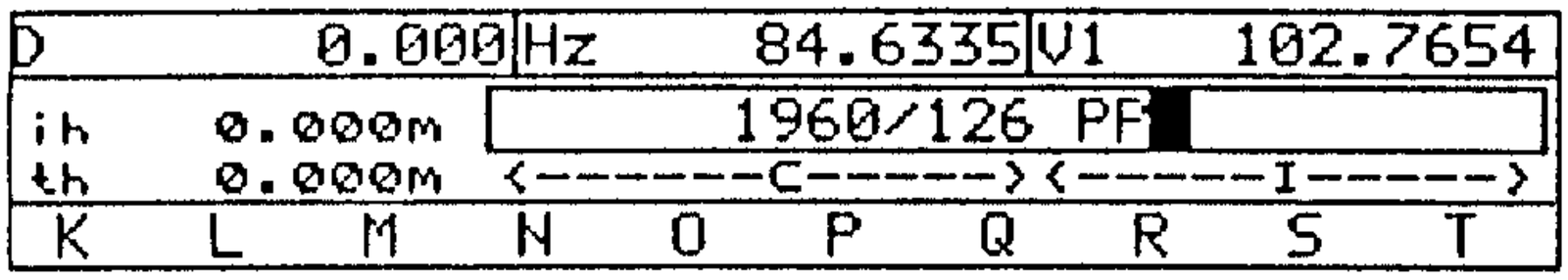


Fig. 5.1.2: Input and measurement menu

(4) Measurement

ENT: Initiates measurement

The display of the signal intensity is indicated by the bar graph in line 3. When the bar graph is in the middle the signal is optimum. When the bar graph is left, the signal amplitude is too low. The measurement can be stopped with **MEN**.

(5) Result menu

After measurement completion two or three measurement elements are displayed in line 1 (see fig. 5.1.4). A new P.I. can be put in.
For further measurements repeat steps (4) and (5).

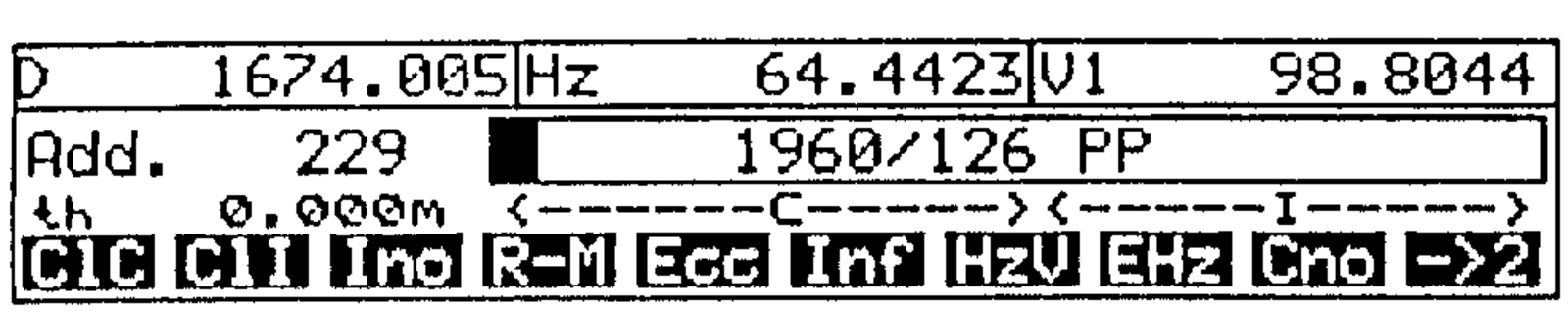


Fig. 5.1.3: Result menu

After measurement the measured values are stored and recorded in the internal memory if necessary. The values can be displayed in the different modes with soft key **FCT** + 7, 8). Because the angle measurement is displayed in the tracking mode, the Hz and V values are always actual.

Important:
The E and h values are not computed again!

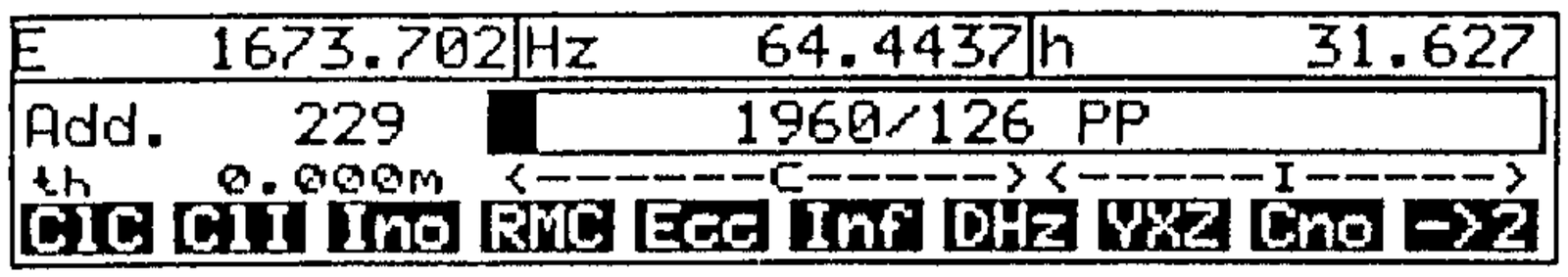


Fig. 5.1.4: Measurement elements

(6) Recording

If soft key 4 is not Rno, the measurement is recorded automatically after termination (INTERNAL MEM).
If an external device is connected you have to select the correct setting of the interface parameters (see TRANSFER). The necessary notes about the interface are given in the chapter INTERFACE DESCRIPTION.

(7) Measurement completion

MEN: Direct return to the main menu.

5.2 Initial menu

(1) Display of the menu

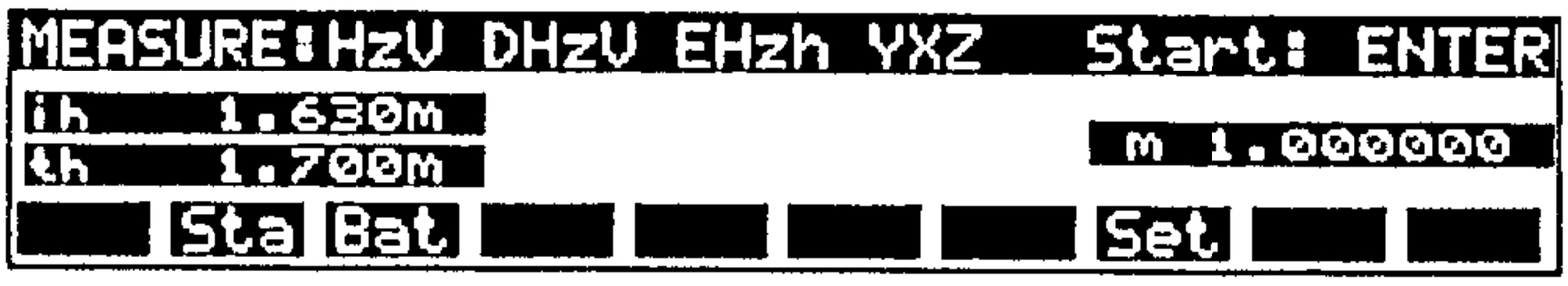


Fig. 5.2.1: Initial menu

Line 1 : Inverted representation of the dialogue line
- Name of the program: MEASURE
- Starts the program: **ENT**

Line 2 : Display of the instrument height
Line 3 : Display of the reflector height
: Display of the scale for the following distance measurements.
Line 4 : Soft keys

Key		Function
Sta	(FCT + 2)	Initial condition of major instrument parameters
Bat	(FCT + 3)	Battery capacity
Set	(FCT + 8)	Setting of the desired direction

The functions can be activated by the FCT key and numeric keys 2, 3 and 8.

(2) Display and storage of the status condition(Sta)
Documentation of the instrument status at measurement time for later measurement assessment. The soft key groups parameters in a single list that were determined or entered in several menus (see fig. 5.2.2).

```
th    1.700m   i   -0.0057
ih    1.630m   c   -0.0032
A     0.000m   SK   0.0000
m  1.000000    SZ   0.0040
P       944hP  METER/GRD/ZENITH/YXZ/
T_       20°C  HPA/MB/C/
```

Fig. 5.2.2: Status condition

List of the displayed parameters:

Input parameters (see also INPUT) and abbreviations

- Instrument height	ih
- Reflector height (target height)	th
- temperature	T_
- Atmosphere pressure	P
- Scale	m
- Addition constant	A

Instrument errors (see also ADJUSTMENT):
Value of

- Index error	i
- Collimation error	c
- Position of the compensator center-point in the direction of the line of sight	SZ

Units (see also UNITS):
- Distance measurement
- Angle measurement
- Vertical reference system
- Coordinate system
- Atmospheric pressure
- Temperature

The Sta function can be left with any key. The request appears automatically if the current condition is to be added to the documentation in the Mem (see fig. 5.2.3).

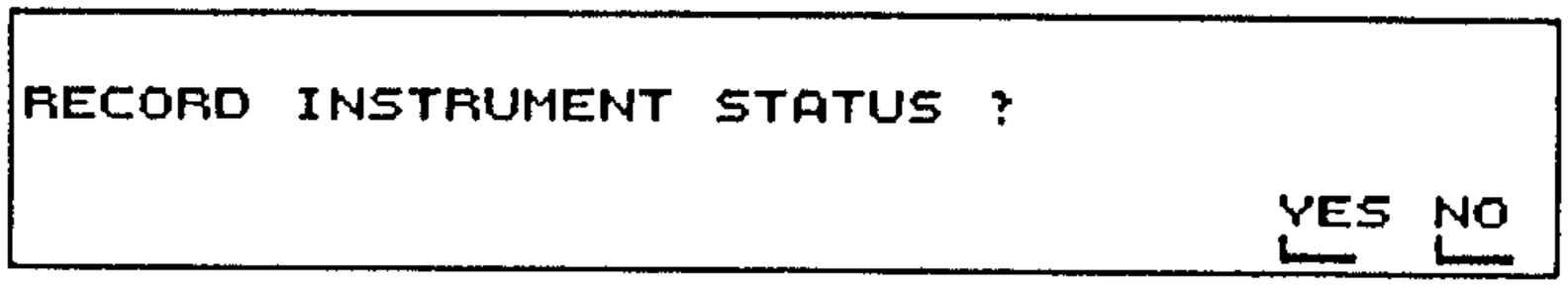


Fig. 5.2.3: Recording

YES : Recording of the values, branch to the initial menu
NO : No recording of the values, branch to the initial menu

(3) Battery condition (Bat)
When you pres the soft key Bat, the battery condition is displayed by a bar graph in the display.
- Bar graph on the right side : The battery is still fully charged.
- Bar graph on the left side : The battery has to be changed soon.

MEN : Change to the initial menu of the MEASUREMENT program (fig. 5.2.1)

(4) Setting of a desired horizontal direction (Set)
With soft key **Set** you can set the horizontal circle to zero or enter a given horizontal direction with the numeric keys.

The function is activated by FCT and numeric key 8.

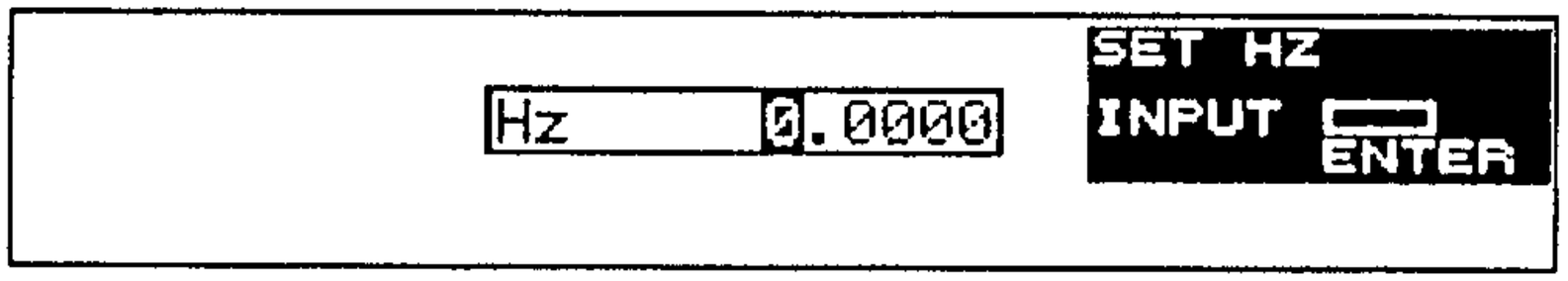


Fig. 5.2.4: Set menu

Zero-set the horizontal circle with **ENT** without any entry. Enter a desired angle with the following keys:

Key	Function
Position selection:	
◄–	The cursor moves left one position without modifying the digit. If there is no digit, a zero is set.
→	The cursor moves right one position without modifying the digit. Zeros are deleted if they precede the first significant digit.
Input: 0,1,...,9	Enter the digits 0,1,...,9 in the applicable positions; existing digits are overwritten. Delete digits preceding the decimal point with 0.

Terminate input with **ENT**; the input bounds are checked:
- Grads : 0 - 399.9999
- DMS : 0 - 359°, 0 - 59', 0 - 59"
- DEG : 0 - 359.9999°
- MIL : 0 - 6399.99

An audible signal sounds if the bounds are exceeded. Correct the wrong value.

To identify the point, a point identification can be entered (see fig. 5.2.5). Sighting of the point and initiating of the following measurement with **ENT**.

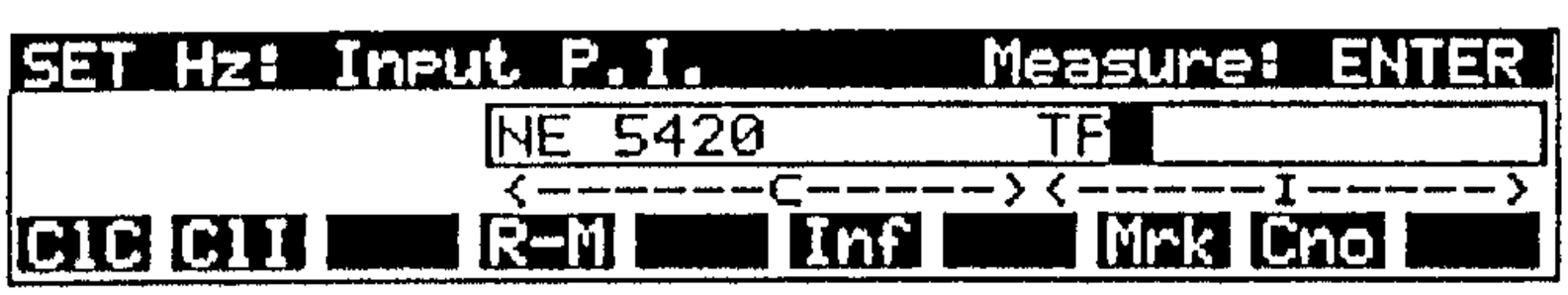


Fig. 5.2.5: Measurement of Set HZ

After storage the display changes to the initial menu, see fig. 5.2.1.

5.3 *Input and measurement menu*

With ENT direct jump from the initial menu to the input and measurement program.

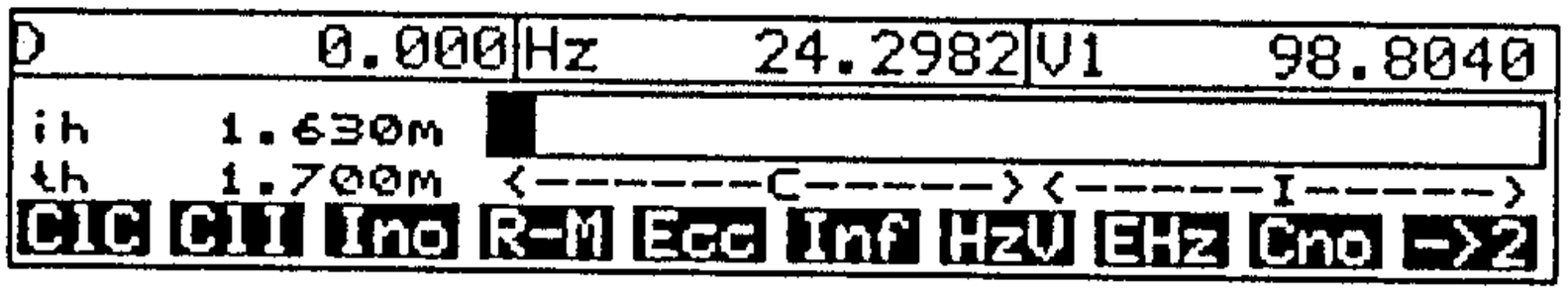


Fig. 5.3.1: Input and measurement menu

(1) Description of the display

Line 1 : Display of the current angle measurement values HZ and V (at the beginning), afterwards also the other measured or computed values, just according to the optional measurement mode

Line 2 : ih or Mem Adr.
27-character display for P.I. input

Line 3 : th and format of the mark selected last

Line 4 : Soft keys

(2) P.I. input

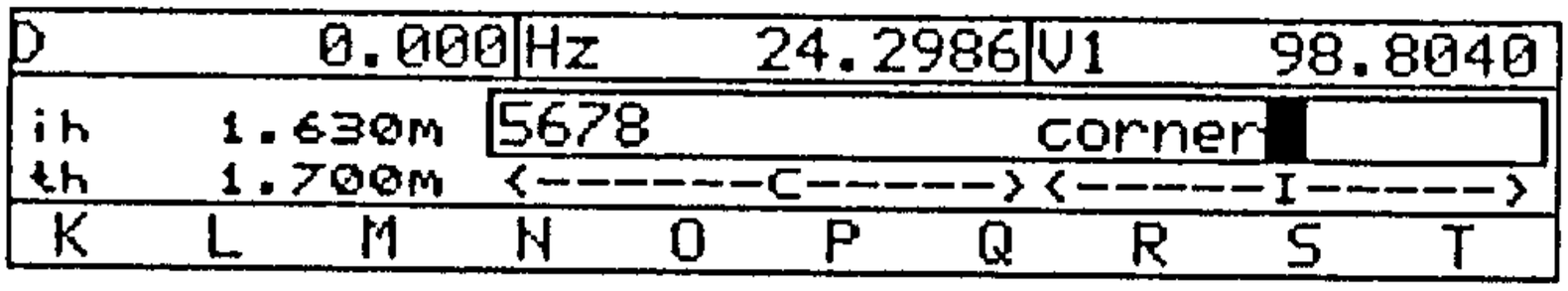


Fig. 5.3.2: P.I. input

Identification and description of a point before a measurement to obtain a unique correlation between the point and the measurement.

- Point identification (P.I.) = point code (C) + additional information (I). Up to 27 characters (letters, digits, special characters and spaces).
- Point code = point number in numeric and/or alphanumeric form. The number of the characters may range from at least 3 to a maximum of 14. Incrementing is possible in this range (see. 5.4.2 (3). Unused character positions may be used for additional information or may contain spaces.
- Additional information = point description in alphanumeric form.

For alphanumeric entries, letters appear instead of the soft keys after pressing the **ABC** key.
A B C D E F G H I J
All other letters and special characters can be selected with the vertical cursor keys ↑, ↓ .

To facilitate input:
1. the input field has a frame (input window) and
2. the point identification is provided with a mark (see (3) and SET).

(3) Marks
Input support by graphical subdivisionoth the P.I. in fields. This improves the readability of the P.I..

The format depends on the number of characters for the point code and the additional information.
Default mark: <-----C------><-----I----->

In the SET mode, the mark format can be selected. The following parameters can be set there individually:
- Tab function **TAB** (facilitates input)
- Beginning and end of the point number field
- Cursor position Cur (faciliation of the input)
- Spaces that are skipped forcibly during P.I. input

5.4 Function keys and soft keys

Function keys and soft keys make the measurement procedure more flexible and support the point input.

5.4.1 Function keys

Their meaning in detail:

TAB	Tab function according to the parameters set int the SET mode.
FCT	Function key for selecting the soft keys together with the numeric keys **0,1,....,9**.

ABC	Function key for activating alpha input, i.e. input of capital or lower-case letters and of special characters with soft key line 4.
1,...,0	Keys for entering digits and selecting soft keys.
-	Negative entries or special characters for the P.I.
.	Special characters for the P.I.
Spacebar	Function as cursor-right and thus deletes the existing entries.
→,◄–	Cursor keys for selecting a position for entry or editing without deleting the cursor position.

5.4.2 Soft keys

Activating of the soft keys by simultaneous pressing of FCT and the associated numeric key.

(1) Survey

Key		Function
Page 1:		
CIC	(FCT + 1)	Cancels the point code in the point identification P.I.
CII	(FCT + 2)	Cancels the additional information in the point identification P.I.
Ino	(FCT + 3)	Point number incrementation on or off
R-M	(FCT + 4)	Changing of the recording mode (measured and/or computed values or no recording)
Ecc	(FCT + 5)	Input of an offset
Inf	(FCT + 6)	Input of an information line
HzV	(FCT + 7)	Selection of the measurement mode
EHz	(FCT + 8)	Selection of the measurement mode HzV original angle measurement values DHz original measurement elements D, HZ and V EHz computed measurement elements E, Hz and h XYZ local coordinates
Con	(FCT + 9)	Compensation on or off
->2	(FCT + 0)	Change to page 2
Page 2:		
Ono	(FCT + 1)	Indirect Object height measurement (only EHz + XYZ)
Tno	(FCT + 2)	Distance tracking
Del	(FCT + 3)	Deleting the last recording
D:N	(FCT + 7)	Selection of the measurement mode for the rangefinder
Mrk	(FCT + 8)	Selection of marks
->1	(FCT + 0)	Change to page 1

(2) Point identification deletion with soft keys CIC and CII
The point code field is deleted completely by soft key CIC and the additional information field by soft key CII. Both fields are then free for new entries.
Individual characters can be canceled with the spacebar.

(3) Increment activation/deactivation with soft key Ion/Ino
This softkey automatically raises or reduces the point number by a desired amount. When calling the input and measurement menu, the incrementation is off (Ino).
Turn on the incrementation with FCT + 3. Change from the P.I. input menu to fig. 5.4.1: Increment entry. Confirmation with ENT. The default increment is 1.

Fig. 5.4.2.1: Increment entry

Enter the new increment starting at the cursor position ▒. The input bounds (-9999 ≤Inkr≤ 99999) are checked automatically. A warning sounds for wrong entries.

Key	Function
1,...,0	Input of the desired increment with the numeric keys. After each digit, the cursor moves one position to the right.
◂–	Entries at the left of the cursor are possible if you move the cursor to the desired field with the ◂ key. Any existing digits are not modified. If there is no digit, zeros are set.
→	The cursor moves right one position without modifying the digit. Leading zeros are deleted.
-	Input of negative increments

- Increment entry termination
Terminate entry with the ENT key; return to the point identification input in the measurement program that was left earlier.
Change of soft key Ino to Ion: Information on incrementation activation/deactivation.

Important:
Only the right-most numeric part of the point code is incremented. The point number can only be changed as far as leading spaces exist before the point number.

20 1.568---1234

incrementation up to 9 999 999

(4) Recording activation/deactivation with soft keys R-M/R-C/RMC/Rno
Soft key FCT + 4 enables you to select different switch settings for the recording modes.

According to the measurement mode (HzV, DHz, EHz or XYZ) the following switch settings are possible:

Rno = Measurement is not recorded.
R-M = Original measurement values (D, Hz, V) or (Hz, V) are recorded.
R-C = Data computed from the measured values are stored, e.g. E, Hz, h - X, Y, Z
RMC = Measured and computed values are stored
1st line: measured values
2nd line: computed values

Important:
Recording successful : The address of the internal memory or "Ext. Record." is displayed in line 3.
Recording off : The display of the address or "Ext. Record." is missing.

(5) Offset input

Points that are not directly visible from the station can be measured by entering an offset.

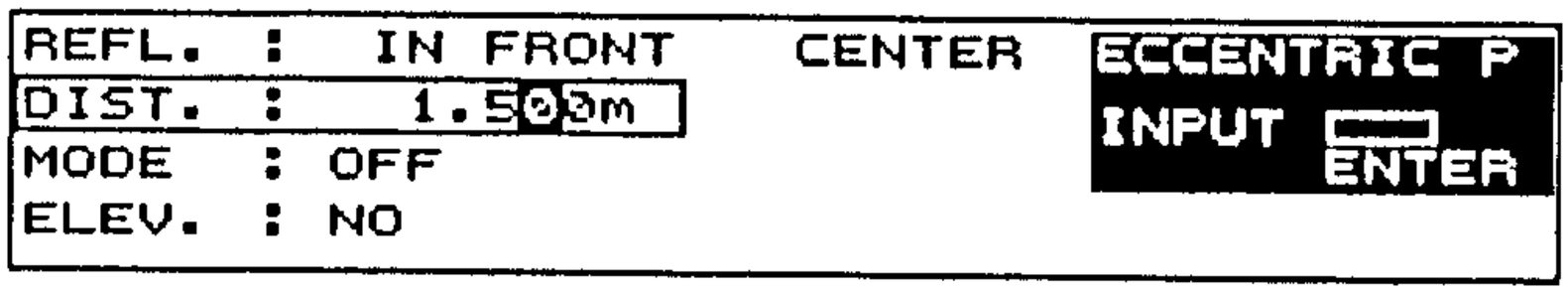


Fig. 5.4.2.2: Offset input

According to the position of the reflector in respect to the center there are different options possible:

Refl. : in front of center
spatial to center (reflector is on the line of sight between the station and the target)
right of center
behind center
left of center

Length : Offset value

Mode : Off
Continuous
Once

Height : No
Yes

Modification input:

↑,↓	Option selection, option scrolling
ENT	Confirmation of selection or modification
MEN	Return to the calling menu

The direction and the horizontal distance are computed (with EHz). If you enter the local system (XYZ), the centric coordinates are computed.
If you enter YES for the height, the offset point and the center must have the same height.

When having sight connection to the center, it is possible:
- to sight the target directly with the horizontal and vertical direction,
- to press **ENT** in order to start the angle measurement,
- to sight the offset position of the reflector and then measure the distance.

The measured offset is then handled like a centric distance. The height of the center as well as of the offset point are supposed to be identical.

(6) Information line input with soft key Inf
In order to record additional information on a measurement, you can put in upt to 27 alphanumeric information with soft key Inf; you then change from the input menu of the measurement mode to fig. 5.4.2.3.

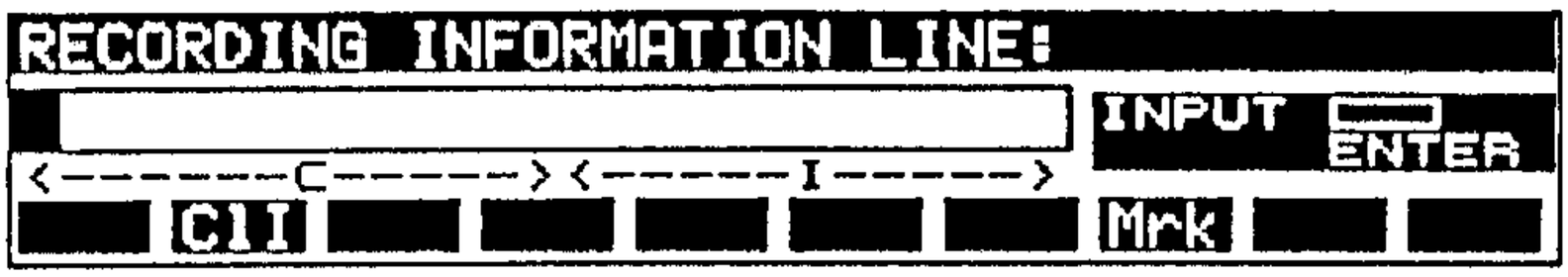


Fig. 5.4.2.3: Information input

The cursor in the first position in line 2 indicated input readiness. Select the input position with the horizontal cursor keys →, ←. Digits can be entered directly, letters and special characters with the **ABC** key or directly with the vertical cursor keys ↑, ↓.

Complete deletion of the information with soft key **CII** (**FCT** + **2**), individual characters with the spacebar.

The information input is terminated by:

MEN : Return to the input and measurement menu without storage
or by
ENT : Input termination with storage at an address

(7) Measurement mode selection with soft key HzV, DHz and YXZ
You can select different measurement mode with these soft keys or the following measured or computed values are alternatingly displayed after measurement.

HzV: Determination of the original angle measurement values
HZ = Horizontal circle reading
V = Vertical circle reading

DHzV: Determination of the original measurement elements D, HZ, and V
D = Slope distance
HZ = Horizontal circle reading
V = Vertical circle reading

EHzh: Determination of the horizontal distance, the horizontal direction and of the height difference
E = Horizontal distance
HZ = Horizontal circle reading
h = Height difference or target height

XYZ Determination of the local coordinates
Y = Easting
X = Northing
Z = Elevation

The last mode when leaving the MEASUREMENT program is the default mode for the next beginning.

(8) Compensation activation/deactivation with soft key Con/Cno
For being able to read angles even in the presence of e.g. strong vibration compensation can be turned off and later turned on again.

Function:
Con : Compensation of the vertical axis tilt by computed correction of the read angle values.
Cno : No correction.

(9) Object height measurement with soft key Ono/on
In the modes EHz and XYZ you can perform remote object elevation measurement by angle measurement after distance and angle measurement to a reference point.

Note:
If you also want to determine the lateral distances to the plumb line point, the line of sight and the vertical plane through the object must be orthogonal.

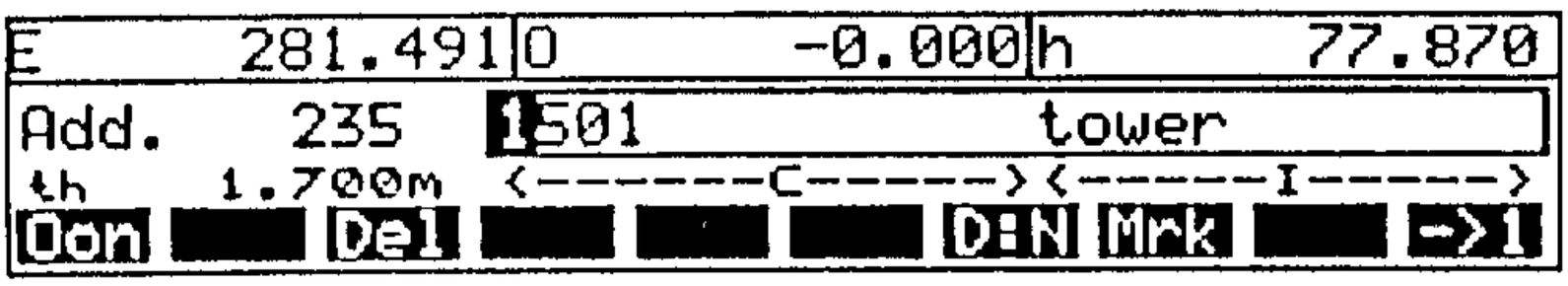


Fig. 5.4.2.4: Object height measurement

Meaning in mode EHz :
E = Horizontal distance between instrument and reflector/target
O = Lateral deviation from the line between the instrument and the reflector.
h = Height of the target

In mode XYZ the results refer to the local system, not to the line between station and object.

Return to the normal function of the actual mode with Ono.
ENT : Storage of the current measurement
MEN : Return to the main menu

(10) Distance tracking with soft key Tno/on
With soft key Tno/on you can switch between single and continuous measurement. Single measurements can be stored with ENT during the tracking. For better using this mode we recommend the input of an increment for the point number. The distance measurements are done forcibly in the special tracking mode with a measuring time of 0,25 sec and an accuracy of 10 mm + 3 ppm.

With Tno you switch back to single measurement.
ENT : Storing of the actual measurement
MEN : Jump back to the main menu

Note:
If you don't move the instrument within 5 sec during the distance tracking, the distance measurement is switched off forcibly for reasons of safety and loss of energy.

Fig. 5.4.2.5: Interruption of distance tracking.

ENT : Continue tracking

(11) Deletion of the last address with soft key Del
The last measurement/address can be deleted with soft key Del.

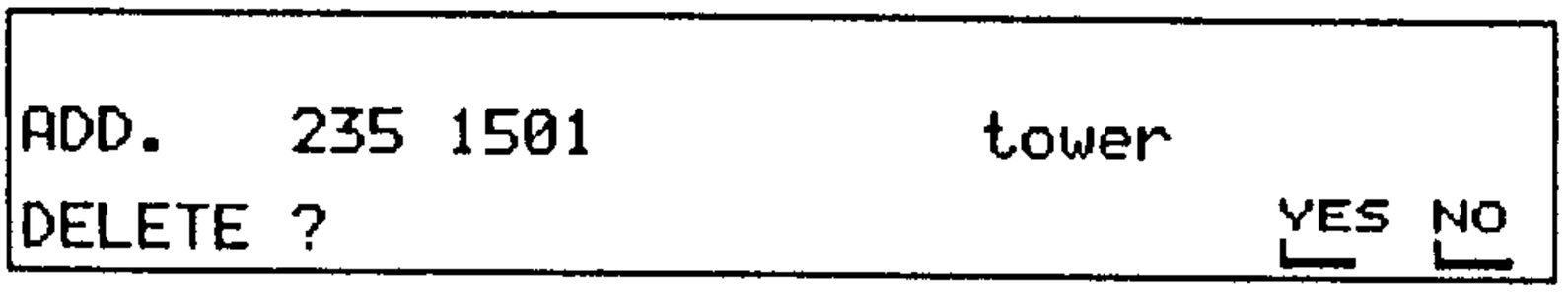


Fig. 5.4.2.6: Delete

YES : The address is deleted. Return to the input menu.
NO : The address is not deleted. Display of "NOTHING DELETED". Return to the input menu.

(12) Rangefinder measurement selection with soft keys D:N/D:R/D:S
Different measurement requirements such as rapid measurement or measurement or super fast measurement are matched by three different option with soft key **D:N**.

D:N : Normal (Default value in the input menu of the measurement)
D:R : Rapid (Option for rapid measurement 0.5 s)
D:S Super fast mode for extremely short measuring time e.g. when measuring moving targets.
Within a measurement mode, the selected option remains active until you change it again.

(13) Mark selection with soft key Mrk
- Purpose
Tailoring to measurement task by selecting different marks that support point identification P.I.

(13) Mark selection with soft key Mrk

- Purpose

Tailoring to measurement task by selecting different marks that support point identification P.I.

- Selection

When you call a measurement mode, the mark used last is displayed automatically (line 3 of the input menu). Call the marks defined in the SET program with soft key **Mrk**. For better recognition of the mark which is worked with, the digit of the soft key changes according to the chosen mark. Step to the desired mark by pressing the soft key repeatedly. The selected mark is used in all programs until you select another one.

5.5 Result menu

After measurement completion the measured values are stored and recorded in the internal memory if necessary. The values of the different modes can be displayed with soft key 7 and 8. Because the angle measurement is done in the tracking mode, the display is actualized continuously.

Important:
The values of E and h or XYZ are not computed again!

Note:
The computed horizontal distance is based on the station height, not on the reflector height (important in the case of big height differences). The height results depend on the entered instrument and reflector heights.

- ih = th :
  H = height difference betwenn the tilting axis of the Rec Elta RL and the reflector

- ih and th entered:
  H = height difference between the station and target elevations.

- H_s + ih and th entered (Hs = known height of the station above the reference plane):
  H = H_z = height of the target above the reference plane.

5.6 Recording

According to the recording mode data is stored internally or externally. (see DATA TRANSFER). The necessary notes are given in chapter INTERFACE DESCRIPTION.
According to the setting of soft key R-M (FCT + 4) you can record in the individual modes as follows:

- Hz, V and D, Hz,V	Rno	Recording deacitvated
	R-M	Recording activated
- E, Hz, h and X, Y, Z	R-C	Recording of computed data
	RMC	Recording of measured and computed data

If an offset point is measured using the soft key option Ecc the following data lines are stored in respect to the recording option:
1. Type and length of the offset
2. Original measurement data D, Hz, V to the center (R-M, RMC)
3. Reduced and centred measurement values E, Hz, h or coordinates to the center (R-C, RMC)

If a measurement is done in position 2, the horizontal angle Hz is transformed to position 1 in the data line of the reduced measurement values E, Hz, h or X, Y, Z. Otherwise position 2 can't be determined any more in a following computation. The measurements in mode HzV and DHz are stored in original values.

6. Coordinates Program

6.1 Overview

Large-area surveys need a coordinate system as a frame.

The measured data is oriented in a coordinate system for processing in the office when you use the MEASUREMENT program modes.

However, in many applications it is necessary or desirable to create or use coordinates directly in the field. The modes required for this purpose are grouped in the COORDINATES program.

(1) Purpose
The COORDINATES program offers four modes (see fig. 6.1.1) for determining, displaying and recording coordinates created in different ways, e.g. stationing on a known point, that is required for side shots and for setting out. In the mode area you can additionally determine the contents of area by coordinates.

(2) Measurement mode selection
Select the COORDINATES program with numeric key 2 in the main menu. This causes a change to the coordinate measurement menu (fig. 6.1.1). The modes can be selected directly with the numeric keys assigned to the programs by the (L) symbols.

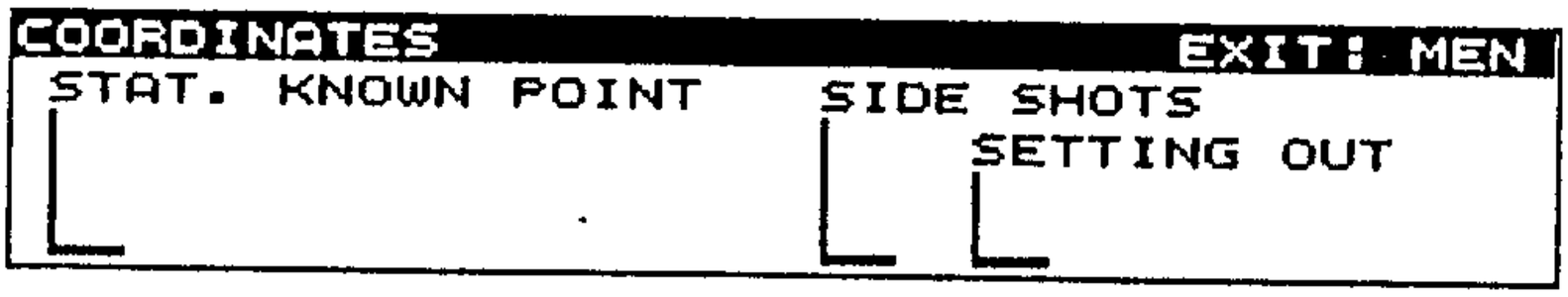


Fig. 6.1.1: Menu of the COORDINATES programs

(3) Description of the modes

Mode 1 Stationing on known point:
Stationing by measurement to known backsight point or by orientation with a given azimuth.

Mode 2 Free stationing:
Stationing by measurement to known reference points and unknown station coordinates.

Mode 3 Polar Points:
Determining of coordinates by measuring D, HZ, and V after stationing.

Mode 4 Setting out:
Setting out by coordinates or with azimuth and distance after prior stationing.

Mode 5 Area (offline):
Computation of the contents of an area by formerly computed or entered coordinates.

