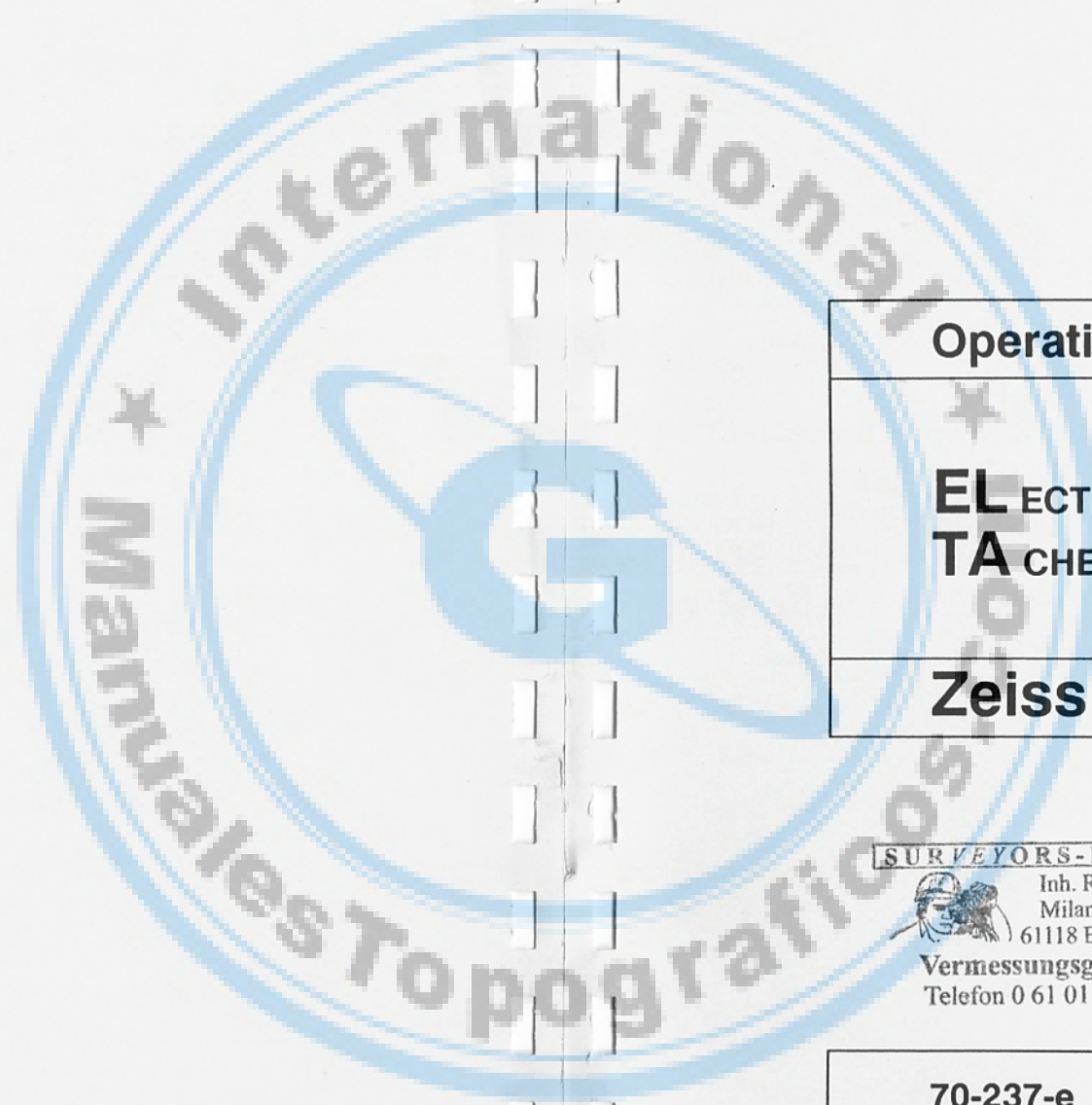


**ZEISS**

Germany



**Operating Instructions**

**EL**ECTRONIC  
**TA**CHEOMETER

**Zeiss Elta 3 and Elta 4**

**SURVEYORS-EXPRESS<sup>®</sup>GmbH**



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**70-237-e**

211288

**Addition to Elta 3/4 operation manual**

**for instruments delivered as of March 1991**

This addition to the operation manual 70-237 describes new features of the Elta 3/4 electronic tacheometers from Carl Zeiss delivered in/after March 1991.

**1 Automatic measurement or manual entry of temperature and air pressure**

For the atmospheric correction of electro-optically measured distances, the temperature and air pressure can be either entered manually or measured automatically, independently of each other.

If the entered or automatically determined temperature and air pressure values differ from the actual values on the measuring distance, this results in a scale factor, i.e. an error which changes linearly with the distance involved. With a deviation of 10 °C or 30 hPa, the error amounts to 10 ppm or 1 mm on 100 m.

In this process, the error influences may add up or compensate each other, either entirely or in part: the measured distance will be too long if the temperature values are too high, and it will be too short if the air pressure values are too high.

As the sensor for automatic temperature measurement is integrated into the outer wall of the housing, it is essential that the instructions for measurement preparation given in the operation manual be observed in the case of pronounced temperature variations or strong solar radiation.

The selection between automatic measurement or manual entry of temperature and air pressure is made in the modes I1 and I2. The decision taken for each value is retained when the Elta is switched off. On reactivation and initialization of the instrument, the previously selected status is displayed.

Example:

A	20
CELSIUS	
M	1015
hPa/mb	

A=temperature measured automatically

M=air pressure entered manually

**1.1 I1: Input of the Air Temperature for Atmospheric Correction of Distances**

Display after selection of mode I 1:

INPUT TEMP.	
I- 1:	E: +-

Activate this mode with ENTER.

AUTO: ON	
C	20
F	68
I- 1: OFF+-:	E

Automatic temperature measurement ON/OFF.

Temperature in degrees Celsius

and in degrees Fahrenheit

Press + or - to switch between OFF/ON, i.e. to deactivate or activate automatic temperature measurement.

SET: +-	
C	20
F	68
I- 1:	E

After ENTER and AUTO: OFF the temperature can be entered manually.

The temperature can be changed in increments of 1°C with + or-. The Fahrenheit display changes automatically.

Range :

- 30° C to + 70° C

- 22° F to + 158° F

TEMP.	
C	23
F	73
I- 1:	RE: +-

The entered temperature is confirmed and recorded with ENTER in both cases.

Exit from this mode with + or -.

**1.2 I 2: Input of the Air Pressure for Atmospheric Correction of Distances**

Display after selection of mode I 2:

INPUT PRESS.	
I- 2:	E: +-

Activate this mode with ENTER.

AUTO:ON	
P	940
Z	632
I- 2:	E: +-

Automatic air pressure measurement ON/OFF.

Display of the air pressure and the barometric elevation above MSL computed from it

Press + or - to switch between OFF/ON, i.e. to deactivate or activate automatic air pressure measurement.

SET: +-	
P	940
Z	632
I- 2:	E

After ENTER and AUTO:OFF the air pressure can be entered manually.

The air pressure can be changed in increments of 4 hPa (3 torrs, 0.1 inch) with + or -; the elevation is computed automatically.

**Range:**

440	to	1460	hPa
330	to	1095	Torr
13.0	to	43.1	in.merc.
6471	to	- 3237	meter

PRESS.	
P	948
Z	561
I- 2:	RE: +-

If the air pressure is unknown, change the pressure value until the displayed elevation roughly corresponds to the ground elevation above MSL. The input is confirmed and recorded with ENTER in both cases.

Exit from this mode with + or -.

**2. A 7: Battery Voltage Display**

BATT. CONTROL	
A- 7:	E: +-

Display after selection of mode A 7:

Activate the mode with ENTER

┌ - - ' ' ┐	
CONTROL	
A- 3:	+-

Battery voltage display:  
 right: full  
 center: sufficient  
 left: prepare battery change

Exit from this mode with + or -.

**3. Battery Buffering**

If the battery voltage is too low, this is indicated by the display BATT and three short acoustic signals. This means that the battery should be changed without switching off the Elta.

While the battery is changed, the instrument is buffered in stand-by operation by an intergrated buffer battery.

**The battery change should be completed within 1 minute.**

After replacement of the battery, press ENTER and the instrument will again be ready for measurement in mode M 2. .

If the battery cannot be changed for any reason, make sure to press the ENTER key to switch off the instrument and to avoid that the buffer battery runs down too fast.

**4. Modified Battery Cassette**

The battery cassettes supplied with the instrument feature an internal fuse protecting the instrument and battery against short circuits. This cassette can also be used in previously supplied instruments whereas the earlier battery cassettes are unsuitable for the new instruments.

## 5. ROM Expansion

In addition to the user-relevant ROMs available in the Elta, e.g. for scale and addition constant, further ROMs have now been provided for instrument height *l*, reflector or target height *t* and the entered or computed station coordinates Y,X,Z. After reactivation of the instrument, these values are thus available for the measuring programs. This does not apply to the modes where the relevant values are set or determined.

## 6. C 6: Free Stationing using 2 Control Points, ERROR SCALE

After the computation and display of the Y, X, Z station coordinates, the new, computed scale *S* is displayed. If this scale lies outside the tolerance limits 0.998500 to 1.001500, the following warning appears:

### ERROR SCALE

S 1.012345  
C- 6: E: +-

S = scale outside tolerance

The complete input and measurement of the free stationing can be repeated by pressing E. Exit from mode C 6 with + or -

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## 1. Introduction

This manual describes the use of the Elta Electronic Tacheometer from Carl Zeiss.

The major features of this instrument are:

- Incremental electronic horizontal and vertical circle reading
- Compensator for correction of the vertical axis inclination
- Electro-optical infrared distance meter using the phase-comparison method
- Liquid crystal display
- Data entry and program control with 3 keys
- RS 232 C (V.24) interface for data input and output

The RS 232 C (V.24) interface affords automatic recording of the measured data with the Rec 200 or Rec 500 Electronic Field Book or with field computers.

The Rec 200 enables unidirectional data transfer, the Rec 500 bidirectional data transfer to computers or peripheral equipment. The Rec 500 also permits the input of alphanumeric data and data processing directly in the field.

Please contact our V-GST department for advice on the connection of computers and peripheral equipment.

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

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

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



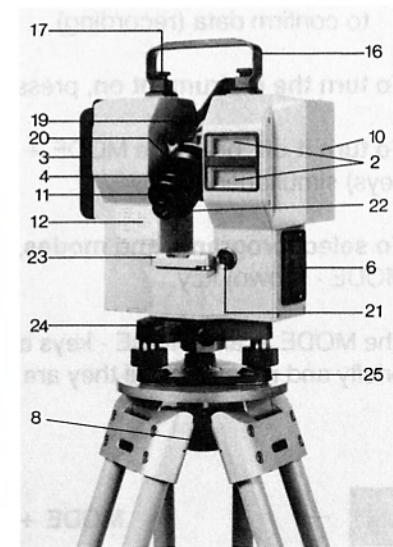
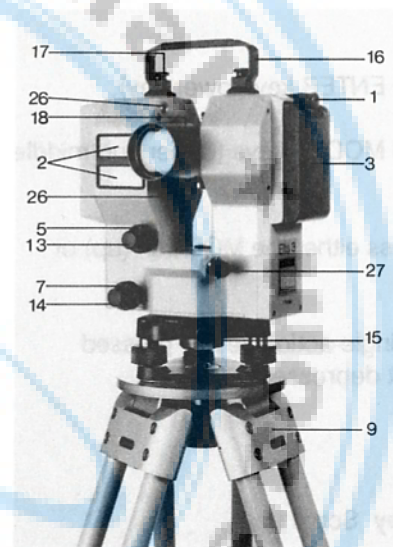
**2 Instrument Description**  
**2.1 Elta Controls**

The software used by this instrument was checked carefully before its release. If you find any execution errors or discrepancies between program execution and program description, please send a written report to our V-GST department.

This manual was revised last in December 1988 . It is subject to change without prior notice for further development.

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 Telegrams: zeisswerk oberkochen  
 Telex: 07 1375 155



- 1 Battery cassette lock
- 2 Display window with illumination
- 3 Battery cassette
- 4 Ring cap
- 5 Vertical fine motion
- 6 Mode selectors
- 7 Horizontal fine motion
- 8 Tribrach attachment screw
- 9 Tripod joint
- 10 Trunnion axis height mark
- 11 Eyepiece mount
- 12 Mode table
- 13 Vertical clamp

- 14 Horizontal clamp
- 15 Spigot clamp
- 16 Handle
- 17 Handle mount
- 18 Sun shade
- 19 Sighting collimator
- 20 Focussing control
- 21 RS 232C interface
- 22 Diopters scale
- 23 Alidade level
- 24 Tribrach circular level
- 25 Tribrach
- 26 Adjustment screws for EDM
- 27 Optical plummet

## 2.2 Keyboard

The keyboard (6) serves

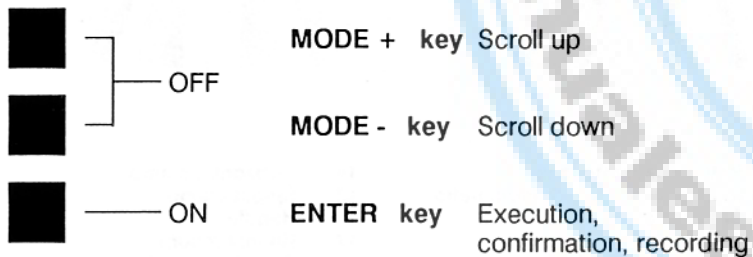
- to turn the instrument on and off,
- to select programs, modes of operation and functions,
- to enter data, and
- to confirm data (recording).

To turn the instrument on, press the ENTER key (lower key).

To turn it off, press the MODE + and MODE - keys (upper and middle keys) simultaneously.

To select programs and modes, press either the MODE + (up) or MODE - (down) key.

The MODE + and MODE - keys are single-action keys if pressed briefly and repeat keys if they are kept depressed.



## 2.3 Angle Measurement Units and Reference Systems

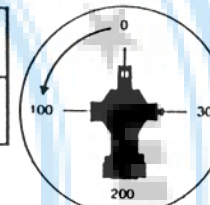
The Elta affords selection of one out of three different angle measurement units and one out of four different vertical reference systems.

The selected unit and the selected vertical reference system are displayed briefly after the instrument has been switched on.

To select another unit and/or vertical reference system, set the U3 or U2 mode.

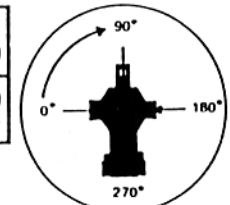
### Vertical reference system

A	289.4560
V	98.8730
M- 2:	RE: +-



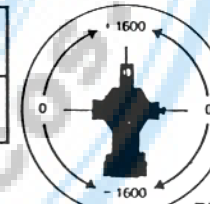
Display example 1  
**zenith angle**  
measuring unit 400 grads

A	183:12.30
V	3:45.20
M- 2:	RE: +-



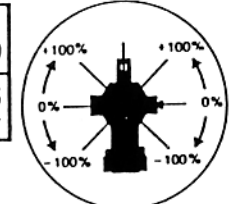
Display example 3  
**elevation angle**  
measuring unit 6400" (mils)

A	4173.30
V	705.50
M- 2:	RE: +-



Display example 2  
**vertical angle**  
measuring unit 360° (DMS)

A	128:16.50
V	16.25
M- 2:	RE: +-



Display example 4  
**slope in %**  
measuring unit Hz 360° (DMS)

## 2.4 Distance Measurement Units and Modes

The Elta affords selection of one out of two different distance measurement units. The selected unit is displayed briefly after the instrument has been switched on.

### Display D: Meters or feet

For changing the unit, select mode U4.

Three distance measurement modes are available:

- |                   |  |
|-------------------|--|
| <b>R (RAPID)</b>  | Rapid measurement (reduced measurement time) |
| <b>N (NORMAL)</b> | Standard measurement                         |
| <b>L (LONG)</b>   | Long distance measurement                    |

For changing the distance measurement mode, select mode I5. The selected mode (R, N or L) is briefly displayed after the instrument has been switched on.