6.2 Stationing on known point

(1) Purpose

Preparatory measurement for orienting the set of directions or the circle, to determine the coordinates of side shots, or to set out coordinated points.

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

If the height is to be computed, too, when you are measuring furthermore, you have to put in the station height. The height Z = 0,000 means no height.

Orient the instrument in the common national coordinates system by measuring to a known reference point. The direction angle from the station to the reference points and the scale are computed from these measurements (fig. 6.2.1).

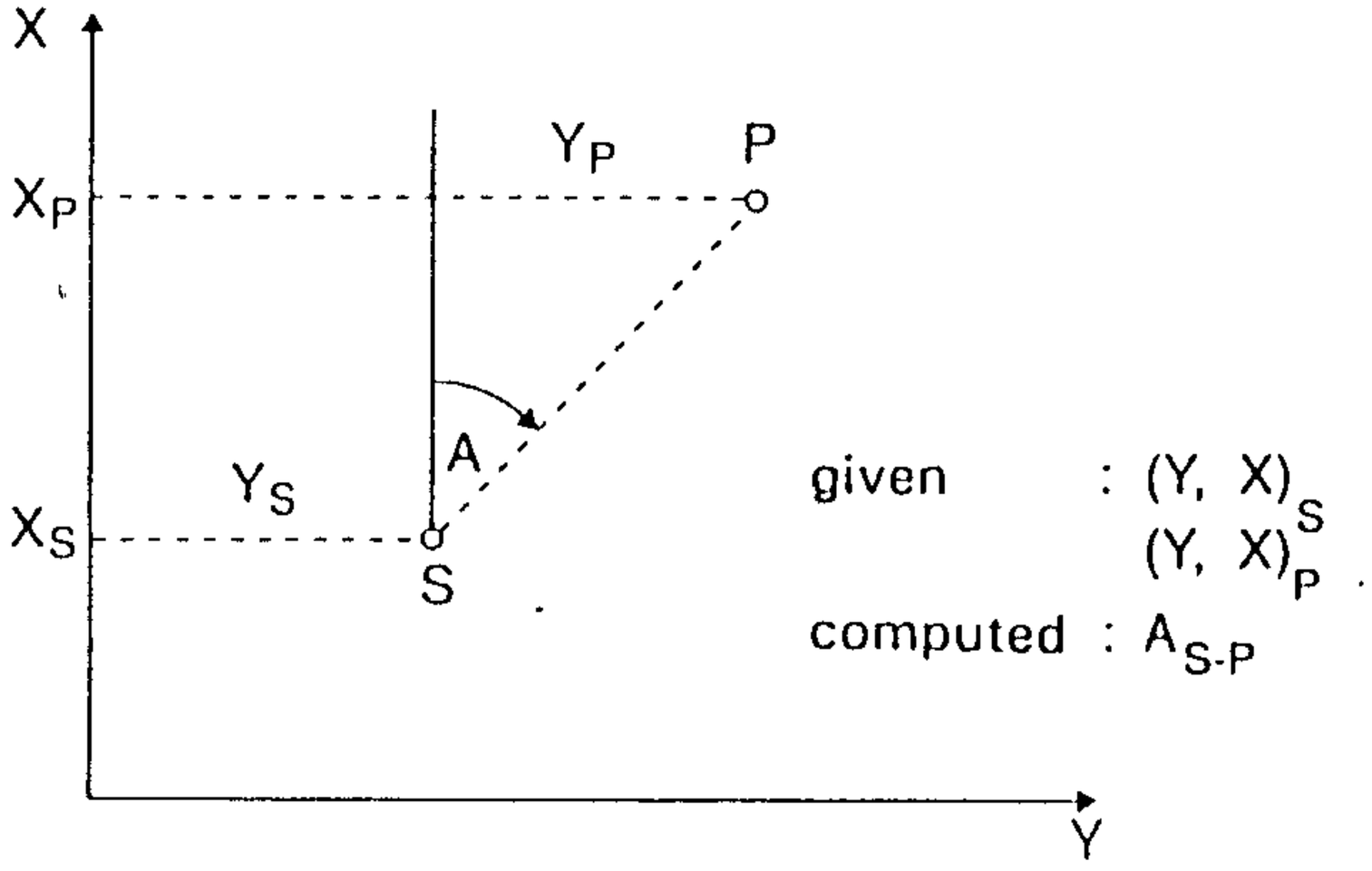


Fig. 6.2.1: Stationing on known point

(2) Mode selection

Call the stationing mode with numeric key 1 in the COORDINATES program (fig. 6.1.1), automatic change to the initial menu of this measurement mode (see fig. 6.2.2).

Fig. 6.2.2: Initial menu of stationing

(3) Recal of known station

ENT : Starts the mode (fig. 6.2.3).

The station can be recalled with soft keys 5 to 8 or entered manually with soft key 3.

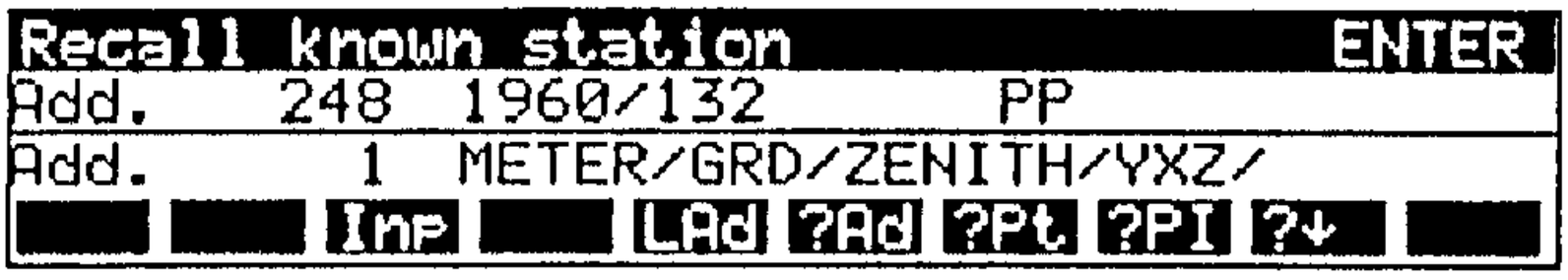


Fig. 6.2.3: Station call

Key		Function
FCT + 3	Softkey Inp	Manuel input of P.I. and coordinates of the station as in the EDITOR program.
FCT + 5	Softkey LAd	Calls the last address in line 2.
FCT + 6	Softkey ?Ad	Calls the station by address.
FCT + 7	Softkey ?Pt	Calls the station by point number.
FCT + 8	Softkey ?PI	Call by point identification.
↑,↓		Scrolls in records.
→,◄–		Toggles between coordinates or point identification P.I. display.

The found address is displayed in line 2 of fig. 6.2.4.

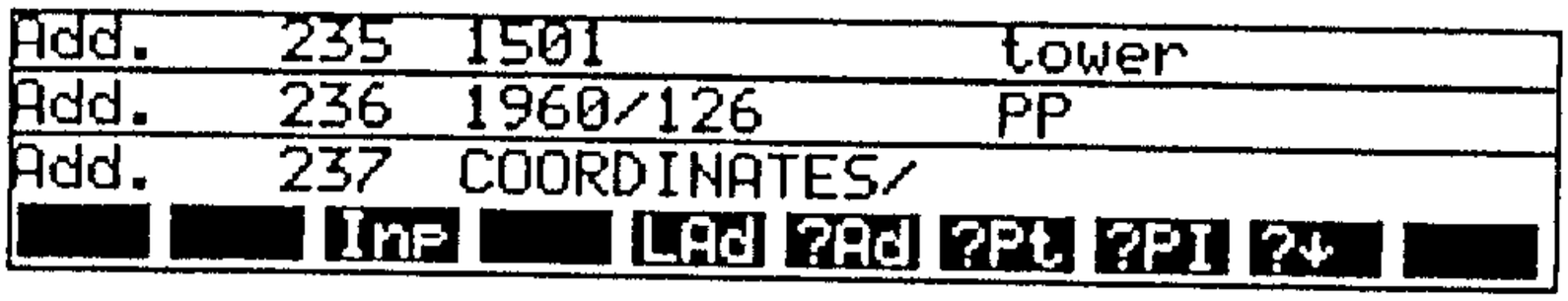


Fig. 6.2.4: Station call

ENT : Confirms point selection; program changes to the display in fig. 6.2.5.

A message appears if the called address does not contain any coordinates.

(4) Orientation method

The orientation can be determined by two methods. Select with numeric key 1 or 2 in fig. 6.2.5.

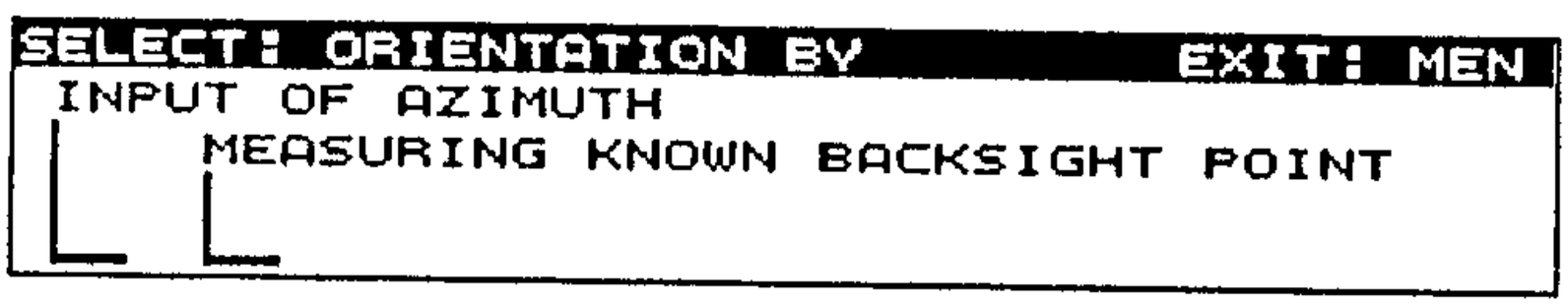


Fig. 6.2.5: Orientation options

Key 1: Distance measurement to the backsight point is not possible, but the direction angle between the station and the backsight point is known (e.g. computed from coordinates) and can be entered (see. (6)).

Key 2: Coordinates of the backsight point is known (available in the memory or entered manually (see.(3)).

Case 1: Orientation with known azimuth

(5) Set HZ menu

Key 1 in fig. 6.2.5 requests entry of the direction angle (fig. 6.2.6). Entry as in chapter 5.2. **(4) Set.**

ENT : Terminates input and changes to P.I. input in the measure menu.

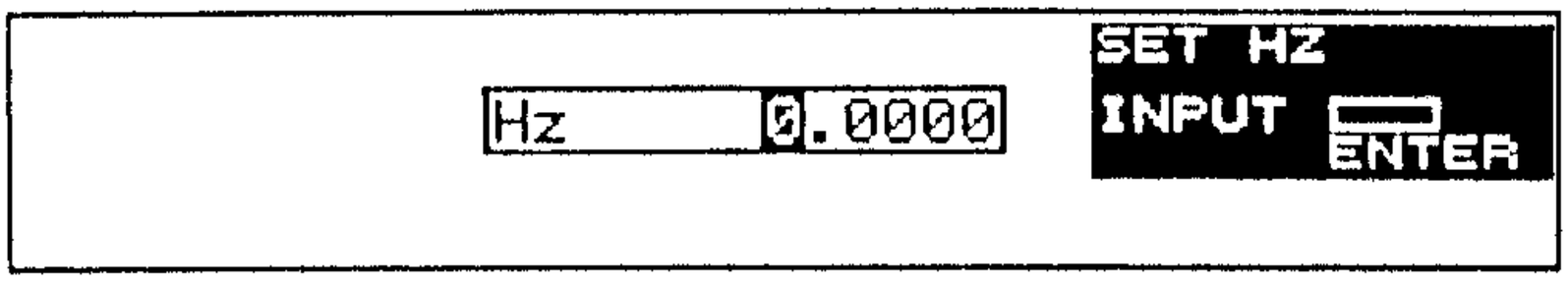


Fig. 6.2.6: Azimuth input

(6) P.I. input in the measure menu

ENT : Calls the measure menu (see. fig. 6.2.7) and enters the point identification in line 2

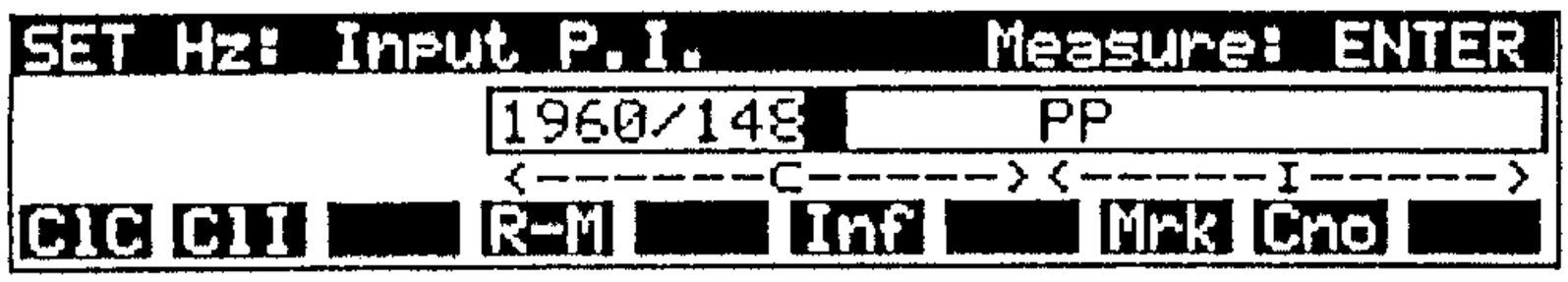


Fig. 6.2.7: P.I. input in the measure men

(7) Measurement

ENT : Sight the backsight point and initiate measurement.

(8) Recording

The set direction angle, the scale (M = 1) and the station coordinates are recorded Return to the main menu (see. fig. 6.1).

Case 2: Orientation with a backsight point

Steps (2) to (4) are similar.

(9) Backsight point recall

If you press key 2 in fig.6.2.5, the display changes to fig. 6.2.8 for recalling the stationing backsight point from the Mem. There is one measurement possible to 1 backsight point.

Fig. 6.2.8: Recall of the backsight point

Calling the backsight point is similar to step (3). Station recall with the soft keys Inp, LAd or ?Ad or with the vertical cursor keys.

ENT : Confirms proper point selection; simultaneous change to the measure menu (fig. 6.2.10).

Fig. 6.2.9 appears if the station and the backsight point are identical.

ENT : Continue measurement and proceed with (9).

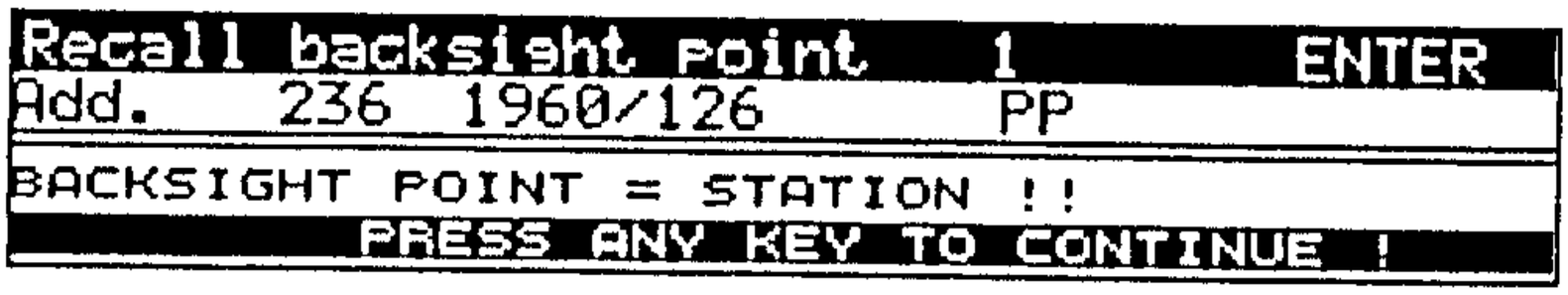


Fig. 6.2.9: Identical points

(10) Measurement

Sight the reflector at the backsight point and initiate measurement with **ENT**.

Select the DTh or Th measurement mode by pressing soft key DTh, i.e. select the measurement option.

DTh : Measurement with rangefinder and theodolite. Interrupt measurement with **MEN** and set soft key to Th if you inadvertently measured the target without prism.

Th : Measurement only with the theodolite.

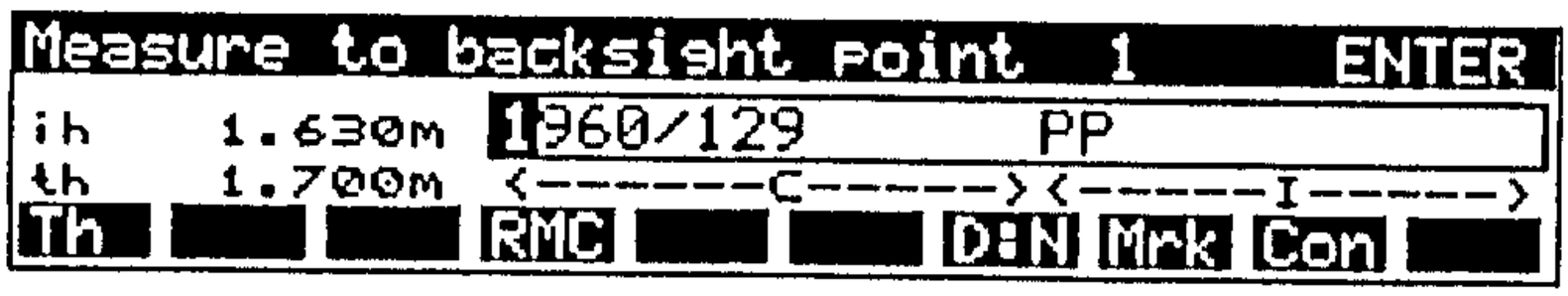


Fig. 6.2.10: Measure menu

(11) Result and scale menu

After backsight measurement, the deviation between the measured values and the values computed from the coordinates (fig. 6.2.11) are displayed in line 1.

Display of:

- **dl** = Longitudinal deviation if measured with DTh
- **dq** = Lateral deviation always is 0,00
- **dz** = Elevation deviation if the station elevation and the backsight point elevation are known.

```
                  dq   0.000m   dz   0.051m
RESIDUALS EXCEEDED, NEW MEASUREMENT
    SET IN INPUT MENU          :m 1.000000
    COMPUTED (STATION.)        :m 1.000000
       RESET TO                :m 1.000000
```

Fig. 6.2.11: Result menu

Measurement continuation depends on whether the given limits have been exceeded or not. Such as:

Deviation too large, new measurement
- The last measurement is not used. Branch to (9). Backsight point recall.

If the deviations are OK, there is a confirmation by the selection of the desired scale. The selected scale is:
- entered in the input menu
- stored
- used for later computations.

Key 2: Scale entry from the input menu (INP)
Key 3: Use of the scale computed during stationing
Key 4: Use of the scale mit M = 1.000 000

Branch to coordinates menu.

6.3. *Free stationing*

(1) Purpose

With free stationing, the coordinates and the elevation of an unknown station point can be determined in any coordinate system. Computation is done by single point adjustment. Reference measurements are possible to 20 reference points. Plane and elevation adjustment are performed separately. Thereby different reference points may be used. The backsight points can be measured with direction and distance, only with directions, or with a combination of the two.
The weighting ratio between direction and distance is 100 : 1. This corresponds to the following mean errors, for example:

mHz = 0.0005 gon
ms = 0.005 m

The weighting ratio can be influenced only indirectly by measuring a point repeatedly.

(2) Mode selection

Call the free stationing mode with numeric key 2 in the COORDINATES program (see fig. 6.1.1), automatic change to the initial menu of this measuring mode.

Fig. 6.3.1: Initial menu of free stationing

It is stated in the entrance menu that all distance measurement is done with scale 1.000 000, independent of any other setting in the INPUT mode.

ENT: Starts the mode and changes to the input menu for the station identification (see fig. 6.3.2).

Fig. 6.3.2: Station entry

ENT : Confirms the entry and changes to the menu for selecting the reference points.

(3) Reference point recall

In the recall menu you can recall reference points from the MEM with soft keys 3 to 8 (see 10, EDITOR program), or enter them manually (see fig. 6.3.3).

Fig. 6.3.3: Reference point recall

Note:

Is the station elevation (Z) also to be computed, the instrument and the target elevation must be entered or modified with the **INP** key.

(4) Measurement to reference points

The reference point can be measured after selecting it. After 2 measurements with direction and distance or 3 direction measurements, the program computes internal approximate coordinates. After measurement to the 2nd or 3rd and all following point, the following selection menu appears:

Fig. 6.3.4: Selection after reference measurement

where:

- dl is the longitudinal deviation (only for distance measurement),
- dq is the lateral deviation,
- dz is the elevation deviation (Z) if the reference point contains an elevation.

Deviation too large, new measurement
- The last measurement is not used, branch to (3)

Next reference point
- Call further reference points,branch to (3)

Adjustment
- Adjustment completion

Repeat steps (3) and (4) for all reference points

(5) Adjustment
If you select the adjustment option, the program computes the plane coordinates, the circle orientation and displays the residuals to the reference points (see fig. 6.3.5).

Fig. 6.3.5: Residuals display

Use the ↑ (up) and ↓ (down) cursor keys to select the individual residuals for assessment.

ENT : All residuals are OK, branch to **(7) Elevation computation**

If the residuals are ot OK, individual measurements can be deleted and added.

(6) Deletion and adding
If the residuals in (5) are not OK, the corresponding measurement can be deleted with soft key **Del**.

Fig. 6.3.6: Delete query

NO : Branch to (5) Adjustment
YES : Measurement deletion (see fig. 6.3.7)

Fig. 6.3.7: Measurement deletion

If you delete individual measurements, adjustment is repeated automatically after ENT. The deleted measurements are retained in the Mem and are marked with DEL within the P.I..
Further measurements can be added with soft key **Add**. Jump to (3), recall of the reference points.

(7) Elevation computation
If elevations are required for further measurements with the polar point or setting-out programs, they must be computed.

Fig. 6.3.8: Elevation computation

NO : No computation of the station elevation
No computation of the elevations in the side shot mode
No computation of elevation differences for setting out
Branch to the result menu (8)

YES :

Case 1:
The measured reference points comprise elevations.
The program computes the station elevation from the reference measurements. Procedure corresponding to plane adjustment.

Case 2:
The measured reference points do not contain elevations. Additional points have to be recalled for elevation stationing. Procedure corresponding to plane stationing (see (3) to (6)).

(8) Result
After stationing, the complete result is displayed (see fig. 6.3.9).

Fig. 6.3.9: Stationing result

YES : Storage of the stationg result (see (9))
NO : Branch to the main menu, the old stationing is retained

(9) Recording
Storage depends on the selected soft key.
Soft key RMR stores both measured and computed values:

- 1.: Measured values D, HZ, V (directly after the measurement). The measurements used for elevation computation are stored again in a separate block. By this step a clear association of measurement and computation is made possible if here measurements are cancelled or further measurements are added.

- 2.: Measured values dl, dq, dr, dz (dl, dq dr after orientation computation, dz after elevation computation)

- 3.: Coordinates X, Y, Z of the reference point

- 4.: Scale M and elevations ih (instrument) and th (reflector)
  Soft key R-C stores items 2. to 4.
  Soft key R-M stores items 1., 3. to 4.

Caution:
Items 3. and 4. are always stored, also for Rno.

6.4 Determination of side shots

(1) Purpose

Determination of the coordinates and elevations of pass points by distance and angle measurement, display and recording of the computed values.
Coordinates computation is possible in a higher-level coordinate system. Local coordinates can be determined in the MEASURE program.

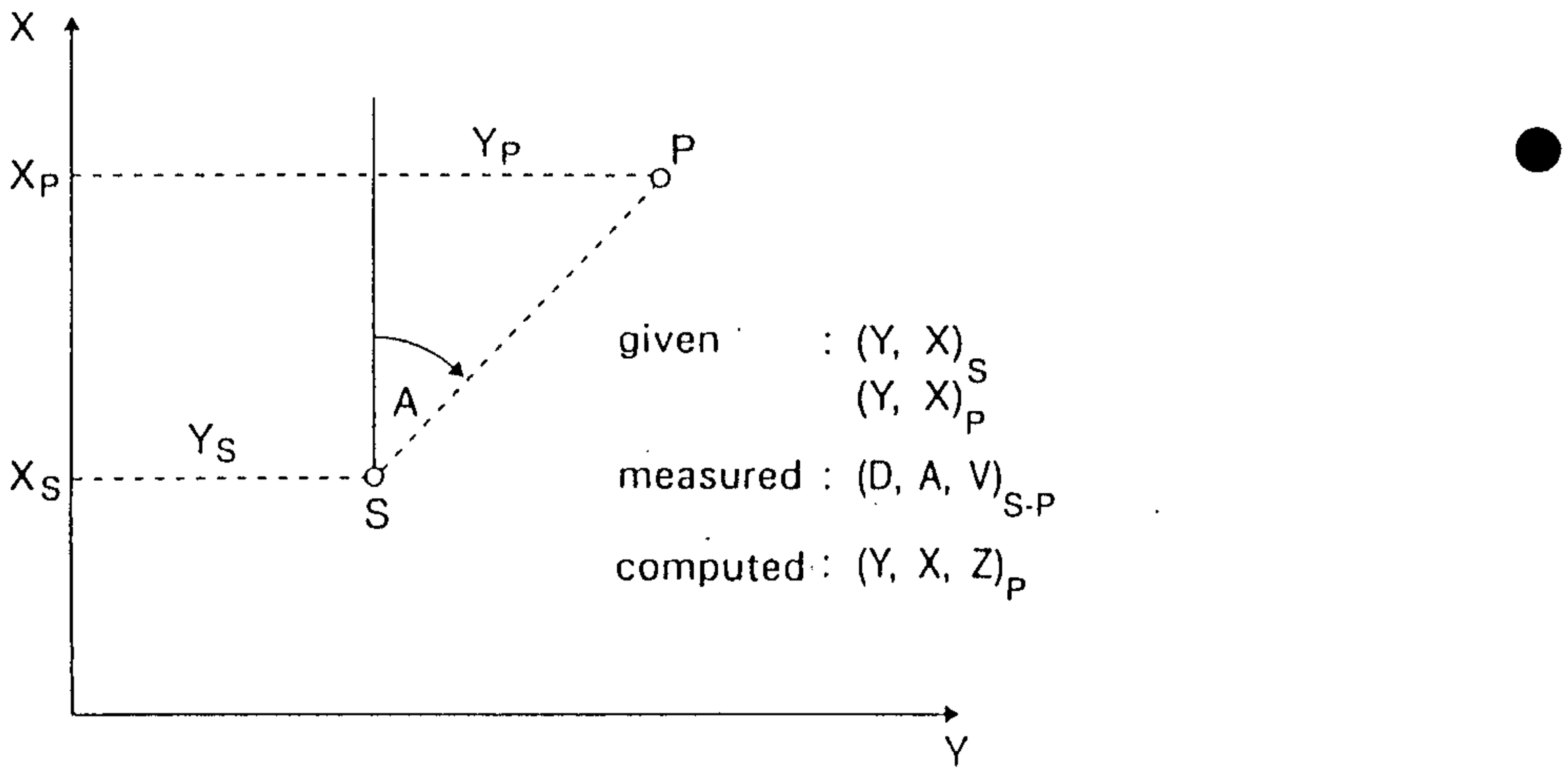


Fig. 6.4.1: Determination of the coordinates of pass points

(2) Mode selection

Call the side shot menu with numeric key 7 ind the COORDINATES program (fig. 6.1.1), automatic change to the initial menu of this measurement menu.

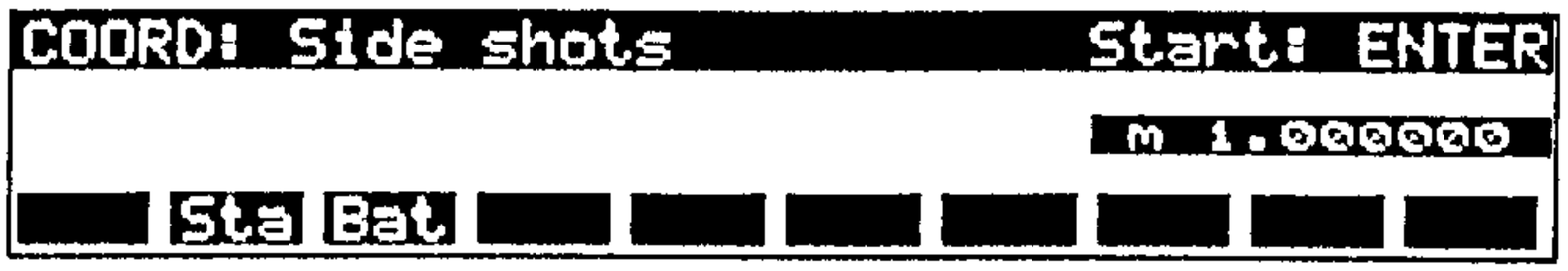


Fig. 6.4.2: Initial menu of side shots

ENT : Display of the last stationing

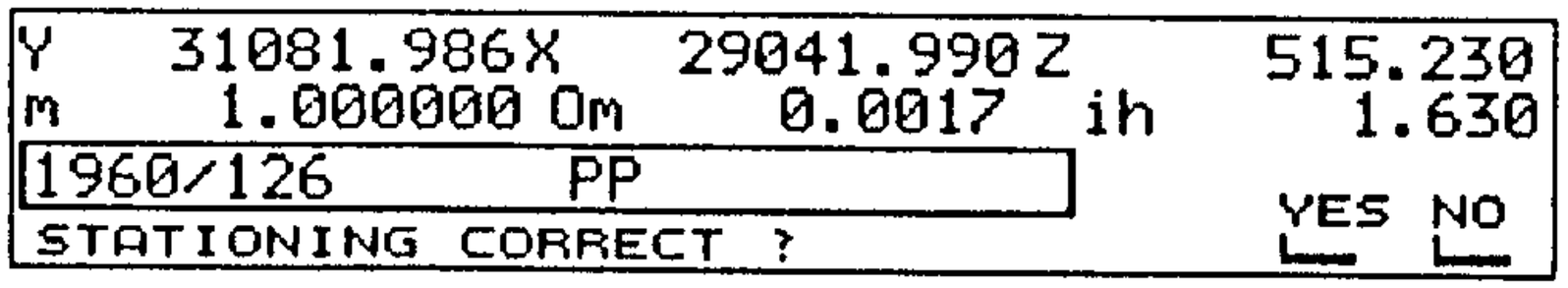


Fig. 6.4.3: Stationing selection

YES : The stationing is valid for this station. Simultaneous change to the measure menu (fig. 6.4.4) for entering the P.I. of the first shot

NO : The stationing is invalid for this station. Change to the coordinates determination menu (fig. 6.1.1), for stationing.

(3) P.I. input in the measure menu

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

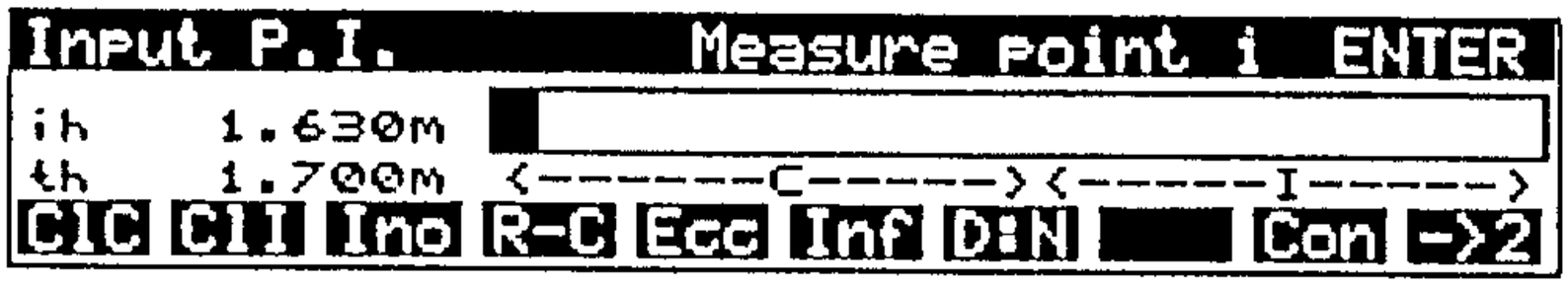


Fig. 6.4.4: P.I. input in the measure menu

(4) Measurement

ENT : Initiates measurement to the pass point

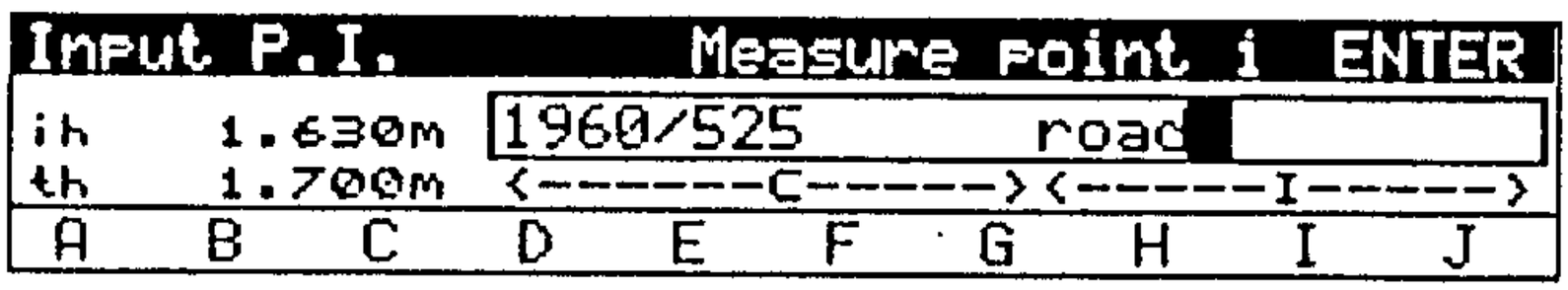


Fig. 6.4.5: Measurement

(5) Result menu

After measurement completion, all three coordinates values are displayed in line 1 (fig. 6.4.6).
The cursor in line 2 of the input field requests input of the new P.I. For further measurements repeat items 3 and 4.

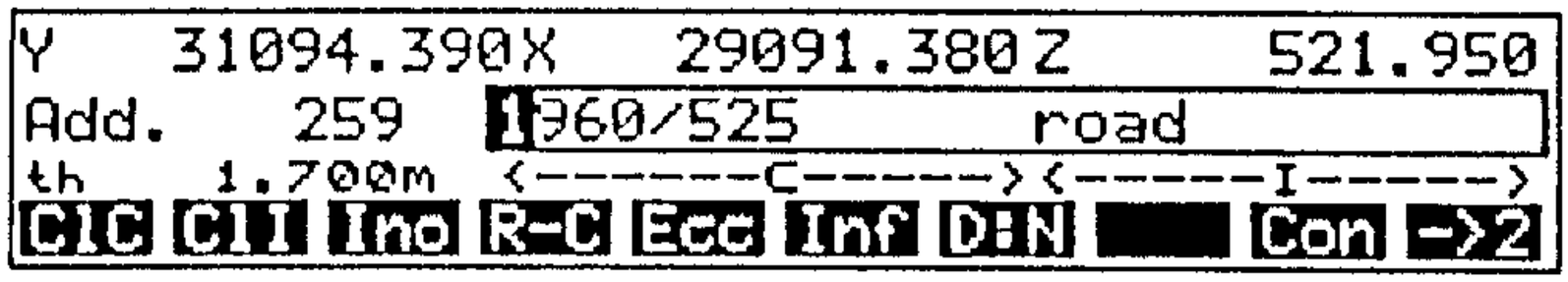


Fig. 6.4.6: Result menu

(6) Recording

Recording successful: an address is displayed in line 2 before the P.I. input field.

Recording of measurement elements or coordinates depends on the setting of soft key 4:

- R-M : Measured values
- R-C : Coordinates
- RMC : Measured values and coordinates

6.5 *Setting out*

(1) Purpose

Locating or setting out coordinated points. The stationing on a known or unknown station as well as the storage in the Mem of the coordinates of the points to be set out are required for setting out by coordinates.

After memory input or recalling the point to be set out from the memory and measurement to the approximate point, the Rec Elta displays as a result the longitudinal deviation dl, the lateral deviation dq, the angle dR from the approximate point to the wanted point auf Näherungspunkt zum Sollpunkt, the radial deviation dr as well as the coordinate deviations dx, dy and dz.

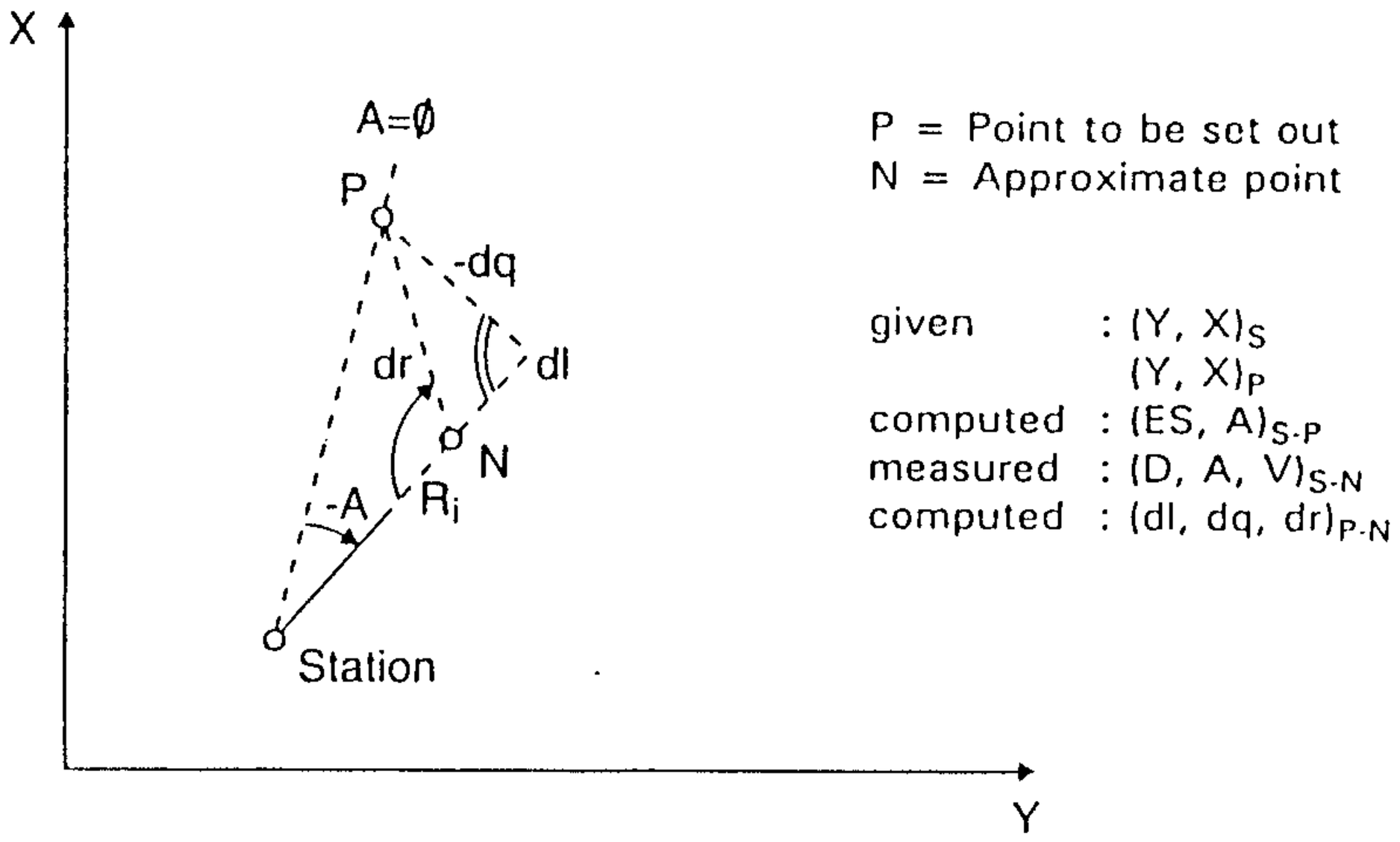


Fig. 6.5.1: Setting out

(2) Mode selection
Call the setting-out mode with numeric key 7 in the COORDINATES program (see fig. 6.1.1), automatic change to the initial menu of this measurement menu.

Fig. 6.5.2: Initial menu of setting out

ENT : Branch to the selection of the setting-out method

(3) Selecting the setting-out method
Two different setting-out methods can be selected according to fig. 6.5.4.

Key 1: Setting out with given coordinates Y, X, Z and orthogonal corrections dl, dq and dr or coordinates corrections dy, dx and dz., simultaneous change to (4) stationing recall.

Key 2: Setting out of side shots with given distance E and direction angle HZ as well as elevation difference h, if these values have been computed beforehand from the station and the setting-out coordinates.
Simultaneous change to the input of an azimuth (see *5.2 Set*).
Then branch to *6.5.5 Setting-out point recall*.

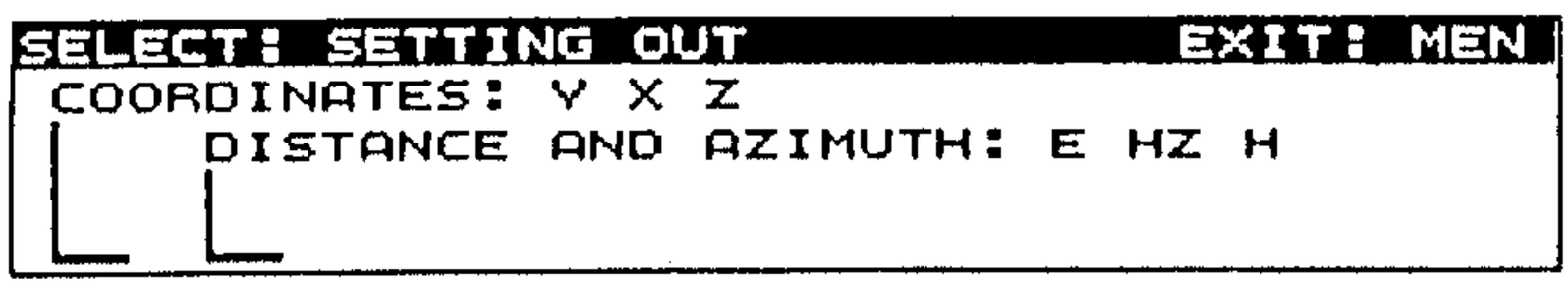


Fig. 6.5.3: Selection of the setting-out method

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

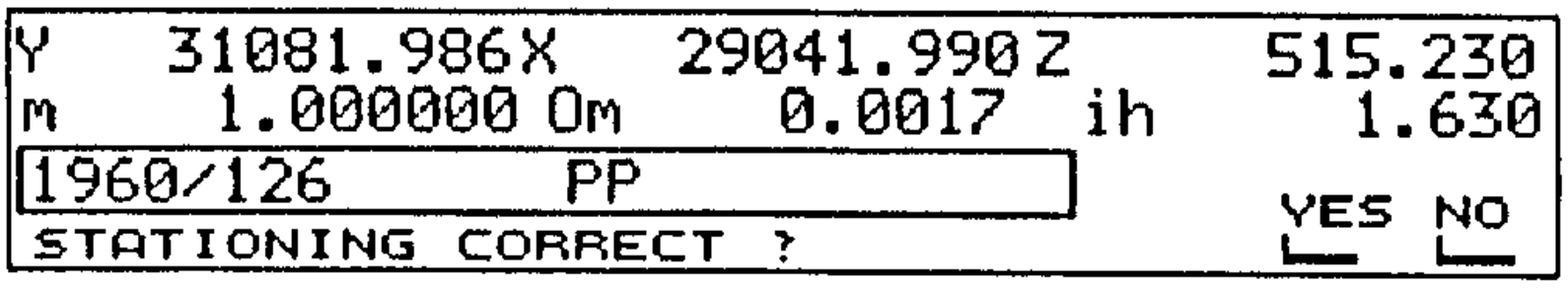


Fig. 6.5.4: Stationing query

YES : The stationing is valid for this station. Branch to the setting-out point recall menu (see fig. 6.5.5)

NO : The stationing is invalid for this station. Simultaneous change to the coordinates determination menu (fig. 6.1.1), for stationing.

(5) Setting-out point recall

The menu for recalling the setting-out points is displayed by selecting the setting-out method (fig. 6.5.5). The setting-out point can be recalled with soft key 5 to 8 or be entered manually with soft key 3.
For setting out by coordinates, records with Y, X, (Z) values are recalled. For side shots, the E, HZ, (h) elements are retrieved.

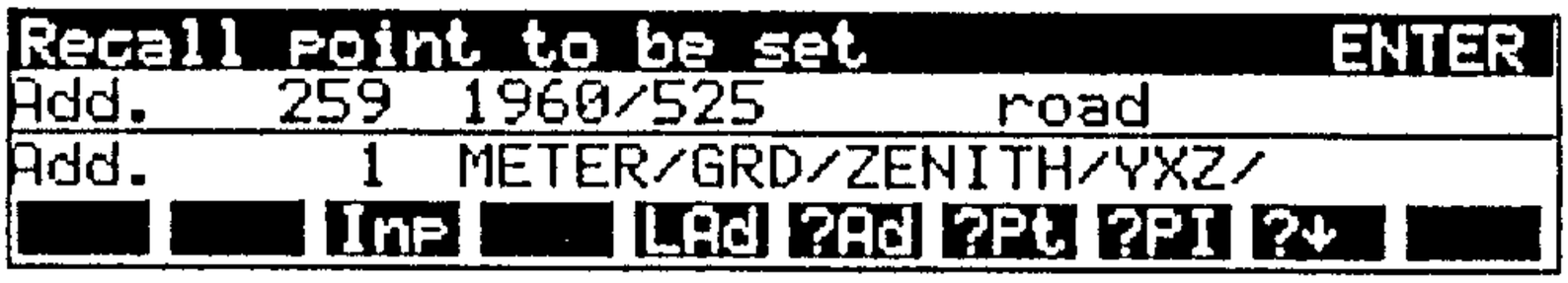


Fig. 6.5.5: Recall of setting-out points

Key		Function
FCT + 3	Soft key Inp	Manual entry of P.I. and station coordinates similarly to 10.3 of the EDITOR program.
FCT + 5	Soft key LAd	Recalls the last address in line 2.
FCT + 6	Soft key ?Ad	Recalls the station point by address
FCT + 7	Soft key ?Pt	Recalls the station point by point number
FCT + 8	Soft key ?PI	Recall by point identifikation
↑,↓		Scrolls in the records.
→,◄–		Toggles between coordinates or point identification P.I.

ENT : Confirms point selection and changes the display to fig.6.5.7.

A message appears if the recalled address does not contain coordinates or side shot elements.

Check for identity of the setting-out point and the station. Fig. 6.5.6 appears if the station and the setting-out point are identical.

ENT : Continue the measurement and then (5)

```
Recall point to be set                    ENTER
Add.    236  1960/126          PP
POINT TO BE SET = STATION !!
          PRESS ANY KEY TO CONTINUE !
```

Fig. 6.5.6: Identical points

(6) Setting-out elements

From the known station and target coordinates, the Rec Elta computes the setting-out elements E (wanted horizontal distance) and Hz (direction angle to the setting-point) and displays them (see fig. 6.5.7). Every setting-out point is internally set to Hz = 0,000 gesetzt. The instrument has to be turned until Hz = 0,000 appears in the display.

```
 Hz→0     Measure point to be set: ENTER
                 1960/525          road
 ih     1.630m
 th     1.700m   Hz     -17.0872E          50.924
 Tno  |    |    | RMC | den |    | D:R |    | Con |
```

Fig. 6.5.7: Setting-out elements

(7) Measurment and result

ENT : Initiates the measurement to the approximate point

```
 Next iteration: ENTER          Record: MEN
 dl        -0.001 dq          0.017 dr        0.017
                  Hz         0.0204
 Tno  |    |    | RMC | All |    | D:R |    | Con |
```

Fig. 6.5.8: Result menu

After measurement completion, the rectangular and polar corrections are displayed. Rectangular corrections dy, dx, dz as coordinate differences between the wanted point and the approximate point. Polar corrections dl (longitudinal deviation) dq (lateral deviation) dR (angle to approximate point) and dr (radial deviation).

- dl positive : Measured distance too short
- dq positive : Approximate point is left of wanted point

The lateral deviation (Hz) is displayed in the tracking mode.
Repeat measurement to the approximate point with **ENT** until the deviations do not longer exceed the given limits.

The tracking mode for distance measurement and computation of the setting-out data is activated and deactivated with soft key **Tno/Ton**. In this mode also persons could be measured who move towards the point to be set out. When the approximation is accurate enough the precise setting out can be performed again by single measurement in mode D:N to a prism.

Note:
If the instrument is not moved within 5 sec during the distance tracking, the distance measurement is switched off for reasons of safety and loss of energy.

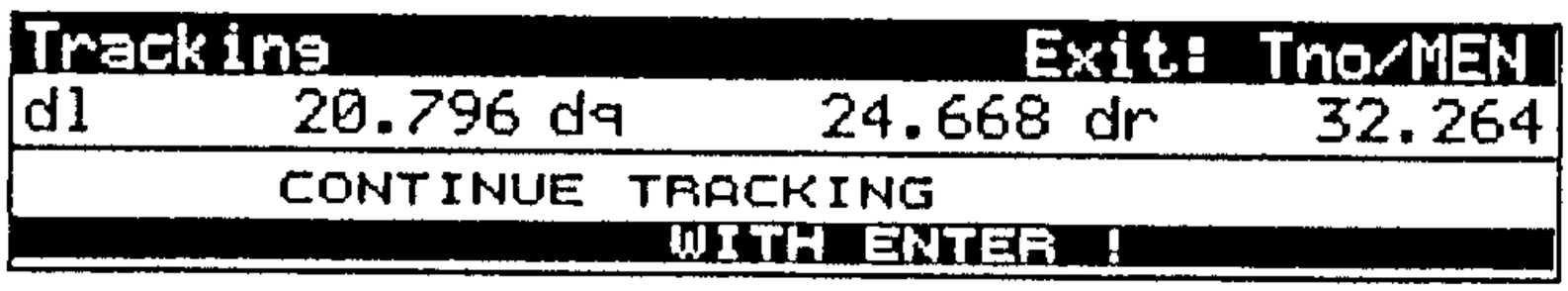


Fig. 6.5.9.:Interruption of distance tracking

ENT : Continue tracking

(8) Measurement termination and recording

MEN : Terminates measurement after setting-out.

Brief display of the address at which the final setting-out elements are stored. The display changes to the recall menu if you want to set out further points.

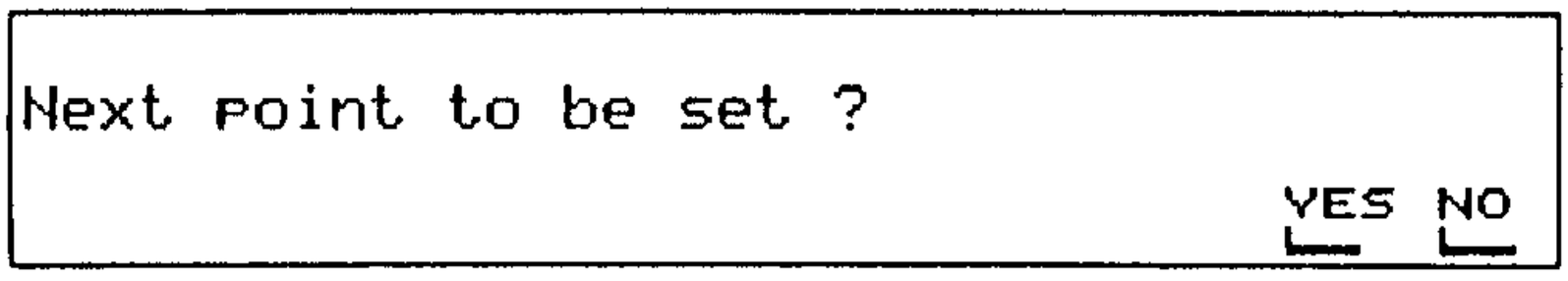


Fig. 6.5.10: Setting-out of further points

YES : Branch to 6.5.5, recall of setting-out points
NO : Branch to the coordinates menu

Recording of the measurement elements or the coordinates depends on the setting of soft key 4 and 5:

- **R-M** : Measured values D, HZ, V
- **R-C** : Computed values depending on the setting of soft key 5:
  - dlq : Longitudinal, lateral and elevation deviation
  - dyx : Coordinate differences (coordinates only)
  - drR : Angle to approximate point and radial deviation
  - ALL : All
- **RMC** : Measured and computed values

For a clear description which point has been set out, the address of the setting-out point is stored in the P.I. right justified.

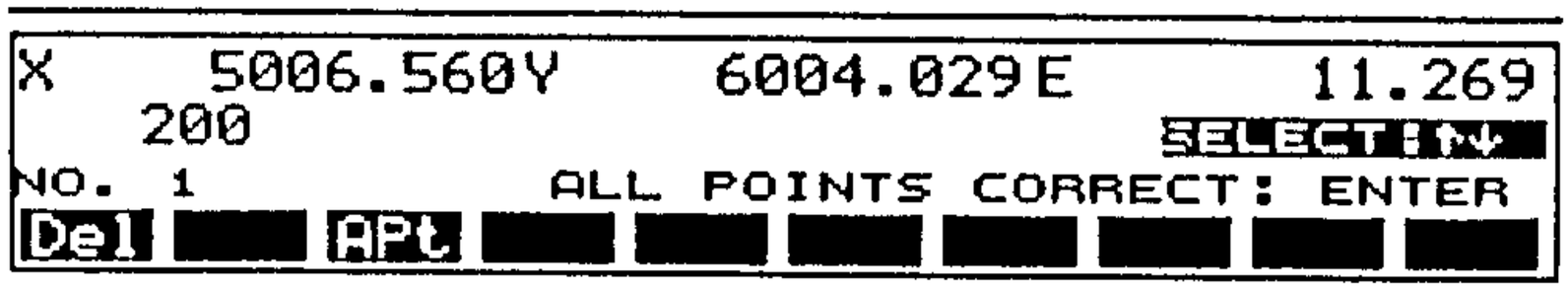


Fig. 6.6.4: Check of the input

Wrongly entered points can be deleted with soft key Del.

Fig. 6.6.5: Deletion of a point

YES : The point is deleted. Branch to (4) Computation of the area
NO : Branch to (4) Computation of the area

Additional points are entered with soft key APt. Hereby you have to take care of the exact sequence. With the cursor keys you can go to that point (see fig. 6.6.4) in front of which an additional point is to be inserted.

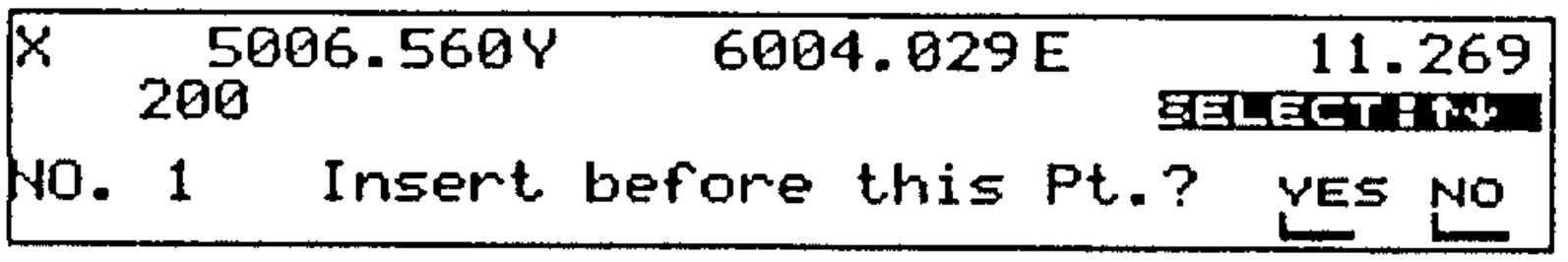


Fig. 6.6.6: Additional points

YES : Branch to selection of points (see fig. 6.6.3)
NO : Branch to (4) Computation of the area

(5) Result

ENT confirms the correct selection and input of all points and displays the result.

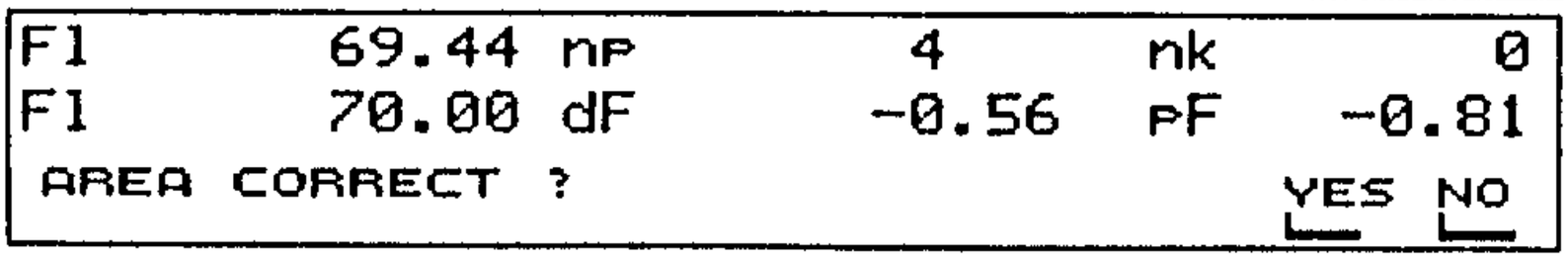


Fig. 6.6.7: Result of the area computation

(3) Calling of the area corner points

Fig. 6.6.3: Calling of the area corner points

Hereby means:

Key		Function
FCT + 1	soft key Are	Starting the area computation
FCT + 3	soft key INP	Manual input of the coordinates
FCT + 4	soft key NAr	Input of a nominal area
FCT + 5	soft key LAd	Calls the last address
FCT + 6	soft key ?Ad	Calls by address
FCT + 7	soft key ?Pt	Calls by point number
FCT + 8	soft key ?PI	Calls by a point identification P.I.
FCT + 9	soft key ?↓	Further searching with the entered P.I.
↑,↓		Scrolls in records
<-,->		Toggles between the coordinates or P.I. display

A detailed description of the searching routines is given in chapter 10. Editor.

ENT : Confirms the selection

Maximum 60 points can be entered.

(4) Computation of the area

The computation is started with soft key **Are**. For checking reasons the points with their P.I. and with their coordinates are displayed again in the sequence of the input. The individual inputs are selected with the cursor keys ↓ and ↑.

7. Special

7.1 Overview

(1) Purpose

The SPECIAL program offers two modes (see fig. 7.1.1) for solving common surveying problems. From the original measurement elements D, HZ, V, the values required by the application are computed, displayed and stored.

Especially in these modes tasks which otherwise have been nearly insoluble can now be solved in a smart and economical way by reflectorless measurement.

(2) Mode selection

Select the SPECIAL program with numeric key 3 in the main menu. The menu of the special programs (see fig. 7.1.1) now appears. The modes can be selected directly with the numeric keys indicated by the (L) symbols.

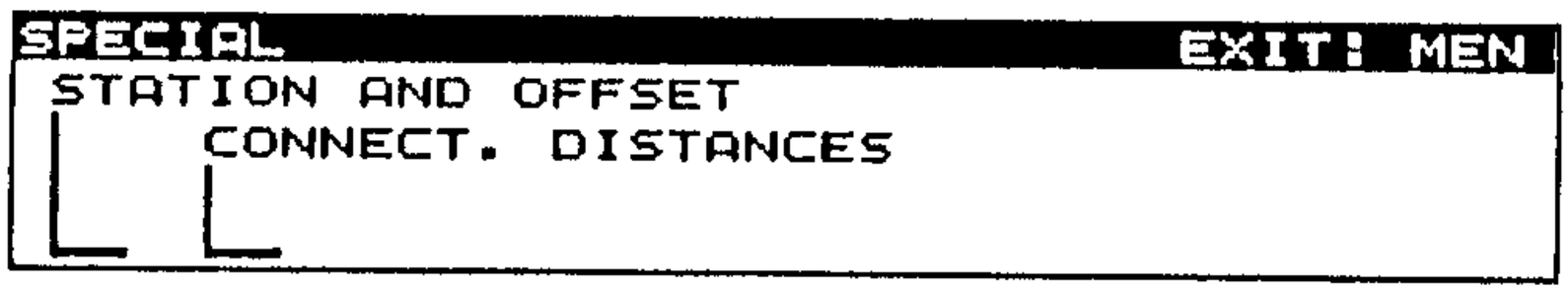


Fig. 7.1.1: Menu of special programs

(3) Modes description

Mode 1: Point-to-line distance

Determination of:

- x = Distance of the plumb line point from the start point P1
- y = Orthogonal distance of the point to the line P1-P2
- h = Height difference between P1 and P2
- Z = Height of the target Pi

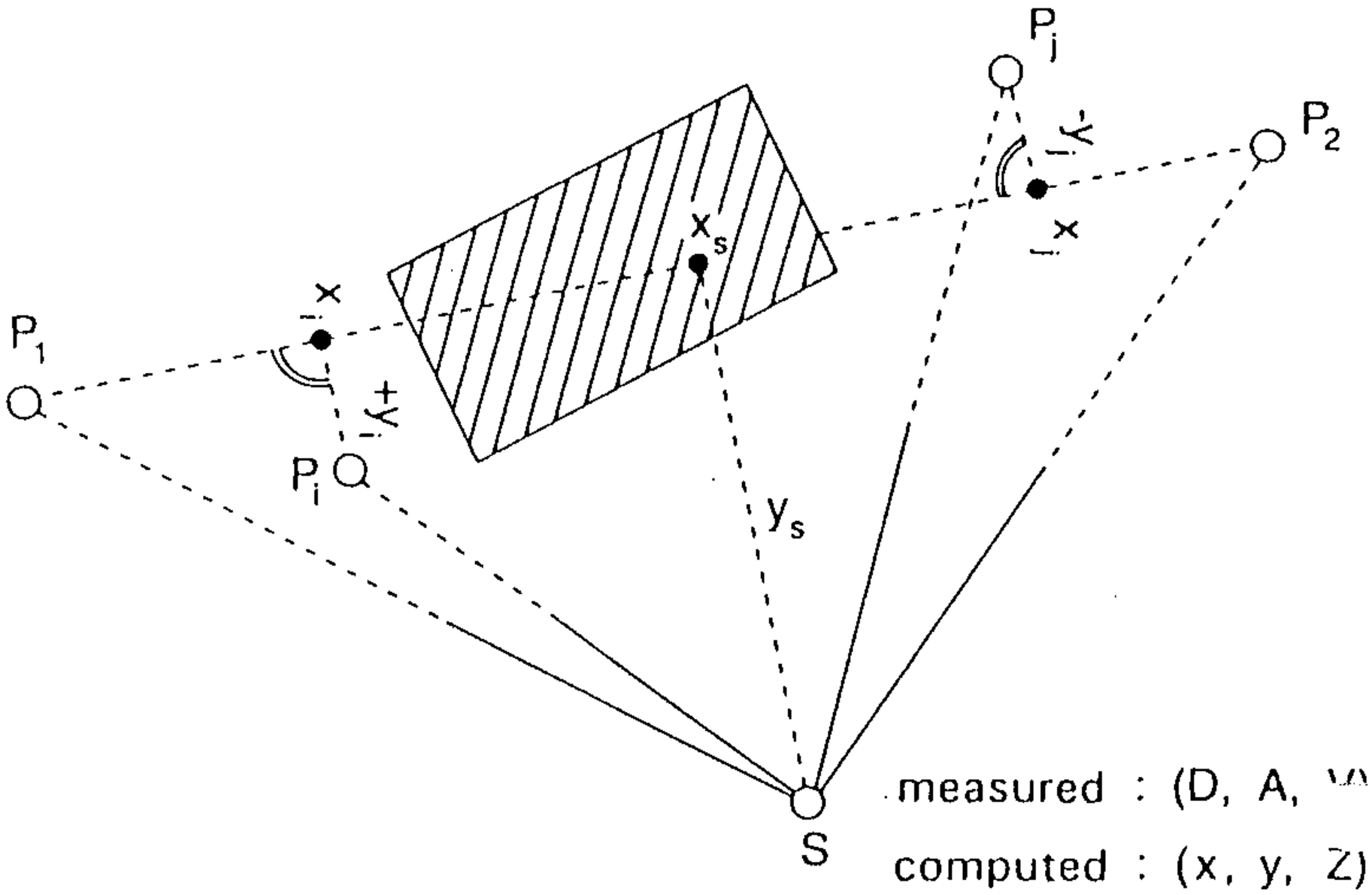


Fig. 7.1.2: Point-to-line distance

Mode 2: Connecting distances

Determination of:

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

between:

- the first sighted and all further points (function 1→P, soft key 5)
- two consecutively sighted points (function P→P, soft key 5).

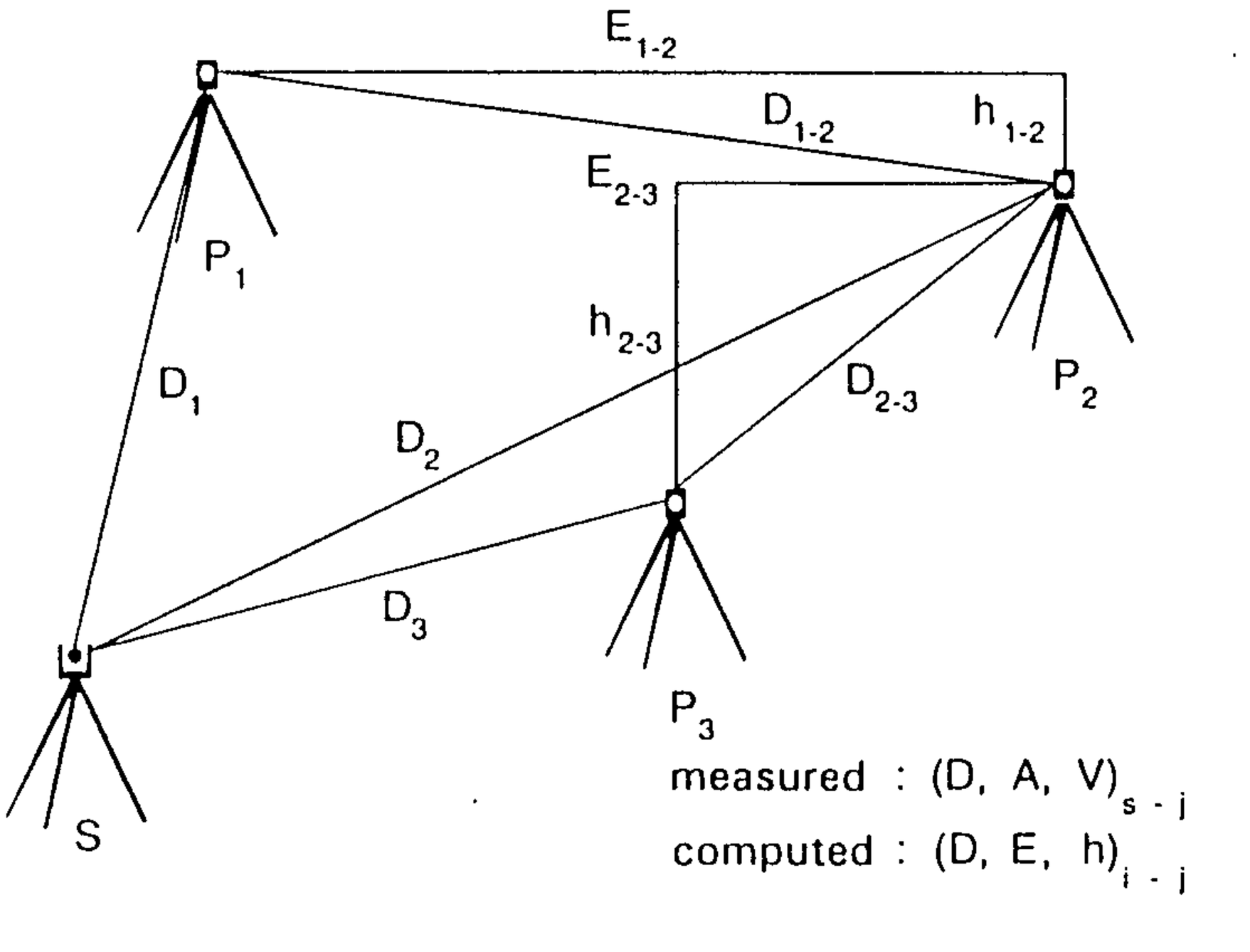


Fig. 7.1.3: Connecting distances

7.2 Point-to-line distance mode

(1) Purpose

Determination of point distances from a reference line specified by angle and distance measurement to the two points P1 and P2.
Orthogonal surveys along measurement line, utility lines, road axes as well as profile surveys are easy with this mode. Is the instrument station chosen freely the points P1 and P2 must be measured. Is the instrument station in a coordinate system the points can be called from the internal memory.

(2) Mode selection

Call the point-to-line distance mode with numeric key 1 in the SPECIAL program (see fig. 7.1.1), automatic change to the initial menu of this measurement mode (fig. 7.2.1).

Fig. 7.2.1: Initial menu of point-to-line distance

(3) Coordinate system selection

Fig. 7.2.2: Coordinate system selection

1. Local system

In the local system both line points P1 and P2 are measured. The height is determined by measuring to the first line point.

ENT : Starts the mode

(4) P.I. input

Enter the point identification in line 2 of fig. 7.2.3.

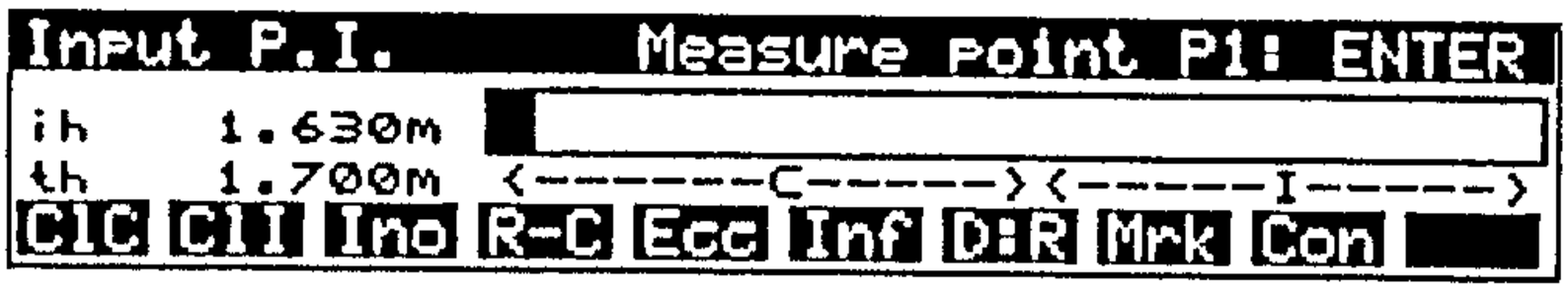


Fig. 7.2.3: Input menu for local system

(5) Measurement to the first line point

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

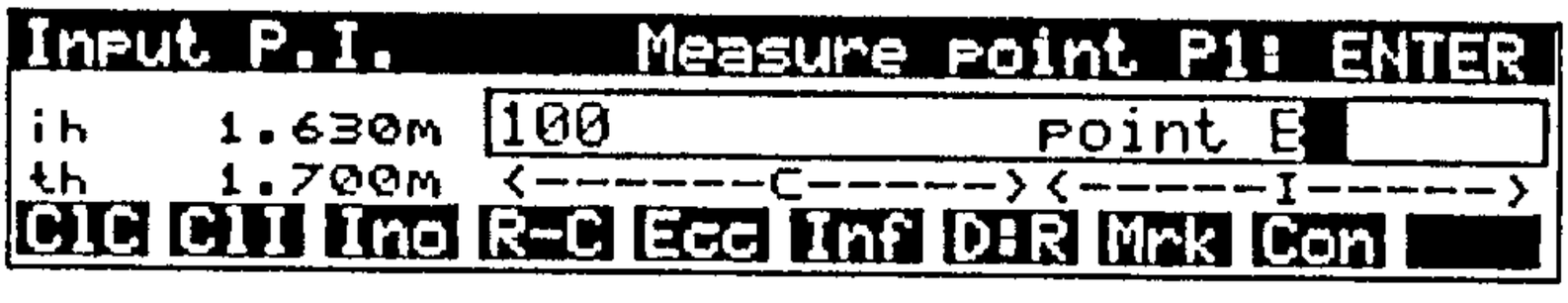


Fig. 7.2.4 Measurement to the first line point

After the measurement the values are recorded corresponding to the setting of soft key 4 -R-M, R-C or RMC.

(6) Measurement to the second line point

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

(7) Result menu

Results after measurement to the two line points (fig.. 7.2.5).

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

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

ENT : Storage in two records if the recording mode is active.

```
P1-P2/STATION                                    ENTER
y          0.000 x     1236.567
y        -18.095 x       -8.440 Z          -6.655
```

Fig. 7.2.5: Result menu of point-to-line distance

If P1 and P2 are identical a message appears in the display (see 7.2.6). Continue measurement with **ENT** and proceed with (4).

```
Measuring !!
Add.    292  101
P1 AND P2 ARE IDENTICAL !
          PRESS ANY KEY TO CONTINUE !
```

Fig. 7.2.6: Identical points

(8) Measurement of lateral points

Change from the result menu to the input menu for measuring detail points (points that are not on the line) with **ENT**. The cursor in line 2 of the input field requests input of the new P.I. For further measurements repeat steps (4). and (5). The local coordinates y, x and z referred to the line are displayed and recorded (fig. 7.2.7).

```
y          76.608 x     256.651 Z          -18.928
Add.     270ec110                    tree
th     1.700m  <-------C------><-----I------>
CIC CII Ino R-C Ecc Inf D:R Mrk Con
```

Fig. 7.2.7: Lateral points

(9) Recording

The measurements are recorded automatically if soft key 4 is R-M, R-C or RMC. Recording successful: the address is displayed in line 2 in front of the P.I. input field.

Important:
If soft key 4 is Rno, recording is off. The address is missing in line 2 then.

(10) Measurement termination

MEN : Direct return to the SPECIAL program.

2. Coordinate system

The last completed system is displayed.

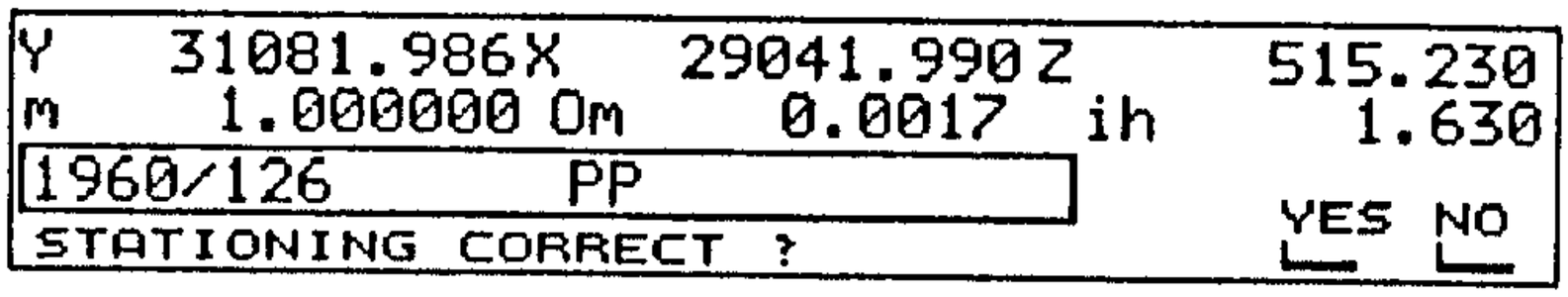


Fig. 7.2.8: Display of the last station

Is this station correct?
YES : Continue with **(11) Recall P1**
NO : Jump to the SPECIAL main menu (fig. 7.1.1)

(11) Recall P1

The coordinates of the points P1 and P2 may be recalled from the memory or entered with soft keys 3-8.

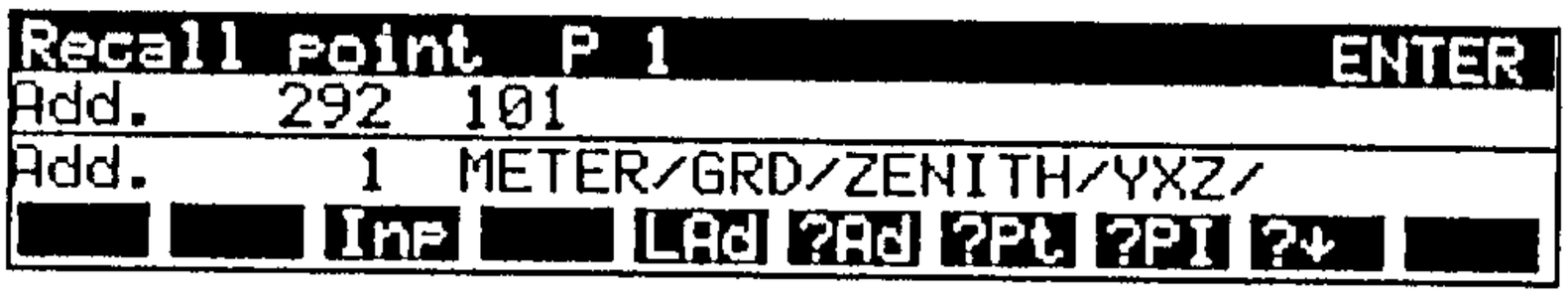


Fig. 7.2.9: Selection of the points P1 and. P2

ENT : Confirm the selection

(12) Result menu

If the points P1 and P2 are correctly recalled or entered, the result will be displayed.