## 2.5 Distance Measurement

After initialization of a distance measurement, the received signal is adjusted automatically. This is indicated by a status message in line D of the display.

The following cases may occur:



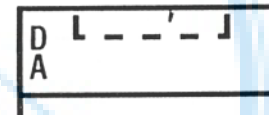
D L' - - - J  
A

Measuring beam interrupted or signal too weak.  
Measurement not possible.



D L - - - J  
A

Automatic signal control not yet completed.



D L - - J  
A

Signal control completed; measurement running

When the distance measurement is completed, the result appears instead of the status message.

Measuring beam interruptions do not affect the measurement precision.

After measurement, the result is corrected by

- the influence of temperature and atmospheric pressure,
- the entered prism or addition constant,
- the entered scale.

## 2.6 Selecting the Coordinate System

4 coordinate systems with the following designations and order of coordinate axes are available:

System 1	System 2	System 3	
Y	X	E	easting
X	Y	N	northing
Z	Z	Z	elevation

System 4	
N	northing
E	easting
Z	elevation

Direction angles are always computed clockwise from northing.

## 2.7 Automatic Instrument Deactivation

To save energy, the Elta is switched off automatically 30 minutes after the last pressure of a key, the last instrument rotation or the last access through the interface.

If the zero-pulse is not captured within 2 minutes after the Elta has been activated, the instrument will be switched off.

## 2.8 Data Recording

Measured, computed and input data can be recorded in the individual modes if a storage device is connected and ready for operation..

Recording is performed automatically after activation of the respective function with "ENTER".

The letter R (recording) in combination with E (ENTER) in the bottom line of the display indicates the possibility of recording.

Example: Mode M2 THEOD. A, V:

A	18:15.10
V	87:06.50
M- 2:	RE: +-

## 2.9 Elta 3 Compensator

The Elta 3 features a liquid compensator which determines the inclination of the vertical axis in the sighting axis and trunnion axis directions.

The working range of the compensator is 2'40" or 48 mgrads in either direction.

The digital compensator display can be used for checking the instrument levelling. If compensation is activated, the influences of the vertical axis inclination on the horizontal and vertical circle readings are automatically taken into account within the compensator working range.

To ensure accurate function, the compensator should be regularly adjusted.

For the display of the vertical axis inclination and for compensator adjustment, mode A 6 COMPENS. + LEVELL. is used.

If necessary, compensation can be deactivated in mode A 5: COMPENS.ON-OFF.

## 2.10 Elta 4 Compensator

The Elta 4 features a compensator which determines the inclination of the vertical axis in the sighting axis direction.

The working range is  $\pm 2'40''$  or 48 mgrads.

In the vertical circle reading, allowance is made for the vertical axis inclination within the compensator working range.

## 3 Programs, Modes and Functions

### 3.1 Measurement Program M

M1	DAV	Tacheometer function with measurement of slope distance D and angle tracking A, V
M2	AV	Angle tracking A, V
M3	E A h	Tacheometer function with measurement of horizontal distance E, difference in elevation h and tracking of horizontal direction A,
M4	TRACKING E, A, V	Tacheometer function with tracking of horizontal distance E and angle tracking A, V
M5	SET A	Resetting of the horizontal circle reading or input of a known horizontal direction A
M6	E A V	Tacheometer function with measurement of horizontal distance E and angle tracking A, V
M7	HOLD A	Storage of the horizontal circle reading by "circle clamp" or "repeat clamp" function

### 3.2 Input Program I

- |                                 |  |
|---------------------------------|--|
| <b>I1 INPUT TEMP</b>            | Input of the air temperature for atmospheric correction of distances   |
| <b>I2 INPUT PRESS.</b>          | Input of the atmospheric pressure for atmospheric correction of distances  |
| <b>I3 INPUT PRISM + ADD.CO.</b> | Input of a prism or addition constant for distance measurement   |
| <b>I4 INPUT SCALE -S PPM -M</b> | Input of the scale or a correction in ppm for multiplication by the measured distance  |
| <b>I5 DIST MODE</b>             | Selection of the distance measurement mode<br>R = Rapid measurement, meas. time 3 sec.<br>N = Normal measurement, meas. time 4 sec.<br>L = Measurement of long distances with slightly reduced precision |

### 3.3 Adjustment Program A

- |                                     |  |
|-------------------------------------|--|
| <b>A1 ADJUST V INDEX</b>            | Determination of the index correction by measurement in both telescope positions           |
| <b>A2 ADJUST A COLL.</b>            | Determination of the collimation correction by measurement in both telescope positions     |
| <b>A3 ADJUST EDM SIGNAL</b>         | Adjustment of the distance meter to the telescope line of sight                            |
| <b>A4 ILLUM. ON-OFF</b>             | Display illumination on/off  |
| <b>A5 COMPENS. ON-OFF</b>           | Compensator on/off (Elta 3 only)   |
| <b>A6 ADJUST COMPENS. + LEVELL.</b> | Adjustment of the compensator and instrument levelling using the compensator (Elta 3 only) |

### 3.4 Units Program U

- |                         |   |
|-------------------------|---|
| <b>U1 A REV</b>         | Reversing the horizontal circle reading direction |
| <b>U2 V REF.</b>        | Selection of the vertical circle reference system |
| <b>U3 UNITS A V</b>     | Selection of the angle measurement unit           |
| <b>U4 UNITS D</b>       | Selection of the distance measurement unit        |
| <b>U5 UNITS PRESS</b>   | Selection of the atmospheric pressure unit        |
| <b>U6 COORD. SYSTEM</b> | Selection of the coordinate system                |

### 3.5 Special Applications Program S

- |                          |   |
|--------------------------|---|
| <b>S 1 CONNECT 1 - P</b> | Determination of connecting distances between the first and all subsequent points |
| <b>S 2 CONNECT P - P</b> | Determination of connecting distances between successive points                   |
| <b>S 3 OBJECT HEIGHT</b> | Height measurement using the vertical circle                                      |
| <b>S 4 POINT TO LINE</b> | Point-to-line distance and intersection point on the line                         |
| <b>S 4 POINT IN LINE</b> | Determination of point positions in a vertical plane                              |

**3.6 Coordinate Programs C**

**C 1 INPUT STATION COORD.** Input of the station coordinates

**C 2 SET A** Input of a direction angle to the backsight point

**C 3 ORIENT COORD.** Stationing and orientation using a known point

**C 4 MEASURE COORD.** Coordinate measurement by centered sighting

**C 5 ECC.MEAS. COORD.** Coordinate measurement by off-center sighting

**C 6 STATION WITH 2 POINTS** Free stationing using 2 control points

**C 7 SETT.OUT COORD.** Polar setting out using coordinates

**4 Control and Measurement**

**4.1 Preparing for Measurement**

**4.1.1 Transporting the Equipment in the Field**

For short distances the instrument can be transported on the tripod while for long distances or in unfavorable conditions the instrument should be transported in its case.

Turn the instrument off during transportation and protect it against shocks and sudden temperature variations.

Before turning the instrument on, allow sufficient time for the instrument to adapt to the temperature prevailing at the site.

If you use the instrument in inclement weather, please cover it with a plastic hood during longer breaks.

Wipe it dry later on with a piece of absorbent cloth and store it in a warm room in its open case so that it can dry completely.

If the sun radiation is intense, place a screen next to the tripod in such a way that the instrument and, if possible, also the tripod legs are in the shadow without instrument control being obstructed.

The centering rod need not be removed from the tripod attachment screw for tripod transportation, but should be fastened at a tripod leg to protect it from damage.

**4.1.2 Setting up the Instrument**

Extend the tripod legs so that the instrument is at a convenient height. The tripod leg spacing should be about 1 meter. On slopes, extend two legs to the same length and the third leg to a shorter length.

Secure the tribrach in a centered position on the tripod head with the levelling screws in their mid-positions.

#### 4.1.2.1 Centering with the Plumb Bob

Insert the plumb bob hook in the attachment screw from below. Roughly center the tripod above the station with the tripod head approximately level. Watch the circular level of the tripod. Push the tripod legs into the ground, keeping the tripod roughly centered by means of the plumb bob.

Vary the length of two tripod legs if centering is off more than 2 cm due to non-uniform tripod point entry in the ground.

Center precisely by shifting the tribrach on the tripod head while keeping the plumb bob as close above the station as possible.

#### 4.1.2.2 Centering the Tripod and the Tribrach with the Optical Plummet

Remove the plumb bob hook from the tripod attachment screw in a downward direction.

Center the circular level of the optical plummet or of the instrument with the tribrach levelling screws.

Focus the circular mark in the plummet telescope by turning the eyepiece sleeve and focus the station by pulling or pushing the sleeve. Shift the tribrach until the station is centered in the circular mark, taking care not to turn it to prevent the line of sight of the optical plummet from becoming non-vertical. Tighten the tripod attachment screw moderately.

#### 4.1.2.3 Centering with the Optical Plummet (without approximate centering with the plumb bob)

Attach the tribrach centrally to the tripod head with the levelling screws in identical positions.

Position the tripod above the station (watch the circular level) and push the tripod legs moderately into the ground.

Center the circular mark of the plummet telescope on the station with the tribrach levelling screws and then center the circular level of the tripod or the optical plummet by varying the length of two tripod legs. Center as described under 4.1.2.2.

#### 4.1.2.4 Centering with the Centering Rod

Attach the tribrach centrally to the tripod head with the levelling screws in their mid-positions. Insert the centering rod in the attachment screw and place its point on the station.

(**Caution:** The centering rod point might jam in tubular pegs!)

Watch the circular levels of the centering rod and the tribrach and push the tripod legs moderately into the ground.

Shift the tribrach on the tripod head and vary the length of one tripod leg, if required, to center the circular level of the centering rod precisely.

**Note:** The tribrach levelling range may be insufficient in some cases. If this occurs, change the position of a tripod leg on the ground.

#### 4.1.3 Focussing and Sighting

Proper sighting is a requirement for precise measurement.

Focus the eyepiece on the cross-hairs. Sight a bright, even-colored surface such as the sky or a piece of paper. Try to keep your other eye open and turn the eyepiece sleeve clockwise from the stop until the cross-hairs are in focus.

Focus the target.

Check for parallax by slightly moving your eye in front of the eyepiece. There must be no relative movement between the cross-hairs and the target.

The end of the single line in the center of the reticle affords the most precise sighting of small targets in particular. The double cross-hairs can be used for sighting strictly geometrical figures such as triangular or circular marks or reflector prisms.

Using the central line with small, low-contrast targets should be avoided.

If there is flicker, try to sight the center.

**Caution:** Sighting of the sun or strong light sources must by all means be avoided. There is the risk of irreparable damage to the eye.



#### 4.1.4 Checking the Battery

The liquid crystal display of the instrument consumes very little energy. One battery will last for about 10 hours of continuous operation.

Display illumination with LEDs costs energy and should therefore be used sparingly.

The BATT error message appears in the display if the battery charge is low. Abort the current measurement in this case, insert a charged battery in the instrument, and repeat the measurement. Thanks to the non-volatile memory of the Elta, battery replacement does not cause the loss of instrument constants, but aborted measurements have to be repeated.

If the battery charge is very low, LCD display segments may be missing when you turn the instrument on, or there may be no display at all.

Recharge spent batteries as quickly as possible.

#### 4.2 Turning on and Initializing the Instrument

Turn the instrument on by pressing the ENTER key. All display segments will now appear in the LCD display (display test) and the display illumination is switched on. It remains on if you press the ENTER key again otherwise it goes out automatically.

The following information then appears:

DIST:	N
METER	
D.M.S.	
ZENITH	

Distance measurement mode, e.g. N (normal)  
Measuring units: meter  
360° in degrees, minutes, seconds  
zenith angle as vertical circle reference system.

**(All following examples are based on this choice of measuring units.)**

T	20
P	1015

Then the display changes to the meteorological data entered last, e.g. air temperature 20° C, atmospheric pressure 1015 hectopascal,

S	1.000020
P	35
A	0.000

followed by the scale, prism constant and

addition constant.

V	ZERO	1
---	------	---

A request then appears to initialize the vertical circle.

Tilt the telescope slowly.

V	ZERO	2
---	------	---

Then tilt the telescope slowly in the opposite direction.

**SLOWER**

If the telescope is tilted too fast **slower tilt** is displayed

**FASTER**

If the telescope is tilted too slowly **faster tilt** is displayed

**Elta 4 only:**  
After initialization of the vertical circle, the Elta 4 switches automatically to mode M2, angle tracking, and is ready for measurement.

**Elta 3 only:**

**A ZERO**

Initialization of the horizontal circle is requested in the display. Turn the instrument slowly.

**SLOWER**

If it is turned too fast, **slower** is displayed.

**FASTER**

If it is turned too slowly, **faster** is displayed.

**REPEAT**

If the instrument has been turned insufficiently, **repeat turning** is displayed.

After initialization, the Elta 3 switches automatically to mode M 2, angle tracking, and is ready for measurement.

### 4.3 Selecting Programs, Modes and Functions

Within a program, modes and functions are selected with the + and - keys and activated with the ENTER key. The + and - keys are also used to exit from the modes and functions.

A different program is selected as follows:  
Press the + or - key until mode 0 is reached in the current program. In the following example, mode A2 (determination of the collimation correction) of the adjustment program is to be selected, starting out from mode M2 (angle measurement).

```
A 18:15.10
V 87:06.50
M- 2: RE: +-
```

Horizontal circle reading

Vertical circle reading

Mode M2 selected

Press the - key twice to set mode M0.

The following display appears:

```
+-: NEXT M
E EXIT M
M- 0:
```

The display indicates that the modes of program M can be set with the + or- key and that program M can be left with the ENTER key.

```
MIAUSC
+- NEXT PR.
E ENTER M
M MEASURE
```

If the ENTER key is pressed, the display changes to the main menu. The first line indicates the programs available: M, I, A, U, S and C.

The selected program- in this case M- is flashing.

[Empty box]

Now another program can be selected with the + or - key or the M program be reactivated with the ENTER key.

MIAUSC
+ - NEXT PR.
E ENTER: A
A ADJUST

Press the + key twice, to set the adjustment program A. A is flashing.

Press the ENTER key to activate the adjustment program A.

+ - NEXT A
E EXIT A
A- 0:

Select the modes of A with + or - .

Exit from A with ENTER

ADJUST
A COLL.
A- 2: E: +-

The desired A2 mode is set by pressing the + key twice: determination of the collimation correction

Press the ENTER key to activate the A2 mode

POS. 1
C 0:00.20
A- 2: E: +-

The execution of this mode is described in 4.4.3.

#### 4.4 Program Description and Control

#### Deletion of the digits after the decimal point in measured values

D 123.---
A 164:----
V 89:----
M- 1: RE: +-

If the instrument is turned fast or if levelling is inadequate, the digits after the decimal point in the angle and distance readings will be deleted in all modes in which measurements are performed.

#### Display layout

For each of the positions 1 and 2, the Elta features a 4-line display with 9 digits per line (see the above example). The first three lines usually indicate the measured, computed or input data with a type identification of the subsequent value as the first digit. A list of all type identifications of the Elta is given in 5.4.2.

The bottom display line is used as a dialog and reference line. It always includes from left to right:

- \* the identifier of the program (M)
- \* the compensation status display (-)
- \* the mode number (1)

followed in most modes by " RE:+- " with the following meaning:

- E The ENTER key starts the next function
- + - The mode can be left with the + or - key.
- R The possibility of recording exists after pressure of ENTER and initialization of the function.

Further hints and uses of E, + or - differing from the standard case are given in the respective modes.

**Display: WAIT**

In the modes M5, C2, C3 and C6 a computational orientation of the horizontal circle is performed on the basis of an input or the measurement of a target sighted with the telescope.

To prevent the function from being influenced by the key pressure, the function is only started after the key has been released and after a waiting time of 1 sec. The display shows "WAIT".

### Measuring procedure in off-center measurement

Combined angle and distance measurement is always performed in the following order:

- \* Horizontal circle reading
- \* Vertical circle reading
- \* Distance measurement

When measuring the outer corners of buildings, for example, this sequence permits direct angle measurement to the corner and distance measurement to an off-center reflector.

### Input of Instrument Height i and Reflector Height t

In the modes M3, S3, S4, S5, C4 and C6 the instrument height i and/or reflector height t need to be entered for elevation computation.

The following display appears in the appropriate position, showing the data entered last for i and t. On the first activation after switching on the instrument, i and t are set to zero.

INP: t	+: I	-
t	0.000	
I	0.000	
M- 3:	RE	

Input of the reflector height is activated with +, of the instrument height with -.

SET: +-	
t	0.000
I	- 000.000
M- 3:	E

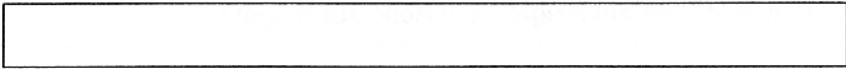
After setting i, for example, by pressing -, the i-line is ready for input or change.

First the - sign flashes. To select a positive instrument height, press ENTER when the - sign is not visible.

The first digit then flashes and can be changed with + or -.

Select the next digit with ENTER and change it in the same way.

After changing the last digit, enter the new value with the ENTER key.



INP: t	+: I	-
t	0.000	
I	0.000	
M- 3:	RE	

The initial display reappears. Now t, for example, can be entered or changed in the same way by pressing the + key.

The input is confirmed with ENTER and the values for i and t are recorded. Afterwards the selected program is continued.

Instead of instrument height i, the height of the instrument trunnion axis above MSL can be entered. This allows the elevation of the target point above MSL to be displayed in mode M3.

Likewise, the elevation of a reference point above MSL can be entered instead of reflector or sighting target height t. This permits the display of the target point elevation above MSL in modes S3 to S5, with the length of the reflector rod remaining unchanged.

#### 4.4.1 Measurement Program M

##### M1: Tacheometer Function with Angle Tracking

A (horizontal circle), V (vertical circle) and slope distance D measurement.

Display after selection of mode M1:

SLOPE D	
TH: A	V
M- 1:	E: +-

Slope distance D  
Theodolite function with A, V

MEASURE POINT	
M- 1:	RE: +-

Sight the reflector and initiate measurement with ENTER

D	L --- ' --- J
A	
V	
M- 1:	RE: +-

Distance meter signal display

D	123.456
A	164:28.32
V	89:46.36
M- 1:	RE: +-

Display and recording of the measured data: slope distance D  
horizontal direction A

zenith angle V

Trigger further measurements with ENTER or exit from this mode with + or -.

**M 2: Theodolite Function, Distance Meter Off**

THEOD.	
TH: A	V
M- 2: E: +-	

A	164:28.32
V	89:46.36
M- 2: RE: +-	

**Display after selection of mode M2:**

Theodolite function with A,V  
Activate the mode with ENTER.

Display and recording of the measured data:  
horizontal direction A

zenith angle V

Circle readings are continuous. The results can be read directly after sighting. Recording with ENTER. Exit from this mode with + or -.

**M 3: Tacheometer Function with Horizontal Distance E, Horizontal Direction A and Difference in Elevation h**

**Note:** Before precise elevation measurements, compensator adjustment with mode A6 is recommended for Elta 3, and the determination of the vertical index error with mode A1 for all Eltas.

**Display after selection of mode M3:**

RED: E	h
TH: A	
M- 3: E: +-	

Measurement of horizontal distance E and difference in elevation h. Continuous display of horizontal direction A. Activate the function by pressing ENTER.

INP: t +: I -	
t	1.800
I	1.600
M- 3: RE	

The display then requests input of reflector height t (key +) and instrument height i (key -).

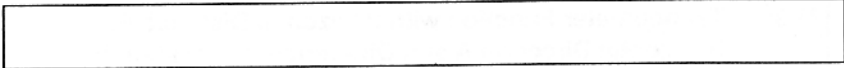
Press ENTER for ending the input and for recording i and t.

MEASURE POINT	
M- 1: RE: +-	

Sight the reflector and initiate measurement with ENTER.

E	L	-	-	-	J
A					

Display of the rangefinder signal



**M 4: Tacheometer Function with Tracking of Horizontal Distance E**

Display and recording of the measured data:

E	996.952
A	23:48.12
h	-79.797
M- 3:	RE: +-

horizontal distance E  
horizontal direction A

difference in elevation h

Trigger further measurements with ENTER.

Press + or - to exit from the mode.

In the computation of the difference in elevation h, allowance is made for instrument height i and reflector height t.

**Display after selection of mode M4:**

TRACK. RED: E
TH: A V M- 4: RE: +-

Indication of tracking mode  
Tracking of horizontal distance E

Theodolite function with A and V

MEASURE POINT
M- 4: RE: +-

Sight the reflector and trigger the measurement with ENTER

E [ - - - ] A
V M- 4: RE: +-

Distance meter signal display

E	172.438
A	168:24.32
V	90:42.36
M- 4:	RE: +-

Continuous display of:  
horizontal distance E  
horizontal direction A

zenith angle V

Recording with ENTER  
Exit from this mode with + or -.

**M 5: Resetting or Input of a Known Horizontal Direction**

Display after selection of mode M 5:

A	SET A	123:45.32
V	90:17.26	
M- 5:	A0 E:	+ -

A, V in tracking

Activation of the mode with ENTER and

**simultaneous** resetting of the horizontal direction to A = 0:00.00.

A	0:00.00
E	SET A
M- 5:	+ -

Activate the input of a given horizontal direction with ENTER.

Or press + or - to continue by sighting of the backsight point (A=0) (p.39).

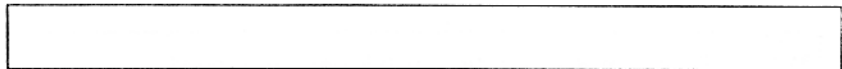
Setting the digits of the horizontal direction:

Press ENTER to switch to the next digit and change it with the + or - key. After changing the last digit the input is ended with ENTER.

A	SET: + -	000:00.00
M- 5:	E	

In case of faulty input of the horizontal direction, press ENTER to repeat the input.

A	ERROR A	500:00.00
M- 5:	E	



A	MEAS. P	123:34.00
M- 5:	E	

A request appears to sight the backsight point.

A	123:34.00
V	89:45.58
M- 5:	+ -

After sighting, switch to angle tracking with ENTER.

Exit from the mode with + or -.



**M 6: Tacheometer Function with Measurement of Horizontal Distance E and Angle Tracking**

**M 7: Storing the Horizontal Circle Reading by "Circle Clamp" or "Repeat Clamp" Function**

Display after selection of mode M 6:

RED: E
TH: A V
M- 6: E: +-

Measurement of horizontal distance E  
Theodolite function with A, V

MEASURE POINT
M- 6: RE: +-

Sight the reflector and start the measurement with ENTER

E L - - ' - J
A
V
M- 6: RE: +-

Distance meter signal display

E 996.952
A 122:16.32
V 90:08.36
M- 6: RE: +-

Result display:  
horizontal distance  
horizontal direction

zenith angle

Initiate further measurements with ENTER. Exit from this mode with + or -.

Display after selection of mode M 7:

A HOLD
A 122:16.32
V 90:08.36
M- 7: E: +-

Horizontal circle not clamped.  
A, V tracking

Activate clamping function with ENTER.

A HOLD
A 122:16.32
LOCKED
M- 7: E: +-

Horizontal circle clamped.  
A display fixed

Unlock the clamp with ENTER.

Repetition of angles is possible in this mode:

Sight the left target, display shows A and V.

Sight the right target, press ENTER, display shows LOCKED

Sight the left target, press ENTER, display shows A and V etc.

Exit from this mode with + or -.

**4.4.2 Input Program I**

**I 1: Input of the Air Temperature for Atmospheric Correction of Distances**

Display after selection of mode I 1:

<b>INPUT TEMP.</b>	
I- 1:	E: +-

Activate this mode with ENTER.

<b>SET: +- C 20</b>	
<b>F 68</b>	
I- 1:	E

Temperature entered last in degrees Celcius

and Fahrenheit.

The temperature can be changed in increments of 1° C with + and -. The Fahrenheit display changes automatically.

**Range:**  
- 30°C to + 70°C  
- 22°F to + 158°F

<b>TEMP.</b>	
C	23
F	73
I- 1:	RE: +-

Input and recording of the changed temperature with ENTER.

Exit from this mode with + or -.

**I 2: Input of the Atmospheric Pressure for Atmospheric Correction of Distances**

Display after selection of mode I 2:

<b>INPUT PRESS.</b>	
I- 2:	E: +-

Activate this mode with ENTER.

<b>SET: +- P 940</b>	
<b>Z 632</b>	
I- 2:	E

Atmospheric pressure entered last and barometric elevation above MSL computed from it.

The atmospheric pressure can be changed in increments of 4 hPa (0.1 in) with the + and - keys.

The elevation is computed automatically.

**Range:**  
440 hPa to 1460 hPa  
6471 m to - 3237 m

<b>PRESS.</b>	
P	948
Z	561
I- 2:	RE: +-

If the atmospheric pressure is unknown, change the pressure display until the displayed elevation corresponds approximately to the ground elevation above MSL.

Input and recording of the changed value with ENTER.

Exit from this mode with + or -.

**I 3: Input of the Prism or Addition Constant for Distance Measurement**

The correlation between the prism and addition constants is described in section 7.2.

The addition constant for the prism constant 35 mm of E series prisms is zero.

<b>INPUT PRISM.</b>	<b>+</b>
<b>ADD. CO.</b>	
I- 3:	E: +-

<b>SET:</b>	<b>+-</b>
<b>P</b>	<b>30</b>
<b>A</b>	<b>0.005</b>
I- 3:	E

<b>SET:</b>	<b>+-</b>
<b>P</b>	<b>35</b>
<b>A</b>	<b>0.000</b>
I- 3:	E

<b>CONST.</b>	
<b>P</b>	<b>35</b>
<b>A</b>	<b>0.000</b>
I- 3:	RE: +-

**Display after selection of mode I 3:**

Activate this mode with ENTER.

Prism constant in mm

Addition constant in m or ft

Change the prism or addition constant with + or -.

**Range:**

Prism constant :  
+ 163 mm to - 92 mm

Addition constant :  
- 0.128 m to + 0.127 m  
- 0.41 ft to + 0.41 ft

Input and recording of the new values with ENTER.

Exit from this mode with + or -.

**I 4: Input of the Scale or a Correction in PPM for Multiplication by the Measured Distance**

This mode allows the reduction of measured distances e.g. to a given net scale or to MSL.

**Display after selection of mode I 4:**

<b>INPUT SCALE - S</b>
<b>PPM - M</b>
I- 4: E: +-

Activate this mode with ENTER.

<b>S</b>	<b>0.999980</b>
<b>M</b>	<b>-20</b>
I- 4: E: SET1+	

Scale as a multiplication factor

Scale in ppm (correction by mm/km)  
The scale can be set to 1.000000 by pressing +.

<b>SET:</b>	<b>+-</b>
<b>S</b>	<b>0.999980</b>
<b>M</b>	<b>-20</b>
I- 4: E	

Change the scale with + or -.

The ppm display changes automatically.

**Range:**

0.998 500 to 1.000 500  
-1500 ppm to + 500 ppm

<b>SCALE</b>	
<b>S</b>	<b>0.999990</b>
<b>M</b>	<b>-10</b>
I- 4: RE: +-	

Input and recording of the changed value with ENTER.

Exit from this mode with + or -.

### I 5: Selection of the Distance Meter Mode

Three distance meter modes are available.

**R (Rapid)** Rapid measurement (meas. time approx. 3 sec.)

**N (Normal)** Normal measurement with approximately 4 sec measuring time.

**L (Long)** For measuring long distances for which the signal intensity of the R and N modes is insufficient. The signal is doubled which corresponds to doubling of the number of reflectors.

Display after selection of mode I 5:

DIST. MODE
NORMAL
I- 5: E: +-

Activate this mode with ENTER.

RAPID
I- 5: E

After pressure of ENTER, the modes RAPID, NORMAL and LONG appear alternately in the display.

Select the desired mode with ENTER while it is being displayed.

DIST: N
I- 5: +-

The selected mode, e.g. N, is displayed

Exit from this mode with + or -.

### 4.4.3 Adjustment Program A

#### A 1: Determination of the Vertical Circle Index Correction by Measurement in Both Telescope Positions

This "adjustment by measurement" should be performed after long storage periods, instrument transportation, major changes in temperature or prior to precise elevation measurements.

Display after selection of mode A 1:

ADJUST V INDEX
A- 1: E: +-

Activate this mode with ENTER.

POS. 1
I 0:00.18
A- 1: E: +-

Request to sight in telescope position I.

Display of last index correction.  
Press ENTER after sighting.

POS. 2
I 0:00.18
A- 1: E: +-

Request to sight in telescope position II.

Press ENTER after sighting.

V INDEX
I 0:00.14
A- 1: RE: +-

Display of the new index correction computed from the two measurements.

Input and recording of the index correction with ENTER or exit from this mode with + or -.

<b>ERROR INDEX</b>
A- 1: CE: +/-

A new index correction is not computed if it exceeds  $\pm 2'40''$ , e.g. due to a sighting error.

If this mode is left with + or -, the previous index correction is retained.

By pressing ENTER the index correction is set to zero (C = Clear).

**A 2: Determination of the Collimation Correction by Measurement in Both Telescope Positions**

This "adjustment by measurement" should be performed after long storage periods, after instrument transportation, major changes in temperature or prior to the measurement of targets differing considerably in elevation.

Display after selection of mode A 2:

ADJUST A COLL.
A- 2: E: +/-

Activate this mode with ENTER.

POS. 1
c 0:00.20 A- 2: E: +/-

Request to sight in telescope position I.  
Display of the last collimation correction.  
Press ENTER after sighting

POS. 2
c 0:00.20 A- 2: E: +/-

Request to sight in telescope position II.  
Press ENTER after sighting.

A COLL.
c 0:00.12 A- 2: RE: +/-

Display of the new collimation correction computed from the two measurements.  
Input and recording of the collimation correction with ENTER or exit from this mode with + or -.

**ERROR  
COLL.**

A- 2: CE: +-

A new correction is not computed if it exceeds  $\pm 2'40''$ , e. g. due to a sighting error.

If this mode is left with + or -, the previous collimation correction is retained .

By pressing ENTER the index correction is set to zero (C = clear).

**A 3: Adjustment of the Distance Meter to the Telescope Line of Sight**

The optical axis of the distance meter and the telescope line of sight must be identical to ensure that the maximum amount of energy is reflected from the prisms when the reflector is sighted.

**Display after selection of mode A3:**

ADJUST  
EDM

SIGNAL  
A- 3: E: +-

Activate the mode with ENTER.

D L - - ' - J

Sight the reflector.

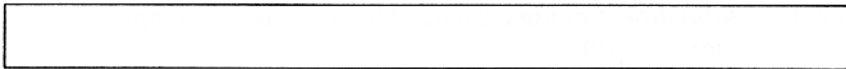
AUTO: ON  
A- 3: E: +-

ENTER alternately switches the automatic signal attenuation OFF and ON.

D L - - ' - J

AUTO: OFF  
A- 3: E: +-

Exit from this mode with + or -.