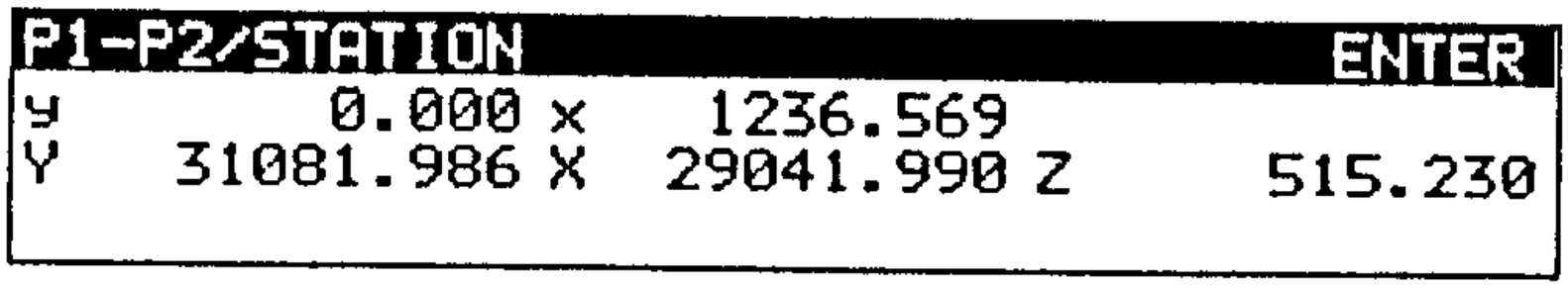


Fig 7.2.10: Result menu for point-to-line distance

where:

- **Line 2** : Local coordinates y and x of the second line point, relative to the P1-P2 axis.

- **Line 3** : Major coordinates Y, X and Z of the standpoint in the reference coordinate system.

ENT : The result will be stored. Continue with **(9) Measurement of lateral points.**

If both points are identical, the relevant display will appear (see fig. 7.2.6).

7.3 Connecting distances mode

(1) Purpose

Distance and angle measurements from a station to two points supply as connecting distances the slope distance (D), the horizontal distance (E) and the height difference (h) between:
- the sighted point and the first point (soft key **1→P**)
- consecutive points (soft key **P→P**).

(2) Mode selection

Call the connecting distances mode with numeric key 2 in the SPECIAL program (see fig. 7.1.1), automatic change to the initial menu of this measurement mode (fig. 7.3.1).

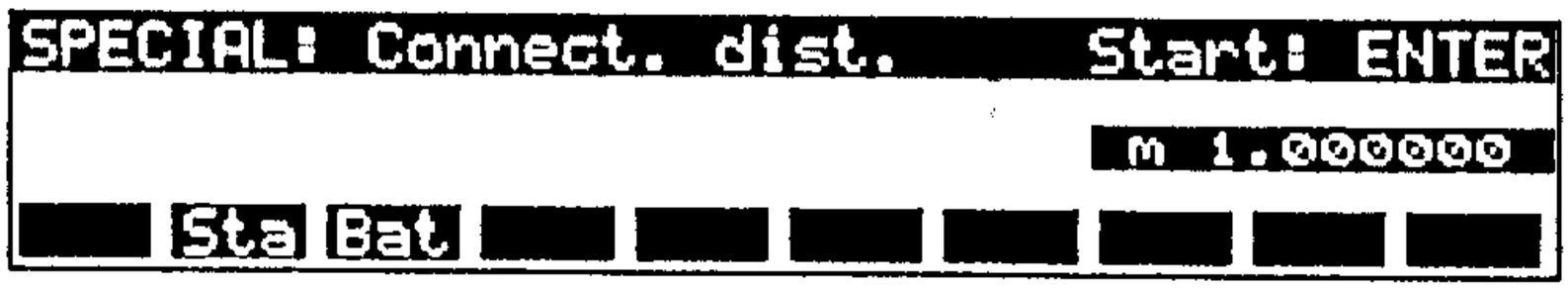


Fig. 7.3.1: Initial menu of connecting distances

ENT : Starts the mode

(3) Coordinate system selection

Fig. 7.3.2: Coordinate system selection

MEN : Return to SPECIAL menu

1. Local system (Key 1)
In the local system the reference points for connecting distances determination can be directly measured.

(4) P.I. entry

Enter the point identification in line 2 of fig. 7.3.3.

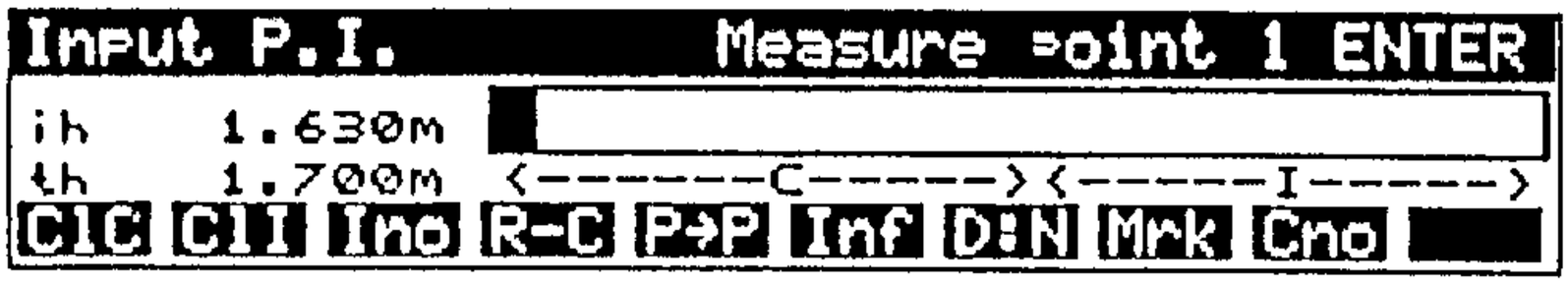


Fig. 7.3.3: Input menu of connecting distances

(5) Measurement to the first point

Sight the reflector of the first point and initiate measurement with ENT.

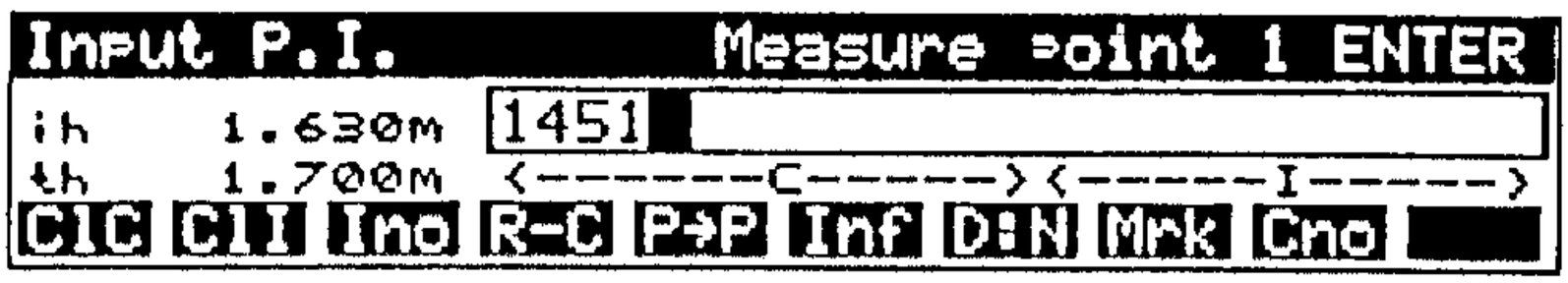


Fig. 7.3.4: Measurement of connecting distances

After the measurement the values are recorded corresponding to the setting of soft key 4 - R-M, R-C oder RMC. Continue with (6)

(6) Measurement to the next point

Enter the point identification for the nexte point in line 2. Sight the reflector of the second point and initiate measurement with ENT.

(7) Result menu

When measurement to the first two points is completed, all three determined elements are displayed in line 1 (fig. 7.3.5). The cursor in line 2 of the input field requests input of the new P.I. For further measurements, repeat steps (5). and (6).

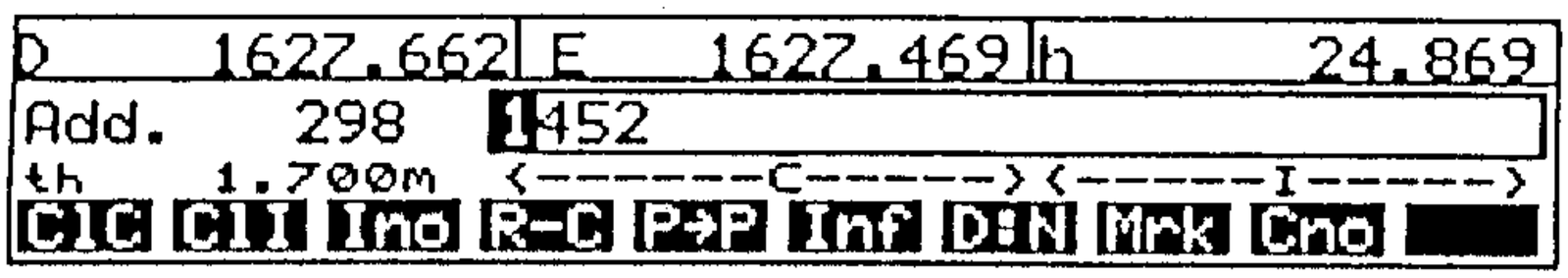


Fig. 7.3.5: Result menu of connecting distances

(8) Recording
The measurements are recorded automatically if soft key 4 is R-M, R-C or RMC. Recording successful: the address is displayed in line 2 in front of the input field.

Important:
If soft key 4 is Rno, recording is off. The address is misssing in line 2.

2. Coordinate system (Key 2)
The connecting distance can be determined in a reference coordinate system. It is then possible to recall the first point from the memeory, or to enter it. It is not necessary to measure the point again.
The last station will be displayed.

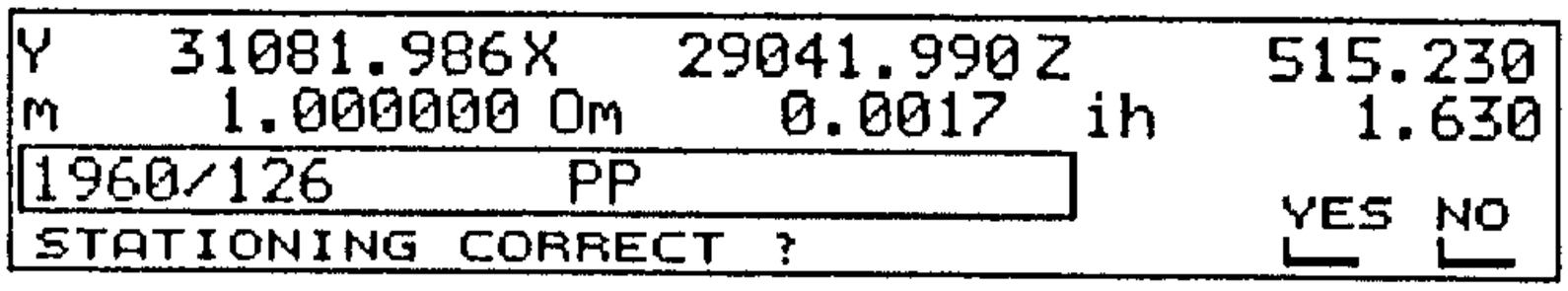


Fig. 7.3.6: Display of the last station

YES : Continue with (8) Recall P1
NO : Jump to SPECIAL main menu (see fig. 7.1.1)

(9) Recall P1
The coordinates of point P1 can be recalled from the memory using the soft keys 3-8, or they can be entered manually.

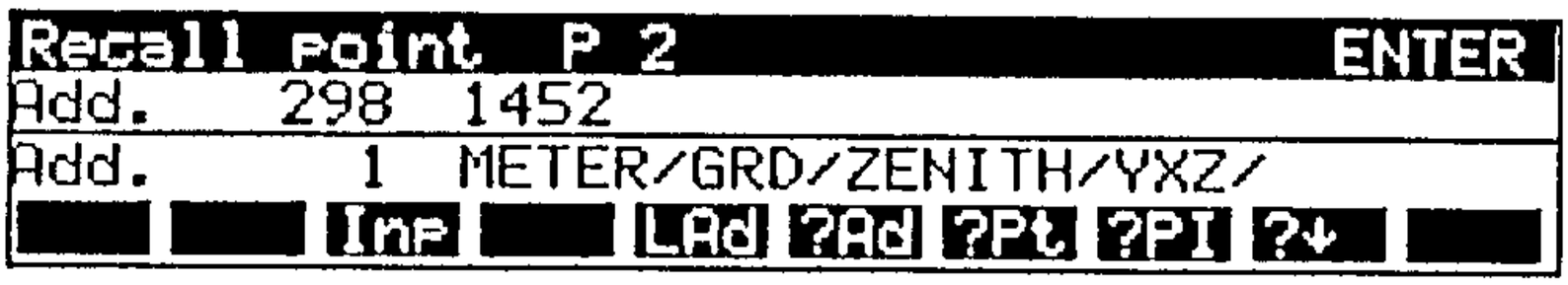


Fig. 7.3.7: Recall P1

If the standpoint is identical to P1, the following message is displayed:

CONNECTION POINT = STAND POINT!!

If the points are selected correctly, there is a change to **(6) Measurement to the next point.**

(10) Finishing the measure and leaving the mode
MEN : Direct return to the SPECIAL program.

8. Adjustment/Preparation

8.1 Overview

(1) Purpose

Extended instrument usage under extreme measurement conditions, transportation, prolonged storage and large temperature variations can cause the instrument to become misaligned. This can cause errored results. Such errors can be eliminated by adjustment and by specific measurement methods. Manual adjustment is described in detail in the Appendix.

(2) Adjustment mode selection

Call the ADJUSTMENT/PREPARATION program in the main menu with key 6; the menu and its modes are displayed (see fig. 8.1.1).

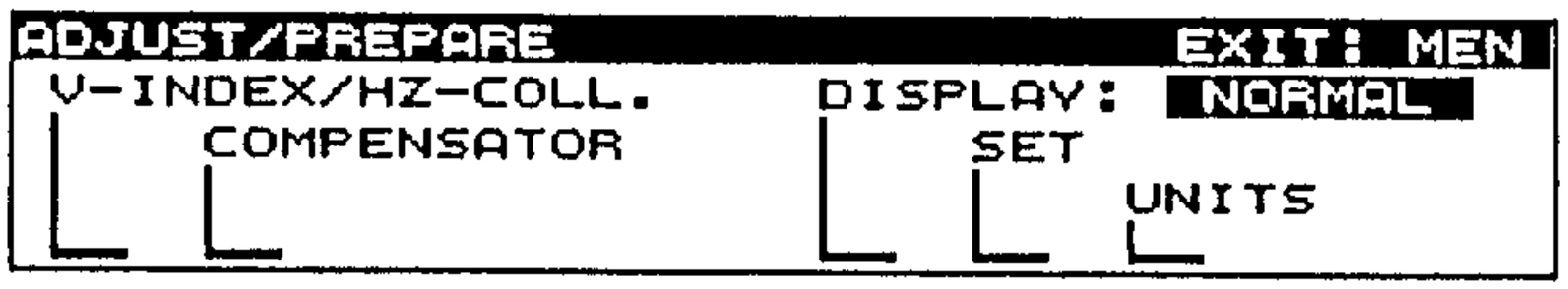


Fig. 8.1.1: Menu of the ADJUSTMENT/PREPARATION program

(3) Explanation of the modes

V-INDEX/HZ-COLLIMATION:

The correction values for index and collimation errors can be computed by zenith angle or direction measurement in both telescope positions.
These correction values are determined in our works before delivery and stored in the Rec Elta RL. They are applied to all measurements so that measurement is required only in one telescope position.
However, these correction values can be determined again and stored any time in this adjustment menu with the V-INDEX/ HZ-COLLIMATION programs. These errors should be determined again or checked in particular before precise elevation measurements or before precise measurements to targets with large level differences.
When this mode is performed the compensator is adjusted automatically. Then this mode must not be repeated separately.
The tilting axis error is determined in our works and the correction is stored in the instrument.

COMPENSATOR:

Just as centre-point determination is recommended for the alidade level, the centre position of the compensator of the Rec Elta RL should be checked periodically by a centre-point determination. This is required in particular before precise elevation measurement in the COMPENSATOR program.

DISPLAY:

By adjusting the contrast of the display it can be accorded to the environmental conditions

Note:
The adjustment of the optical axis of the electronic impulse distance meter is not necessary with this instrument type.

Options in the mode SET

MARKS:

To identify and describe a measurement or a point, a point identification (P.I.) consisting of a point code an additional information (up to 27 characters) has to be entered before measurement. To improve the readiability of the 27 characters and to facilitate P.I. input, you can individually mark the input fields.

DECIMAL DIGITS:

The number of decimal places for the different measurement and computation elements e.g. directions, angles, distances, coordinates and heights can be freely selected according to the application.

SIGNAL:

Activation or reactivation of the audible sinal

MEM INITIALATION:

Removing of problemens in the internal memory. All data get lost.

PC-DEMO:

The screen contents on the Rec E can be displayed on a PC screen.

UNITS:

Determination of the units it is to be measured with.

8.2 V INDEX/HZ COLLIMATION

(1) Purpose

The determination of the index correction should be performed after long storage periods or after instrument transportation, after large temperature variations and before precise elevation measurements.

(2) Initial menu selection

The index correction of the vertical and horizontal circle can be checked with the V INDEX/HZ COLLIMATION. Press key 1 (fig. 8.1.1) to call the initial menu (see fig. 8.2.1) that shows the value of the last determination.

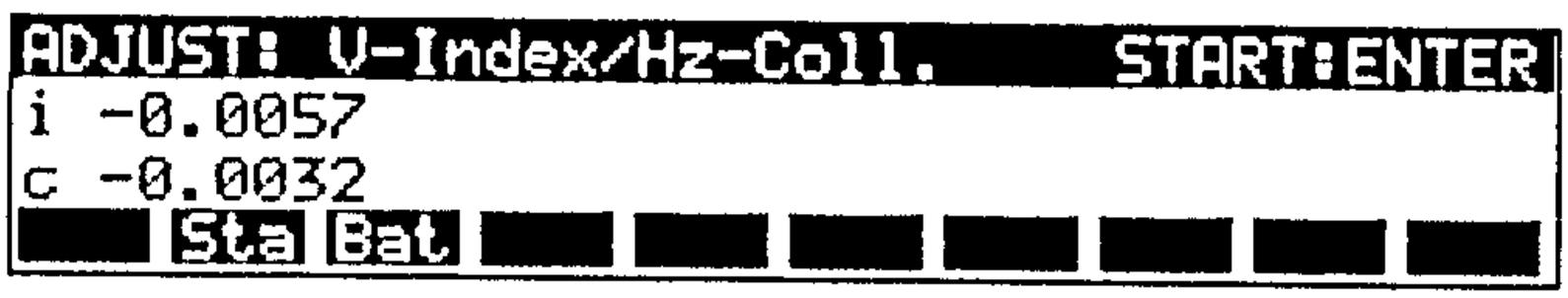


Fig. 8.2.1: Initial menu V Index/Hz Collimation

(3) Input and measurement menu

Press ENT to change from the initial menu to the P.I. input and measurement menu. A point identification can be entered before the measurement in the first telescope position for later identification of the determination (see fig. 8.2.2).

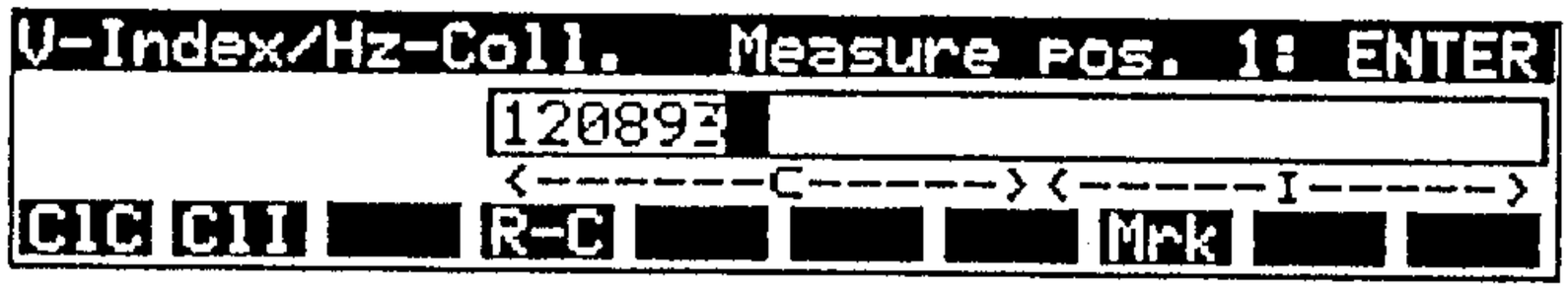


Fig. 8.2.2: Input and measurement menu, position 1

(4) Measurement

After measuring the zenith angle and the horizontal directions in both telescope positions, the deviation is computed the Rec Elta RL and stored together with the two angles/ directions. The measure menu (see fig. 8.2.2) requests you to sight the target in position 1. The measurement itself is activated with soft key **ENT**. After measurement in the first telescope position, the measure menu requests measurement in the second position (fig. 8.2.3).

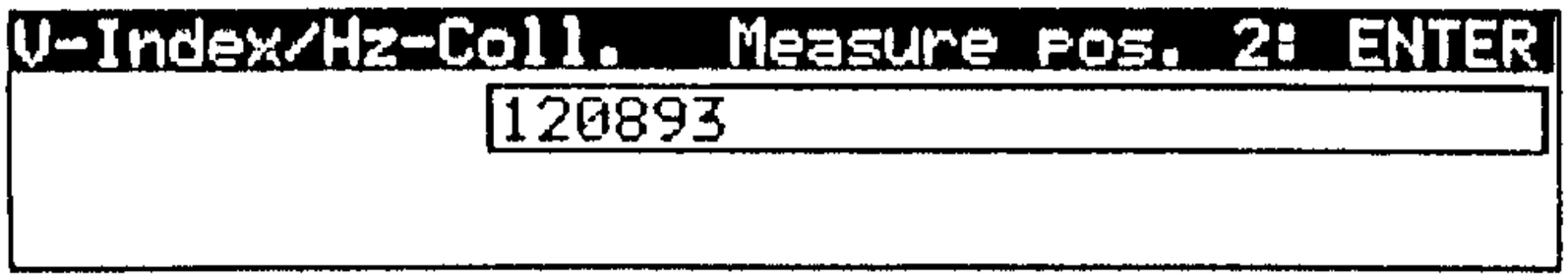


Fig. 8.2.3: Measure menu, position 2

(5) Result of determination

The old and the new correction are displayed in the result menu (fig. 8.2.4) for comparison. You have to decide which one to use for further measurement.

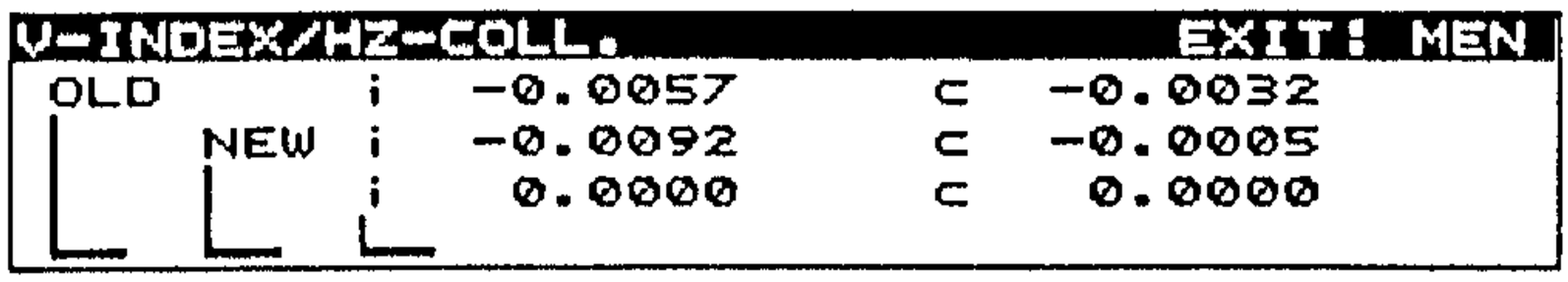


Fig. 8.2.4: Result of determination

Key		Function
1	-	old correction is retained (e.g. determination error)
	-	no storage
2	-	new correction is used for further measurements
	-	storage with angles/directions in both positions
3	-	correction is set to zero
	-	storage without angles/directions
MEN	-	exit from the menu
	-	the old value is retained
	-	return to the calling program part.

(6) Error condition

If the correction exceeds 2'40" or 49.5 mgrads, no new correction is computed and an audible signal sounds as warning.

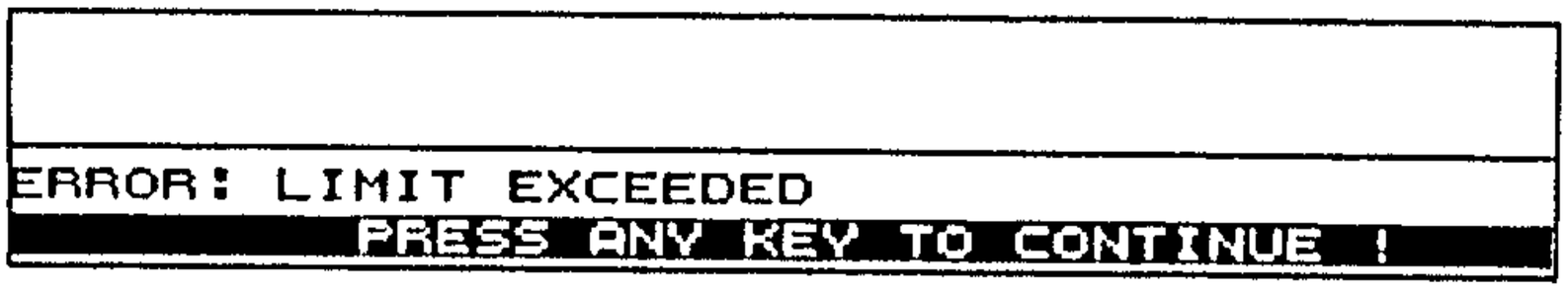


Fig. 8.2.5: Error message

MEN : Exit from the error display. Continue with (3) (fig. 8.2.2).

8.3 Compensator

(1) Purpose

Just as centre-point determation makes sense for the alidade level, the compensator in the Rec Elta RL requires periodic checking by centre-point determination with the COMPENSATOR mode especially before precise elevation measurements.

(2) Initial menu selection

The centre-point determination can be checked with the option COMPENSATOR. Press key **2** (fig. 8.1.1) to access the initial menu (see fig. 8.3.1) which displays the centre-point components in the sighting axis (SZ).

Fig. 8.3.1: Initial menu of centre-point determination and levelling

(3) Centre-point determination

The compensator enters its operating range when you level the Rec Elta RL with the level, and then automatically compensates any residual vertical axis tilts in the sighting axis direction to determine the centre-point precisely, it is important to allow time for the liquid in the compensator to settle. This is why the Rec Elta RL must be stabilized with the horizontal clamp (25) before measurement.

Press the ENT key to initiate compensator reading in position 1 (see fig. 8.3.2).

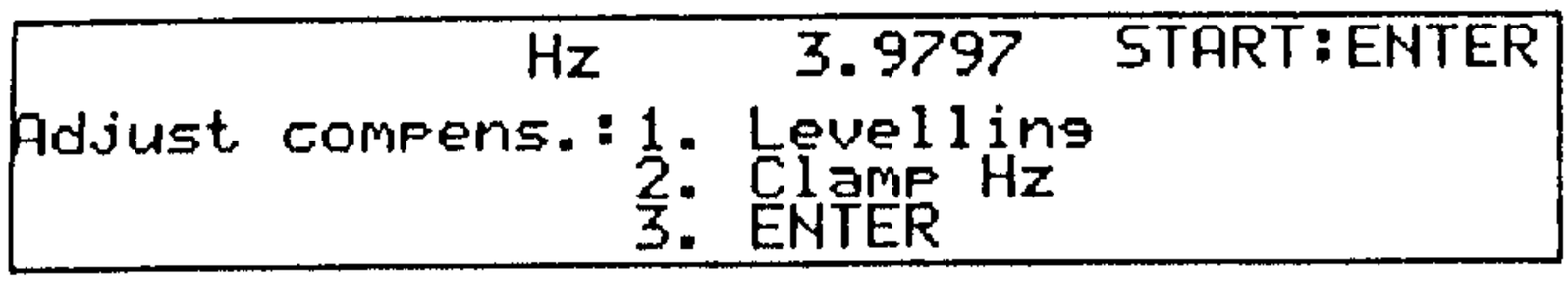


Fig. 8.3.2: Compensator reading in position 1

As for centre-point determination with the alidade level, turn the Rec Elta RL through 180° or 200 grads to ± 5 grads. Again stabilize the instrument with the Hz clamp and initiate the compensator reading in position 2 with the **ENT** key.

```
                Hz      0.5596  START:ENTER
Adjust compens.: 1. Turn Hz →0 (+5/-5)
                 2. Clamp Hz
                 3. ENTER
```

Fig. 8.3.3: Compensator reading in position 2

(4) Result

After computation, the centre-point components and the residual axis tilts in sighting axis direction are displayed (see fig. 8.3.4). If the instrument is not sufficiently levelled, there is an error message.

```
 LEVELLING                                Exit: MEN
SK    0.0000          - NK   0.0000
SZ    0.0045          | NZ  -0.0027
```

Fig. 8.3.4: Centre-point components

where:

SK	0.0000	Centre-point components in tilting axis direction
SZ	-0.0004	Centre-point components in sighting axis direction
−NK	-0.0000	Tilt in tilting axis direction
|NZ	0.0014	Tilt in sighting axis direction
positive value		Tilt to the right or front
negative value		Tilt to the left or rear

In instruments with a one-axis compensator the SK and NK values are always 0,0000!

If no error occured, the SK and SZ values are recorded automatically.

(6) Error condition

If the centre-point values exceed:

SZ = ± 25.5 mgrads = 82.6"

SK = ± 51.5 mgrads = 165.6"

then fig. 8.3.5 indicates the determination error.

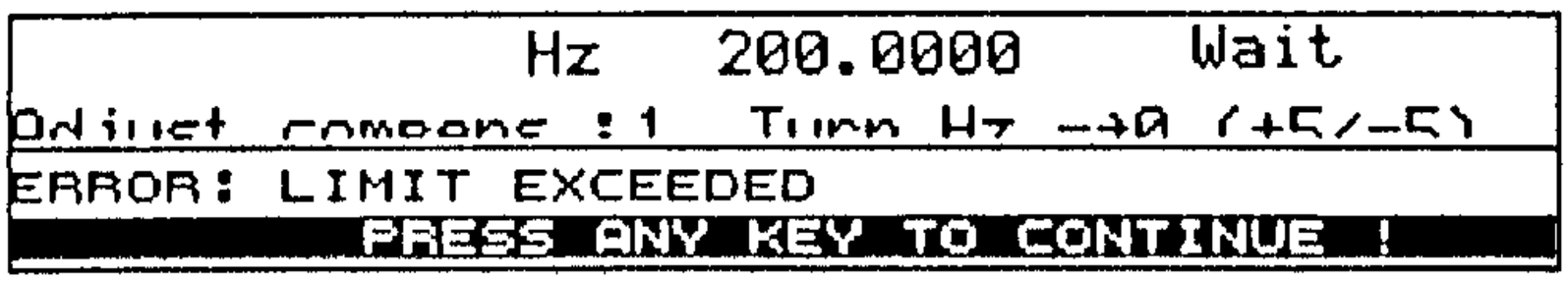


Fig. 8.3.5: Error message

MEN : Prior centre-point values are retained.
Then branch to the ADJUSTMENT/PREPARATION menu

(7) Levelling with the compensator

More precise levelling than with the alidade level of the instrument is possible with the digital display of the compensator also in this program. Instruments with a one-axis compensator only display the inclination of the vertical axis in the direction of the collimation axis.

Precise levelling with the tribrach screws (24) is obtained when about zero is displayed for both tilts. However, more precise levelling is not absolutely required if compensation is on because the applicable correction values for the vertical axis tilts are applied automatically to the horizontal and verticle circle readings.

Precise levelling can make sense if the compensator has to be turned off for any following measurement because of vibrations.

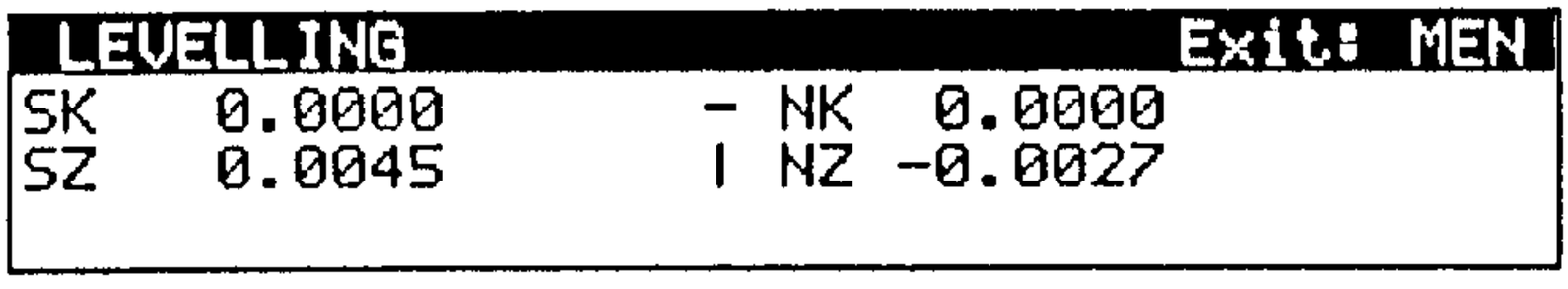


Fig. 8.3.6: Levelling with the digital display

If the compensator operating range of ± 2'40" is exceeded for levelling, an appropriate message appears in the display.

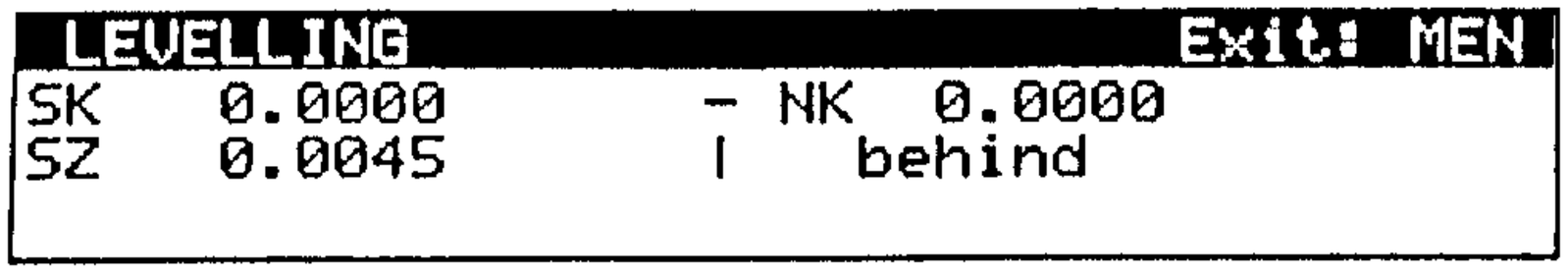


Fig. 8.3.7: Tilt direction

Explanations to fig. 8.3.7:

Tilt to the left	→	Display "left"
Tilt to the right	→	Display "right"
Tilt to the rear	→	Display "rear"
Tilt to the front		Display "front"

Important:

The digital display of the inclination of the vertical axis can be called in the whole program with the **LEV** key.

MEN : Return to the calling program part or to the ADJUSTMENT/ PREPARATION menu.

8.4 Display

(1) Purpose

By adjusting the contrast of the display it can be accorded to the environmental conditions.

(2) Mode change

You can select NORMAL, DARK or BRIGHT with numeric key 6. The change operates directly on the display.

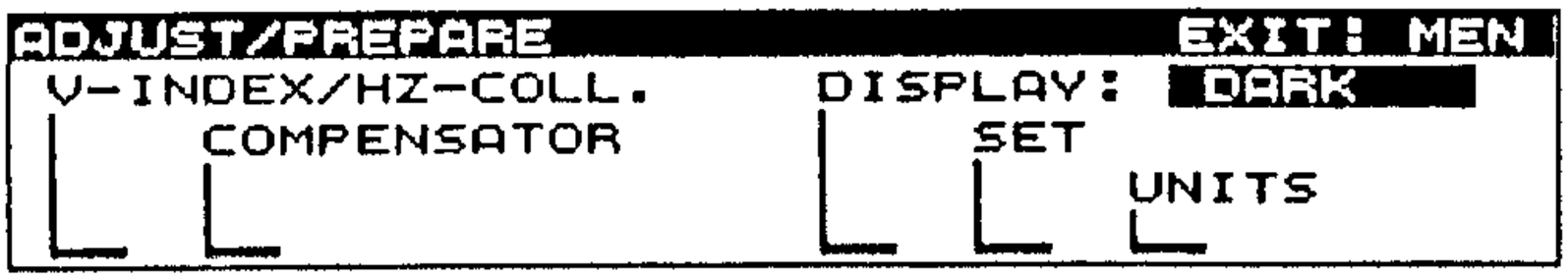


Fig. 8.4.1: Change of the display

8.5. Set

8.5.1 Overview

(1) Purpose

To identify a point or a measurement for later processing, it has to be coded or described in detail. In the SET mode, the format of the point identification and, to facilitate input, a freely selectable marking can be set individually.

Depending on the application it may be useful to select individually the number of decimal digits for the measured and computed elements.

(2) Set mode selection

The mode SET is directly called with key 7. The SET programs menu with its options (fig. 8.6.1.1) is displayed. Use keys 1, 2, 3, 6 and 7 to select the modes directly.

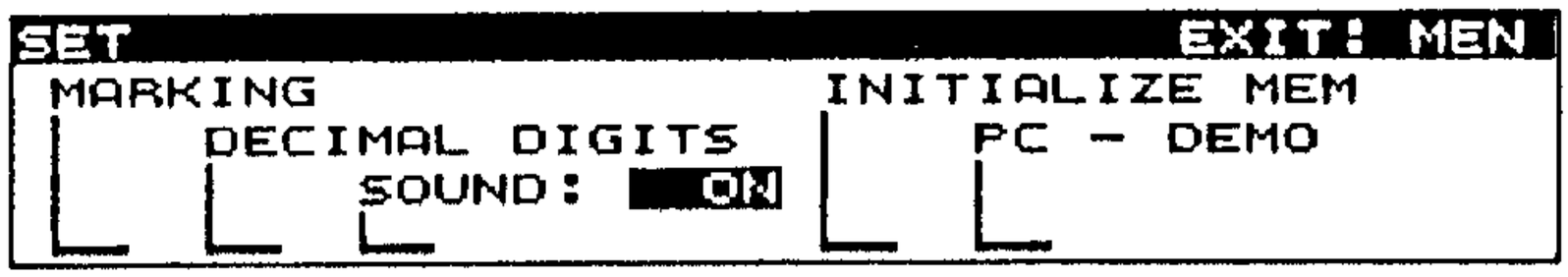


Fig. 8.5.1.1: Initial menu of the SET program

(3) Explanation of the modes

Mode : MARKING
To identify and describe a measurement or a point, a point identification (P.I.) consisisting of a point code and additional information (up to 27 characters) has to be entered before measurement.
To improve the readability of the 27 characters and to facilitate P.I. input, you can individually mark the input fields.