**A 4: Turning the Display Illumination On and Off**

Adjust the distance meter or check its adjustment as follows:

- Loosen the two hex socket rings (26) locking the distance meter adjustment screws.
  - Sight the reflector from a distance of at least 200 m with signal attenuation ON.
  - **a) The signal is displayed**  
Set the signal attenuation to OFF for checking the adjustment. Move the cross-hairs away from the reflector center using the fine motion drives. The signal must fall off if the adjustment is OK.
  - **b) No signal display appears**  
i. e. the distance meter adjustment is not correct.  
Move the telescope with the fine motion drives until a signal is displayed.  
Then carefully turn the distance meter adjustment screws in alternation with the hexagonal adjustment pin until the signal is at its maximum.  
Move the telescope cross-hairs closer to the reflector center until a minimum signal is displayed, and repeat the adjustment.
  - The lower adjustment screw shifts the distance meter beam in the vertical direction and the upper screw in the horizontal direction.
- If the signal display moves out of the field to the right | \_\_\_\_\_ |' during this procedure, set the signal attenuation function to ON with ENTER and wait till the signal display centers. Then switch the automatic control OFF with ENTER and proceed with the adjustment.
- Repeat this procedure until the signal display is at its maximum in centered sighting of the reflector. Retighten the hex socket rings (26).

Display after selection of mode A 4:

ILLUM.  
ON-OFF

A- 4:    E: +-

Activate the mode with ENTER.

ILLUM.  
ON

A- 4:    E: +-

The illumination is switched ON or OFF with ENTER.

Exit from this mode with + or -.

**Note:** The illumination can also be turned on immediately after switching on the instrument if ENTER is pressed during the display test (all LCD segments visible and illumination on).

**A 5: Switching the Compensator On and Off (Elta 3 only)**

The compensator is ready for operation as soon as the Elta 3 has been switched on. Strong wind or ground vibrations may disturb the compensator function; this is indicated by deletion of the digits after the decimal point in the measured data. It is advisable to switch off the compensator in such cases.

Display after selection of mode A 5:

<b>COMPENS. ON-OFF</b>	
A- 5:	E: +-

ENTER acts like a switch which alternately activates and deactivates the compensator

<b>COMPENS. ON</b>	
A- 5:	E: +-

Compensator switched on  
The negative sign after the mode in line 4 indicates that the compensator is switched on.

<b>COMPENS. OFF</b>	
A 5:	E: +-

Compensator switched off  
Exit from the mode with + or -

**A 6: Adjustment of the Compensator and Levelling of the Instrument Using the Compensator (Elta 3 only)**

The compensator should be adjusted at regular intervals, but in particular before precise elevation measurements are performed.

Display after selection of mode A 6:

<b>ADJUST COMPENS.</b>	
+LEVELL.	
A- 6:	E: +-

Activate the mode with ENTER

<b>CLAMP AND</b>	
PRESS E	
A- 6:	E: +-

Lock the instrument with Hz clamp and trigger measurement with ENTER in position 1.

<b>TURN 0</b>	
A	180:--.--
<b>CLAMP E</b>	
A 6:	E: +-

Turn the instrument approximately to 0° (±5°), clamp it and trigger measurement with ENTER in position 2.

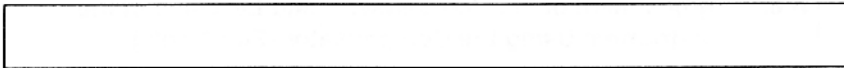
A	0:00.48
<b>V</b>	
V	0:00.34
A- 6:	E: +-

After determination of the compensator adjustment, the vertical axis inclination is displayed:

Display A: inclination in trunnion axis direction, positive value indicates inclination to the right

Display V: inclination in sighting axis direction, positive value indicates inclination to the front





Now the instrument can be levelled very precisely by means of the footscrews. The inclinations displayed for both directions should be roughly zero.

If the compensator is activated, higher levelling precision is not required as the appropriate corrections for the vertical axis inclination are applied automatically to the horizontal and vertical circle readings.

If the compensator working range of  $\pm 2'40''$  is exceeded before or during levelling, this is indicated in the display.

A	LEVEL	
A	LEFT	
V	BEHIND	
A- 6:		+-

The indications LEFT or RIGHT and BEHIND or BEFORE show the instrument inclination in position I.

A	LEVEL	
A	OUT OF	
V	RANGE	
A- 6:		+-

If levelling is outside a range of  $\pm 5'$ , the display shows:

Exit from the mode with + or -.

#### 4.4.4 Units Program U

U 1: Reversing the Horizontal Circle Reading Direction

Display after selection of mode U 1:

A REV.
U- 1: E: +-

Activate the mode with ENTER

A REV.
A - 332:44.28
V 101:26.18
U- 1: E: +-

ENTER acts like a switch alternating between clockwise and counterclockwise horizontal circle reading (ccw readings marked with - sign).

Exit from this mode with + or -.

**U 2: Selection of the Vertical Circle Reference System and the Main Operating Position (Position 1)**

V REF.  
U- 2: E: +-

V REF.  
ZENITH  
U- 2: E: +-

POS. 1  
DISPLAY  
RIGHT  
U- 2: E: +-

ZENITH  
DISPL. R  
U- 2: E: +-

Display after selection of mode U 2:

Activate this mode with ENTER.

The following displays appear in alternation  
ZENITH, VERTIC, +-ELEV., SLOPE %

Select the wanted reference system with ENTER while it is being displayed.

Then the main operating position (POS. I) can be selected.

The display alternately shows  
DISPLAY RIGHT (Elta display on the right)  
DISPLAY LEFT (Elta display on the left).

The main operating position is selected by pressing ENTER when the appropriate display appears.

After input with ENTER, the reference system and the main operating position = position I (R=RIGHT; L=LEFT) are displayed. These settings are retained even if the instrument is switched off.

Exit from this mode with + or -.

**U 3: Selection of the Angle Measurement Unit**

Display after selection of mode U 3:

UNITS. A. V  
U- 3: E: +-

Angle measurement units.

Activate this mode with ENTER.

UNITS. A. V  
D.M.S.  
360:00.00  
U- 3: E: +-

The following displays appear in alternation:

360° in degrees, minutes, seconds

or

UNITS. A. V.  
GON  
400.0000  
U- 3: E: +-

400 grads

or

UNITS. A. V.  
MIL  
6400.00  
U- 3: E: +-

6400 mils

UNITS. A. V  
D.M.S.  
360:00.00  
U- 3: E: +-

Select the wanted unit by pressing ENTER while it is being displayed. The selected unit is displayed and is retained even if the instrument is switched off.

Exit from this mode with + or -.

**U 4: Selection of the Distance Measurement Unit**

UNITS D
U- 4: E: +-

**Display after selection of mode U 4:**

Distance measurement units

Activate this mode with ENTER

UNITS D METER
U- 4: E: +-

Then the display alternately shows  
METER and FEET.

Select the wanted unit by pressing  
ENTER while it is being displayed.

UNITS D METER
U- 4: +-

The selected unit is displayed and  
retained even if the instrument is  
switched off.

Exit from this mode with + or -.

**U 5: Selection of the Atmospheric Pressure Unit**

UNITS PRESS.
U- 5: E: +-

**Display after selection of mode U 5:**

Atmospheric Pressure  
Units

Activate this mode with ENTER.

UNITS PRESS.
hPa/mb/ U- 5: E: +-

The following displays appear in  
alternation:

Hektopascal / millibar,  
Torr and inches of mercury

Select the wanted unit by pressing  
ENTER while it is being displayed.

UNITS PRESS.
hPa/mb/ U- 5: +-

The selected unit is displayed and is  
retained even after the instrument is  
switched off.

Exit from this mode with + or -.

**U 6: Selection of the Coordinate System**

<b>COORD. SYSTEM</b>
U- 6: E: +-

<b>COORD. SYSTEM</b>
Y X Z U- 6: E: +-

X Y Z U- 6: E: +-
----------------------

E N Z U- 6: E: +-
----------------------

N E Z U- 6: E: +-
----------------------

<b>COORD. SYSTEM</b>
Y X Z U- 6: +-

Display after selection of mode U 6:

Activate the mode with ENTER

The following displays appear in alternation:

Coordinate system 1

or

Coordinate system 2

or

Coordinate system 3

or

Coordinate system 4

Select the desired coordinate system by pressing ENTER while it is being displayed.

For details see also 2.6.

The selected coordinate system is displayed and retained even if the instrument is switched off.

Exit from this mode with + or -.

**4.4.5 Special Applications Program S**

**S 1: Determination of Connecting Distances Between the First and All Subsequent Points**

This mode is used to determine the slope distance, horizontal distance and difference in elevation between the point sighted first and all subsequent points (with an identical reflector height in all sighted points).

Display after selection of mode S 1:

<b>CONNECT. 1 - P</b>
S- 1: E: +-

Activate the mode with ENTER

<b>MEASURE POINT</b>
S- 1: RE: +-

Request to sight the first point

Trigger the measurement with ENTER

D	17.432
E	17.408
h	-0.894
S- 1: RE: +-	

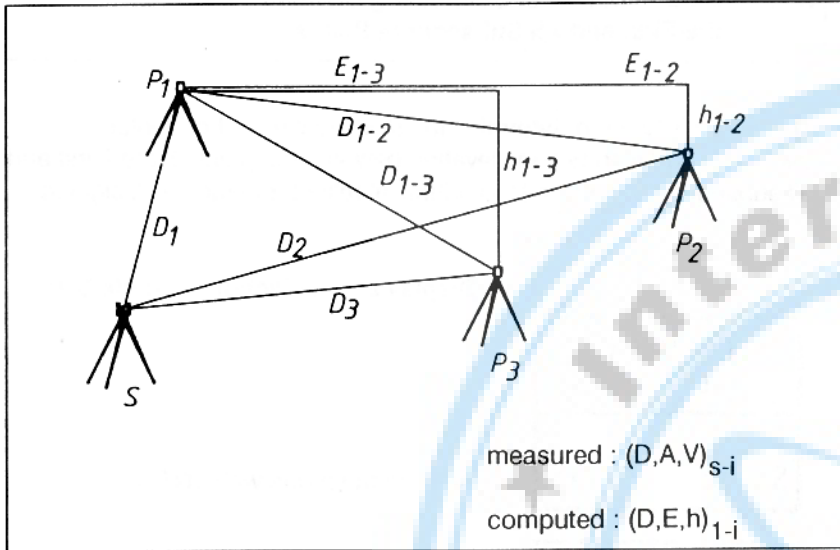
Display and recording of slope distance D, horizontal distance E

and difference in elevation h

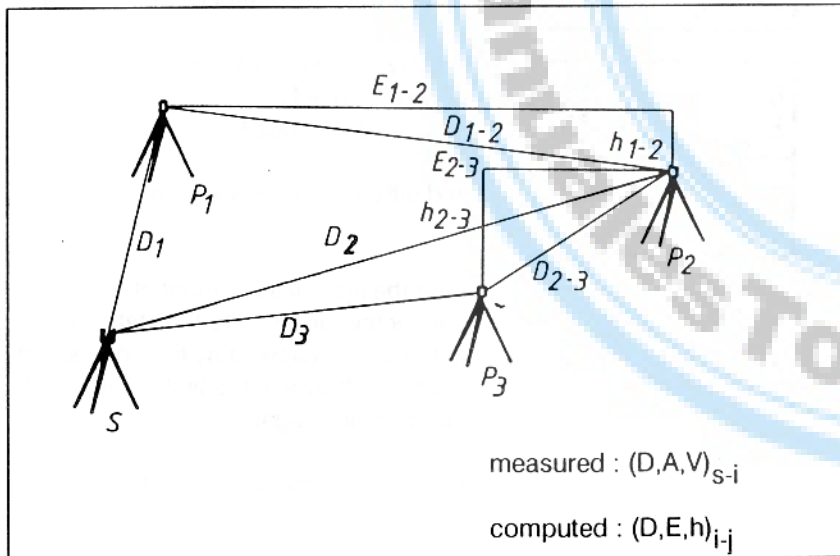
After the first measurement, the connecting distance to the station is determined, followed by the connecting distances between the first point and all further points sighted.

Exit from this mode with + or -.

**Example: Connecting distance 1-P (S1)**



**Example: Connecting distance P-P (S2)**



**S 2: Determination of Connecting Distances Between Successive Points**

This mode is used to determine the slope distance, horizontal distance and difference in elevation between two points sighted successively (with an identical reflector height in all sighted points).

Display after selection of mode S 2:

CONNECT. P - P	
S- 2:	E: +-

Activate the mode with ENTER

MEASURE POINT	
S- 2:	RE: +-

Request to sight the first point.

D	45.203
E	45.201
h	0.433
S- 2:	RE: +-

Trigger the measurement with ENTER

Display and recording of  
 slope distance D  
 horizontal distance E

and difference in elevation h.

After the first measurement, the connecting distance to the station is determined, followed by the connecting distances between successively sighted points.

Exit from the mode with + or -.

**S 3: Height Measurement using the Vertical Circle**

<b>OBJECT HEIGHT</b>	
S- 3:	E: +-

t	INP: t + 1.800
S 3:	RE

<b>MEASURE POINT</b>	
S- 3:	RE: +-

E	23.714
O	0.000
h	1.378
S- 3:	RE: +-

**Display after selection of mode S 3:**

Height measurement

Activate the mode with ENTER

Activate input of reflector or reference point height t with +.

Press ENTER to confirm and enter the reflector height.

Sight backsight point P and trigger measurement and recording with ENTER.

E = horizontal distance between instrument and P

O = transverse deviation from the line instrument - P

h = height of the reflector

E	24.261
O	5.123
h	3.807
S- 3:	RE: +-

Tilt the telescope upwards. Display h continuously shows the height of points perpendicular above the reflector.

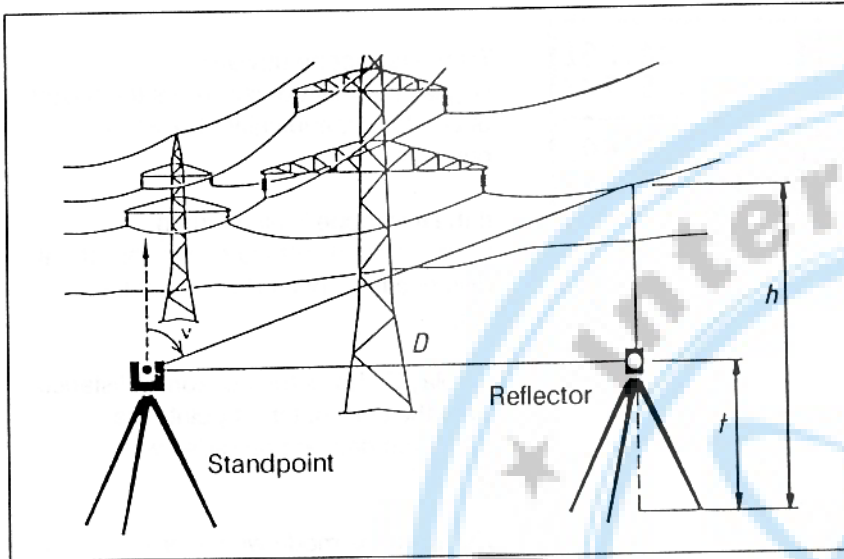
If the telescope is also turned horizontally, display O shows the lateral distance from point P (+ = right, - = left).

Display E shows the horizontal distance from the current target point. The displayed data are recorded with ENTER.

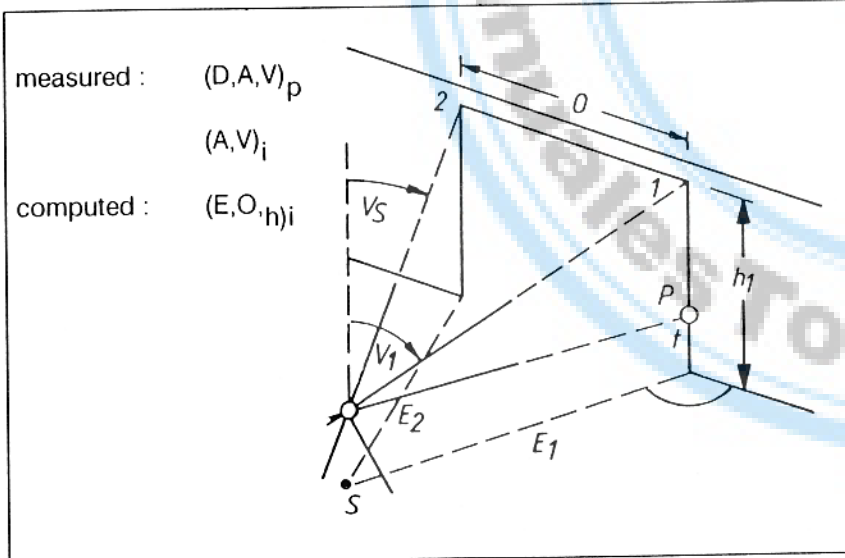
Exit from the mode with + or -.

**If the reflector height is entered as t, all h-values indicate the height above the ground. However, if t stands for the elevation of the reflector above MSL, all h-values are elevations above MSL.**

**Example: Height of a power line**



**Example: Height and width of a passage**



**S 4: Determination of Point-to-Line Distance and Intersection Point on the Line**

Display after selection of mode S 4:

**POINT TO LINE**  
 S- 4: E: +-

Point-to-line distance and intersection point

Activate the mode with ENTER

INP: t +  
 t 1.800  
 S- 4: RE

Press + to activate the input of the height of starting point P1. See S3 for the meaning of t.

Press ENTER to confirm and enter the height.

**MEAS. P1**  
 S- 4: E: +-

Sighting of starting point P1 is requested.

Trigger the measurement with ENTER

**MEAS. P2**  
 S- 4: E: +-

Sighting of end point P2 is requested.

Trigger the measurement with ENTER.

E 28.217  
 O 11.440  
**MEAS. P**  
 S- 4: RE: +-

Display of the instrument position:

E = distance of the intersection point from P1

O = distance of the instrument from the line

Sighting of detail points P is requested

Trigger the measurement with ENTER.

E	58.217
O	8.367
h	0.432
S- 4:	RE: +-

E = distance of the intersection point from P1

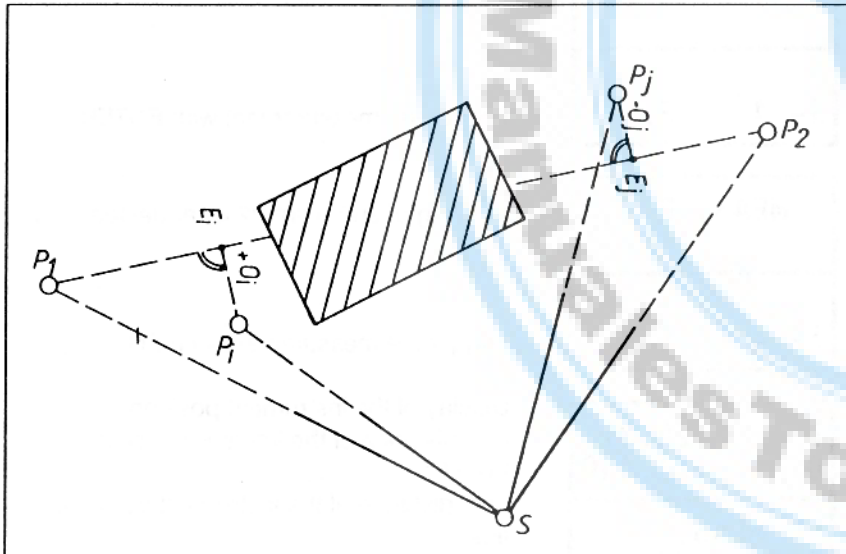
O = distance of point Pn from the line

h = difference in elevation between P1 and Pn (provided that the reflector heights are identical in P1 and Pn).

Press ENTER for measuring the next detail point.

Exit from the mode with + or -.

**Example: Alignment in a line**



**S 5: Determination of Point Positions in a Vertical Plane**

**Display after selection of mode S 5:**

POINT IN LINE	
S- 5:	E: +-

This mode determines the position of a point in relation to starting point P1, without using a reflector but by simple angle measurement in a vertical plane defined by the line P1 - P2.

Activate the mode with ENTER

INP: t +	
t	1.800
S- 5:	RE

Press + to activate the input of the height of starting point P1. See S3 for the meaning of t.

Press ENTER to confirm and enter the height.

MEAS. P1	
S- 5:	E: +-

Request to sight starting point P1.

Trigger the measurement with ENTER.

MEAS. P2	
S- 5:	E: +-

Request to sight the end point P2.

Trigger the measurement with ENTER



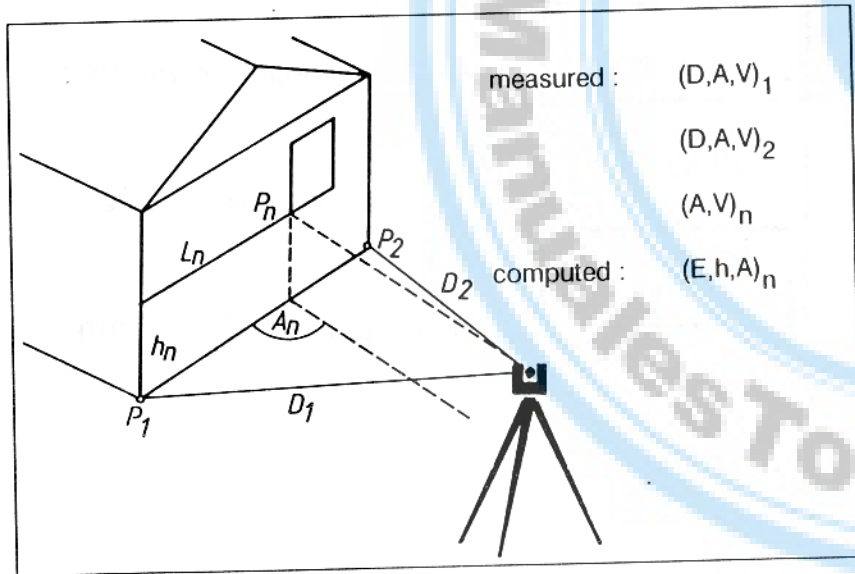
E	49.998
A	78:00.00
h	3.634
S- 5:	RE: +-

E = horizontal distance between P1 and P2 or Pn  
 A = angle between the horizontal sighting direction and vertical plane (90° max.)  
 h = height difference between P1 and P2 or Pn

Measurement only by the use of Hz and V circles;  
 the data are displayed continuously.

Exit from the mode with + or -.

**Example: Measurement of a building facade**



**4.4.6 Coordinate Measurement Program C**

**C 1: Input of Station Coordinates**

The coordinate system can be selected in mode U 6. In the following, the coordinate system 1 - geodetic system - is used.

**Display after selection of mode C 1:**

INPUT STATION	
COORD.	
C- 1:	E: +-

Activate the mode with ENTER

Y	0.000
X	0.000
Z	0.000
C- 1:	EAST.

Y flashes in the first line, indicating ready-for-input status. The X or Z line can be selected with - or + before the input.

Input in the Y line (EAST. display in line 4):

- Y flashes, start input with ENTER.
- Now the - sign flashes after Y. For positive Y, press ENTER when the - sign is not visible.
- Then press ENTER to go to the first digit which can be changed with + or -.
- The input is confirmed with ENTER and the next digit flashes.
- Repeat this procedure for all 7 digits.
- After input of the last digit with ENTER, Y flashes again.
- The same line can be selected again with ENTER, e.g. to make corrections, or the X line is selected with - and the procedure is repeated for the input of the X coordinate (NORTH display in line 4).

- The same procedure is used for the input of the Z coordinate (ELEV. display in line 4). The Z coordinate normally means the station elevation above MSL. The instrument height *i* need not be added as it is taken into account separately.

- For the correction of previously entered coordinates, e.g. when X is flashing, the Y coordinate can be selected with +, the Z coordinate with -.

- The input mode can only be left with - when Z is flashing.

Y	1000.000
X	2000.000
Z	500.000
C- 1:	RE: +-

Press ENTER for display and recording of the entered coordinates.

Exit from the mode with + or -.

The entered coordinates are deleted when the instrument is switched off.

**C 2: Input of a Given Direction Angle to a Backsight Point**

**Display after selection of mode C 2:**

SET A	
A	123:45.32
V 90:17.26	
C- 2:	A0 E: +-

A, V tracking

Activation of the mode with ENTER

A	000:00.00
E	SET A
C- 2:	+ -

and resetting of the horizontal direction  
A = 0:00.00.

Press ENTER for the input of a horizontal direction.

After pressing + or -, the backsight point (A = 0) is sighted (p. 76).

Input of the horizontal direction in digits:

SET: +-	
A	000:00.00
C- 2:	E: +-

Press ENTER to switch to the next digit which can be changed with the + or - keys.

After changing the last digit, the input is ended with ENTER.

ERROR A	
A	500:00.00
C- 2:	E

In case of faulty input of the horizontal direction, press ENTER to repeat the input.

**C 3: Circle Orientation using Station and Target Point Coordinates**

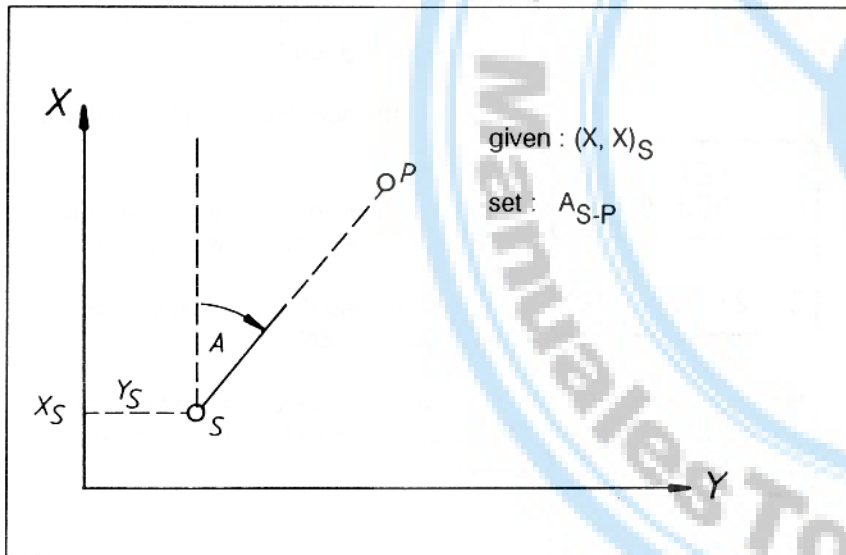
A	MEAS P	123:34.00
C- 2:	E	

Then sighting of the backsight point is requested.

A	123:34.00
V	89:45.58
C- 2:	E: +-

After sighting, switch to angle tracking with ENTER.

Exit from the mode with + or -.



Display after selection of mode C 3:

ORIENT. COORD.	
C- 3:	E: +-

Activate the mode with ENTER

Y	1000.000
X	2000.000
STATION	
C- 3:	E: +-

Display of the station coordinates entered in C1 or computed in C6 (without display of station elevation Z).

Y	0.000
X	0.000
REF. P	
C- 3:	EAST.

Input of the target point coordinates as described in mode C 1 (without Z coordinate).

ERROR COORD.	
C- 3:	E: +-

If the station and target point coordinates differ by less than 1 m, this is indicated and the input of the target point coordinates can be repeated after ENTER.

Y	2000.000
X	2000.000
REF. P	
C- 3:	RE: +-

After input of the coordinates, press ENTER for confirmation and recording.

**MEASURE  
REF. P**

C- 3: RE: +-

A 90:00.00

V 89:42.12

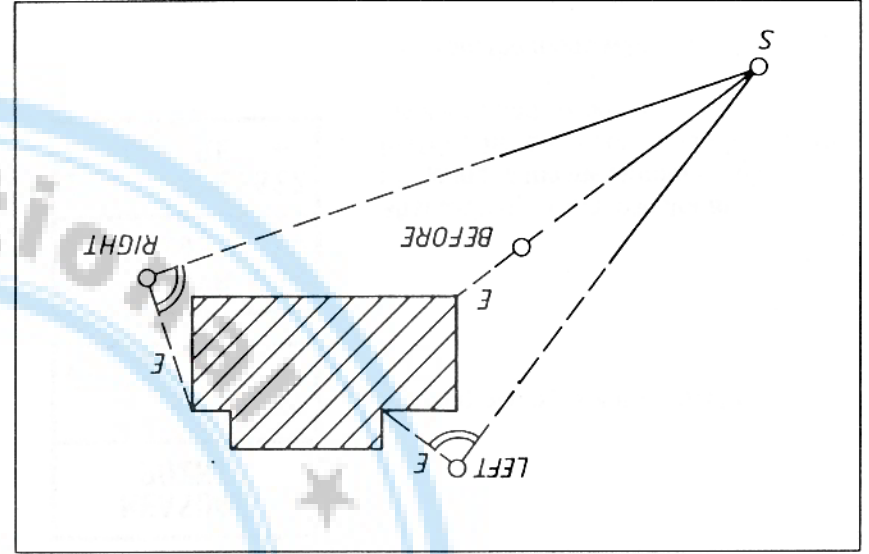
C- 3: +-

Request to sight the backsight point.

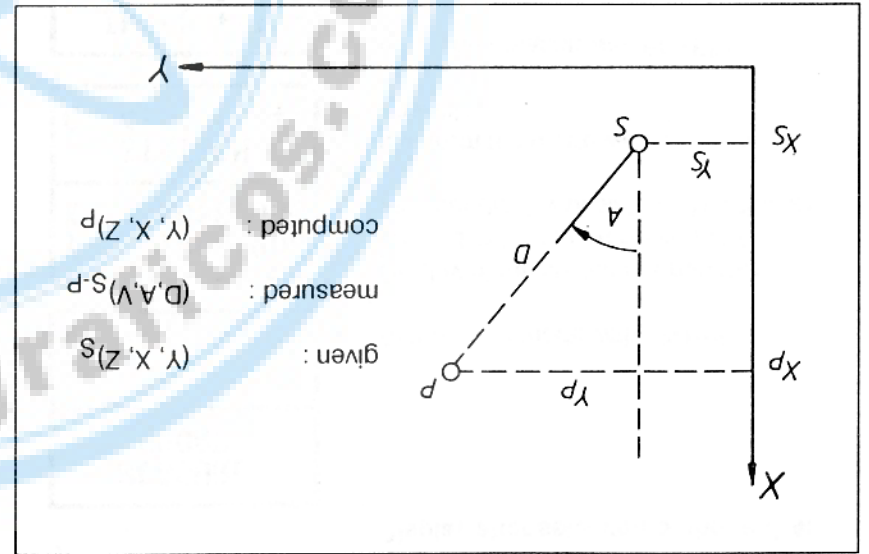
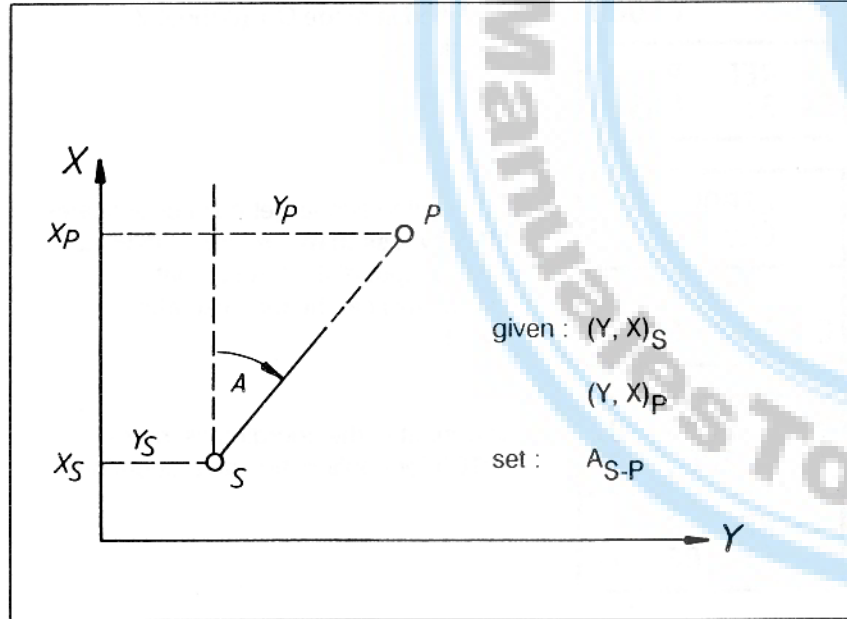
Press ENTER to initiate and record measurement of the backsight point.