Mode : DECIMAL DIGITS
The number of decimal places for the different measurement and computation elements e.g. directions, angles distances, coordinates and heights, can be selected according to the application.

Mode : PC-DEMO
The contents of the Rec E screen can be displayed on a PC screen.

8.5.2 Markings

(1) Purpose
To increase the readability of the 27 characters and to facilitate P.I. input, you can individually mark the input fields.
Freely selectable marks facilitate input. Up to 7 different marks can be used. When calling a mark in a mode, soft key Mk1 displays by its digit which mark it is.

(2) Selection of the markings
Call the Marking option in the SET program with numeric key 1(see fig. 8.6.1.1), automatic change to the mark selection menu (see figb. 8.6.2.1)

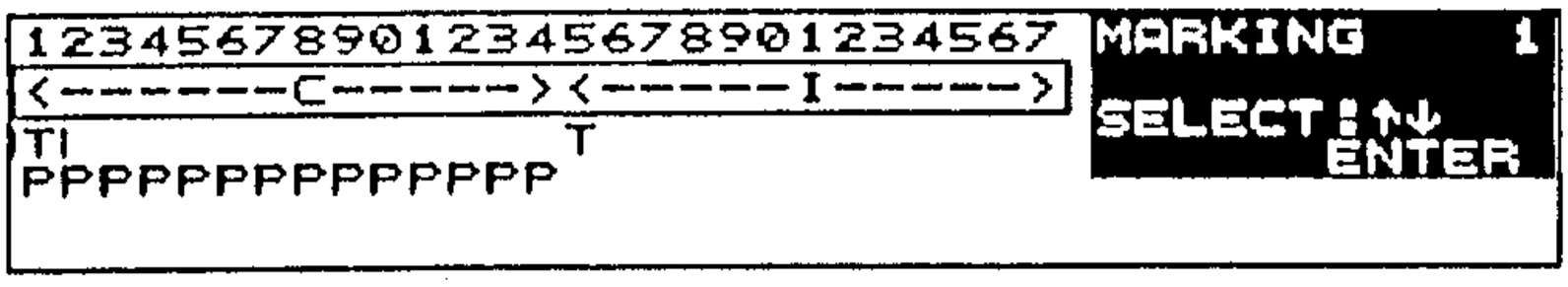


Fig. 8.5.2.1: Mark selection menu

The mark information is stored in the internal Mem. It contains a default mark on delivery. Other marks are not set. New marks entered are stored automatically. Data do not get lost thereby.

Description of mark 1 : Default mark - Rec 500 format

Line	Contents	Function
1	Column ruler Characters 1 to 27	Aid for precise locating a character within the P.I.
2	Marking line	Subdivision of the P.I. into point code(C) and additional information(I). Facilitation of the input in the P.I. field which can be underlaid by individually selectable characters. During P.I. entry underlaid spaces are always skipped, not used in the default marking.
3	Tab stops	Default tab stops in columns 1 and 15.
	ENTER	Aktivates the input routine
4	Point number field	Specification of the point number field (default 1 to 14); marked by 14 Ps.
5	Soft keys	This line is not used when you select an option or a mark. When you press the ENT key, soft keys appear in the line that afford modification of the tab stops and of the point number field.

8.5.2.1 Defining your own marks

(1) Purpose
Individual marks facilitate point identification input by their graphical representation.

Apart from the default formats upt to 6 different marks can be defined. In our works, the default mark is assigned to mark number 1. All are freely available for own markings.

When you access a mark with the cursor keys and activate input with the ENT key, the default mark is set as a modification aid.

(2) Mark selection

Key	Function
↑,↓	Scrolling through all (set or blank) marks.
MEN	Exit from the default mark menu and call of the MARKING selection menu (fig. 8.6.2.1).
ENTER	Aktivates the input routine for the selected mark which can then be modified.

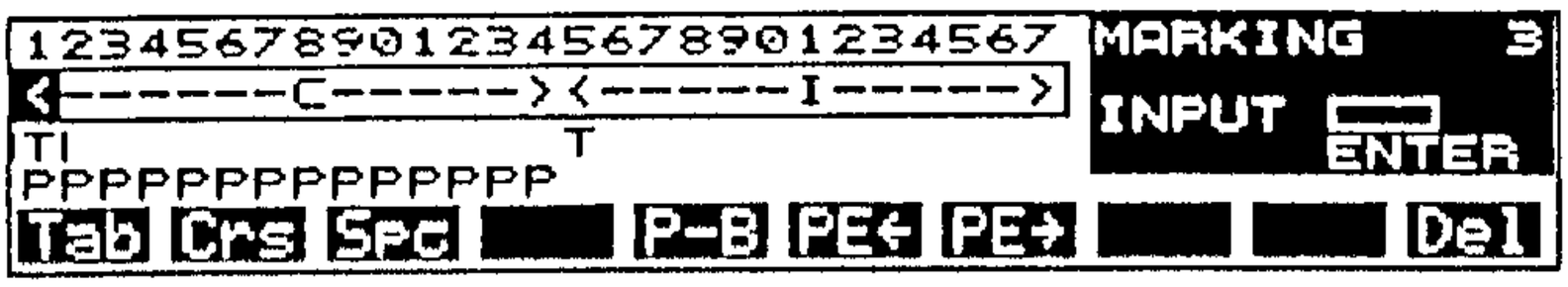


Fig. 8.5.2.1.1: Input menu for mark modification

You can now change this default mark according to your requirements.

(3) Entering your own marking line
The following hard and soft keys support the entry of marks.

Key	Function
ABC	Aktivates alpha input for defining a mark; the soft keys in line 5 are replaced by the letters of the alphabet.
◄-,→	Select a given position in the input field with the horizontal cursor keys.
1, 2, ...,0	Enter the mark with letters and special characters with the numeric key.

(4) Setting tab stops (optional)
A random number of tab stops can be set.

Key	Function
◄-,→	Select the desired position.
Soft key Tab	A "T" (tab stop) is set in line 3 in this position. The tab stop can be reset with the same soft key.

(5) Setting a cursor position

In order to obtain a quicker measurement sequence, it is useful after measurement to set the cursor automatically to the default input position of the next point.

Key	Function
◂-,→	Select the desired position.
Soft key Crs	This position in the third line is marked by two vertical lines. Cursor and tabstops can be set at the same place.

(6) Setting a space (optional)

This position cannot be selected during P.I. entry, i.e. it is skipped automatically. The space is effective only within the additional information, not within the point number.

Keye	Function
◂-,→	Select the desired position.
Soft key Spc (Space)	The character "_" appears in the mark line at this position. Any existing character is overwritten. This space can be deleted again by overwriting with another character.

(7) Specifying the point number field

The point number field must always be specified. In this field:
- incrementation is performed
- point numbers are retrieved with ?Pt.

For specification, use the soft keys P-B for the beginning and PE→ or PE◄- for the end of the field. The following bounds apply to the number of characters in the point number:
- Minimum size of the point number field: 3 digits
- Maximum size of the point number field: 14 digits

Exceeding these bounds is not possible.

Key	Function
◄-,→	Select the desired position.
Soft key P-B	A 3-digit point field begins at this position.
Soft key PE◄-	To reduce the field size by one digit.
Soft key PE→	To increase the field size by one digit.

The specified field is marked in line 4 with at least 3 Ps and up to 14 Ps.

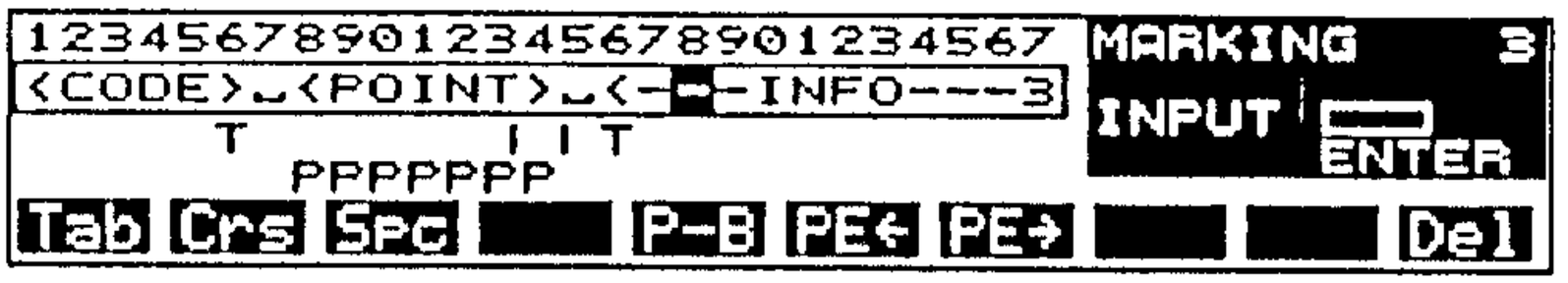


Fig. 8.5.2.1.2: User-defined mark

(8) Restrictions
The following specifications are mutually exclusive:

- Point number field and space
  . Spaces in a point number field are automatically deleted when pressing ENTER.

- Alphanumeric characters in a point number field
  . Alphanumeric characters in a point number field restrict the field for the point number.

(9) Storing the entry or modification

With the **ENT** key you can include the entered or edited mark in the list of marks. Exiting before storage is possible with the **MEN** key as in all other menus.

Key	Function
ENTER	Exit from the editor mode. Modification storage. Call of the fig. 8.5.2.1.2 selection menufor selecting the next mark.
MEN	Exit form the Editor mode. The modification is not saved, the old mark is retained. Proceed with fig. 8.5.2.1.2

(10) Deleting a mark

Marks that are no longer required can be deleted with soft key **Del**.

Key	Function
↑,↓	Mark selection.
ENTER	Mark input activation
9	Softkey Del Fig. 8.5.2.1.3 is displayed.

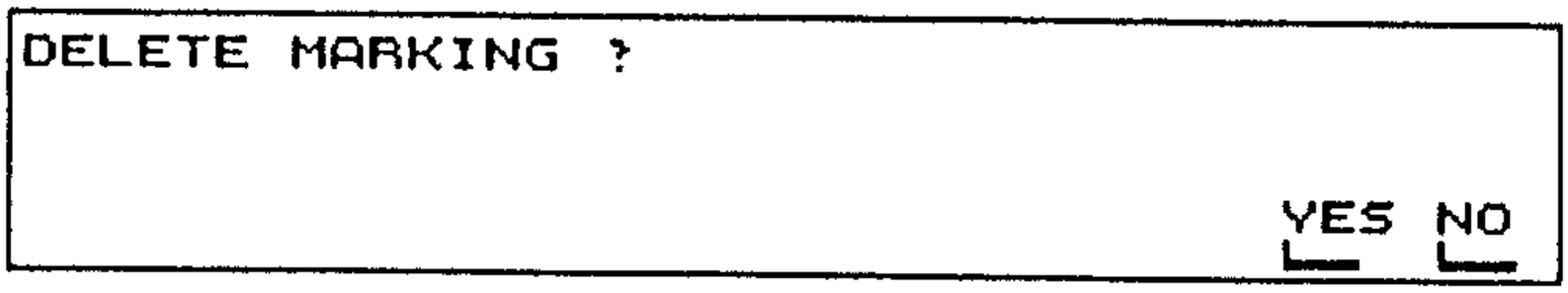


Fig. 8.5.2.1.3: Mark deletion

NO : The mark is displayed again.

YES : The mark is deleted; the display changes to fig. 8.5.2.1.4

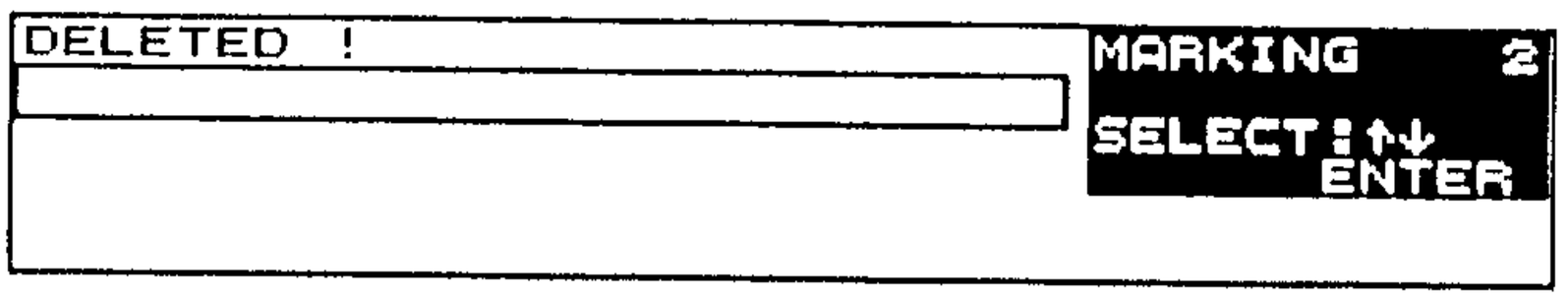


Fig. 8.5.2.1.4: Mark deleted

↑, ↓ : If you do not enter a new mark, this display appears as long as the cursor keys are pressed.

ENTER : The default mark is set in the deleted mark to facilitate mark input.

8.5.3 Decimal digits

(1) Purpose

You can set the number of decimal places for the angle and distance measurements.

(2) Mode selection

Call the DECIMAL DIGITS option in the SET program with numeric key 2 (see fig. 8.6.3.1).

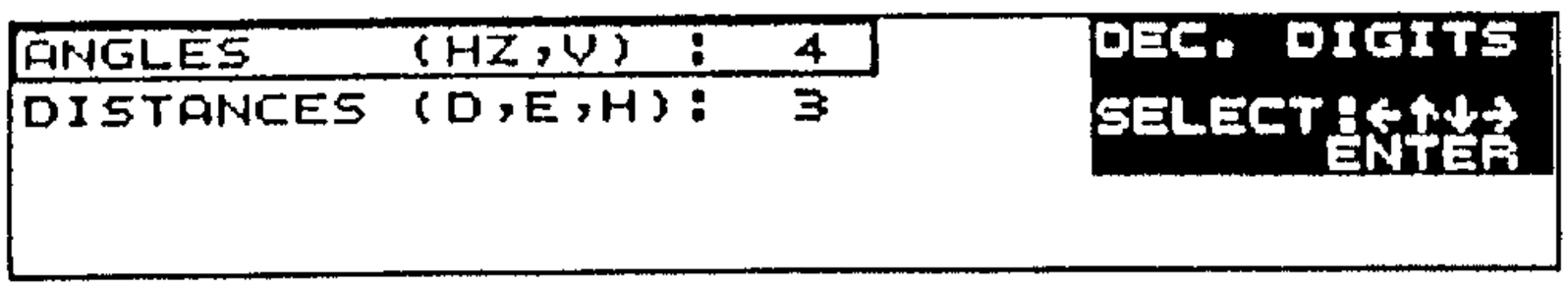


Fig. 8.5.3.1 : Decimal digits mode

(3) Angle or distance selection

Select the decimal digits for angle or distance with the cursor keys ↑ (up) and ↓ (down).

MEN : Branch to the SET program.
ENT : Mode selection

(4) Modification

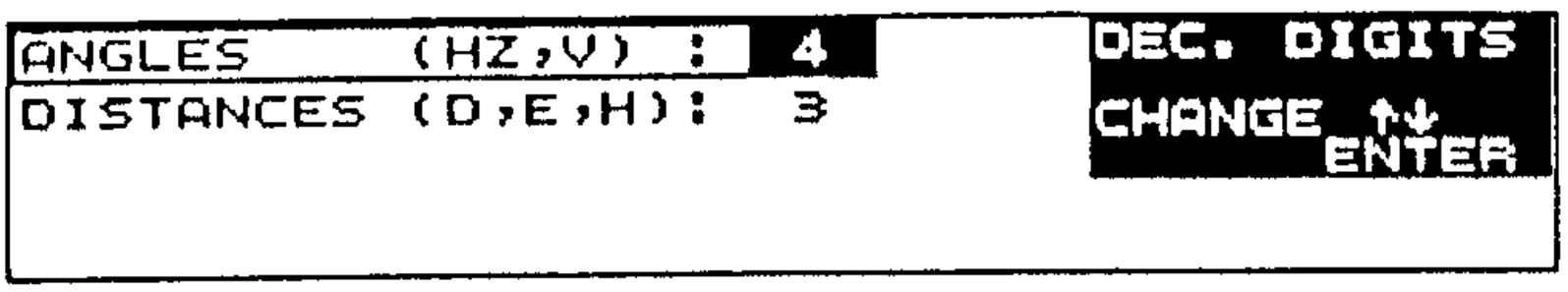


Fig. 8.6.3.2: Mode selection

With the cursor keys ↑ (up) and ↓ (down) you can select 2 to 5 decimal digits in the angle mode and 2 to 4 decimal digits in the distance mode (see fig. 8.6.3.3).

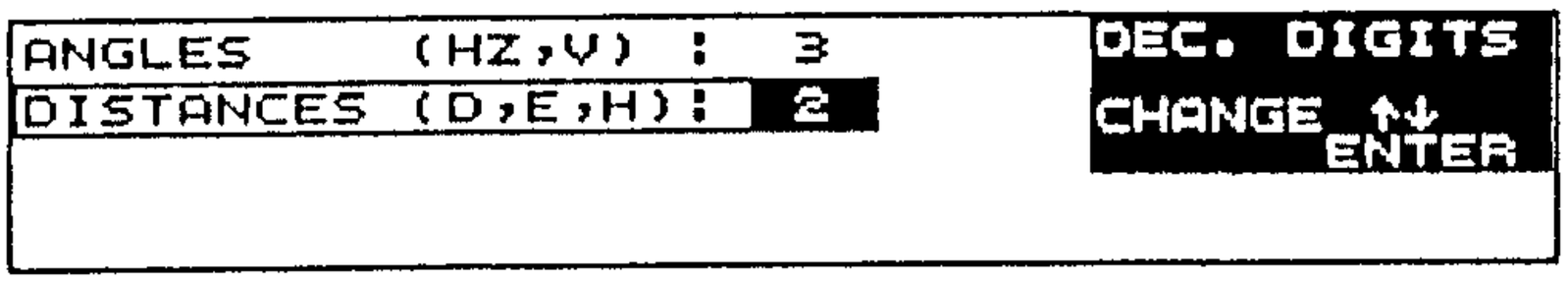


Fig. 8.6.3.3: Input

ENT : The modification is saved.

(5) Modification termination

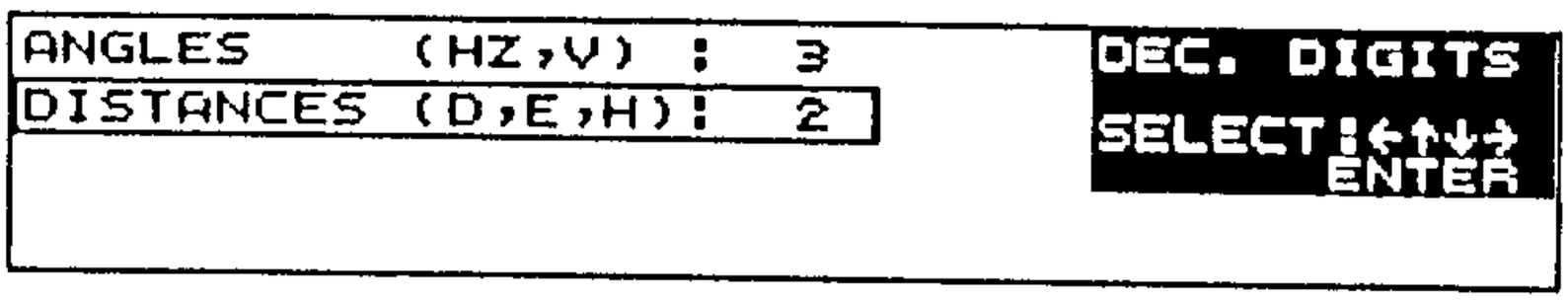


Fig. 8.6.3.4: Modification

8.6.4 Audible signal

The audible signal can be switched on and off directly with the numeric key 3 (see also **1.4.2 Audible signal**).

8.6.5 Mem initialization

(1) Purpose

You are told by an error message 4WR if there is no further recording in the Mem possible. The Mem has to be reinitialized in this case. Beforehand, the datastored in the Mem must be transferred to another storage medium because initialization causes the data to be lost.

(2) Calling the mode

The mode is called with numeric key 6.

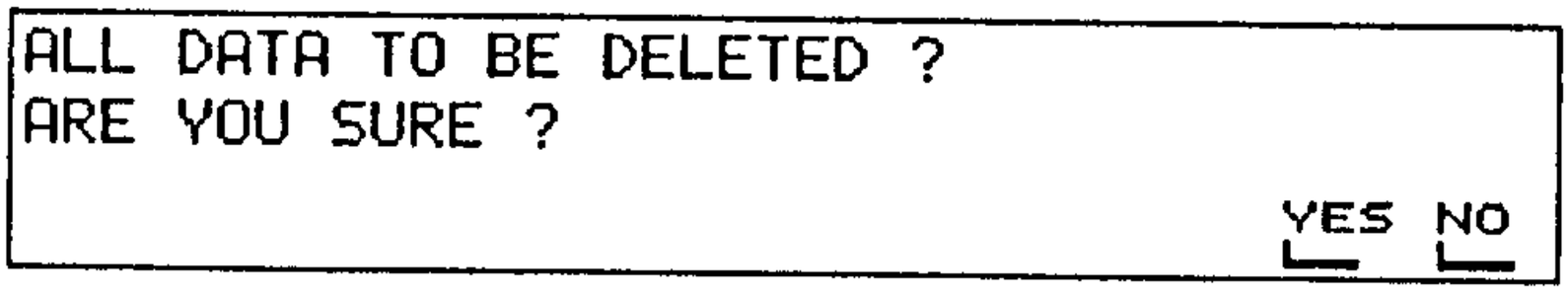


Fig. 8.6.5.1: Mem initialization

Yes : The Mem is initialized. All data get lost. Branch the SET menu.
NO : Branch to the SET menu.

8.6.6 PC-DEMO

(1) Purpose

The current screen contents on the Rec E can be displayed on a PC screen for demonstration purposes. In this way a system demonstration is possible even with a large audience.

(2) Mode selection

For the demonstration, the Rec E must be connected to a DOS-compatible PC, e.g. with the cable 708177-9270 (see also 11.3.3). The Carl Zeiss program RECE_TRM.EXE must be running on the PC.

Now press the number 7 key in the SET menu.

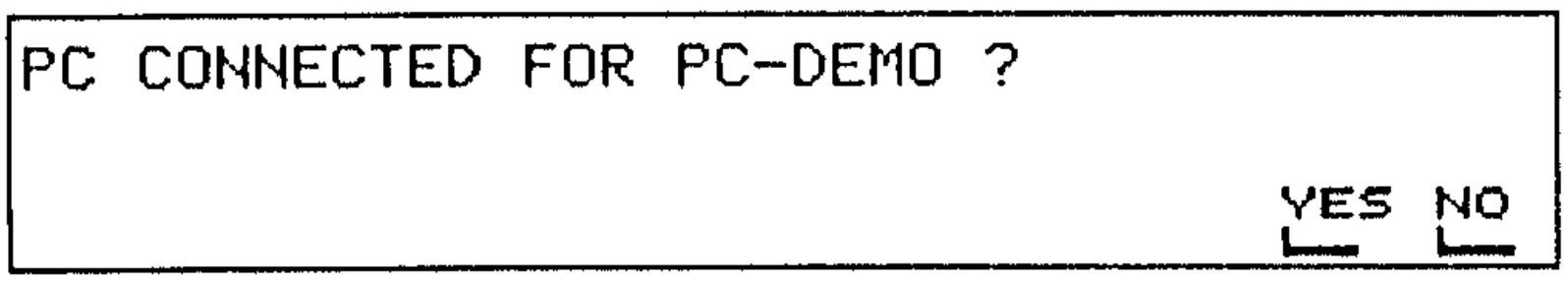


Fig. 8.6.6.1: PC-DEMO verification

NO : Return to menu 8.1.1

YES : All Rec E program menus will be displayed on the PC display. In addition, the displayed image of each key pressed will be briefly lit.

Warning:

Only press the YES key when the PC is connected and the RECE_TRM program has been started, otherwise the Rec Elta will crash. The instrument can then only be switched off after the batteries have been removed.

During a demonstration with **PC-DEMO**, the reaction times on the Rec Elta are noticeably slower. The instrument can therefore not be used as quickly as is normal.

(3) Ending the PC-DEMO

The PC-DEMO mode can be exited in several ways:

1. Switch the Rec Elta off, then on again. The Rec Elta will then operate without **PC-DEMO**.

2. Select the **PC-DEMO** mode during the demonstration mode. Press the **NO** key when asked for verification (fig. 8.6.6.1). The Rec Elta will then operate in its normal mode.

(4) Extra information

Further information on the operation of the software on the PC may be obtained by using the command **RECE_TRM -H**.

8.6.7 Units

(1) Purpose
Selection of the units to be used for measuring.

(2) Program selection
With numeric key 8 you enter the menu of units.

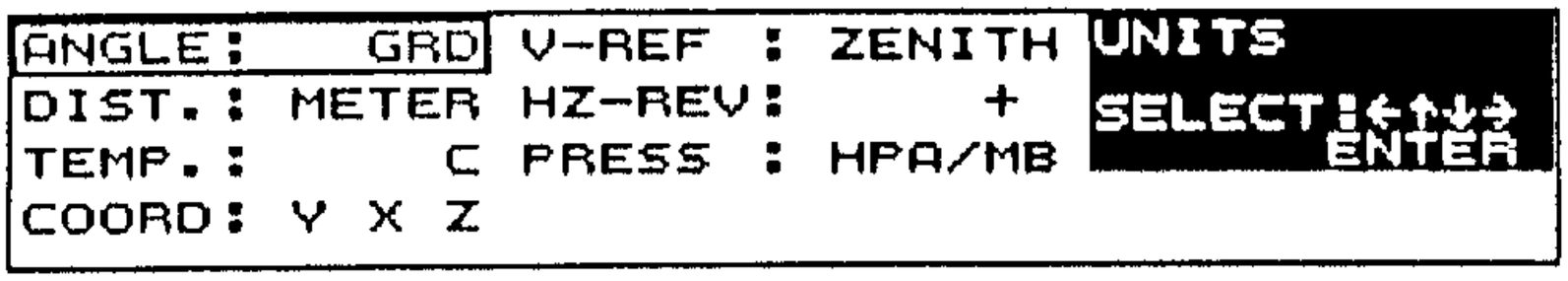


Fig. 8.6.7.1: Selection menu of UNITS

(3) Selection of the unit to be changed
Move the input field with the cursor keys ◄– (left), → (right), ↑ (up) and ↓ (down).

MEN : Exit form the units menu.
Storage of the new unit in the internal memory if you selected a new unit.
Return to the main menu.

(4) Input activation
Confirm proper selection with ENT; simultaneous change to the editing menu.

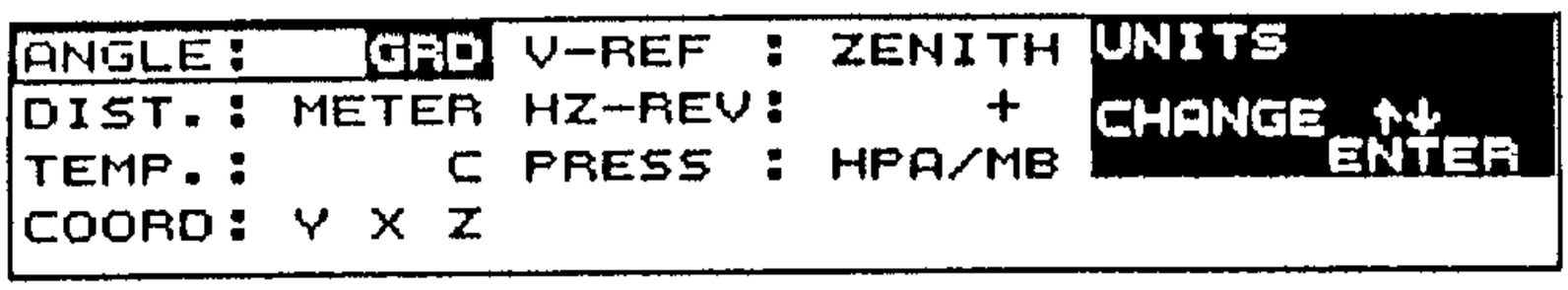


Fig. 8.6.7.2: Editing menu

(5) Entry editing
Press the vertical cursor keys ↑, ↓ until the desired measuring unit appears in the input field.
ENT : Entry of the new unit in the Rec Elta NV - RAM. Change to the selection menu (see fig. 8.6.7.1).
MEN : The old unit it retained. Change to the selection menu (see fig. 8.6.7.1).

9. Transfer program

9.1 Overview

(1) Purpose

The data measured in the field can be transferred to a computer in the office for further processing or they can be sent to a printer for documentation. In general, devices which are connected to a Rec Elta are called peripheral devices.

Data transfer from the peripheral device to the Rec Elta is required, e.g. for setting-out in order to compute the setting-out elements in the field from coordinates computed by the computer in the office.

Communication between the Rec Elta and the peripheral device is only possible if the data transfer parameters are properly set in this program.

Future software updates in the Rec Elta are possible with this program.

An external recording can be connected to the RS 232 C interface instead of the internal Mem.

Future software updates for the Rec Elta are possible with this program.

In the terminal mode you can use special software together with an external computer.

(2) Transfer mode selection

Select the TRANSFER program with numeric key 7; the selection menu appears (fig. 9.1.1).

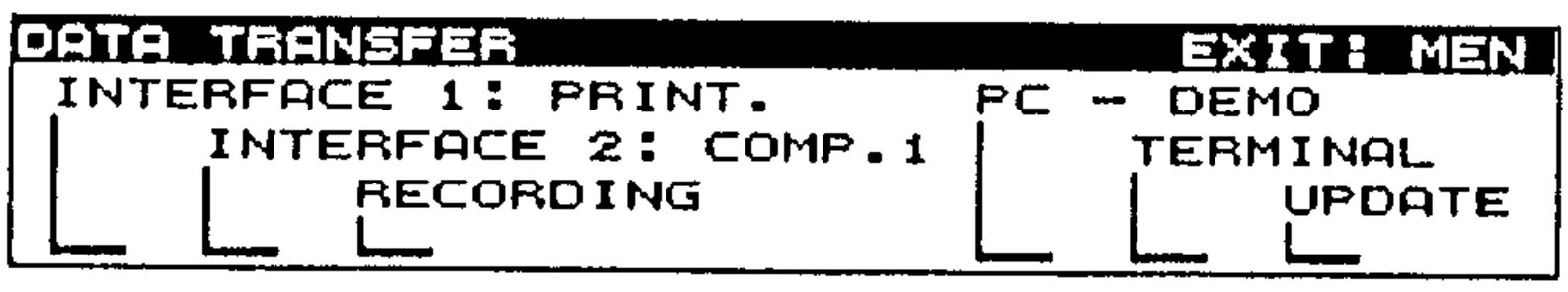


Fig. 9.1.1: Selection menu of TRANSFER

9.2 Interface selection

(1) Purpose

Three interfaces (inteface 1, 2 and recording) can be defined by setting the data transfer parameters and they can be called during the data transfer.

(2) Interface access

The handling of the interfaces is identical. Therefore the description of interface 1 is sufficient. Recording access see 9.4.

- Interface 1: Default printer interface for line-controlled transfer
- Interface 2: Default computer interface for software-controlled transfer.

Select the interface with numeric key 1 (interface 1) or 6 (interface 2) in fig. 9.1.1; fig. 9.2.1 appears for specifying the data transfer direction or defining parameters.

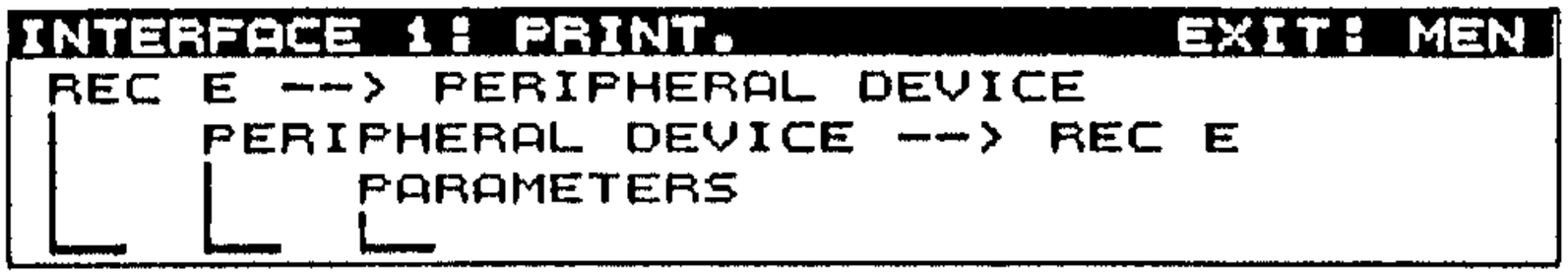


Fig. 9.2.1: Selection of the transfer direction

(3) Selection of the data transfer direction

As indicated by fig. 9.2.1, the bidirectional data transfer capability of the Rec Elta enables data transfer with

- numeric key 1: from the Rec Elta to a peripheral device
- numeric key 2: from the peripheral device to the Rec Elta

Case 1: Data transfer from the Rec Elta to a peripheral device
Connect the peripheral device to the Rec Elta before data transfer.

(4) Data selection
The data to be transferred can be selected with soft keys (fig. 9.2.2).

All : All records
Adr : One record (enter the address)
A→A : From a start address up to an end address (enter the addresses). Exit from data selection with **MEN**
LAd : Last address
Pt. : Point number
P→P : From a start point up to an end point
?Pt : Point identification

Fig. 9.2.2: Record selection

(5) Data transfer
Data transfer can be started after record selection (see fig. 9.2.3). Beforehand, the data transfer program has to be started in the computer and initiated so that data can be received from the Rec Elta.

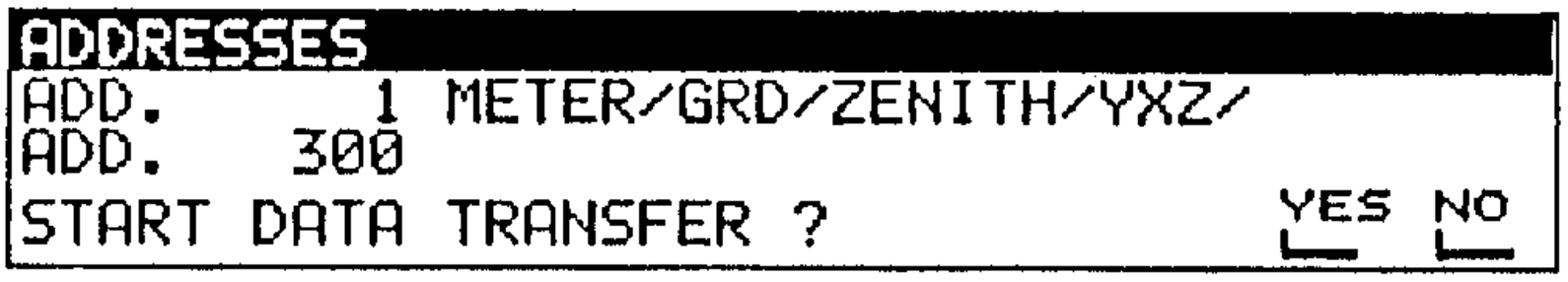


Fig. 9.2.3: Start of the data transfer

YES : Starts data transfer; the transferred addresses are displayed continuously.
NO : Returns to the record selection menu (fig. 9.2.2).

Case 2: **Data transfer from a peripheral device to the Rec Elta**
Connect the peripheral device to the Rec Elta before data transfer.

(6) Peripheral device connection and data transfer
Peripheral device connection is requested in fig. 9.2.4.
Beforehand, the data transfer program has to be started in the computer and initiated so that data can be transferred to the Rec Elta.

Fig. 9.2.4: Peripheral device connection

YES : The Rec Elta displays "READY TO RECEIVE" to indicate that data transfer can be started.
NO : Exit and change to fig. 9.2.1.

9.3 Parameter Setting

(1) Purpose
Individual configuration of the interface by setting parameters for communication with the peripheral device.

(2) Setting menu selection
Numeric key in fig. 9.2.2 calls the selection menu for setting the data transfer parameters.

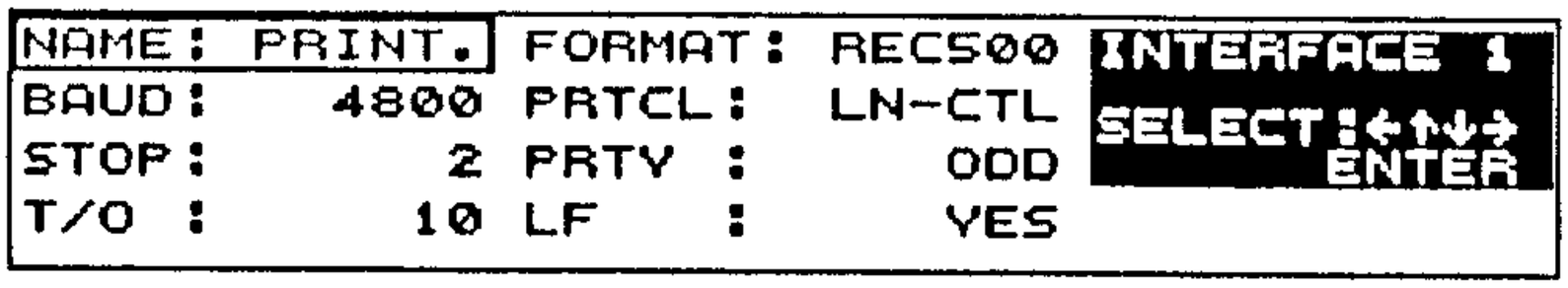


Fig. 9.3.1: Setting of data transfer parameters

(3) Selection of the parameters to be set
Use the cursor keys ◂– (left), → (right), ↑ (up) and ↓ (down) until the desired parameter appears in the input field.

MEN : Change to page 2, if required, to set additional spaces for data transfer (see (6)).

(4) Input activation:
ENT : Confirms correct selection; the editing menu (fig. 9.3.2) appears.