The instrument switches to angle tracking. The horizontal circle is oriented for azimuths.

Exit from the mode with + or -.



Example : Off-center points (C5)



Example : Centered coordinate measurement (C4)

**C 5: Measuring Coordinates by Off-Center Sighting**

Display after selection of mode C 5:

ECC. MEAS. COORD.	
C- 5:	E: +-

Activate the mode with ENTER

Y	1000.000
X	2000.000
STATION	
C- 5:	E: +-

Display of the station coordinates entered in C1 or computed in C6 (without display of station elevation Z).

INPUT ECCENTR.	
C- 5:	E: +-

Request to enter the eccentricity.

REFLECT. BEFORE	
C- 5:	E: +-

Selection of the type of eccentricity:  
 BEFORE: reflector in front of the center  
 BEHIND: " behind " "  
 LEFT: " left of " "  
 RIGHT: " right of " "

Z	452.622
C- 4:	RE: +-
Y	1998.039
X	1958.960

After sighting of the reflector and triggering of the measurement with ENTER, the target point coordinates are displayed and recorded.

Exit from the mode with + or -.

MEASURE POINT	
C- 4:	RE: +-

Sighting of the point is requested.

I	1.500
C- 4:	RE
t	1.800
INP:t +: I -	

After confirmation with ENTER:  
 Activate the input of the reflector height with + and of the instrument height with - (see 4.4).  
 Press ENTER for the input and recording of I and t.

Y	1000.000
X	2000.000
STATION	
C- 4:	E: +-

Display of the station coordinates entered in C1 or computed in C6 (without display of station elevation Z).  
 Exit from the mode with + or - is possible.

MEASURE COORD.	
C- 4:	E: +-

Activate the mode with ENTER

Display after selection of mode C 4:

**C 4: Measuring Coordinates by Centered Sighting**

**C 6: Free Stationing using 2 Control Points**

E 0000.000  
C- 5: RE: +-

Enter the amount of eccentricity in digits.

ECCENTR.  
E 2.500  
T BEFORE  
C- 5: RE: +-

Confirmation and recording of the eccentricity data:  
E = amount of eccentricity  
T = type of eccentricity

MEASURE POINT  
C- 5: RE: +-

Sighting is requested.

Y 2000.537  
X 1958.858  
C- 5: RE: +-

After sighting of the off-center reflector and triggering of the measurement with ENTER, the coordinates are displayed and recorded.

Elevation Z is not displayed as the difference in elevation between the off-center and center points is not measured.

The missing Z coordinate characterizes an off-center measurement.

Exit from the mode with + or -.

STATION.  
WITH 2  
POINTS.  
C- 6: E: +-

**Display after selection of mode C 6:**

This mode determines the coordinates and elevation of a freely selected station by angle and distance measurement to two control points.

INP: t +: I -  
t 1.800  
I 1.500  
C- 6: RE

Activate the input of the reflector height with + and of the instrument height with - (see 4.4).

Press ENTER for confirmation and recording of i and t.

INPUT  
COORD. P1  
C- 6: E: +-

Request to enter the first backsight point.

Y 0.000  
X 0.000  
Z 0.000  
C- 6: EAST.

Enter the coordinates Y,X,Z of the first backsight point (as C1).

Y 1000.000  
X 2200.000  
Z 510.000  
C- 6: RE: +-

Press ENTER for confirmation and recording of the coordinates of the first backsight point.

<b>INPUT COORD. P2</b>	
C- 6:	E: +-

Request to enter the second backsight point.

Y	0.000
X	0.000
C- 6:	EAST.

Enter the coordinates Y,X of the second backsight point. Elevation Z is not entered as it is always derived from the first control point.

<b>ERROR COORD.</b>	
C- 6:	E: +-

If the X and Y coordinates of P1 and P2 differ by less than 1 m, this is indicated and the input of the coordinates of the first backsight point can be repeated after ENTER.

Y	1300.000
X	2000.000
C- 6:	RE: +-

Press ENTER for confirmation and recording of the coordinates of the second backsight point.

<b>MEASURE P 1</b>	
C- 6:	RE: +-

Measurement of backsight point P 1 is requested.

Press ENTER for measurement, recording and brief display of the measured data.

<b>MEASURE P 2</b>	
C- 6:	RE: +-

Measurement of backsight point P 2 is requested.

Press ENTER for measurement, recording and brief display of the measured data.

Y	1000.000
X	2000.000
Z	500.000
C- 6:	RE

Computation and display of the Y,X,Z station coordinates.

Press ENTER for confirmation and recording.

S	0.999922
A	90:00.00
V	90:11.28
C- 6:	RE: +-

For checking the correctness of the entered point coordinates and of the measurement, the display shows scale S.

The instrument switches to angle tracking.

The horizontal circle is oriented for azimuths.

Recording of the data with ENTER.

Exit from the mode with + or -.

**Exception:** Free stationing for surveys in a network of aligning bases or a local coordinate system. Backsight point 1 is the starting point, backsight point 2 the end point of a line.

The coordinates of point 1 then are  $X = 0$  and  $Y = 0$ .

The coordinates of point 2 are  $X = \text{distance P1-P2}$  and  $Y = 0$ .

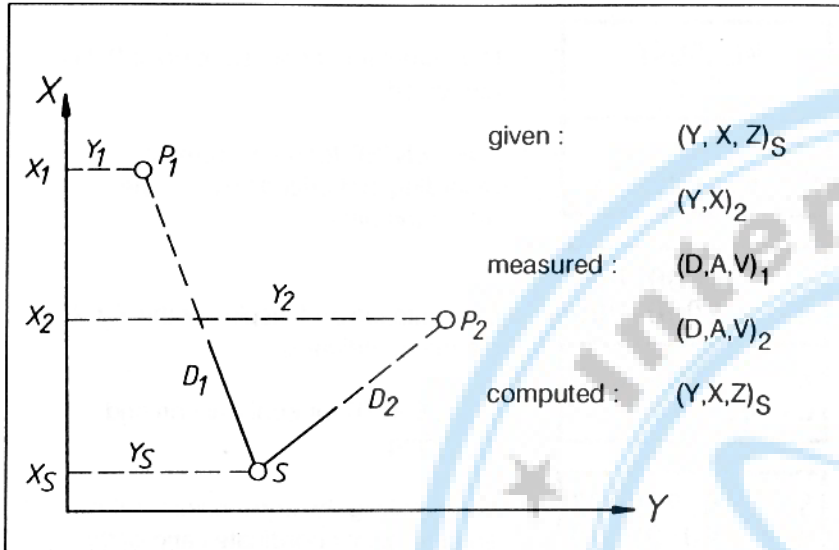
If distance P1-P2 is not given, it can be measured in mode S 1 (4.4.4.1), e.g. 123.456 m. In this case the coordinates are:

For P1  $X = 0$   $Y = 0$

For P2  $X = 123.456$   $Y = 0$

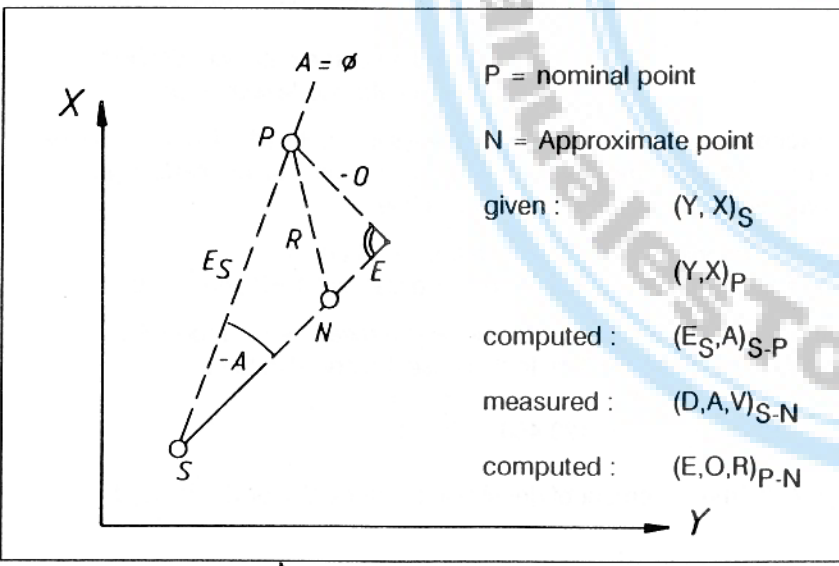
For the measurement of detail points, mode C 4 or C 5 is used.

**Example: Free stationing (C 6)**



given :  $(Y, X, Z)_S$   
 $(Y, X)_2$   
 measured :  $(D, A, V)_1$   
 $(D, A, V)_2$   
 computed :  $(Y, X, Z)_S$

**Example: Polar setting out by coordinates (C 7)**



P = nominal point  
 N = Approximate point  
 given :  $(Y, X)_S$   
 $(Y, X)_P$   
 computed :  $(E_S, A)_{S-P}$   
 measured :  $(D, A, V)_{S-N}$   
 computed :  $(E, O, R)_{P-N}$

**C 7: Polar Setting Out by Coordinates**

Display after selection of mode C 7:

SETT. OUT COORD.	
C- 7:	E: +-

Activate the mode with ENTER.

Y	1000.000
X	2000.000

Display of the station entered in C 1 or computed in C6 (without display of station elevation Z).

STATION	
C- 7:	E: +-

Y	0.000
X	0.000

Enter the coordinates Y,X of the setting out point.

SETT. P	
C- 7:	EAST.

Y	1000.000
X	2200.000

Display and recording of the coordinates of the setting out point. (Z = 0).

SETT. P	
C- 7:	RE: +-

ERROR COORD.	
--------------	--

If the X and Y coordinates of the station and the setting out point differ by less than 1 m, this is indicated. Press ENTER to return to the station coordinate display.

C- 7:	E: +-
-------	-------



[Empty display box]

E	200.016
A	5:30.45
MEAS. P	
C- 7:	E: +-

Polar setting out data:  
 E = nominal distance computed from the coordinates and divided by scale  
 A has been converted in such a way that A = 0 is the setting out direction.  
 Display of A in tracking.

Now turn the tacheometer until A = 0 is displayed.

Trigger the measurement with ENTER.  
 The display then is as follows:

E	0.038
A	0:04.56
O 0.287	
C- 7:	E: MEAS+

Difference: longitudinal (fixed)  
 transverse as an angle (tracking)  
 transverse as a distance (fixed)

Press + to trigger the next measurement with the same display.  
 After ENTER the display changes to

E	0.004
R	0.005
O 0.003	
C- 7:	RE

Difference: longitudinal  
 radial  
 transverse

These differences are recorded with ENTER

E: INPUT SETT. P	
C- 7:	+-

Press ENTER for the input of the next setting out point.

Exit from the mode with + or -.

## 5 Interface Description

### 5.1 Elta Interface

The Elta interface is an asynchronous serial interface conforming to DIN standard 66020 (V.24/RS 232 C).

Apart from the Rec 200 and Rec 500 Electronic Field Books, hand-held computers and other transportable computers can be connected directly to the Elta provided they have a freely programmable interface (V 24 / RS 232 C). For information on data transfer control refer to section 5.3

Detailed information on interfacing capabilities is available upon written request from our V-GST department.

#### 5.1.1 Transmission Parameters

Transmission mode	Asynchronous, serial
Code	ASCII
Baud rate	1200
Start bit	1
Stop bits	2
Word length	7 bits + parity bit
Parity	Odd

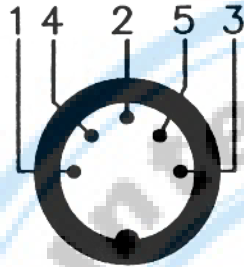
## 5.1.2 Connectors

Elta connector

5-point stereo DIN 41 524 connector

Elta pin assignment

- Pin 1
- Pin 2 Ground
- Pin 3 DSR ( + 5V)
- Pin 4 Transmitted Data (OUT)
- Pin 5 Received Data (IN)

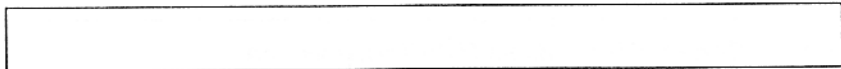
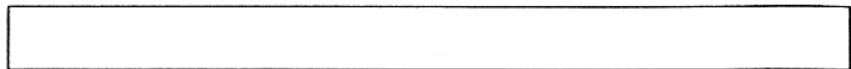


## 5.2 Elta Control by a Computer

Control words are used for data transfer synchronization and control and for status and parameter testing.

These control words are alphanumeric strings without blanks that are terminated with CARRIAGE RETURN (ASCII dec. 13) and LINE FEED (ASCII dec. 10).

Function	Control Word from Computer	Elta response	
		Normal	Error
MODE + key	S12<	Q<	E<
MODE - key	S11<	Q<	E<
ENTER key	S14<	Q<	E<
Instrument identification and program status PPP	?00< (Elta 3)!702770.9905/PPP< ?00< (Elta 4)!702790.9905/PPP<		E<
Query on mode Mode selection	?M0< SM0/_PBB;<	!_PBB;< Q<	E< E<
P program M, I, A, U, S, C BB mode number			
Query on measuring unit Input of measuring unit	?P1< SP1/00000000EEAA;<	!00000000EEAA;< Q<	E< E<
EE = 00 meter, EE = 01 feet AA = 10 DMS, AA = 00 mils, AA = 01 grad, AA = 11: dec. deg.			
Query on V-reference system Input of V-reference system	?P3< SP3/0000000000BB;<	!0000000000BB;< Q<	E< E<
BB = 00 zenith angle, BB = 01 vertical angle BB = 10 height angle, BB = 11 slope in % DD = 00:XYZ, DD = 01:XYZ DD = 10:ENZ, DD = 11:NEZ C = 0: Position I Display right C = 1: Position II Display left			
Query on addition constant y = 1: meter, y = 2: feet	?KA< = #18{KAy}VXXXXX.XXX;<		E<
Input of addition constant Meter: 3 dec. places (-0.128 to 0.127 m) Feet: 2 dec. places (-0.41 to 0.41 ft)	SKA/VXXXXX.XXX;<	Q<	E<



Function	Control Word from Computer	Elta response	
		Normal	Error
Query on Hz-rotation y = 1 : grad, y = 2 : DMS, y = 4 : mils	?KH < # 18{KHy} VXXXX.XXXX; < =	E < =	E < =
Input of Hz-rotation (with the chosen measurement unit)	SKH/-VXXXX.XXXX; < =	Q < =	E < =
Query on instrument height y = 1 meter, y = 2 feet	?KI < # 18{KIy} VXXXXX.XXX; < =	E < =	E < =
Input of instrument height Meter: 3 dec. places Feet: 2 dec. places	SKJ/VXXXXX.XXX; < =	Q < =	E < =
Query on reflector height y = 1 meter, y = 2 feet	?KR < # 18{KRy} VXXXXX.XXX; < =	E < =	E < =
Input of reflector height Meter: 3 dec. places Feet: 2 dec. places	SKR/VXXXXX.XXX; < =	Q < =	E < =
Query on station coordinates (always based on system 1: Y/X/Z)	?KY < # 18{KYy} VXXXXX.XXX; < = ?KX < # 18{KXy} VXXXXX.XXX; < = ?KZ < # 18{KZy} VXXXXX.XXX; < =	E < = E < = E < =	E < = E < = E < =
Input of station coordinates Meter: 3 dec. places Feet: 2 dec. places	SKY/VXXXXX.XXX; < = SKX/VXXXXX.XXX; < = SKZ/VXXXXX.XXX; < =	Q < = Q < = Q < =	E < = E < = E < =
Query on target point coordinates - Y-coordinate - X-coordinate - Z-coordinate	?KV < # 18{KVy} VXXXXX.XXX; < = ?KU < # 18{KUy} VXXXXX.XXX; < = ?KW < # 18{KWy} VXXXXX.XXX; < =	E < = E < = E < =	E < = E < = E < =
Input of target point coordinates Meter: 3 dec. places Feet: 2 dec. places  y = 1 meter, y = 2 feet	SKV/VXXXXX.XXX; < = SKU/VXXXXX.XXX; < = SKW/VXXXXX.XXX; < =	Q < = Q < = Q < =	E < = E < = E < =

Function	Control Word from Computer	Elta response	
		Normal	Error
Query on scale Input of scale (0.998500 - 1.000500)	?KS < # 18{KSy} VXXXXX.XXX; < = SKS/-X.XXXXXX; < =	E < = Q < =	E < = E < =
Query on temperature y 1: XX in °C (37 C to 170 C)	?KT < # 18{KTy} VXXXXX.XXX; < =	E < =	E < =
Input of temperature	SKT/.....VXXXX; < =	Q < =	E < =
Query on pressure y 1: XXXX in hPa (440 hPa to 1460 hPa)	?KP < # 18{KPy} VXXXXX.XXX; < =	E < =	E < =
Input of pressure	SKP/.....XXXX; < =	Q < =	E < =
Load text "TTTTTT" into line x of the display. x = 1, 2, 3 (counted from the top) T = 0..9, A..Z and space	LDx/TTTTTT; < =	Q < =	E < =
Note :	- is a blank (ASCII dec. 32) # is STX (ASCII dec. 2) < is CARRIAGE RETURN (ASCII dec. 13) = is LINE FEED (ASCII dec. 10) V is the sign of the numerical value		
All data are entered in the measuring unit set on the Elta. Note the number of decimal places in the input of meters (3) or feet (2). In case of faulty call (wrong format or wrong value) the Elta transmits E < = .			