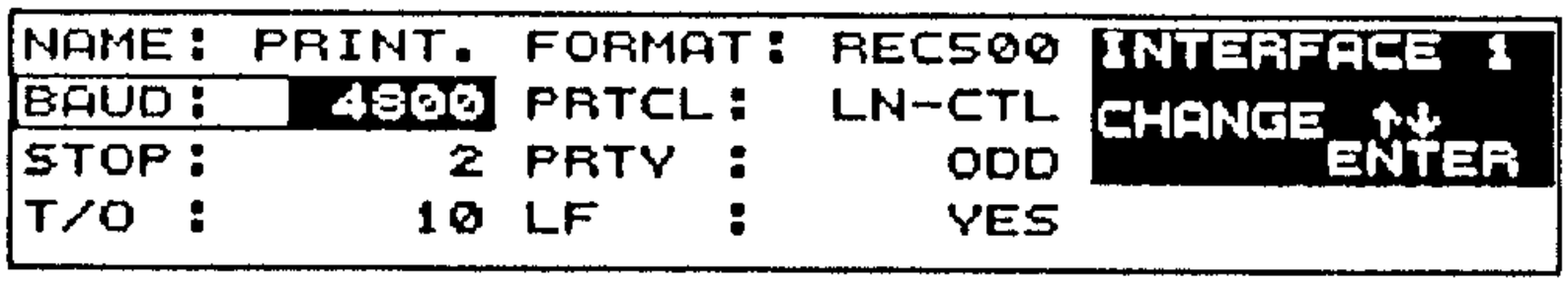


Fig. 9.3.2: Editing menu

(5) Entry editing:
Press the vertical cursor keys ↑, ↓ until the desired parameter appears in the input field.

ENT : The selected parameter is saved and the input field is free for selecting another parameter.
MEN : Return to the calling program part (fig. 9.2.1).

(6) Editing options

Default parameter settings:

Parameter	Interface 1	Interface 2
1. NAME :	PRINT.	COMP.1
2. BAUD :	4800	9600
3. PRTCL :	LN-CTL	REC500
4. STOP :	2	2
5. PTY :	ODD	EVEN
6. T/O :	10	10
7. LF :	YES	YES

Changes:

Names or values can be selected from a list of the selected parameters.

- **NAME** : Mode 1 - Mode 2 - Print - Comp.1 - Comp.2 - Accoust - Modem - Cass.- Buffer
- **BAUDRATE** : 300 - 600 - 1200 - 1800 - 2400 - 4800 - 9600
- **STOP** : 1 or 2 bits
- **T/0 (Time Out)** : 0 - 10 - 20 - ... - 90 Sek.
- **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 - no
- **LF (Line Feed)** : Yes - No

Note:

Detailed information on data transfer is given in chapter 11., INTERFACE DESCRIPTION.

9.4 Recording

(1) Purpose

If the data have to be transferred to an external storage medium (e.g. Rec 500), you have to activate the external recording mode. After instrument initialation you can read in the system test which recording mode is active.

(2) Access

The recording mode is called by numeric key 3 in the transfer program.

Fig. 9.4.1: Recording

(3) Parameter

The parameters have to be harmonized one to the other instrument so that the data transfer runs without problems.

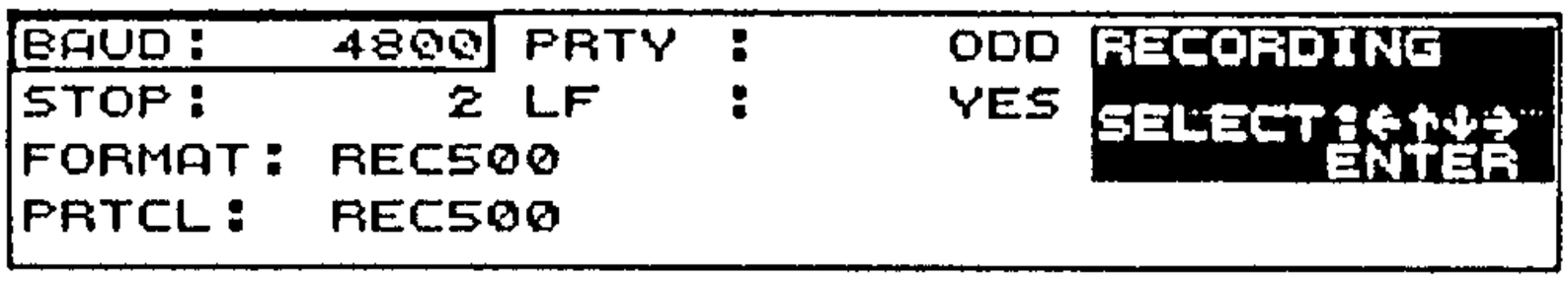


Fig. 9.4.2: Parameter

Selection and editing see *9.3 Parameter*.

(4) Change of recording mode

With numeric key 2 (fig.: 9.4.1) you can directly select between:
- INTERNAL (MEM) and
- EXTERNAL (RS 232-C).

The setting remains as long as it is changed again. A suitable note is given with every recording in the different modes.

MEN : Return to the TRANSFER menu.

9.5 Update

This menu allows updating the software in the Rec Elta.

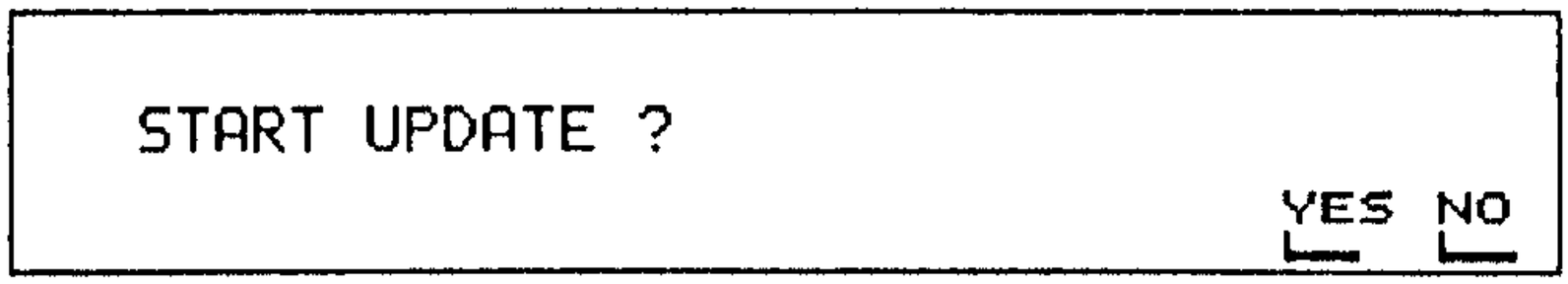


Fig. 9.5.1: Selection menu of update

YES : Start Update

Beforehand, the update program has to be started in the computer and initiated so that the update can be started in the Rec Elta RL.

NO : Branch to the transfer menu

9.6 Terminal

9.6.1 Survey

(1) Purpose

With the terminal mode of the Rec Elta RL you get the possibility to combine the instrument with a computer to establish a personal system. The computer can be provided with own programs which individually are adjusted to the tasks to be done. Clearly structured system commands arrange the communication between the instrument and the computer.
The keyboard and the display of the Rec Elta RL can be used as display and input unit of the system.

(2) Options

In the terminal mode the user completely gets away from the given user interface of the Rec Elta RL.
At his free disposal there are now

- keyboard,
- display,
- control commands,
- function calls and
- graphics commands.

Thereby the user is able to program the

- user interface,
- input,
- sequence of measurement,
- computation and
- recording

in the adapted computer according to his own ideas.

On principle the procedure of the interaction between the Rec Elta RL and a computer in the terminal mode is as follows:
Every key stroke at the Rec Elta RL sends a key code to the computer via the interface. The code is there interpreted by the programm according to the procedure and can either

- send a function call to the Rec Elta RL or
- write to the display of the Rec Elta RL or
- cause some other action in the computer.

(3) Program call

The program is called with numeric key 8 in the DATA TRANSFER program.

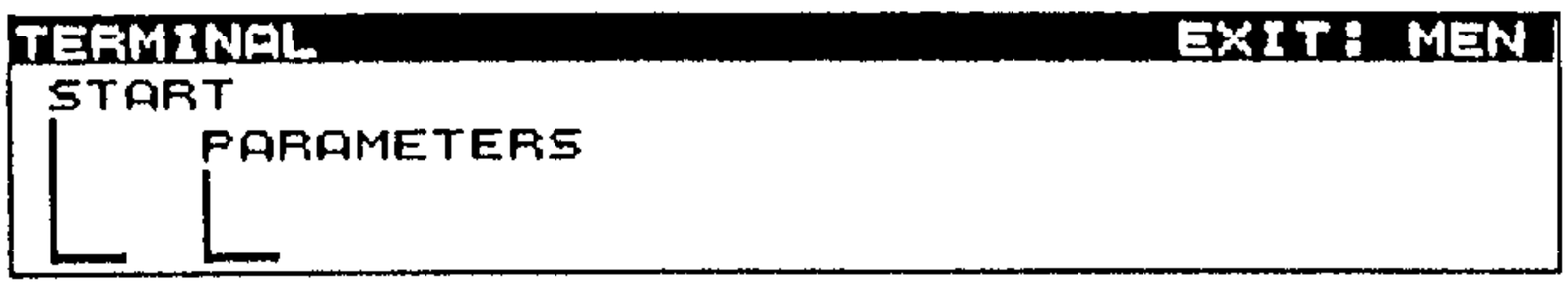


Fig. 9.6.1: Terminal mode

With numeric key 1 the terminal mode is activated.

- the display is cleared
- the terminal mode is activated
- the connected computer controls the system

FCT + MEN : Terminates the terminal mode

9.6.2 Setting parameters

For a smooth interaction between the Rec Elta RL and the connected computer the parameters have to be set properly. With numeric key 2 you get to the display and editing menu.

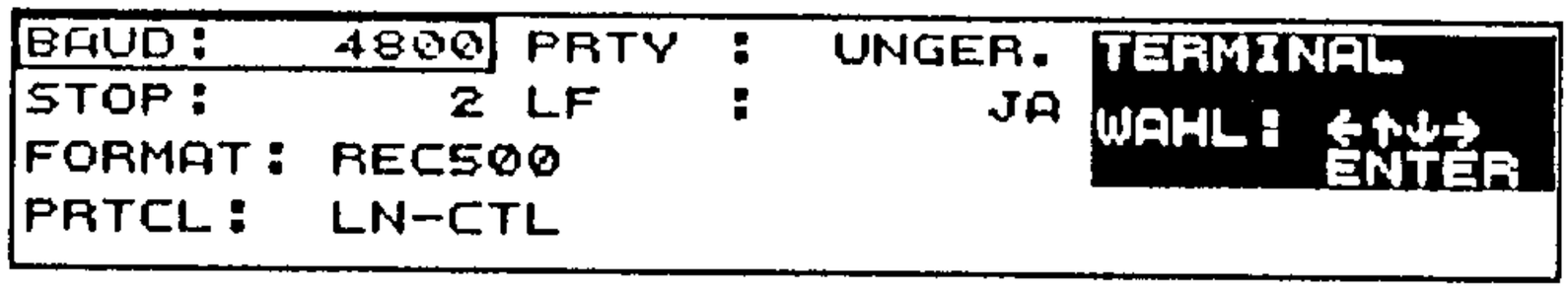


Fig. 9.6.2: Parameter

The display and the editing is performed as you see in the DATA TRANSFER program.

(1) 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 : stably set to 10 seconds

MEN : Return to the terminal mode program

Note:
We recommend to choose in the terminal mode either LN - CTL or XON/XOFF as transfer protocol in order to get a direct question - answer procedure.

9.6.3 Key codes

Key codes are only possible from the Rec Elta RL to the computer.

The formats of the key codes and the answers are stable. The dialogue between the Rec Elta RL and the computer is stable. The answer must be sent to the Rec Elta RL within 10 seconds, otherwise a TIME OUT appears there which has to be cleared by any key stroke.

Explanations:

<	CR	Carriage Return (ASCII 13 dec.)
=	LF	Line Feed (ASCII 10 dec.) if set

Key	Code	Key	Code	Meaning
TAB	T09<	CTL/TAB	T19<	Switching off
1	T31<	CTL/1	T21<	
2	T32<	CTL/2	T22<	
3	T33<	CTL/3	T23<	
4	T34<	CTL/4	T24<	
5	T35<	CTL/5	T25<	
6	T36<	CTL/6	T26<	
7	T37<	CTL/7	T27<	
8	T38<	CTL/8	T28<	
9	T39<	CTL/9	T29<	
0	T30<	CTL/0	T3D<	
MEN	T01<	CTL/MEN	T11<	Leaving the T mode
INP	T02<	CTL/INP	T12<	
LEV	T03<	CTL/LEV	T13<	
MEM	T04<	CTL/MEM	T14<	
ABC	T05<	CTL/ABC	T15<	
°/-	T2D<	CTL/°/-	T2E<	
SPC	T20<	CTL/SPC	T10<	
◄	T06<	CTL/◄	T16<	
▲	T07<	CTL/▲	T17<	
	T08<	CTL/	T18<	
►	T0A<	CTL/►	T1A<	
ENT	T0D<	CTL/ENT	T1D<	

9.6.4 Control commands

Control commands are only possible from the computer to the Rec Elta RL.

The formats of the control commands and the answers are stable. The dialogue between the computer and the Rec Elta RL is stable.

Explanations:

<	CR	Carriage Return (ASCII 13 dec.)
=	LF	Line Feed (ASCII 10 dec.) if set

Call	Answer	Meaning
SEC<	Q<	CR is the delimiter of every string
SEL<	Q<	CR+LF are delimiters of every string
SEO<	Q<	Switching off the Rec Elta RL
?00<	702705-0000/1.00	instrument identification
?01<	1234567	instrument number
T11<	Q<	Leaving the terminal mode

9.6.5 Recalling and setting Instrument parameters

This is only possible from the computer to the Rec Elta RL.

The formats of recalls, answers and setting commands are stable. The dialogue between the computer and the Rec Elta RL is stable.

Explanations:

<	CR	Carriage Return (ASCII 13 dec.)
=	LF	Line Feed (ASCII 10 dec.) if set

Recall	Answer
?P1<	!0000FFGGEEAA;<
?P2<	!00000000000K;<
?P3<	!00000000000BB;<

Setting	Answer
SP1/0000FFGGEEAA;<	Q< E< in case of error
SP2/00000000000K;<	Q< E< in case of error
SP3/0000000000BB;<	Q< E< in case of error

Meaning of the parameters:

AA =	00	mil	01	grad
	10	DMS	11	Deg. dec.
BB =	00	zenith	01	vertical
	10	elev.angle	11	percent slope
EE =	00	meter	01	feet
FF =	00	hPa	01	torr
	10	in Merc		
GG =	00	Celsius	01	Fahrenheit
K =	00	comp. on	01	comp. off

9.6.6 Recalling and setting constants

This is only possible from the computer to the Rec Elta RL.

The formats of the recalls, answers and setting commands are stable. The dialogue between the computer and the Rec Elta RL is stable.

Explanations:

<	CR	Carriage Return (ASCII 13 dec.)
=	LF	Line Feed (ASCII 10 dec.) if set

Recall	**Answer**
?Kxx<	For K1|xxy 12345678901234|<
Setting	**Answer**
SKFor K1|xxy 12345678901234|	<Q<E< in case of error

xx = type code

y = measuring unit (see 14.5.5)

A	addition constant
HV	Hz-rotation
ih	instrument height
th	reflector height
m	scale
T_	temperature
P	pressure
SK	centre-point in rectangular direction
SZ	centre-point in sighting direction
c	collimation correction
i	index correction

9.6.7 Function calls

The computer recalls measuring functions in the Rec Elta RL, performs them there and sends the measuring result to the computer. The data sets are given in the Rec 500 format or in the Rec E format M4 (see 14.5.2) according to the choice made. The transfer protocol set is also valid.

Explanations:

<	CR	Carriage Return (ASCII 13 dec.)
=	LF	Line Feed (ASCII 10 dec.) if set

Call	**Answer in the Rec E format M4**
FD0<	measured data D (with scale and add.const.)
FW1<	measured data Hz V
FMO<	measured data D Hz V (without scale and add.const.)
FMS<	measured data D Hz V (with scale and add.const.)
FMR<	measured data E Hz h (with scale and add.const.)

9.6.8 Graphics commands

This is only possible from the computer to the Rec Elta RL.

The formats of the commands and the answers are stable. The dialogue between the computer and the Rec Elta RL is stable.

When entering the terminal mode the size of letters is set to 7 pixels. The size of the display is 240 * 38 pixels.

Cursor positions have to be entered with 2 digits, pixel positions with 3 digits, if necessary with leading zeroes.

Explanations:

<	CR	Carriage Return (ASCII 13 dec.)
=	LF	Line Feed (ASCII 10 dec.) if set
|		Separator (ASCII 124 dec.)

Command	Answer	Reaction
G5O<	Q<	Switch on character height 5 pixels
G5F<	Q<	Switch off character height 5 pixels
GIO<	Q<	Switch over to inverse video
GIF<	Q<	Switch over to normal video
GBO<	Q<	Switch on sound
GBF<	Q<	Switch off sound
GBL<	Q<	Activating a long sound
GBS<	Q<	Activating a short sound
GCC<	Q<	Clears the cursor
GCB(xx)<	Q<	Sets cursor xx characters to the left side and clears these characters
GCL(xx)<	Q<	Sets cursor xx characters to the left side
GCR(xx)<	Q<	Sets cursor xx characters to the right side
GCS(xxx|yyy)<	Q<	Sets the cursor on pixel position, the former cursor is cleared

Command	Answer	Reaction
GDC<	Q<	The display is cleared
GSO<	Q<	Switch on the immediate display, everything is shown at once on the display
GSF<	Q<	Switch off the immmediate display, everything is shown after the GDO command
GDO<	Q<	Display of formerly entered strings
GXY(xxx|yyy)<	Q<	Set the pointer for display of text
GTC(STRING)<	Q<	Display of text from the cursor position set, the cursor then is located behind the text, the text pointer (GXY) is not changed
GPR(STRING)<	Q<	Display of text to the position defined by GXY. The text pointer is located behind the last character.
GPS(xxx|yyy)<	Q<	Setting of a pixel
GPC(xxx|yyy)<	Q<	Clearing of a pixel
GHL(STRING)<	Q<	Display of the command line with text
GFR(xxx|yyy|lll|hhh)<	Q<	Drawing a frame from the lower left corner with length l and height h
GLF(xxx|yyy|lll)<	Q<	Drawing a line down right
GLH(xxx|yyy|lll)<	Q<	Drawing a line to the right
GLR(xxx|yyy|lll)<	Q<	Drawing a line up right
GLV(xxx|yyy|lll)<	Q<	Drawing a line upwards
GKY(xxx|yyy)<	Q<	Drawing a menu hook. The position is stored in the text pointer and can be used for the GPR command.
GSW<	Q<	Clearing of the display, drawing of a sandglass

10. Editor program

10.1 Overview

(1) Purpose
Input, recall and display, editing and deletion of records.

(2) Editor function selection
Select the EDITOR program with numeric key 8. Change to the selection menu.

```
SELECT DISPLAY: ↑↓  DATA: →
Add.      1  METER/GRD/ZENITH/YXZ/
Add.      2  HPA/MB/C/
Del Edt Inp ACd LAd ?Ad ?Pt ?PI ?↓  Inf
```

Fig. 10.1.1: Selection menu of EDITOR

(3) Description of the selection options
The soft keys in line 4 afford entering, recalling and displaying, editing and deleting records.

Key		Function
↑,↓,→,◄-		Scrolling in the data and toggling between the display of measured or computed data or the P.I.
FCT + 1	soft key Del	Deletion of records with different options (soft key 5 to 8)
FCT + 2	soft key Edt	Editing or records
FCT + 3	soft key Inp	Input of coordinate records
FCT + 4	soft key ACd	Additional codes for a series of records
FCT + 5	soft key LAd	Display of the last address
FCT + 6	soft key ?Ad	Memory search for a given address
FCT + 7	soft key ?Pt	Memory search for a given point number
FCT + 8	soft key ?PI	Memory search for a given point identification
FCT + 0	soft key Inf	Recording of an information line

10.2 Record display

(1) Purpose

- Survey of the recorded data
- Record checking before editing or deletion
- Search for given records

(2) Search for records with cursor keys

The vertical cursor keys ↑,↓ afford scrolling in the data (fig. 10.2.1). The horizontal cursor keys →,◄– toggle between display of the P.I. and the associated coordinates or measured data (fig. 10.2.1 and 10.2.2). The display window remains on line 2, the soft key line remains visible during all operations, and in the first line the dialogue information is replaced by a third record.

Key	Function
↑	Scrolls down in the data file. Jumps directly from the first record to the last address.
↓	Scrolls up in the data file. Jumps directly from the last record to the first address.
→	Shifts the display field right, coordinates or measured values are visible.
◄–	Shifts the display field left, P.I. is visible.

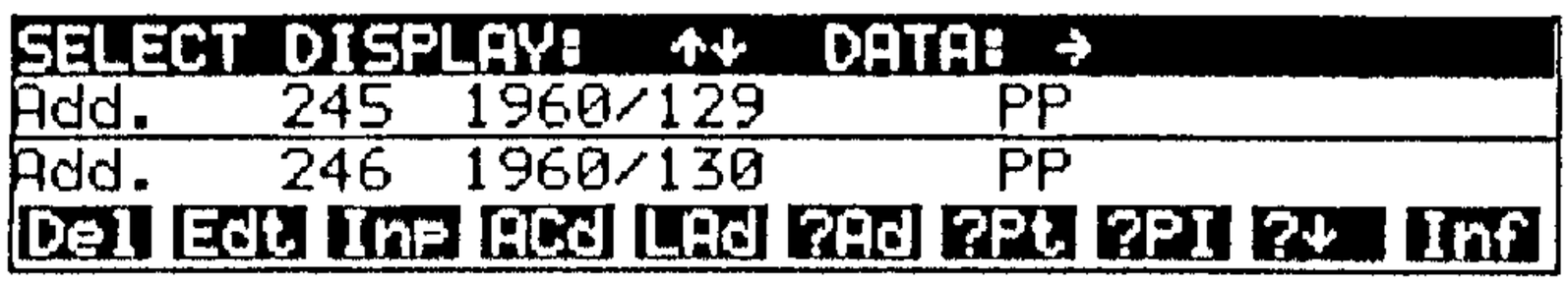


Fig. 10.2 1: Left side of the record address + point identification

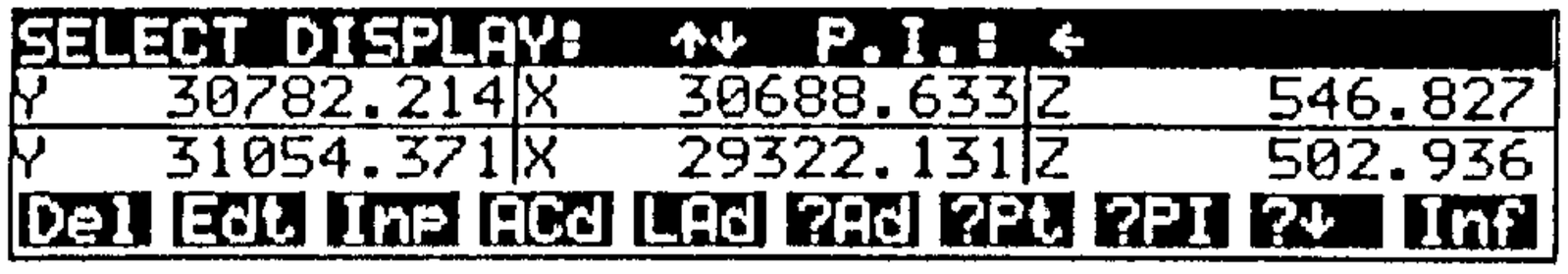


Fig. 10.2.2: Right side of the record coordinates or measured values

10.3 Record retrieval with soft keys

(1) Purpose

If you know the point number, address or point identification, records can be retrieved in different ways. The search begins at the current address (framed in line 2, see fig. 10.2.1).

Note:
If records are repeatedly stored with the same point number or point identification you can look for the corresponding record with soft key ?↓.

(2) Recall with soft key LAd

Pressing soft key LAd causes the last address to be displayed in line 2 (see fig. 10.1.1). Vertical cursor keys lead directly to the first (↓) or the second-last address (↑).

(3) Recall with soft key ?Ad

Soft key ?Ad directly retrieves a given address and displays it. Up to 4 digits can be entered. Address input is similar to the INPUT program. The found record is displayed and framed in line 2 (see fig. 10.2.1). The preceding and following records are also displayed (see fig. 10.2.1).

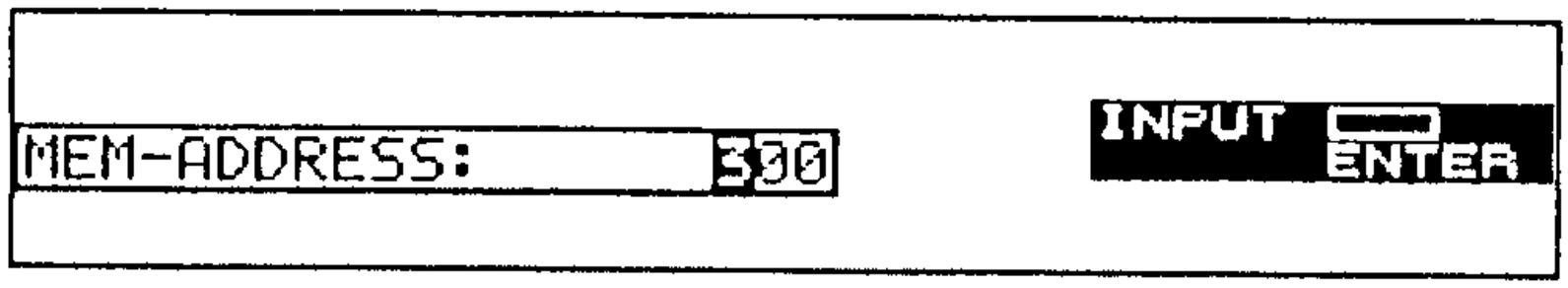


Fig. 10.3.1: Recall by address

(4) Recall with ?Pt

Soft key ?Pt retrieves a specified point number (see fig. 10.3.2).

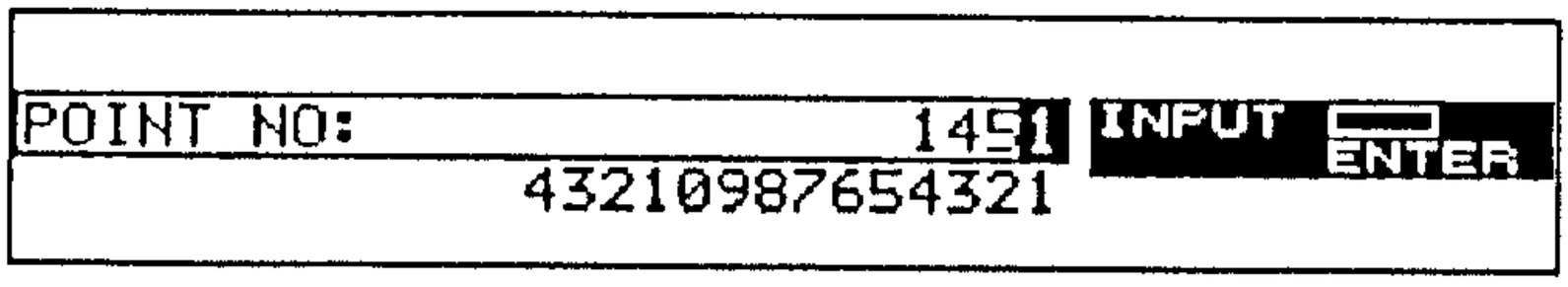


Fig. 10.3.2 : Recall by point number

The retrieved record is displayed and framed in line 2 (see fig. 10.2.1). The preceding and following records are also displayed.

(5) Recall with ?PI

Soft key ?PI can be used to search for a totally or only partially known point identification in a specific mark (see fig. 10.3.3).

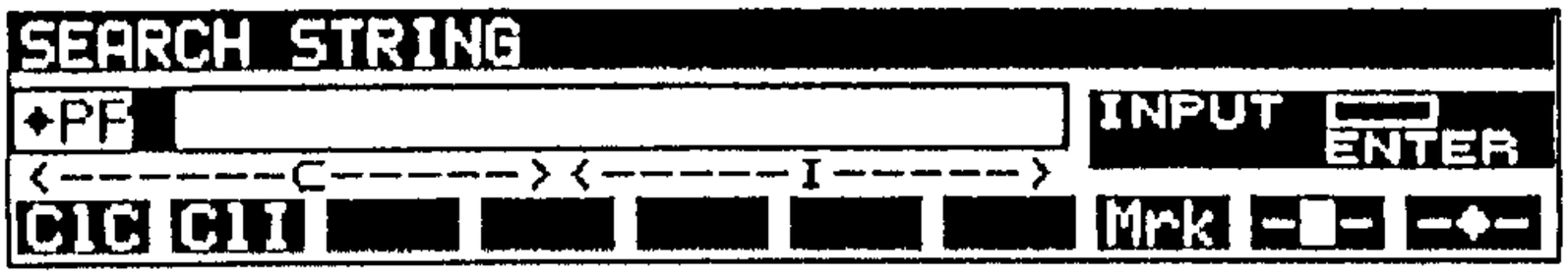


Fig. 10.3.3 : Search by partial point identification

Retrieval is supported by 3 soft keys.

Mrk : Selection of the mark

-▪- : Place holder for unknown characters (formatted input). Stands for random information that is suppressed during retrieval.

-♦- : Wildcard for an unknown area (unformatted input).

Place holders and wildcards can be used in different combinations.

10.4 Additional code

Soft key ACd provides fast access to random records for adding further information or overwriting errored information. When you call this option, the whole P.I. is filled with place holders.

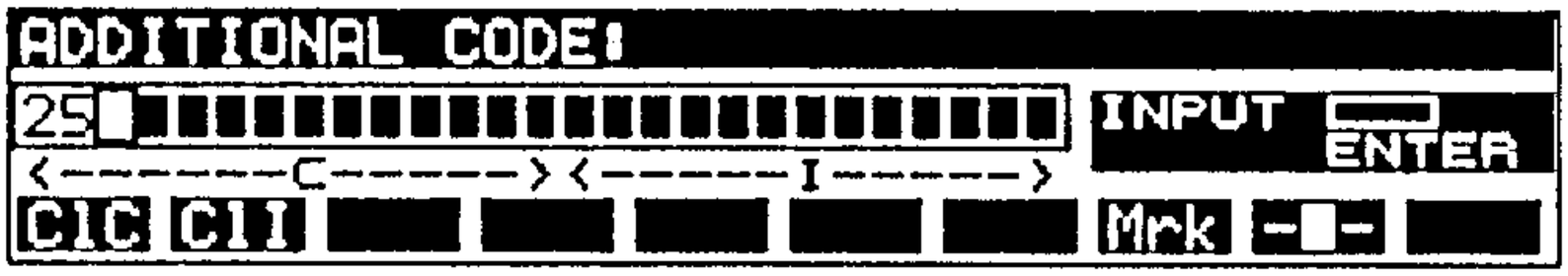


Fig. 10.4.1 : Additional code

After selecting the desired mark with soft key Mrk, you can overwrite the place holder with the required modifications. Inadvertently modified place holders can be restored with soft key -▪-. ENT calls the selection menu for the records to be edited (see fig. 10.4.2).

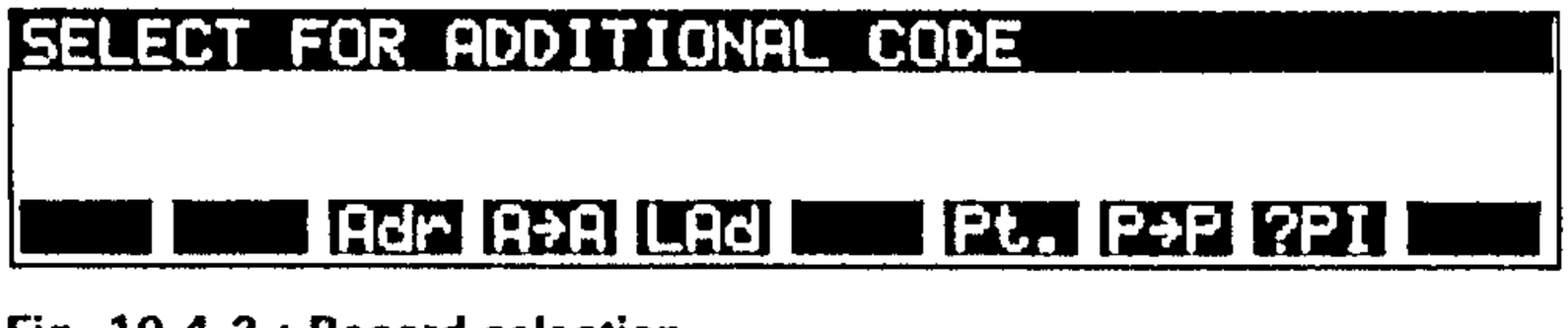


Fig. 10.4.2 : Record selection

Selection is supported by 6 soft keys:

Adr : Editing information at a given address

A→A : Editing from a given address to another address

LAd: : Editing of the last address

Pt. : Editing the information on a given point number. If the point number is redundant, the correct point can be located under program control (see fig. 10.4.3).

P→P : Editing form a given point number up to a given point number

?PI : The records to be edited can be selected by the criteria described in (5). Recall with ?PI.

```
D        51.367E        50.926h        6.718
ADD.    297    1451
CONTINUE SEARCHING ?                   YES  NO
```

Fig.10.4.3 : Search continuation

YES : The search is continued.
NO :

```
ADDRESSES
ADD.    297 1451
ADD.    298 1452
WRITE ADD. CODE ?                      YES  NO
```

Fig. 10.4.4: Overwriting

YES : Brief display of the modification and return for selecting further records.
NO : The record is not overwritten (brief display: Nothing Overwritten!). Branch to the menu for selecting further records.
MEN : Return to the DISPLAY SELECT program.

For the meaning with further soft keys see 10.3 and 10.4.

10.5 Entry of coordinate records/ polar elements

(1) Purpose

Manual entry of coordinate records and polar elements E-Hz-h that are required for computation and measurement but are not contained in the memory. Records can be entered with the **Inp** key which should not be confused with the **INP** key for calling the INPUT program. As the entry of coordinates and of polar elements is identical only the entry of coordinates is described.

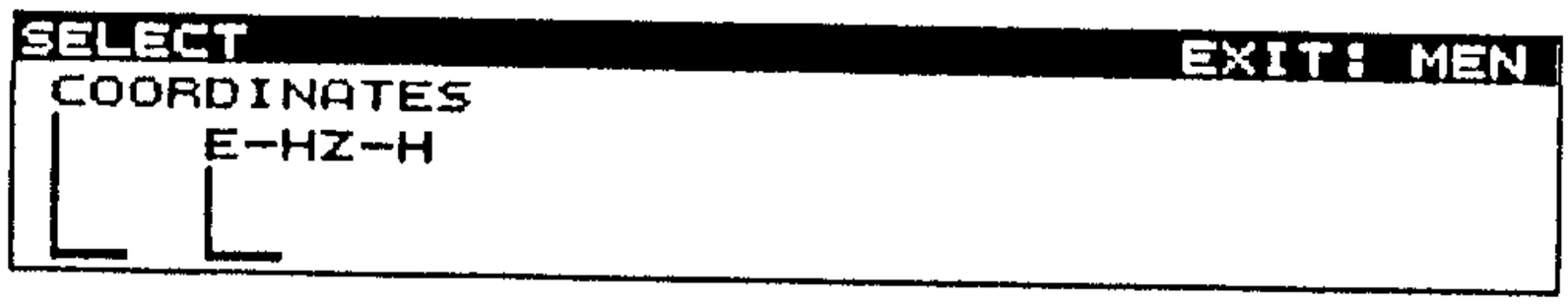


Fig. 10.5.1: Coordinates/E-HZ-H

(2) Input menu

Key 1: Branch to the coordinates input menu

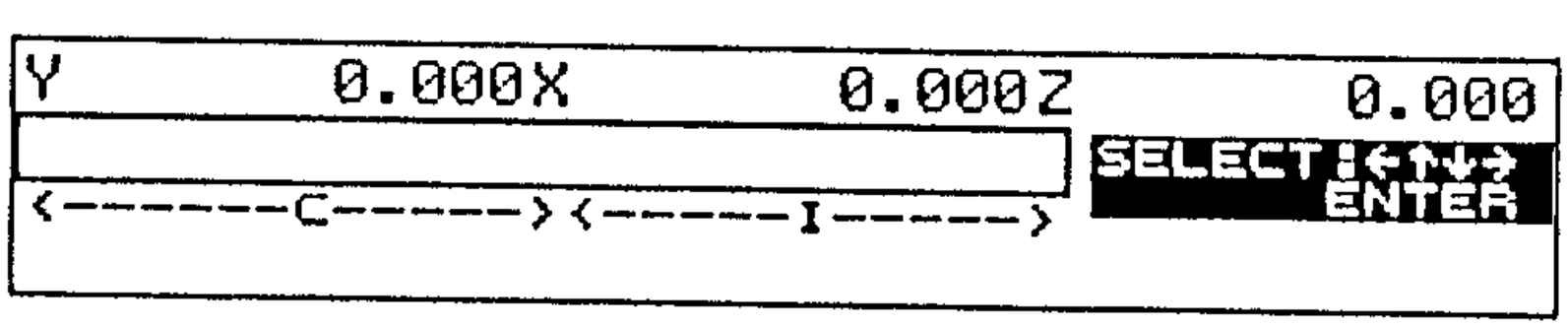


Fig. 10.5.2: Input selection menu

(3) Input field selection

The vertical or horizontal cursor keys move the input field to the coordinate or P.I. to be entered.

(4) Input activation

ENT : Activates input in the point identification (see fig. 10.5.3) or coordinate display field (see fig. 10.5.4) The soft keys in line 4 support input.

(5) P.I. input

Input of numbers, letters or special characters for the P.I. according to the input menu of the measurement modes (5.2). The mark selected last is displayed below the input field (see fig. 10.5.2). Selecting another mark with soft key Mrk is possible.

Further soft keys support input.
Soft key Inf (see Appendix A 2) suspends P.I. input for entering an information line that is stored first.
The **ABC** key causes the soft key line to be overwritten by the alpha assignment.
ENT terminates input. Change to the selection menu (see fig. 10.5.2).

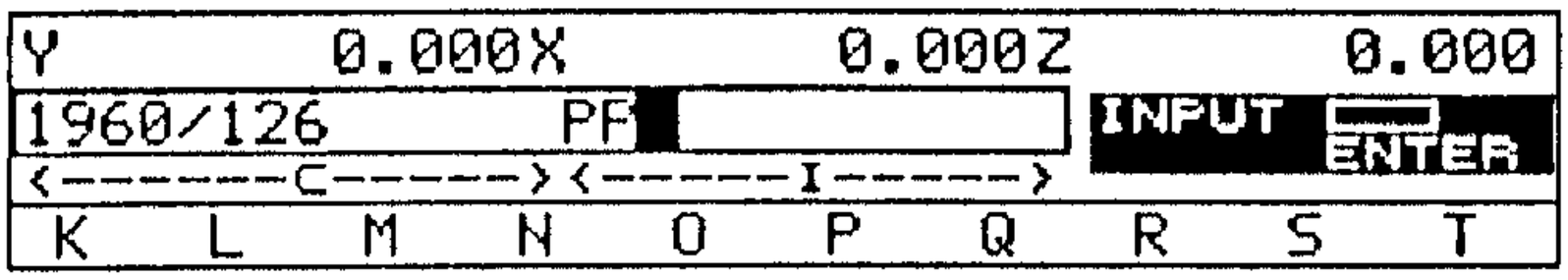


Fig. 10.5.3: P.I. input menu

(6) Coordinates input
Steps (3) and (4) apply similarly. Input of numbers according to the INPUT program (2.2.1.1) - (see fig. 10.5.4).
ENT : Terminates input.