### 5.3 Control Diagrams for Data Transmission

#### 5.3.1 Normal Mode

```

:LISTEN :END
Elta_ | A < = | _____ | # Data < = | _____ | _____ :
: | _____ | _____ | _____ | _____ | _____ :
Periph. | B < = | _____ | Q < = | _____ | _____ :
| | _____ | _____ | _____ | _____ | _____ :
| | <0,5s | >1s | <2s | 0,2s | _____ :

```

#### 5.3.2 Errors

##### NO PERIPHERAL CONNECTED

```

: END
Elta_ | A < = | _____ | _____ :
Periph. | _____ | _____ | _____ :
| | _____ | _____ | _____ :
| | >0,5s | _____ | _____ :

```

##### READY B ERROR

```

Elta_ | A < = | _____ | R < = | _____ | A < = | _____ | # Data < = | _____
Periph. | B < = | _____ | B < = | _____ | Q < = | _____

```

##### ACKNOWLEDGEMENT Q ERROR

```

Elta_ | A < = | _____ | # Data < = | _____ | R < = | _____ | A < = | _____ | # Data < = | _____
Periph. | B < = | _____ | Q < = | _____ | B < = | _____ | Q < = | _____

```

##### REQUEST A ERROR

```

Elta_ | A < = | _____ | A < = | _____ | # DATA < = | _____
Periph. | R < = | _____ | B < = | _____ | Q < = | _____
| | _____ | _____ | _____ | _____ | _____ :
| | or W < = | _____ | _____ | _____ | _____ :

```

##### DATA ERROR

```

Elta_ | A < = | _____ | # Data < = | _____ | # Data < = | _____
Periph. | B < = | _____ | W < = | _____ | Q < = | _____

```

**Note:** T can be used instead of B or Q to extend the maximum acknowledgment time.

Every T increases the time for B by 0.2 sec. and the time for Q by 2 seconds.

## 5.4 Record formats

### 5.4.1 List and Meanings of Type Identifiers

The type identifiers in the Elta display always comprise one letter. For clear distinction, the data records are in some cases identified by 2 letters and an additional character indicating e.g. the selected measuring unit.

Example: D· $\alpha$  D = Slope distance,  $\alpha$  = 1: meter  
 Hz $\beta$  Hz = Horizontal angle,  $\beta$  = 2: DMS

$\alpha$  = distance measuring unit

$\alpha$  = 1: meter  
 $\alpha$  = 2: feet

$\beta$  = angle measuring unit

$\beta$  = 0: slope in %  
 $\beta$  = 1: grads  
 $\beta$  = 2: DMS  
 $\beta$  = 3: deg. (dezimal)  
 $\beta$  = 4: mils

$\gamma$  = vertical reference system

$\gamma$  = 1: zenith angle  
 $\gamma$  = 2: vertical angle  
 $\gamma$  = 3: elevation angle  
 $\gamma$  = 4: slope in %

### Type identifiers

Elta display    data record    meaning

#### Measured data:

D	D· $\alpha$	slope distance
E	E· $\alpha$	horizontal distance
O	O· $\alpha$	transverse deviation
R	R· $\alpha$	radial deviation
h	h· $\alpha$	difference in elevation
A	Hz $\beta$	horizontal direction (azimuth)
V	V $\gamma$ $\beta$	vertical angle
I	i· $\beta$	index correction
Y	Y· $\beta$	collimation correction

#### Coordinates:

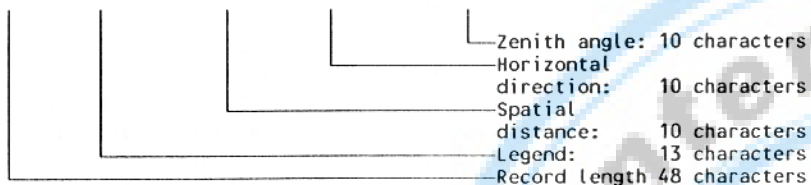
Y	Y· $\alpha$	Y coordinate
X	X· $\alpha$	X coordinate
Z	Z· $\alpha$	Z coordinate
E	E· $\alpha$	easting
N	N· $\alpha$	northing

#### Input data:

I	ih $\alpha$	instrument height
t	th $\alpha$	reflector or target height
A	A· $\alpha$	addition constant
P	P·0	prism constant in mm
C	C·1	temperature in °C
F	F·2	temperature in °F
S	S·0	scale factor
M	M·0	correction in ppm
T	T· $\alpha$	type of eccentricity
E	E· $\alpha$	horizontal eccentricity

### 5.4.2 Record format in mode M1

```
#48(D·α;Hzβ;vγβ)··1234.567;··199.2348;···93.4760;<=
```



Legend contents:

D = spatial distance identifier  
 Hz = horizontal direction identifier  
 v = vertical angle identifier

α = distance measuring unit  
 β = angle measuring unit  
 γ = vertical reference system

Symbols:	#	is	STX	=	ASCII	dec.	2
	<	is	CR	=	ASCII	dec.	13
	=	is	LF	=	ASCII	dec.	10
	·	is	SP	=	ASCII	dec.	32
	(	=	ASCII	dec.	123		
	)	=	ASCII	dec.	125		
	;	=	ASCII	dec.	59		
	.	=	ASCII	dec.	46		
	-	=	ASCII	dec.	45		

### 5.4.3 Examples for data record formats

The data record formats listed here correspond in form and contents to the examples of 4.4.

#### Mode M1

```
#48(D·1;Hz2;V12)···123.456;··164.2832;···89.4636;<=
```

#### Mode M2

```
#33(Hz2;V12)··164.2832;···89.4636;<=
```

#### Mode M3

```
#33(th1;ih1)·····1.800;·····1.600;<=
```

```
#48(E·1;Hz2;h·1)···996.952;···23.4812;···-79.797;<=
```

#### Mode M4

```
#48(E·1;Hz2;V12)···172.438;··168.2432;···90.4236;<=
```

#### Mode M6

```
#48(D·1;Hz2;V12)···996.952;··122.1632;···90.0836;<=
```

#### Mode I1

```
#33(C·1;F·2)·······23;·······73;<=
```

#### Mode I2

```
#33(P·1;Z·1)·······948;·······561;<=
```

**Mode I3**

#33(P•0;A•1)•••••35;•••••0.000; <=

**Mode I4**

#33(S•0;M•0)••0.999990;•••••-10; <=

**Mode A1**

#18(i•2)•••••0.0014; <=

**Mode A2**

#18(c•2)•••••0.0012; <=

**Mode S1**

#48(D•1;E•1;h•1)•••••17.432;•••••17.408;•••••-0.894; <=

**Mode S2**

#48(D•1;E•1;h•1)•••••45.203;•••••45.201;•••••0.433; <=

**Mode S3**

#48(E•1;0•1;h•1)•••••23.714;•••••0.000;•••••1.800; <=

#48(E•1;0•1;h•1)•••••24.261;•••••5.123;•••••3.807; <=

**Mode S4**

#18(th1)•••••1.800; <=

#48(E•1;0•1;h•1)•••••28.217;•••••11.440;•••••0.000; <=

#48(E•1;0•1;h•1)•••••58.217;•••••8.367;•••••0.432; <=

**Mode S5**

#18(th1)•••••1.800; <=

#48(E•1;Hz2;h•1)•••••49.998;•••••78.0000;•••••3.634; <=

**Mode C1**

#48(Y•1;X•1;Z•1)••1000.000;••2000.000;••500.000; <=

**Mode C3**

#48(Y•1;X•1;Z•1)••2000.000;••2000.000;•••••0.000; <=

#33(Hz2;V12)•••••90.0000;•••••89.4212; <=

**Mode C4**

#33(th1;ih1)•••••1.800;•••••1.500; <=

#48(Y•1;X•1;Z•1)••1998.039;••1958.960;••452.622; <=

**Mode C5**

#33(E•1;T•1)•••••2.500;••••••••••1;<=
#48(Y•1;X•1;Z•1)••2000.537;••1958.858;•••••0.000;<=

**Mode C6**

#33(th1; ih1)•••••1.800;•••••1.500;<=
#48(Y•1;X•1;Z•1)••1000.000;••2200.000;•••510.000;<=
#48(Y•1;X•1;Z•1)••1300.000;••2000.000;•••••0.000;<=
#48(D•1;Hz2;V12)•••200.281;•••39.2429;•••87.0307;<=
#48(D•1;Hz2;V12)•••300.025;••129.2431;•••90.1128;<=
#48(Y•1;X•1;Z•1)••1000.000;••2000.000;•••500.000;<=
#48(S•0;Hz2;V12)•••0.999922;•••90.0000;•••90.1128;<=

**Mode C7**

#48(Y•1;X•1;Z•1)••1000.000;••2200.000;•••••0.000;<=
#48(E•1;R•1;O•1)•••••0.004;•••••0.005;•••••0.003;<=

**6 Care and Maintenance**  
**6.1 Charging the Battery**

For the power supply of the Elta, a NiCd battery (708151) is used, which can be recharged with the LG 9 battery charger (708150).

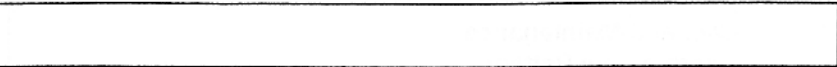


The battery charger must only be used for charging the type of battery specified above. It must be protected from humidity. The battery charger can be set to 110 V and 220 V mains voltage. Before starting operation, check the voltage setting on the selector switch at the bottom of the device.

After connection of the battery charger to the mains, the green power indicator lamp is lit. Place the battery into the charger cradle and lock it with the screw. Now the yellow lamp is also lit, indicating that a trickle charge is flowing, which will charge an empty battery within 60 hours. For normal charging, the start button is pressed, the yellow indicator lamp goes out and the red indicator lamp is lit. The charging takes 12 hours the charger then switches automatically to trickle charge (yellow indicator lamp).

If the start key for normal charging should be pressed inadvertently while a charged battery is inserted, the charging process can be stopped to protect the battery against excess charge. For this, the battery cassette is removed from the charger and the mains plug is pulled for about 30 seconds. When operation is restarted, the trickle charge continues to flow (yellow indicator lamp). After power failure in the mains, the battery charger automatically resumes charging, with the 12 hour charging period remaining unaffected by the interruption.





**Hints on proper handling of rechargeable batteries:**

- To ensure full capacity, a new battery should be charged 2 or 3 times in the 12-hour process before the first use.
- Do not charge batteries by the 12-hour process in everyday use unless the power indicator in the Elta shows inadequate battery charge (usually after 6 to 10 hours operating time).
- Virtually fully charged batteries should only be buffered with trickle charge (60 hours).
- Do not over-discharge batteries by short-circuiting of contacts.

**6.2 Eliminating the Collimation Error**

A collimation error exists if the telescope line of sight is not perpendicular to the telescope tilting axis. This error affects angle measurements made in one telescope position only.

This error is normally measured in mode A2 and corrected automatically if it does not exceed  $\pm 2'40''$ . If it is greater than  $\pm 2'40''$ , set the collimation correction to 0 in mode A2 by pressing ENTER and adjust the telescope cross-hairs manually.

To do this, remove ring cap (4), sight a well-defined target in both telescope positions with the line of sight approximately horizontal, and measure the directions in mode M2. Average the two readings and set the average with the horizontal fine motion (7). Now move the cross-hairs with the adjustment screws until they cover the target.

Before tightening an adjustment screw, loosen the opposite adjustment screw.  
Both adjustment screws must be tight after adjustment.

**6.3 Adjusting the Alidade Level**

Set the instrument up in an absolutely stable way, i.e. clamp it in the tribrach with clamp (15) and fasten the tribrach on a solid tripod with screw (8).

Turn the instrument so that the alidade level (23) is parallel to the line connecting two levelling screws and center the level in this position 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, and center the bubble as precisely as possible with this levelling screw.

Turn the instrument in the opposite direction and eliminate one half of the bubble error with the third levelling screw and the other half with the level adjustment screw.

Please note the following:

- Do not warm up the level unilaterally.
- Loosen the opposite adjustment screw before tightening an adjustment screw.
- Both adjustment screws must be tight after adjustment.
- The bubble should center precisely in any instrument direction after adjustment.

Adjust the alidade level very carefully and check its adjustment regularly.

In the Elta 3, the alidade level can also be directly adjusted after compensator adjustment and precise levelling in mode A6 using the compensator display.

**7 Information on the Elta**  
**7.1 Error Messages**

The following error indications can appear in the display:

**BATT** Low battery.  
 Replace or recharge the battery.

- Error 01** ROM defective
- Error 02** RAM defective
- Error 03** NV-RAM defective
- Error 40** Distance meter error.
- Error 41** Distance meter error.
- Error 42** Distance meter error.
- Error 43** Distance meter error.
- Error 50** Distance meter error.
- Error 51** Distance meter error.
- Error 52** Distance meter error.
- Error 55** Distance meter error.
- Error 60** Vertical angle measurement error
- Error 80** Compensator error
- Error 81** Data transfer error
- Error 82** Data transfer error

Errors with numbers higher than 40 can usually be eliminated by pressing ENTER. If the error display appears permanently, servicing is required.

**Note:** If the instrument does not respond to key depressions any more, you can turn it off by removing the battery cassette.

**7.2 Prism and Addition Constants**

All Zeiss rangefinders are matched to Zeiss reflectors so that the addition constant is 0.

If non-Zeiss reflectors are used, the addition constant can be determined by measurement, if required, and entered in the Elta.

It is also possible to enter the known prism constant of the reflector in the Elta. The prism constant is a function of the geometric size of the prism, the glass type and the location of the mechanical reference point.

The prism constant for Zeiss reflectors is 35 mm.

The relationship between the addition constant  $Acz$  for Zeiss instruments, the prism constant  $Pcz$  for Zeiss reflectors and the prism constant  $Pf$  for non-Zeiss reflectors is as follows:

$$Acz = Pcz - Pf$$

**Example:**

Zeiss reflector	prism constant	$Pcz = 35 \text{ mm}$
Non-Zeiss reflector	prism constant	$Pf = 30 \text{ mm}$
Addition constant for Zeiss instruments used with this reflector		$Acz = +5 \text{ mm}$

In this case either the prism constant 35 mm or the addition constant +0.005 m can be entered in the Elta (see section 4.4.2.3).