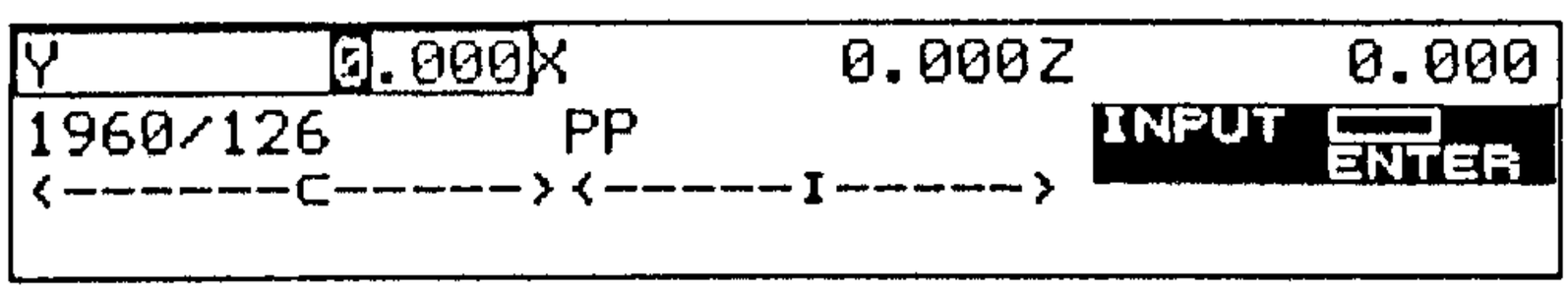


Fig. 10.5.4: Coordinates input menu

(7) Input termination
MEN : Terminates input in the selection menu (see fig. 10.5.2). Change to fig. 10.5.5 which requests a decision on recording the data.
YES : Displays the address of the stored data and changes to the input selection menu for the next record (see fig. 10.5.2). The entries made in the last record are displayed and need only be edited.
NO : Change to the EDITOR display(see fig. 10.1.1).

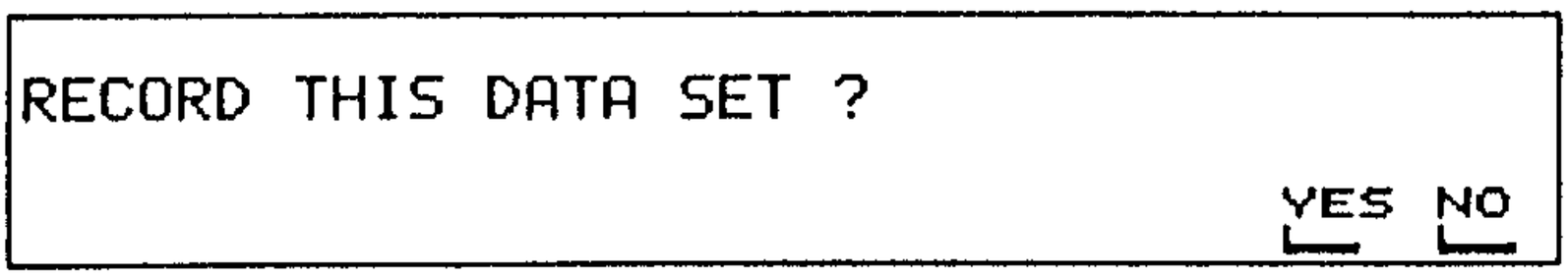


Fig. 10.5.5: Data recording

10.6 Record editing

(1) Purpose

Editing of errored point identifications or coordinates.
In all other records, only the P.I. field can be edited. The other input fields are blocked against input.

(2) Selection of the record to be edited

Recall the record to be edited with the cursor keys or with the soft keys **LAd**, **?Ad**, **?Pt** oder **?Pl** (see 10.3 (2)-(3)). The record to be edited is displayed in line 2 of the display.
Call the editing routine with soft key **Edt**; change to the display of fig. 10.5.1.
Edit as described in Coordinate records input (10.5 (2) to (7)).

(3) Particularities

Soft keys Ino and are not active for editing the P.I.

ENT : The edited record is stored at the old address.

10.7 Record deletion

(1) Purpose

Deallocating storage space by deleting the whole memory or by selectively deleting specific measurement or values.
After the deletion of records the contents of the Mem can be renumbered. The description is given at the end of this chapter in (7) Renumbering.

(2) Record selection

Select records for deletion with the following soft keys (fig. 10.7.1):

All : All records
Adr : One record
A→A : From a start address to an end address
LAd : Last address
Pt. : Point number
P→P : From a start point to an end point
?PI : Point identification

Fig. 10.7.1: Record selection

(3) Soft key All

Soft key All changes the display to fig. 10.7.2 which asks if all data is to be deleted.

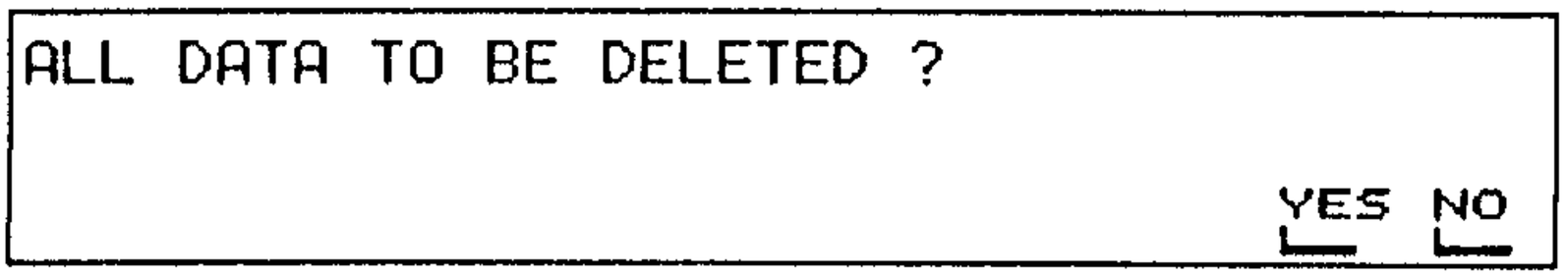


Fig. 10.7.2: Deletion of all data

YES : The question appears again to avoid inadvertent deletion (see fig. 10.7.3).
NO : Brief display: NOTHING DELETED!
Change to the record selection menu (see fig. 10.7.1)

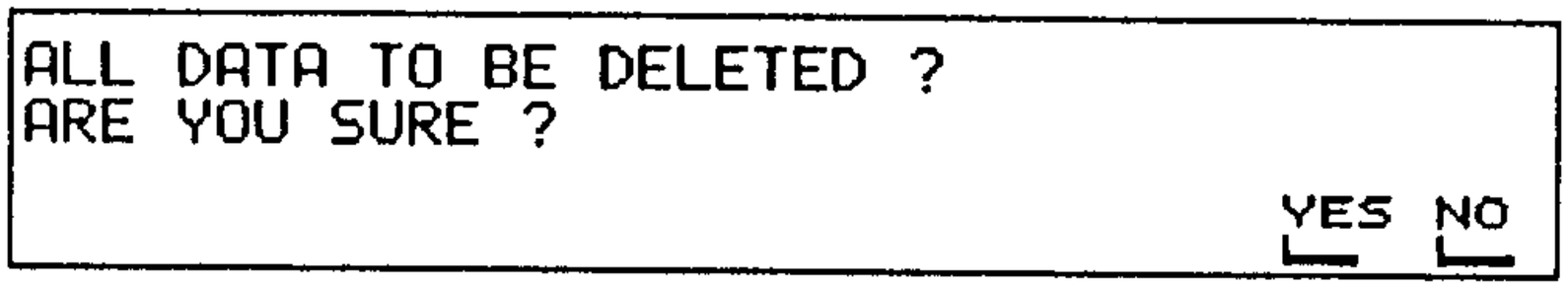


Fig. 10.7.3: Deletion check

YES : All records are deleted.
NO : Brief display: NOTHING DELETED!
Branch to the record selection (see fig. 10.7.1).

(4) Soft key A→A

Soft key A→A changes to display to fig. 10.7.4 for the selection of the start and end addresses.

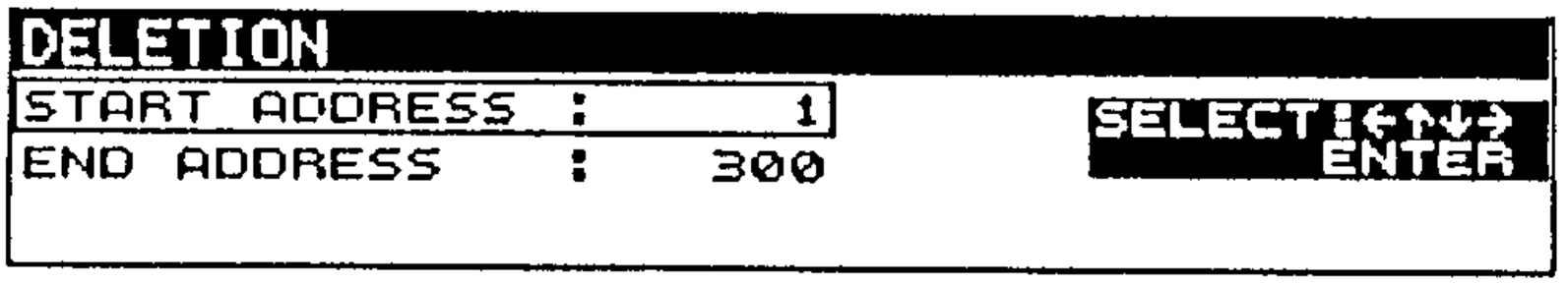


Fig. 10.7.4: Selection

↑, ↓ : Selection of the start and end addresses
ENT : Confirms the selection. Branch to the input menu (see fig. 10.7.5).
MEN : Branch to Deletion (see fig. 10.7.9).

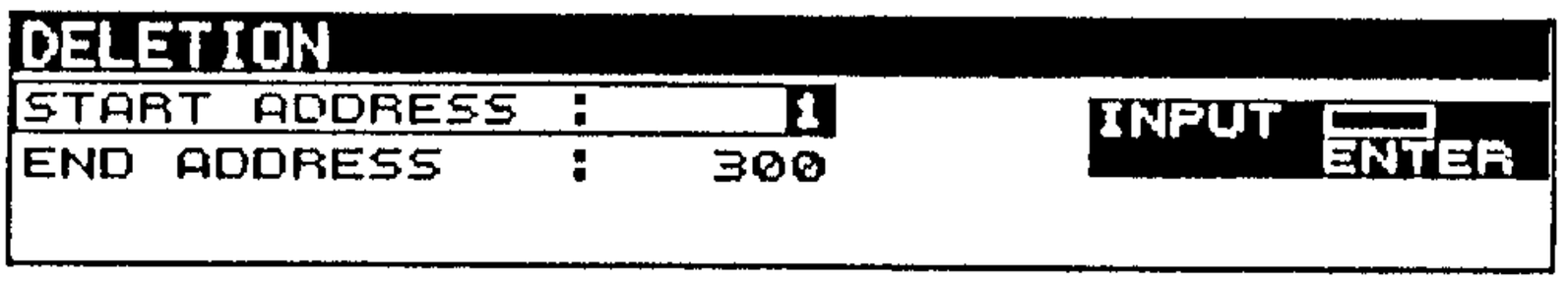


Fig. 10.7.5: Address input

MEN : Resets the old values
ENT : Confirms input and branches to Selection (see fig. 10.7.4).
Repeat the procedure for the end address.
MEN : Branch to (6) Deletion (see fig. 10.7.9).

(5) Soft key P→P

Soft key P→P affords deletion of addresses from a given point number up to another given point number. If there are redundant point numbers, the correct ones can be selected under program control.

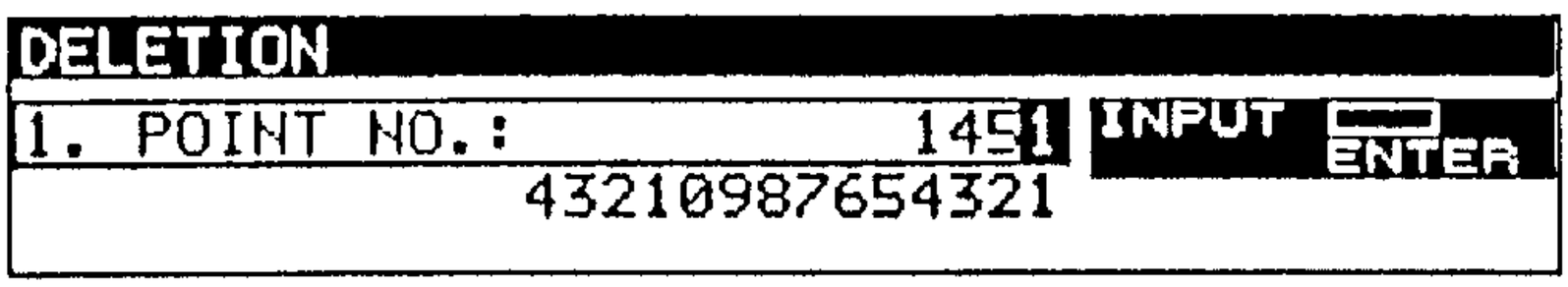


Fig. 10.7.6: Input of the first point number

MEN : Brief display: NOTHING DELETED!
Branch to the record selection (see fig. 10.7.1)
ENT : Start of the search and display of the following query:

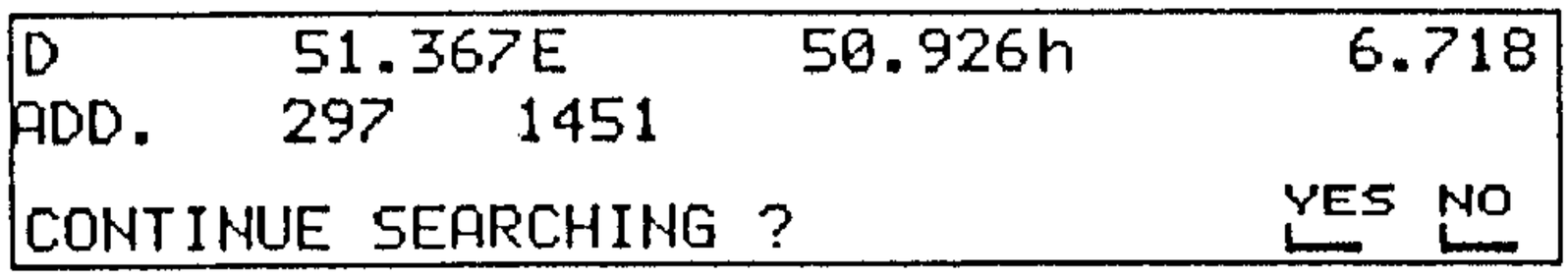


Fig. 10.7.7: Continue

YES : Search is continued
NO : Input of the second point number (see fig. 10.7.8)

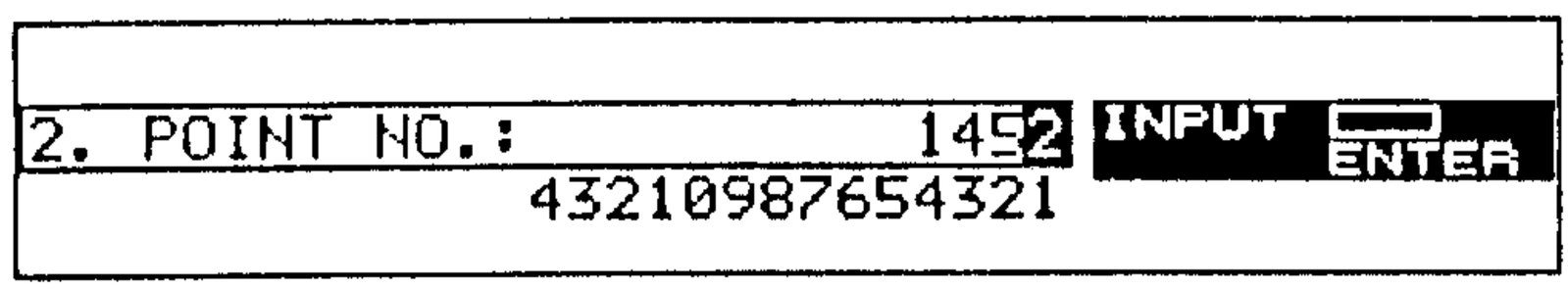


Fig. 10.7.8: Input of the second point number

MEN : Brief display: NOTHING DELETED!
Branch to the record selection (see fig. 10.7.1)
ENT : Branch to 10.7.7: Continue

When the second point number is found:
NO : Branch to (6) Deletion.

(6) Record deletion

The retrieved PD.dIS. and the associated addresses are displayed automatically.

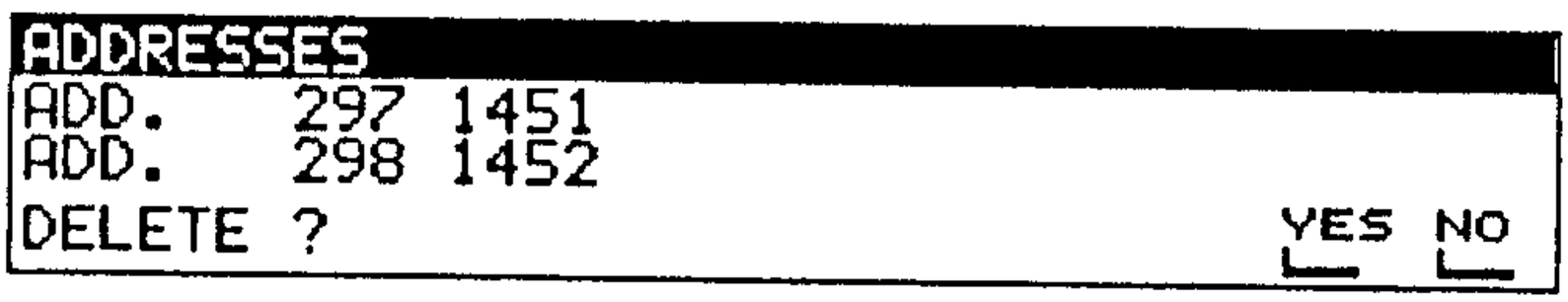


Fig. 10.7.9: Deletion

YES : Brief display of the deleted records. Branch to the selection menu (see fig. 10.7.1).
NO : Brief display: NOTHING DELETED!
Branch to the selection menu (see fig. 10.7.1).

The remaining soft keys are described in 10.3 Record Retrieval.

(7) Renumbering

The renumbering menu is displayed automatically if you leave the menu with MEN after deletion. When the Mem is renumbered, the data in the Mem are completely available again. A start address for the renumbering can be entered in order to accelerate the procedure or not to change special addresses.

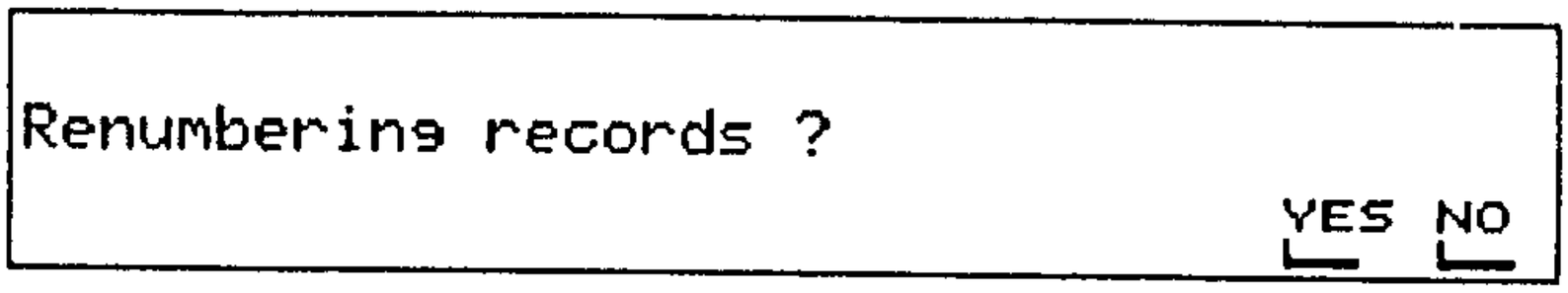


Fig. 10.7.10: Renumbering

NO : Branch to the selection menu (see fig. 10.7.1).
YES : Branch to the entry of start address

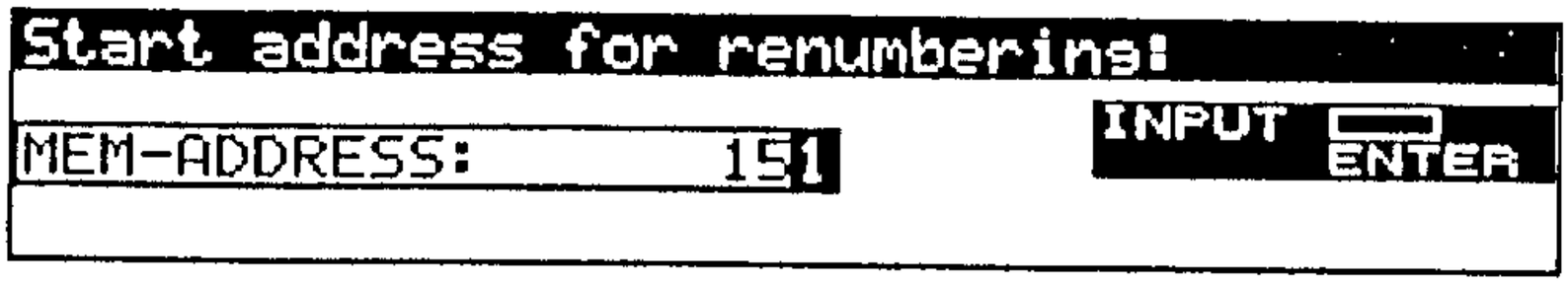


Fig. 10.7.11: Entry of a start address

Starting with the entered address, the records are renumbered. The records in front of this address remain unmodified. The default value is 1.

ENT : Entry of the address and renumbering. Branch to the selection menu (see fig. 10.7.1).

MEN : Branch to the selection menu (see fig. 10.7.1) without renumbering.

11. Interface Description

11.1 What is an interface

An interface is the point of contact between 2 systems or system areas, i.e. the point at which information is interchanged. To ensure it is understood in the same way by the sending and the receiving system, specific rules must be defined for the transfer of signals and data. Since different conditions generally exist in communicating systems, it is particularly important during interface definition that these differences are compensated.
Basically 3 types of interfaces can be distinguished: hardware, software and user interfaces.

11.1.1 Hardware interfaces

Hardware interfaces physically interconnect functional units such as measuring devices, computers or printers. Important for the user are, for example:

- Shape and pin assignment of the connectors at the functional units and the connecting cables. Section 11.3 deals with this.
- The data transfer method. The parameters and protocols for controlling data transfer are described in chapter 11.4.

11.1.2 Software interfaces

Software interfaces establish links between programs or program parts.

The data to be transferred must have a defined structure: the record format. The Carl Zeiss record formats are described in section 11.5.

If the two programs use different internal record formats, format conversion is required on one side.

11.1.3 User interfaces

Another interface that is particularly important for controlling a system is the user interface. Interfaces between the user and the system are the display, the keyboard and the software options for user guidance. The Rec Elta - 14T - concept places particular importance on the design of the user interface.

11.2 The Hardware interfaces in the Rec Elta RL

The Rec Elta RL consists of the functional units and the displaying and operating unit. There are two interfaces for a peripheral unit (e.g. a computer, a printer):

One interface is on the left side of the operating and displaying unit, the other one is at the slip ring connection.

Note:
Only one of both interfaces may be used at a time.

The Rec Elta performs the function of a measurement sensor. In response to a given command, it senses measured values, corrects them (for the atmospheric conditions, the instrument errors etc.) and displays them on the display.

The interface to the periphery is an asynchronous serial interface that corresponds to DIN 66020 (V 24 / RS 232 C). The connector assignment is given in chapter 11.3.1.

This interface has two functions in the Rec Elta RL - concept:

(1) Data transfer

Direct data transfer of measured data between the Rec Elta RL and the connected peripheral unit (computer, printer,...).

A series of data transfer parameters and protocols are available for controlling this operation (see chapters 9.2 and 11.4).

(2) Software update

Software for the Rec Elta RL can be loaded via the interface (see chapter 9.4).

11.3 Connectors

11.3.1 8 - point connector at the operating and displaying unit

The connector is an 8-point stereo connector (female) as per DIN 41524.

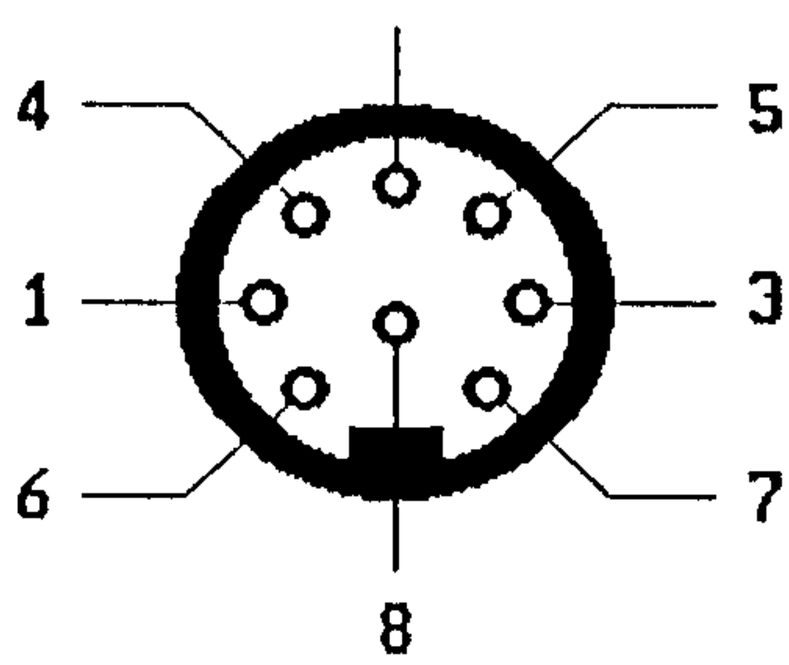


Fig. 11.3: Pin assignment (seen from the outside)

Pin	Signal	ON/OFF	Designation	Meaning
1				not assigned
2	GND		Signal ground	
3				not assigned
4	TD	OFF	Transmitted Data	
5	RD	ON	Received Data	
6			NC	not assigned
7			NC	not assigned
8			NC	not assigned

11.3.2 Cables

The following table lists the Catalogue numbers for some standard cables.

Peripheral device	Rec Elta RL 8-point
DOS-PC, 9-point	708177 - 9260
DOS-PC, 25-point	708177 - 9270
EPSON printer	708177 - 9300
Adapter cables Rec 500, 25-point *)	708177 - 9290

*) The adapter cable connects the Rec Elta RL (8-point round connector) with all existing Rec 500 cables (25-point DB connector) used for data transfer to computers under software control (see 11.4.3.1). This cable also enables:

- customers who already have connected a Rec 500 to a computer, to connect a Rec Elta RL to the existing Rec 500 cable and by this means to a computer
- to use all existing connections from the Rec 500 to a computer via software control also for the Rec Elta RL.

11.4 Transfer parameters and protocols

The Rec Elta RL provides a series of options for data transfer synchronization. The interface settings recommend, for example, communication with printers via control lines and with computers by a software dialogue.However, the XON/XOFF dialogue can also be recommended for printers or computers.

11.4.1 Optional transfer parameters

(1)	Baud rate	300, 600, 1200, 2400, 4800, 9600	
(2)	Stop bits	1, 2	
(3)	Time out	00, 10, 20, 30, ... , 90 seconds (00 = Time out off)	
(4)	Formats	Rec 500, Rec E	
(5)	Protocols	Rec 500	Softwaredialog
		MODEM	Rec 500 Dialogue + 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, no	
(7)	Line feed	YES, NO	CR LF or only CR as data line termination

*) End byte — Some computers require a special end byte to terminate data transfer. By default the Rec Elta 15 uses the end byte EOT = ASCII dec. 4. It is transmitted as an additional EOT end character.

11.4.2 Default parameters

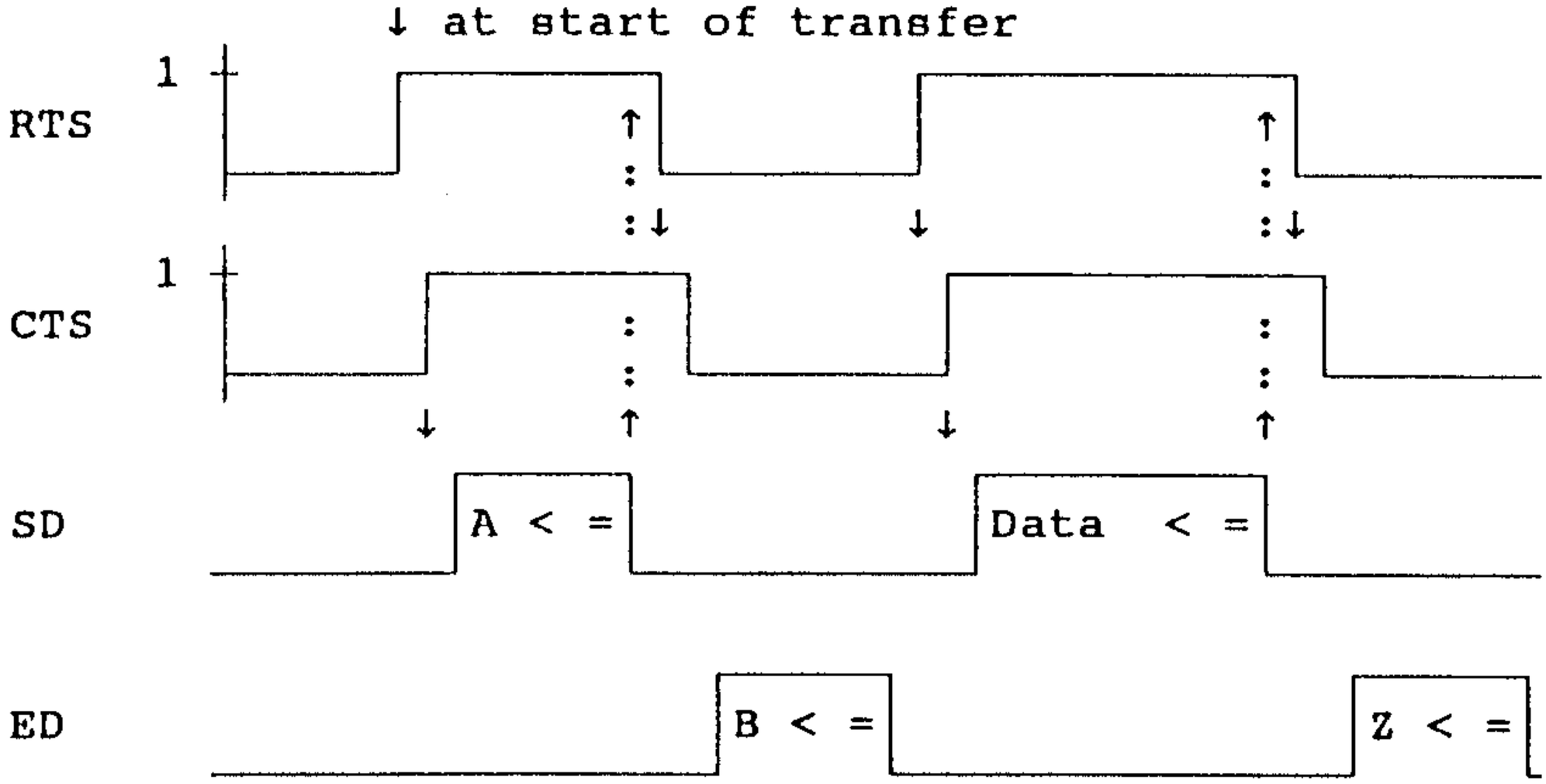
Parameter	Rec Elta RL
BAUD	4800
FORMAT	REC500
PRTCL	REC 500
STOP	2
PRTY	ODD.
T/O	10
LF	YES

11.4.3 Protocol timing diagrams

11.4.3.1 Rec 500 - Software dialogue

11.4.3.2 MODEM/Rec 500 + line control (Modem Lines)

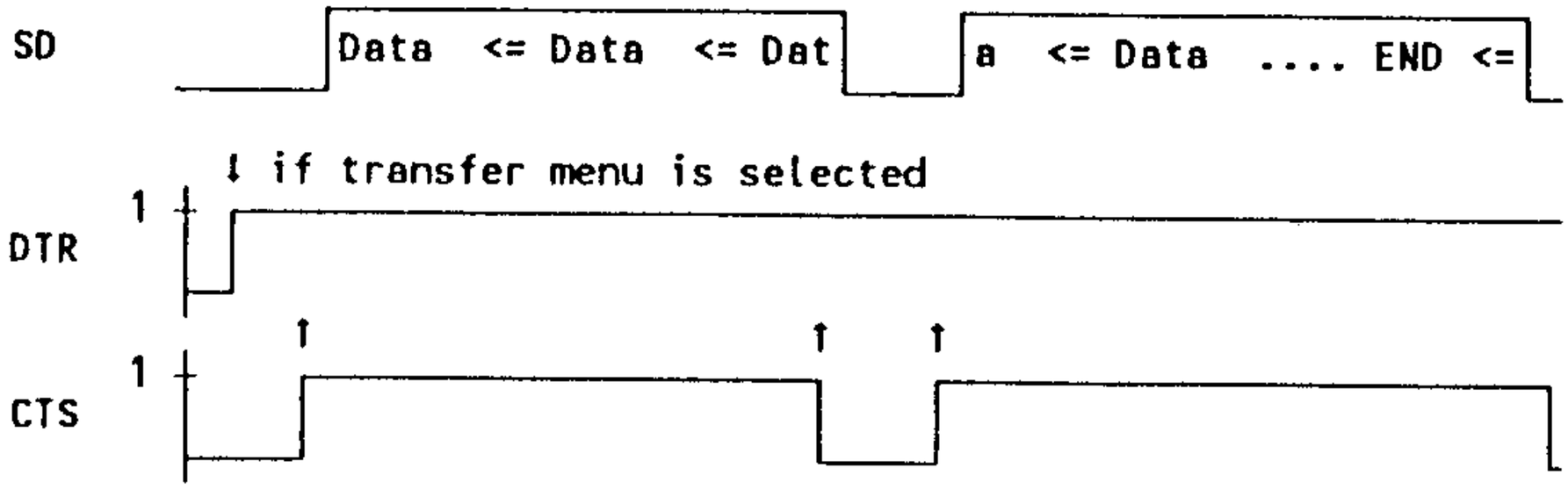
Caution: This protocol should be selected only for computers connected via a modem!



- The dialogue corresponds to the Rec 500 software dialogue (11.4.3.1)
- In addition, lines for a modem are active.
- Once the data to be transferred has been selected and transfer started, **RTS** is set to **Log '1'**.
- If the modem returns **CTS** (after a delay of approx. 80 msec), "A CR LF" can be transmitted because at this time the line to the computer is through-connected at the other modem side.
- **RTS** is reset after the transfer of this first control word (also for data).
- The modem now removes **CTS**.
- After a short delay, bytes are received from the modem (control word "B CR LF" or data) because the other modem side can now set **RTS - CTS**.

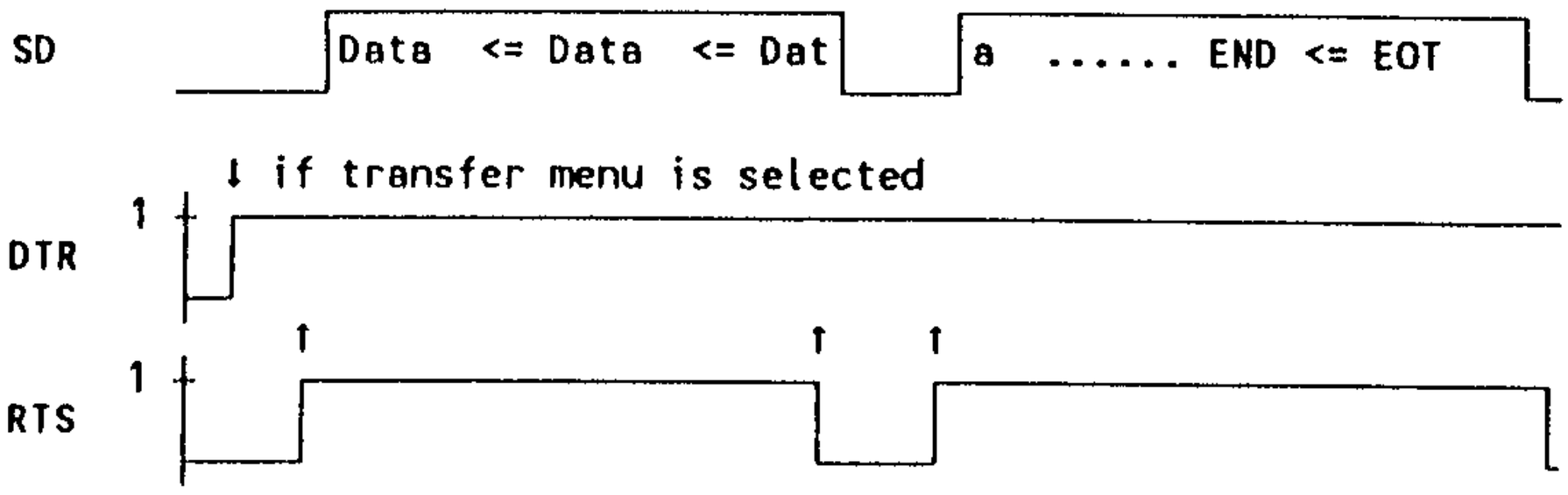
11.4.3.3 LN-CTL (line control)

This common line handshake is suited above all to printers, cassette devices or the like (SD from the Rec Elta RL), but also to computers (SD from the Rec Elta RL or from the computer).

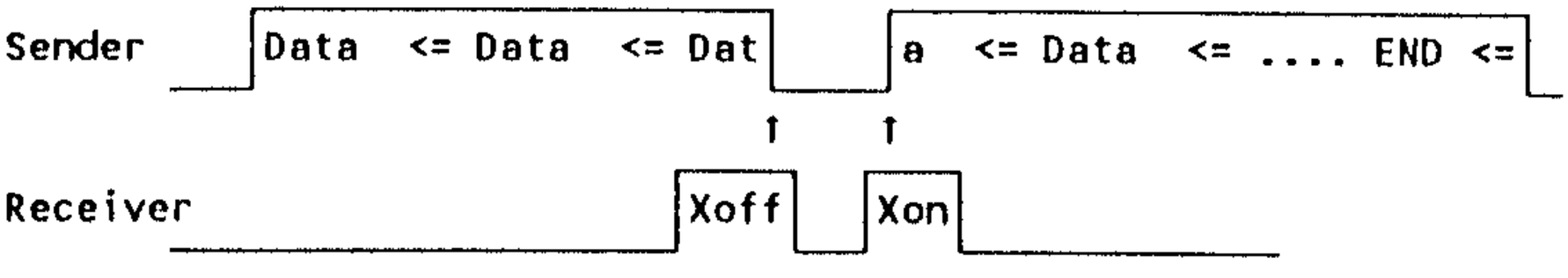


- In this mode, the sender continously sends records as long as CTS is Log '1'.
- CTS changes to Log '0' if the peripheral device cannot receive the data fast enough (buffer overflow).
- The byte in progress is transferred completely.
- When CTS becomes Log '1' again, transfer is continued.
- The timeout set in the Set menu is used.