### 7.3 Formulae

#### 7.3.1 Basic Distance Measurement Formula

All distances between the Elta and the prisms are computed from the following basic components:

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

with:

$D_k$  = corrected distance  
 $D_0$  = uncorrected distance  
 $D_i$  = internal corrections  
 $A$  = addition constant (Mode I3)  
 $M_i$  = influence of meteorological data

The influence of meteorological data  $M_i$  is computed according to:

$$M_i = (1 + (n_0 - n) * 10^{-6}) * (1 + (a * T * T + b * T + c) * 10^{-6})$$

with:

$n = (79.146 * P) / (272.479 + T)$  = refractive index  
 $n_0 = 255$  = standard refractive index

$P$  = air pressure in hPa or mbar  
 $T$  = temperature in degrees Celsius

$a = 0.004$  correction coefficients  
 $b = 0.066$  for vapour pressure  
 $c = -4.486$  and frequency drift

Carrier wavelength 0.86  $\mu\text{m}$   
 Modulation wavelength 20 m  
 Precision measuring scale 10 m

#### 7.3.2 Distance Computation and Reduction in Elta

The slope distance displayed on the Elta is the distance between the Elta trunnion axis and the prism. It is computed as follows from the measured slope distance and the input scale:

$$D = D_k * M$$

with :

$D$  = displayed slope distance  
 $D_k$  = basic distance according to 7.3.1  
 $M$  = scale ( mode I4 )

The difference in elevation and the horizontal distance are computed as follows:

$$dh = dh_1 + dh_2$$

with:

$dh_1 = D_k * \cos(Z)$   
 $dh_2 = (D_k * \sin(Z)) * (D_k * \sin(Z)) * 6.8 * 10^{-8}$   
 $dh_2$  = influence of earth curvature and refraction ( $k = 0.13$ )

and:

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

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

with:

$D_k$  = corrected slope distance  
 $Z$  = measured zenith angle [grad]  
 $M$  = scale  
 $dh$  = computed difference in elevation  
 $E$  = computed horizontal distance

Computation of scale for reduction to MSL:

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

$R$  = earth radius ( 6370 Km )  
 $h$  = elevation above MSL (Km)

$$S_2 = S_1 * m$$

$S_1$  = measured distance in elevation h  
 $S_2$  = distance reduced to MSL

This computation formula also applies to other earth radii.

### 7.3.3 Testing the Elta with Calibrated Distances

All distances measured are corrected in the Elta by:

- the entered scale ( Mode I4 )
- the entered addition constant ( Mode I3 )
- the entered pressure and temperature ( Modes I2, I1 )
- internal influences

As some of these corrections are interdependent, it is not possible to separate their influences.

Before the actual calibration measurement, therefore, the parameters scale, addition constant, air pressure and temperature must be entered into the Elta with their current values.

This ensures the complete and accurate performance of all corrections in the Elta, and it also enables a direct nominal/actual comparison in the case of given distances.

Should further questions arise, please contact Carl Zeiss, Dept. V-GST.

### 7.3.4 Correction and Computation Formulae for Angle Measurement

#### V-Angle Measurement

$$V_k = V_0 + i + SZ_a$$

Where:

- $V_0$  = uncorrected V circle reading
- $i$  = index correction
- $SZ_a$  = current vertical axis inclination in sighting axis direction

#### Hz-Angle Measurement

$$Hz_k = Hz_0 + Hz_1 + Hz_2 + A$$

where:

- $Hz_0$  = uncorrected Hz circle reading
- $Hz_1$  =  $c/\sin(V_k)$   
(collimation correction)
- $Hz_2$  =  $SQ_a/\tan(V_k)$   
(correction for vertical axis inclination in trunnion axis direction)
- $A$  = circle orientation due to  
**SET A (M5 and C2), ORIENT COORD. (C3) and STATION. WITH 2 POINTS (C6)**

**8 Technical Descriptions**  
**8.1 Technical Data Elta 3**

**Precision**

**Angle measurement**

Standard deviation Hz 2" / 0.5 milligrad  
 as per DIN 18723 V 2" / 0.5 milligrad

**Distance measurement**

Standard deviation 3 mm + 3 ppm

**Telescope**

Aperture 45 mm  
 Length 170 mm  
 Field of view at 100 m 2.4 m  
 Shortest focussing distance 1.2 m  
 Magnification 30 x

**Angle measurement**

Hz and V circles electronic, incremental zero-point encoder for horizontal and vertical circle

**Measuring units**

360° D.M.S  
 400 grads  
 6400 mils

**Vertical reference system**

zenith angle  
 elevation angle  
 vertical angle  
 slope %

**Least unit**

1", 0.2 milligrad, 0.01 mil

**Compensator**

Type two-axis liquid compensator  
 Range ± 2'40" or 48.0 mgrad  
 Setting accuracy 1" or 0.3 mgrad

**Distance measurement**

Method electro-optically with modulated infrared light  
 Transmitter/receiver optics coaxial, in theodolite telescope

**Range**

with 1 prism 1.6 km  
 with 2 prisms 2.0 km  
 with 7 prisms 2.5 km  
 Maximum range 5.0 km

**Display**

Illumination quadruple LCD in both telescope positions  
 LED, software-controlled

**Data recording**

RS 232 / V24 interface

**Connectable recorders**

Rec 200\* with MEM 800  
 Rec 500

**Storage capacity**

Rec 200\* with MEM 800: 800 numeric records  
 Rec 500: 2000 alphanumeric records

**Digital inputs for:**

temperature  
 air pressure  
 scale  
 prism or  
 addition constant

**Power supply**

Continuous operation NiCd batteries, 4.8V, 1.8Ah approx. 10 hrs.

**Levelling**

Circular level 10' / 2mm on tribrach  
 Tubular level 30" / 2mm

**Clamps and slow motions**

coaxial, parallel

**Centering**

- Zeiss centering system  
 - Wild centering system

**Temperature range**

- 20 °C to + 50 °C

**Dimensions (WxHxD)**

Height of trunnion axis 232 x 270 x 127 mm  
 158 mm (Zeiss system)  
 196 mm (Wild system)

**Weights**

Instrument incl. btrr. 4.7 kg  
 Case 2,5 kg

## 8.2 Technical data Elta 4

### Precision

#### Angle measurement

Standard deviation Hz 3" / 1 milligrad  
as per DIN 18723  
V 3" / 1 milligrad

#### Distance measurement

Standard deviation 3 mm + 3 ppm

### Telescope

Aperture 45 mm  
Length 170 mm  
Field of view at 100 m 2.4 m  
Shortest focussing distance 1.2 m  
Magnification 30 x

### Angle measurement

Hz and V circles

electronic, incremental  
zero-point encoder for  
vertical circle

Measuring units

360° D.M.S  
400 grads  
6400 mils

Vertical reference system

zenith angle  
elevation angle  
vertical angle  
slope %

Least unit

2", 0.5 milligrad, 0.01 mil

### Compensator

Type  
Range  
Setting accuracy

one-axis compensator  
±2'40" or 48.0 mgrad  
2" or 0.6 mgrad

### Distance measurement

Method

electro-optically with  
modulated infrared light  
coaxial,  
in theodolite telescope

Transmitter/receiver optics

### Range

with 1 prism 1.2 km  
with 2 prisms 1.6 km  
with 7 prisms 2.2 km  
Maximum range 4.0 km

### Display

Illumination

quadruple LCD in both  
telescope positions  
LED, software-controlled

### Data recording

RS 232 / V24 interface

### Connectable recorders

Rec 200\* with MEM 800  
Rec 500

### Storage capacity

Rec 200\* with MEM 800: 800 numeric records  
Rec 500: 2000 alphanumeric records

### Digital inputs for:

temperature  
air pressure  
scale  
prism or  
addition constant

### Power supply

continuous operation  
NiCd batteries, 4.8V, 1.8Ah  
approx. 10 hrs.

### Levelling

Circular level 10' / 2mm on tribrach  
Tubular level 30" / 2mm

### Clamps and slow motions

coaxial, parallel

### Centering

- Zeiss centering system  
- Wild centering system

### Temperature range

- 20 °C to + 50 °C

### Dimensions (WxHxD)

Height of trunnion axis  
232 x 270 x 127 mm  
158 mm (Zeiss system)  
196 mm (Wild system)

### Weights

Instrument incl. btrr. 4.7 kg  
Case 2,5 kg

### 8.3 Accessories - Description, Maintenance

In the whole system, the trunnion axis is at a uniform height above the tribrach surface:

158 mm with DIN center spigot

196 mm with Wild centering system

The trunnion axis of the KTR or the target is 100 above the mounting surface.

#### 8.3.1 Tripod

The S 24 Tripod (70 72 22) is supplied with the instrument.

Please make sure that the wooden parts are tight. The upper leg joints and the tips have adjustable screws.

The leg joint friction can also be adjusted by means of the 6 hex. socket screws located below the joints. Adjust the friction so that, when lifting the tripod by its head, the legs fold slowly.

#### 8.3.2 ED or EW Tribrach

The ED or EW Tribrach is supplied with the instrument. They differ in the forced-centering system: DIN spigot center or Wild centering system.

The levelling screws are self-adjusting, i.e. adjustment is not required. The circular level can be adjusted with two capstan screws (see section 8.2.6).

#### 8.3.3 Reflectors

Modular reflector components are used for distance measurement (refer to the illustrations in section 8).

#### 8.3.4 Prism Rod

The prism rod required for setting up tiltable reflectors features a thread adapter. The 5/8" adapter at the top of the graduated telescopic rod can be removed, reversed and screwed on again. A M8 thread is then available at the top for attaching a (non-tiltable) single reflector.

The graduation shows the height of the prism above the rod point in both cases.

The extension rod can be inserted between the telescopic rod and the adapter. It increases the height indicated by the graduation by 1 m.

Since the prism rod point can be removed, an extension rod can also be attached at the lower end of the prism rod.

### 8.3.5 Optical Plummets

Optical plummets are built into the vertical axis of the instrument or attached to the tribrach (type EWL), or are available as insertion plummets for stations with vertical viewing (type V or VW), for horizontal viewing (type NZ or NW) or for stations and roof surveying points (type NZ or NZW). Their eyepieces can be focussed onto the reticle and target.

### 8.3.6 Adjusting the Optical Plummets

The line of sight of optical plummets is the optical extension of the trunnion axis.

The optical plummet in the instrument and those for insertion in the tribrach are subject to the same adjustment conditions and are identical in adjustment and adjustment checking.

Check the levels first (see section 8.3.7).

Then move the reticle in the plummet telescope with its adjustment screws until the target remains centered when the plummet is turned through  $180^\circ$  in the trunnion axis.

If the optical plummet is mounted on the tribrach, the nominal line of sight can be determined with a plumb bob. It is also possible to turn the whole tribrach on the tripod head by two times  $120^\circ$  depending on the shape of its baseplate. Mark the original position on the tripod head to ensure that the tribrach center can be returned to the original position after turning it. Level again after turning.

### 8.3.7 Adjusting the Levels

Levels serve to adjust instruments or accessories relative to the center of gravity, e. g.

- vertical axis in the vertical,
- optical plummets in the vertical,
- forced centering systems in the horizontal,
- telescope line of sight in the horizontal,
- prism rods in the vertical.

Adjustment checking and adjustment are easy with levels located over a trunnion axis on a tribrach, e. g. alidade and circular levels of instruments or insertion plummets. After precisely centering the bubble and turning through  $180^\circ$ , the bubble error is twice the adjustment error, i. e. half of the bubble error should be removed with the level adjustment screws and the other half with the tribrach levelling screws.

The circular level on the centering rod can also be reversed and checked and adjusted as described above, but instead of eliminating the inclination with the tribrach levelling screws the rod should be placed in a vertical position by shifting the tribrach on the tripod head.

The non-reversible level on the tribrach can be adjusted by means of an instrument with vertical axis installed in the forced-centering system.

Center the instrument level and eliminate any bubble error of the tribrach level with the adjustment screws of the latter.

The circular level of the prism-holder rod can be checked and adjusted after the rod has been placed in a vertical position by other means, e. g. rod in tripod or aligned vertically with a plumb bob or with a theodolite by means of the telescope.

If a three-leg prism-holder rod tripod is available, the level can be adjusted by reversing the rod in the tripod (see above).

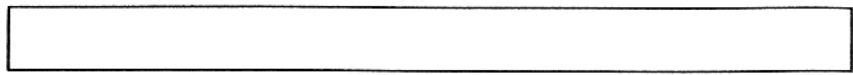
Telescope levels can be adjusted by vertical circle reading after the vertical index error has been determined. If the vertical circle readings add up to precisely 360 degrees when the same target is sighted direct and reversed, the telescope line of sight is horizontal at a vertical circle reading of  $90^\circ$  and the telescope level should be centered. If not, adjust it with its adjustment screws.



**9. Accessories Ordering Data**

Catalog number		Approx. Weight in kg
708151	Battery pack	0.4
708150	LG 9 battery charger 90-120 V, 185-264 V, 50/60 Hz, for 708151	1.1
704206	Thommen barometer 0-5000 m /mbar	0.3
704213	Thommen barometer 0-15000 ft / inch Hg	0.3
707222	S 24 tripod	6.0
709551		
- 9901	Protective cover and carrying strap for S 24	1.0
707286	Prism holder rod with graduation	1.5
707287	Extension (1 m) for prism holder rod	0.6
707288	Prism holder tripod	3.8
707125	Tribrach ED for Zeiss forced centering system	1.0
706137	Optical plummet V for nadir points, vertical eyepiece, for insertion into tribrach ED	0.2
706138	Optical plummet N for nadir points, horizontal eyepiece, for insertion into tribrach ED	0.3
706139	Optical plummet NZ for nadir and overhead points, horizontal eyepiece, for insertion into tribrach ED	0.4
707126	Tribrach EW for Wild forced centering system	0.9
706141	Optical plummet VW for nadir points, vertical eyepiece, for insertion into tribrach EW	0.4
706142	Optical plummet NW for nadir points, horizontal eyepiece, for insertion into tribrach EW	0.5
706143	Optical plummet NZW for nadir and overhead points, horizontal eyepiece, for insertion into tribrach EW	0.6
707127	Tribrach EWL with attached optical plummet	1.0
706705	Sighting target E	0.3
706814	Sighting target E with adapter for use with Zeiss forced centering system	0.5
706815	Sighting target E with adapter for use with Wild forced centering system	0.7

Catalog number		Approx. Weight in kg
706765	KTR 1 N reflector, tiltable (incl. 1 prism) for attachment to prism holder rod 707286, extension 707287, adapter 706767 or Wild adapter 704538	0.6
706706	Sighting target for attachment to KTR 1	0.4
706767	Adapter for insertion of a KTR 1 into tribrachs with Zeiss forced centering system	0.2
704538	Adapter for insertion of a KTR 1 into tribrachs with Wild forced centering system	0.4
706761	ETR 1 T reflector, rigid (incl. 1 prism) for attachment to prism holder rod 707286 or extension 707287	0.3
706762	ETR 1 N reflector, rigid (incl. 1 prism) for attachment to prism holder rod 707286 or extension 707287	0.3
706763	ETR 1 S reflector, rigid (incl. 1 prism) for attachment to prism holder rod 707286 or extension 707287	0.3
706771	Building accessory for ETR 1 comprising: rod for building surveys, sighting collimator	0.5
706824	Building reflector complete, comprising: ETR 1 T, rod for building surveys and sighting collimator	0.8
706769	T 3 cross beam for extending a KTR 1 into a triple reflector	0.2
706770	TR 7 cross beam for extending a KTR 1 into a reflector with 7 prisms	0.4
706816	TR 19 cross beam for extending a KTR 1 into a reflector with 19 prisms	0.6
709617	Storage case for: two tribrachs ED or EW two adapters for DIN or Wild forced centering system three KTR 1 reflectors, four ETR reflectors two cross beams T 3, one cross beam T 7	2.5



Catalog number	Approx. Weight in kg
708214	3.0
708118	0.1
708111	0.2
708112	1.0
708158	0.2
708218	3.5
708217	3.5
707291	0.3
708424	0.9
708020	0.1
708021	0.1
708022	0.1