11.4.3.4 LN-CTL + end byte

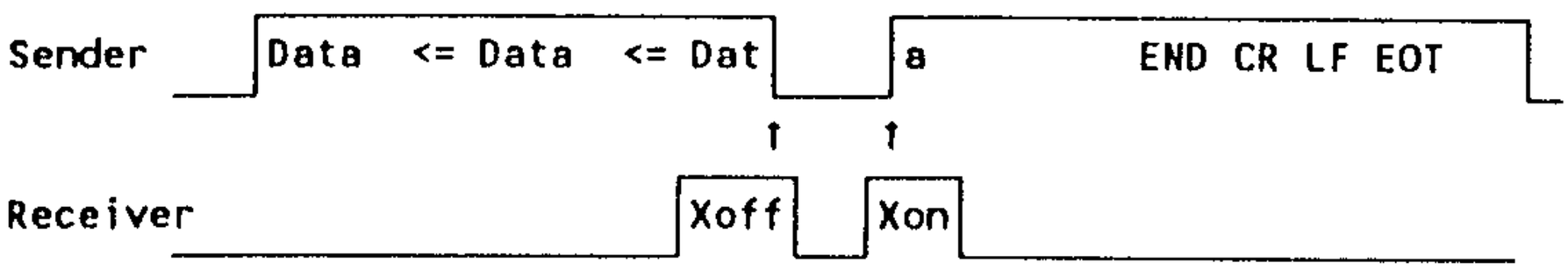


11.4.3.5 XON/XOFF mode



- When **XOFF** is received, the character in progress is transmitted completely.
- Then a delay occurs until **XON** arrives from the receiver.
- Data transfer is then continued.

11.4.3.6 Xon/Xoff + end byte



11.5 Record formats

For data transfer between the Rec Elta RL and peripheral units there are two default record formats, the Rec 500 format (11.5.1) and the Rec E format (11.5.2).

In addition to the Rec 500 record format which has been approved for many years we achieved an even more detailed record format description with the new Rec E formats. The record begins with a format information which is helpful for external evaluation.

All data blocks are preceded by a type identification. The numeric data fields all have 14 digits and can also take in numerical values with a specified number of decimal digits in addition to decimal point and sign.

11.5.1 The Rec 500 record format

```
Position:
0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

Fields:
<-><--><-----------><----------><><----------><><----------><><-------><--

Example:
   1122 12345678901234ASDFGHJKLZXCV D     2500.941 Hz     256.5224 V1 102.1234

Space:
LLL    L                          L          L              L              <=

Meaning:
    ADR   Code C   Add.info.      Z T1   Distance  T2  Hor.direct. T3 Zen.angl

Number of digits:
 3   4 1              27              1 2      12      1 2      13      1 2     9   11
```

Abbr.	Designation	Chars.	num/alpha	Meaning
L	Space	1		
ADR	Addresse	4	num	Consecutive number of the record (address) at the Rec Elta RL 4 spaces
P	point identific.	27	num/alpha	Point C and additional information Z
T1	Type cd.1st value	2	num/alpha	e.g. D = slope distance, E = horizontal distance
W1	1st value	12	num	
T2	Type cd.2nd value	2	num/alpha	e.g. Hz = horizontal direction
W2	2nd value	13	num	
T3	Type cd.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 The Rec E record format M5

By reason of better readability and clearness the Rec 500 format has been enlarged to the new Rec E formats. The enlargement includes the clear description of the unit behind of the respective values and the introduction of an error sign as indication of an erroneous readout of the Mem.

```
          1         2         3         4
12345678901234567890123456789012345678901234567890123456789
For_M5|Adr_12345|T2a_12345678901234567890123456789012345678|
          value1    <----------value 2---------->

5         6         7         8         9
01234567890123456789012345678901234567890123456789012345
T3_12345678901234_dim3|T4_12345678901234_dim4|
   <--value 3--->          <--value 4--->

    1         1         1
    0         1         2
67890123456789012345678901
T5_12345678901234_dim5|?<=
   <--value 5--->
```

Abbr.	Designation	Chars.	num/alpha	Meaning	
For_	code	4	alpha	Rec E format	
M5	format type	2	alpha	measured data, blocks	5
Adr_	code	4			
	value 1	5	num	Mem address	
T2	Type cd.2nd value	2	alpha		
a	Marking	1	num	a = 1-7 out of Mem	
	Value 2	27	alpha	Point identification	
T3	Type cd.3rd value	2	alpha		
	Value 3	14	num	14-digit value	
dim3	Unit	4	alpha	4-digit unit	
T4	Type code	2	alpha	value 4	
	value 4	14	num	14-digit value	
dim4	Unit	4	alpha	4-digit unit	
T5	Type code	2	alpha	value 5	
	value 5	14	num	14-digit valueWert	
dim5	Unit	4	alpha	4-digit unit	
?	Code	1	alpha	? if errored, otherwise _	

Special characters:

|	Separation	1	ASCII 124
_	Space	1	ASCII 32
<	CR	1	ASCII 13
=	LF	1	ASCII 10 (optional)

11.5.3 List of all records

The following table lists the existing records ordered by programs, modes and functions. To accomodate the additional functions of the Rec Elta RL, the number of fields has been increased compared to the Rec 500.
In the point identification field (P.I.), texts (e.g. mode titles) are created in different places by the program. These are given explicitly in the P.I. column. Point identification that can be entered by the user are indicated by (.....).
If you choose Rec E format M5 the record is enlarged with the type codes and characters presented at 11.5.2 (see example initial condition).

Program/Mode/Function P.I.	Type codes T1	T2	T3	Remark
INITIAL INSTRUMENT CONDITION				
METERS/GRADS/ZENITH/YXZ/	-	-	-	
For M5|Adr ....|TG METER/GON/ZENITH/YXZ/	|	|	|	|
HPA/MB/°C/	-	-	-	
INPUT VALUES	m	th	ih	
INPUT VALUES	T_	P	A	
INDEX CORR.	-	-	i	
COLL. CORR.	-	c	-	
COMP.C-PNT.	-	SQ	SZ	
INPUT-Program				
INPUT VALUES	m	th	ih	
INPUT VALUES	T_	P	A	
INPUT VALUES	T_	P	A	
UNITS-Program				
METERS/GRADS/ZENITH/YXZ/	-	-	-	
HPA/MB/°C/	-	-	-	

Program/Mode/Function P.I.	Type codes T1	T2	T3	Remark
EDITOR (input)				
.....	Y	X	Z	Depending
.....	X	Y	Z	on the
.....	E_	N_	Z	selection
.....	N_	E_	Z	in the
.....	E	Hz	h	UNITS
				program
ENTRY OF AN INFORMATION RECORD				
.....	-	-	-	
ADJUSTING/PREPARATION				
ADJUST./PREPAR./V INDEX/				
HZ COLL./	-	-	-	
.....	Vi	Vi	i	Vi = V1-V4
.....	Hz	Hz	c	
ADJUST/COMPENSATOR/	-	-	-	
	-	SK	SZ	
MEASURE				
MEASURE/	-	-	-	
.....	-	Hz	Vi	
.....	D	Hz	Vi	h = V1-V4
.....	E	Hz	Vi	
.....	Y	X	Z	
.....	Ti	-	-	i=v,l,h,r,s

Program/Mode/Function P.I.	Type codes T1	T2	T3	Remark
MEASURE/(SET / HZ /)	-	-	-	
.....	-	Hz	Vi	Vi = V1-V4
SPECIAL				
SPECIAL/CONNECTING DIST/	-	-	-	
.....	D	Hz	Vi	Vi = V1-V4
.....	D	E	h	
SPECIAL/POINT TO LINE DIST/	-	-	-	
				P1/P2
.....	D	Hz	Vi	Vi = V1-V4
.....	E	Hz	h	
.....	Ti	-	-	l=v,l,h,r,s
.....	E	Hz	(h)	
.....	y	x	h	Dist. P1-P2
.....	y	x	Z	Stat.coord.
				Detail point P_i
.....	D	Hz	Vi	Vi = V1-V4
.....	y	x	Z	
.....	Ti	-	-	i=v,l,h,r,s
.....	y	x	(Z)	

Program/Mode/Function P.I.	Type codes T1	T2	T3	Remark
COORDINATES				
COORDINATES/	-	-	-	
STAT. KNOWN POINT/	-	-	-	
				Set
.....	-	Hz	Vi	Vi = V1-V4
	m	th	ih	m=1.000000
.....	-	Hz	Vi	Backsight
.....	D	Hz	Vi	Vi = V1-V4
.....	(dl)	dq	-	
.....	-	-	(dz)	
.....	Y	X	Z	Station
.....	m	Om	ih	
COORDINATES/SIDE SHOTS/	-	-	-	
.....	D	Hz	Vi	Vi = V1-V4
.....	Y	X	Z	
.....	Ti	-	-	i=1,2,3,4,5
.....	Y	X	(Z)	
COORDINATES/SETTING-OUT/	-	-	-	
.....	D	Hz	Vi	Vi = V1-V4
.....	dl	dq	dr	
.....	dy	dx	dz	
.....	dr	Ri	dz	

Program/Mode/Function P.I.	Type codes T1	T2	T3	Remark
COORDINATES/AREA/	-	-	-	
.....	Y	X	Z	Depending on
.....	X	Y	Z	the selection
.....	E_	N_	Z	in the UNITS
.....	N_	E_	Z	program
.....	Y	X	E	Depending on
.....	X	Y	E	the selection
.....	E_	N_	E	in the UNITS
.....	N_	E_	E	program
.....	Fl	np	nk	P.I.
(nominal area and deviation)	(Fl	dF	pF)	When nominal area entered

11.5.4 List of all type codes

The type codes in the records described above are explained in the following table. On principle the type codes have got 2 digits, the second character mostly is a space.

c	Collimation correction	4
de	Coordinate difference in the easting Selection: E = Easting, N = Northing (control as for dy)	3
dF	Difference between entered and computed area	2
dl	Longitudinal deviation of a measurement (stationing) Longitudinal deviation for setting- out	3
dn	Coordinate difference in the northing Selection: E = Easting, N = Northing (control as for dx)	3
dq	Lateral deviation of a measurement (stationing) Lateral deviation for setting-out	3
dr	radial deviation for setting-out	3
Ri	Angle on approximate point	4
dx	Coord.diff. for setting-out	3
dy	Coord.diff. for setting-out	3
dz	Elevation deviation of a measurement (stationing) Elevation difference for setting-out	3
e	X coordinate in the local system Selection: E = Easting, N = Northing	3
h	Elevation difference	3

TC	Meaning		Decimals
i	Index correction		4
ih	Instrument height		3
m	Scale (e.g. stationing)		6
me	Mean coordinate error in the Easting Selection: E = Easting, N = Northing		3
mn	Mean coordinate error in the Northing Selection: E = Easting, N = Northing		3
mx	Mean coord. error	in X direction	3
my		in Y direction	3
mz		in the elevation	3
n	Y coordinate in the local system Selection: E = Easting, N = Northing		3
nk	not active		
np	number of area points		0
pF	Difference of area in percent		2
th	Target or reflector height		3
x	Y coordinate	local	3
y	X coordinate	system	3

TC	Meaning	Decimals
A	Addition constant	3
D	Slope distance	3
E	Horizontal distance	3
E_	X coordinate Selection: E = Easting, N = Northing	3
Fl	Measured or nominal area	2
Hz	Horizontal direction	4
N_	Y coordinate Selection: E = Easting, N = Northing	
O	Lateral distance (indirect elevation determination)	3
Om	Orientation (stationing)	4
P	Atmospheric pressure	
	hPa/mb	0
	Torr	0
	InMerc	1
Ri	Angle on approximate point	4
SK	Compensator centre-point: component in tilting axis direct.	4
SZ	Compensator centre-point: component in line of sight direct.	4
T_	Temperature	0

TC	Meaning	Decimals
T	Type of target eccentricity Tv: In front of Tl: Left of Th: Behind Tr: Right of Ts: Spatial to (Zentrum) The offset length is stored in the associated value.	3
V	Vertical angle V1 zenith angle V2 vertical angle V3 height angle V4 % inclination	4
X	Coordinates-Northing	3
Y	Coordinates-Easting	3
Z	Elevation	3

11.6 Data transfer programs from Carl Zeiss

Data transfer programs are available from Carl Zeiss for some computer types:

Computer	Name	Language	Cat. number
DOS-comp. PC	RECPCD	German	708044
	RECPCE	English	708045
Siemens MX-Series	CZMX	German	708058
VAX/MicroVAX	REC500VAX	English	708059

Current information is given in the valid price list.

11.7 Linkage to office software

After data transfer, the field survey data is available in an ASCII-File for 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. As a rule, the data cannot be used in the manufacturer's format (here e.g. the Rec 500 format) with the office software. It must therefore be converted to the required internal format.
This step has been taken by most of the software companies operating on the German market. Such a conversion program performs two basic steps:

(1) Only the information required for further processing is read from the data records.
(2) The retrieved information is arranged in such a way that the processing software can recognize and process it.

The retrieval criteria for filtering are the type codes of the Rec 500 records. To group all coordinates records of a survey, for example, a check is made after reading a record from the source file if the type codes Y, X, Z exist in the corresponding locations of the data string. If not, the next record is read; if yes, the data string is rearranged in the required way and stored in the destination file.

The procedure is similar if only the original measured data D, Hz, V or Hz, V are required. In this case the problem could occur that every record must also be assigned the target height, addition constant, temperature, atmospheric pressure etc., for example. These parameters are always stored in the source file when they are changed. The data conversion program must then also recognize such records by means of the type codes and add them to the following measurement records in the desired. form. Whenever a new data record with such parameters is detected in the source file, the following measured data is assigned the new values.

Appendix

A 1 Formulae

A 1.1 Correction and Computing Formulae for Angle Measurement

(1) 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 tilt in the sighting direction

(2) Hz direction measurement

$$Hz_k = Hz_0 + Hz_1 + A$$

where:

Hz_0	=	Uncorrected Hz circle reading
Hz_1	=	c/sin(Vk) - collimation correction
A	=	Circle shift for orientation, e.g. Set HZ

A 1.2 Basic Formula for Distance Measurement

Each distance is computed from the following basic components:

$$D_k = (D_0 + D_i + A) * M_i$$

where:

D_k	=	Corrected distance
D_0	=	Uncorrected distance
D_i	=	Internal corrections
A	=	Addition constant
M_i	=	Effect of meteorological data

The effect 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	=	(79.18 * P) / (273.15 + T) = Refraction indes
n_0	=	253.9 = Group refraction indes
P	=	Atmospheric pressure in hPa or mbar
T	=	Temperature in degrees Celsius
a	=	0.001 = coefficient for vapor pressure correction

Carrier wave length 0.91 mikrons

A 1.3 Distance Computation and Reduction in the Rec Elta RL

The slope distance displayed in the Rec Elta is the distance between the Rec Elta tilting 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 elevation 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)) * $6.8\ 10^{-8}$
dh_2	=	Effect of earth curvature and refraction (k = 0.13)

$$E = (E_1 + E_2) * M$$

E_1 = $D_k * \sin (Z + R)$
R = $6.5 * 10^{-7} * D_k * \sin (Z)$
= Effect of refraction
E_2 = $- 1.57\ 10^{-8} * dh * D_k * \sin (Z)$
= Effect of earth curvature

where:
D_k = Corrected slope distance
Z = Measured zenith angle [grads]
M = Scale
dh = Computed elevation difference
E = Computed horizontal distance

Scale computation for reduction to MSL:

$$m = \frac{R}{R+h}$$

$S_2 = S_1 * m$

R = Earth radius (6370 km)
h = Elevation above MSL (Km)
S_1 = Measured distance at the elevation h
S_2 = Distance reduced to MSL

This computation formula is used for all earth radii.

Remark:
When a scale is computed in a stationing routine, reduction to the mapping system (e.g. Gauß-Krüger reduction) is performed in addition to elevation reduction.

A 1.4 Rec Elta RL check on Calibrated Distances

If the Rec Elta RL is checked on a calibrated distance it is convenient to measure with prisms (distances partly longer than 200 m). In the INP menu you have to switch then to prism: **YES**. Exception: Distances shorter than 5 m should be measured reflectorless because of better accuracy.
All measured distances are always corrected in the Rec Elta RL for:

- the entered scale (see INPUT program)
- the entered addition constant (see INPUT program)
- the effect of the pressure and the temperature (see INPUT program)
- internal values

This is why the current scale, addition constant, pressure and temperature have to be entered in the Rec Elta RL before calibration measurement. This ensures that all corrections are applied completely and correctly in the Rec Elta RL. This method also allows direct actual/should-be comparison for given distances.

If you want to correct for the atmospheric conditions externally, the temperature should be set to 20°C and the atmospheric pressure to 940 hPa in the Rec Elta RL. The internal correction then is zero.

A 1.5 Prism and Addition constant

All Zeiss rangefinders are matched to the Zeiss reflectors so that they have the addition constant 0.
For measurement with reflectors made by other manufacturers, the addition constant, if any, can be determined by measurement and entered in the Rec Elta RL.

Another option consists in computing an addition constant from the known prism constant of the reflector used and to enter it in the Rec Elta RL. This prism constant can be computed from the geometrical size of the prism, the type of glass and of the location of the mechanical reference point.

The prism constant determined in this way for Zeiss reflectors is 35 mm.

The following relationship exists between the addition constant Acz for Zeiss instruments, the prism constant Pcz for Zeiss reflectors, and the prism constant Pf for reflectors made by 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 used with this other reflector		A_{cz}	= + 5 mm

At the Rec Elta RL the addition constant + 0.005 m can be set (see **INP** input menu).

A 2 List of Soft Keys

This list contains a brief survey of all soft keys. Detailed information is given in the corresponding program part.

Two different types can be distinguished:

1. Soft keys that initiate a function with or without return to the calling location.
2. Soft keys that display a switch setting and allow changing it.

A 2.1 Alphabetic List

Designation	Meaning
A→A	Delete, transfer or add an additional code from address i to address j
Adr	Delete, transfer or add an additional code at at given address
ACd	Add an additinal code to a series of records in the Editor
?Ad	Search memory for address
All	Delete, transfer or add additional code - all addresses
Bat	Display the battery capacity
CIC	Cancel the point code C within the point identification (P.I.)
CII	Cancel the additional information I within the point identification (P.I.)
Crs	Set a cursor
Del	Delete data files. Delete the last recording in the Mem
D:N,D:R,D:S	Select the measurement mode for the distance meter

Designation		Meaning
dlq drR	den	Store deviations in longitudinal and lateral directions, coordinate differences , angle on approximate point.
YXZ	ALL	Store actual coordinates or all elements
DTh	Th	Toggles between D-Hz-V measurement and Hz-V measurement
Edt		Editing of records with the editor
Ecc		Offset entry
Fl		Computation of an area
HzV EHz	DHz YXZ	Measurement modes in the MEASURE program
Inf		Input of an information line
Ino	Ion	Switch for incrementing the point number
Inp		Input of coordinate records/polar elements
Con	Cno	Compensation on/off
LAd		Displays the last address. Delete or transfer only the last address.
Mrk		Scrolling in a predefined list of marks to support P.I. input.
Ono	Oon	Object elevation measurement
P-B		Set a point number block
PE->		Increase the point number size
PE<-		Reduce the point number size

Designation		Meaning
Pt.		Delete or transfer a specified point number
?Pt		Search in memory for a point number
↓?		Continue searching
P→P	1→P	Connecting distances switch
P→P		Delete or transfer from point number i to point number j
?PI		Search in memory for a specified part of point identification Delete or transfer all line with a specified part of point identification
Rno R-C	R-M RMC	Recording on/off
Set		Set a direction
SFI		Entry of a nominal area
Spc		Set a space
Sta		Display and optional storage of the initial instrument condition (units, input values, instr. error correc.)
Tab		Set a Tab
Tno	Ton	Tracking mode for distance measurement
→2 →1		Call the following (preceding) soft key line
-▪-		Place holder
-♦-		Wildcard

A 3 Technical Data Rec Elta RL , RL-S

Precision Angle measurement	*Rec Elta RL*	*Rec Elta RL-S*
Standard deviation as per DIN 18723		
Hz:	0.5 mgrads / 1.5"	0.5 mgrads / 1.5"
V :	0.7 mgrads / 2"	0.7 mgrads / 2"
Precision distance measurement		
Single measurement		
- Normal (1.5 s)	5 mm + 3 ppm	20 mm + 3 ppm
- Rapid (0.5 s)	10 mm + 3 ppm	50 mm + 3 ppm
- Super Fast (0.1 s)	100 mm + 3 ppm	100 mm + 3 ppm
Tracking (0.25 s)	10 mm + 3 ppm	100 mm + 3ppm

Telescope	
Aperture	45 mm
Telescope length	170 mm
Field of view at 100 m	2.4 m
Shortest sighting	1.2 m
Magnification	30 x
Angle measurement	
Hz and V circle	Electronic, incremental, Zero-point setter for V and Hz (can be switched off)
Measuring units	360° (DMS) 360° (DEG) 400 grads 6400 mils
Vertical reference system	Zenith angle Elevation angle Vertical angle Per cent inclination
Least display unit	0.2 mgrads / 1" selectively
Compensator	
Type	One-axis compensator
Range	± 2' 40" or 48.0 mgrads
Distance measurement	
Method	Electro-optical, with modulated infrared light (0.9 μm) pulse transit time measurement
Transmitter/telescope optics	coaxial, 40 mm receiver optics

Range	*Rec Elta RL*	*Rec Elta RL-S*
without reflector	up to 200 m*	up to 400 m*
with reflective foil	500 m	1000 m
with 1 prism	from app. 50 m to 6000 m	
with 3 prisms	from app. 50 m to 8000 m	

*depending on surface texture and reflectivity

Display	4 lines with 40 characters each complete graphics capability (240 x 8 pixels), Size of letters 5 x 5 and 5 x 7 pixels, Type of letters normal and invers.
Keyboard	2 lines with 12 keys each for instrument control, numeric and alphanumeric input, 10 buttons are positioned to the bottom display line as variable soft keys
Programs	structured in menues for measurement and setting out, coordinates, special applications, input adjustment, units, setting, switches, terminal mode
Terminal mode	for the call off personalized programs and freely definable displays from an external computer via RS 232 or slip ring
Clamps and fine motions	coaxial, parallel axes
Interface	RS 232 C/V 24

Power supply	
internal	NiCd battery pack, 4.8V, 2.4 Ah, approx. service life 2 h of tracking, 6 to 8 h single measurement, charching time 1.5 h
external	via slip ring: with car battery adapter or external battery 6 V; 7.0 Ah

Audible signal generator

	Confirms a measurement or is in combination with a system message

Levelling

Circular level	10' / 2mm at the tribrach
Tubular level	30" / 2mm

Centering

	Zeiss forced centering Wild forced centering optical plummet in the vertical axis centering rod

Optical plummet

Magnification	twice
Shortest sighting	0.5 m

Range of temperature

	- 10 °C to + 40 °C

Dimensions

W / H / D	232 x 270 x 182 mm
Tilting axis height	158 mm (DIN spigot) 196 mm (WILD centering)

Weights

Instrument incl. batt.	5.2 kg
Case	3.5 kg

A 4 Error Messages

The following error messages can appear in the display:

BATTERY EMPTY	Battery low. Change or charge battery.
Error 01	ROM defective
Error 02	RAM defective
Error 03	NV-RAM defective
Error 04	NV-RAM defective
Error 05	NV-RAM defective
Error 06	NV-RAM defective
Error 30 - 39	Error in rangefinder section
Error 60	Error in V angle section
Error 80	Error in compensator
Error 81	Error in data transfer section
Error 82	Error in data transfer section

Errors 01 to 06 require servicing.

Errors with error numbers ≥30 can generally be reset with ENTER. If the eror display persists, servicing is required.

Note:
If the instrument does not respond to key pressure in any mode, you can turn it off by removing the battery cartridge.

Error 501 - 509	Error in the operating and displaying unit (Service)
Error 581	I / O receive error (PARITY, FRAMING,OVERRUN)
Error 584	TIMEOUT because CTS/XON is missing
Error 585	TIME OUT for data transfer
Error 586	Dialogue opening error (only software dialogue)
Error 587	TIMEOUT during data reception
Error 588	"B" did not arrive in the dialogue loop (see also 586)
Error 589	Format error in the data string form the computer (wrong separator)
Error 590	Character error in the data string from the computer (too many decimal points, blank in wrong place)
Error 591	Non-alphanum. character in P.I.
Error 593	No decimal point in the distances or angle value from the computer
Error 595	Service
Error 599	Data transfer untimely stopped by the computer

A 5 Measurement Preparation

A 5.1 Transport

Protect the instrument against hard shocks and sudden temperature changes during transport, and turn the instrument off.

Short distances: Instrument on tripod
Longer distances: Instrument in the case

Allow sufficient time for the instrument to adapt to the environmental temperature. A temperature difference of 1° C means an acclimatization time of 1 minute.

A 5.2 Instrument setup

Extend the tripod legs to a convenient length and tighten the tripod clamps. Screw on the instrument in the centre of the tripod head with the tribrach screws in their centre positions.

Centering and levelling:

- Position the tripod roughly above the station and tread the tripod legs moderately into the ground with the tripod head approximately level.

- Coarse centering:
  Centre the circle of the optical plummet (22) on the station with the tribrach screws (19).
  Focus the circle by turning the eyepiece.
  Focus the station mark by pushing in or pulling out the eyepiece of the optical plummet.

- Coarse levelling:
  Centre the circular level by changing the tripod leg length.

- Precision levelling:
  Centre the tubular level by centre-point determination.
  Centre-point determination:
  . Set the axis of the tubular level parallel to the line connecting two tribrach screws,
  . Centre the level with these two tribrach screws,
  . Turn the instrument through 180 ° or 200 grads,

. Eliminate half the bubble error with the tribrach screws (centre-point),
. Turn the instrument through 90° or 100 grads and centre the level with the third tribrach screw,
. Turn the instrument around the vertical axis. There must be no bubble error; if there is, repeat centre-point determination.

- Precision centering:
  Shift the tribrach on the tripod head until the circle of the optical plummet covers the mark. Tighten the tribrach mounting screw(30).

- Repeat precision levelling and precision centering, if required, until the tubular level bubble always returns to the initial position also after turning the instrument, and the station mark always remains in the circle figure.

Humid weather and rain:
- Cover the instrument with the plastic hood before long breaks.
- Wipe the instrument with an absorbent cloth and allow it to dry in the pen case in a warm room.

Sun:
- Use a sun shade in hot sun light.

A 5.3 Telescope Adjustment and Sighting

- Focussing the reticle:
  . Sight a bright, neutral surface (sky, white paper),
  . Turn the eyepiece (9) until the reticle is in focus.

- Focussing the target:
  . Turn the focussing ring (7) until the target is in focus.

- Parallax check:
  . Move your head slightly in front of the eyepiece. There should be no relative movement between the target and the reticle; check the focussing, if required.

Warning:
Never sight the sun or a strong light source to avaoid eye injury.

A 6 Power supply

Operating hints for the battery charger LG 91

For power supply of the electronic theodolite ETh and the electronic total station Elta and Rec Elta you can use the new NiCd batteries (70 81 55, 4.8 V, 2.4 AH) as well as the former NiCd batteries with 4.8 V, 1.8 AH (70 81 51), (70 81 52) and (70 81 54). These batteries are rechargeable with the battery charger LG 91 (70 81 50 - 9910).

Before charging
- protect LG against humidity
- at the beginning of the charging the temperature of the battery must not be lower than +10°C

Before the first using the voltage setting has to be checked at the slide switch at the bottom of the LG 91 which can be switched to 115 V or 230 V voltage.

Charging
- put in the battery cartridge into the tray of the LG 91 and screw it
- connect the LG 91 to the power network
- the red pilot lamp indicates the charging current
- an dead battery needs about two hours of charging time
- after network power failure the LG automatically resumes charging and the entire charging time of two hours will not be exceeded

Termination of charging
- the red pilot lamp signals the termination of charging
- a saving charging current continues flowing
- the batteries can't be overcharged

Connection to a car battery

Connection of the LG 91 to a car battery by an additional cable (70 80 90) with a standard connector for cigarette lighter and a 2-point round connector for connection to the LG 91, the length of the cable is 2 m.

Technical data
- Input: 230 V or 115 V ± 10 % alternating current
- Output: 4.8 V, 1800 mA direct current

Operating hints for external power supply with a car battery

The external power supply for the Rec Elta consists of a DC/DC converter (mobile power adapter CPA 20 WR 05), which converts the car voltage from 12V to 5.6V. There is a connector which fits into standard cigarette lighters of a car. At the other end there is a 8-point round connector for connection to a Rec Elta.

Fuse:

The converter is primarily protected by a 5A S (slow) fuse. The fuse is in the cigarette lighter connector and is to be found when simply unscrewing the top.

The top of the cigarette lighter connector is the positive element (+), the lateral contact-pieces have to be connected to the negative element (car ground). The converter is secured against exchange of positive and negative elements. In order to avoid any defects you should ensure that the negative element is situated on the car body.

Accessories:

When using the converter the battery packs at the Rec Elta have to be replaced by the battery compensator no..: 708186 - 9500.

The cable length of the DC/DC converter is 1,6 m totally. Usually this cable length is not sufficient to provide a connection between the cigarette lighter in the car and the connector at the Rec Elta without restraining the measurement. Therefore ZEISS offers two additional cables.

1. Combined current and data transfer connector cable for the Rec Elta (70 81 77 - 9350) with:
   - 8-point round connector to the Rec Elta,
   - 25-point supplementary connector (female) to the Rec 500,
   - 8-point round connector for power supply (DC/DC converter) overall length of the cable 1,6m.

One end of this cable is connected to the Rec Elta. On the other side of the cable there are two connectors, a round one for power supply and the 25-point one for the data exit, here provided for the Rec 500.

2. Extension cable for power supply (70 81 77 - 9360), 8-point on both sides, 10m long.

A 7 Adjustment

A 7.1 Axis errors

Axis errors exist if the line of sight of the telescope is not vertical to the tilting axis of the telescope (measurement of the horizontal angle) or when the values of the measurement of the vertical angle in position I and II can't be completed to 360° or 400 gon. This errors affect angle measurements in only one telescope position.

The errors are normally measured in the ADJUST program and then automatically compensated if they do not exceed ± 2'40".

Note:
Do not change the adjustment in the vertical and horizontal direction. Mechanical elimination of the index and collimation error may be performed only by the service.

A 7.2 Alidade Level Adjustment

Set up the instrument in an absolutely stable way, i.e. clamp the instrument in the tribrach with the clamp (28) and fasten the tribrach on a stable tripod with screw (30).

To adjust, turn the instrument so that the alidade level (12) is parallel to the line connecting two levelling screws, and centre the bubble with one of the two levelling screws.

Then turn the instrument through a right angle so that the level points to the third levelling screw. Use this levelling screw to centre the level as precisely as possible.

After turning the instrument in the opposite direction, eliminate half the bubble error with the third levelling screw and the other half with the level adjustment screw.

Observe the following during adjustment:
- Avoid one-sided level heating.
- Loosen the opposite screw before tightening an adjustment screw.
- After adjustment completion, both adjustment screws must be tight.
- The level should centre properly after adjustment in any instrument sighting direction.

Adjust the alidade level very carefully and check it regularly.

A 7.3 Optical Plummet Adjustment

Optical plummets are installed in the vertical axis of the instrument or attached to the tribrach (type EWL), or they are available as insertion plummets for ground point with vertical viewing (V or VW), horizontal viewing (NZ or NW) or for ground and roof surveying points (NZ or NZW).

The line of sight of the optical plummet is the optical continuation of the vertical axis.

The optical plummet in the instrument and the optical plummets that can be inserted in the tribrach have the same adjustment conditions and are equivalent in testing and adjustment.

First check the levels (see section 3.4.). Then shift the reticle in the plummet telescope with the adjustment screws until the target figure remains in the centre afte a 180° turn of the plummet in the vertical axis.

If you use an optical plummet attached to the tribrach, the nominal line of sight can be determined with the plumb bob. You can also turn the whole tribrach through 2 x 120° on the tripod head depending on the shape of the baseplate. Mark the initial position on the tripod head to ensure that its centre can be returned to this point after the rotation. Level again after rotation.

A 7.4 Level Adjustment at Accessories

Levels serve to align the instrument or parts of instruments relative to the direction of the force of gravity, e.g.:

- Vertical axis in the vertical,
- Optical plummet collimation in the vertical,
- Forced centering systems in the horizontal,
- Telescope line of sight in the horizontal,
- Prism rods in the vertical.

Checking the adjustment and adjustment itself is very simply done for levels on a tribrach, for tubular and circular levels of instruments, and for insertion plummets. After precise bubble centering to the scale or centering circle of the level and 180° rotation in the vertical axis, the bubble error is twice the adjustment error; half of it can be eliminated with the level adjustment screws and the remainder with the tribrach levelling screws.

The circular level at the centering rod is also "reversible" and has to be checked and adjusted as described. Instead of tilt setting with the tribrach screws, adjust the centering rod vertically by shifting the tribrach on the tripod head.

The "non-reversible" level at the tribrach can be adjusted by inserting a device with a vertical axis in the forced centering system. When its level is adjusted and centered, the bubble error of the tribrach level can be eliminated completely with its adjustment screws.

The circular level at the prism rod can be checked and adjusted after the rod has been set up vertically with other means, e.g. rod in tripod, with plumb bob or with the theodolite by means of the telescope.

If you have got a rod tripod with 3 legs, "adjustment by reversing", see above, is possible by rotation in the tripod.

A telescope level can be adjusted with vertical circle readings and setting after the vertical index error has been determined. If the V circle readings add up to precisely 360° when you sight the same target in telescope positions I and II, the telescope line of sight is horizontal for a V circle reading of 90° and the telescope level must centre , or be centered with it adjustment screws.

A 8 Accessories

A 8.1 Description

The whole system features a uniform height of the tilting axes above the tribrach mount:

158 mm for DIN spigot
196 mm for Wild centering

The height of the tilting axis of the KTR or the target above the mounting surface is 100 mm.

(1) 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 have adjustable screws.

The friction of the leg joints can be adjusted with 6 hex socket screws directly below the axes. When you lift the tripod at its head, the legs should fold slowly.

(2) Tribrach

The ED or EW tribrach is supplied with the instrument. They differ only in forced centering: DIN spigot (ED) or "Wild" forced centering system (EW).

The levelling screws are self-adjusting, i.e. adjustment is not required. The circular level can be adjusted with 2 capstan screws, see section 3.4.

(3) Reflectors

The reflectors for distance measurement form a modular system.

(4) Prism rod

The prism rod for setting up tiltable reflectors has an adapter. The 5/8 inch thread atop the telescope rod with graduation can be screwed off, turned round and screwed in again.

Then there is an M 8 thread for a single reflector (not tiltable) at the top.

The graduation indicates the height of the prism above the rod tip in both cases.

The extension rod can be screwed between the telescopic rod and the adapter. One meter then has to be added to the height read.

The screw-off tip of the prism rod provides the option to attach an extension rod at the lower part of the prism rod.

A 8.2 Catalogue Numbers

(1) Power supply

708155	Battery pack 4.8 V, 2.4 Ah
708150-9910	LG 91 battery charger 90-120V,185-264V, 50/60Hz for 708155
708157 - 9360	Extension cable for power supply 10 m long, 8 - point on both sides
708177 - 9350	Combined current and data transfer connector cable for Elta/ Rec Elta with: 8 - point round connector to the Elta/Rec Elta 25 - point connector to the Rec 500 8 - point round connector for power supply, 1.6 m long
708186 - 9500	Battery case with compensation weight for external power supply

(2) Tripods

707225	S 25 tripod
707286	Prism rod with graduation
707287	Prism rod extension (1m)
707288	Prism rod tripod

(3) Tribrachs

707125	ED tribrach for Zeiss forced centering system
707126	EW tribrach for Wild forced centering system
707127	EWL tribrach with attached optical plummet

(4) Optical plummets

706137	Optical plummet V for ground points, for vertical viewing, for insertion in ED tribrach
706138 - 9901	Optical plummet N for ground points, for horizontal viewing, for insertion in ED tribrach
706139 - 9901	Optical plummet NZ for ground and roof surveying points, for horizontal viewing (in ED tribrach)
706141	Optical plummet VW for ground points, for vertical viewing, for insertion in EW tribrach
706142	Optical plummet NW for ground points, for horizontal viewing, for insertion in EW tribrach
706143	Optical plummet NZW for ground and roof surveying points, for horizontal viewing (EW tribrach)

(5) Targets

706705	Target E
706814	Target E with adapter for use in Zeiss forced centering system
706815	Target E with adapter for use in Wild forced centering system
706706	Target for use on the KTR 1

(6) Reflectors

706765	KTR 1 N reflector, tiltabel (with 1 prism) for use on prism rod 707286, extension 707287 or spigot or Wild adapter 704538
706767	Adapter for inserting a KTR 1 in tribrachs with Zeiss forced centering system
704538	Adapter for inserting a KTR 1 in tribrachs with Wild forced centering system
706762	ETR 1 N reflector, rigid (with 1 prism) for use on prism rod 707286 or extension 707287
706763	ETR 1 S reflector, rigid (with 1 prism) for use on prism rod 707286 or extension 707287
706771	Corner-sighting set for ETR 1, consisting of: Corner-sighting rod and sighting collimator
706824	Corner-sighting reflector, complete, consisting of: ETR 1 N, corner sighting rod and sighting collimator
706769	T 3 traverse for converting a KTR 1 to a triple reflector
706770	T 7 traverse for converting a KTR 1 to a 7x reflector
706816	T 19 traverse for converting a KTR 1 to a 19x reflector

(7) Special accessories

708186 - 9100	Slip ring option
704116	Steep sighting prism
704105 - 9901	Ninety-degrees eyepiece F
704137	Lens filter for sun observation
706334	Reticle illumination (reflector sighting under adverse illumination conditions)
706776	ETR 1 adapter 106 mm for using an ETR 1 on prism rod 707281 (not E series)
707264	KTR 1 adapter 6 mm for using a KTR 1 on prism rod 707281 (not E series)
706768	Adapter 181 mm for using a KTR 1 in the Zeiss tribrach system

(8) Cases

709617	Accessories case for: two ED or EW tribrachs, two adapters for DIN or Wild forced centering,three KTR 1 reflectors, four ETR reflectors, two T 3 traverses, one T 7 traverse
708566	Case for the Rec Elta

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