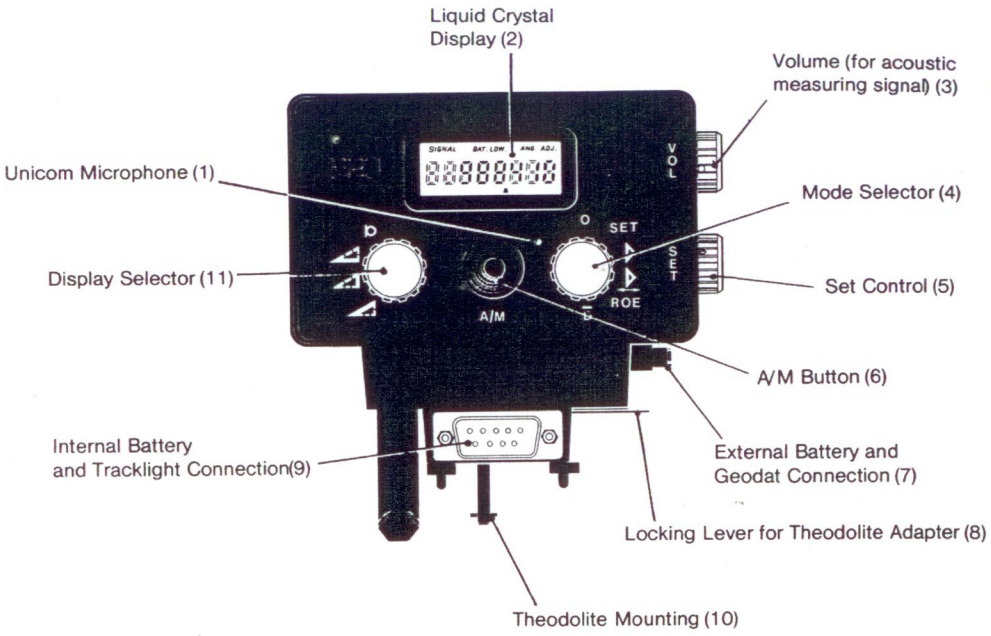
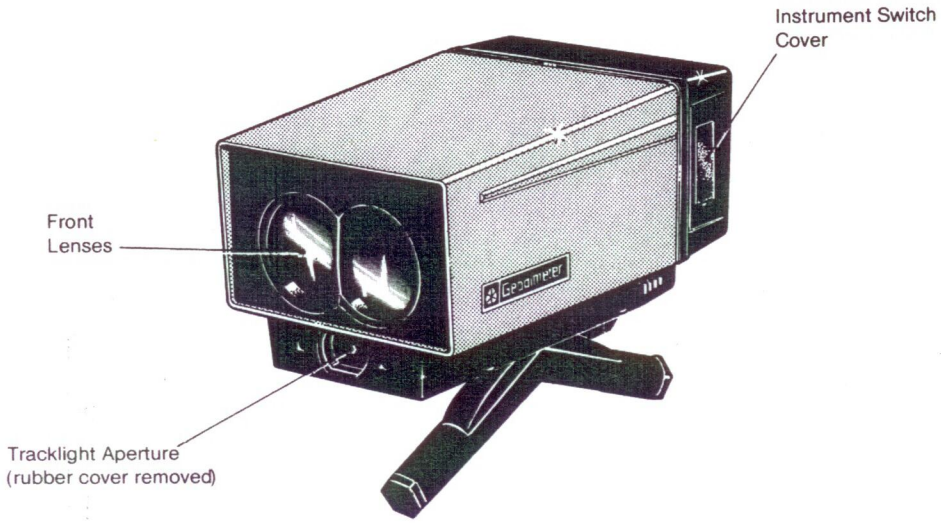


FRONT VIEW

Fig. 1.2 Instrument General Detail



REAR VIEW

Fig. 1.3 Instrument General Detail

Basic Description

Fig. 1.4 shows a simplified block diagram of the functions of the instrument. The following description gives the operator an insight into the capabilities of the instrument.

Geodimeter 220 forms a part of a measurement system. The instrument is fitted with a two way data communication which can be connected to the optional recording instrument – Geodat if required.

The instrument operates in the infrared range of the electromagnetic spectrum and transmits an infrared beam which is optically aligned to a target. The target comprises a reflecting prism or prisms depending on range (see Specification). The returned signal is received by the instrument and is applied to a phase comparator. The output is decoded and presented onto an easy to read LCD display. The result can be entered into an automatic recording data memory, Geodat, for processing either by desk top calculator or computer at a convenient time.

Geodimeter 220 has a built-in vertical angle sensor (automatic reduction sensor) for the calculation of horizontal and vertical distances. For more precise measurements the angle value can be adjusted to the Theodolite value to obtain very high accuracy. This is mainly used when defining the vertical height, in trigonometric levelling and other precise surveying measurements.

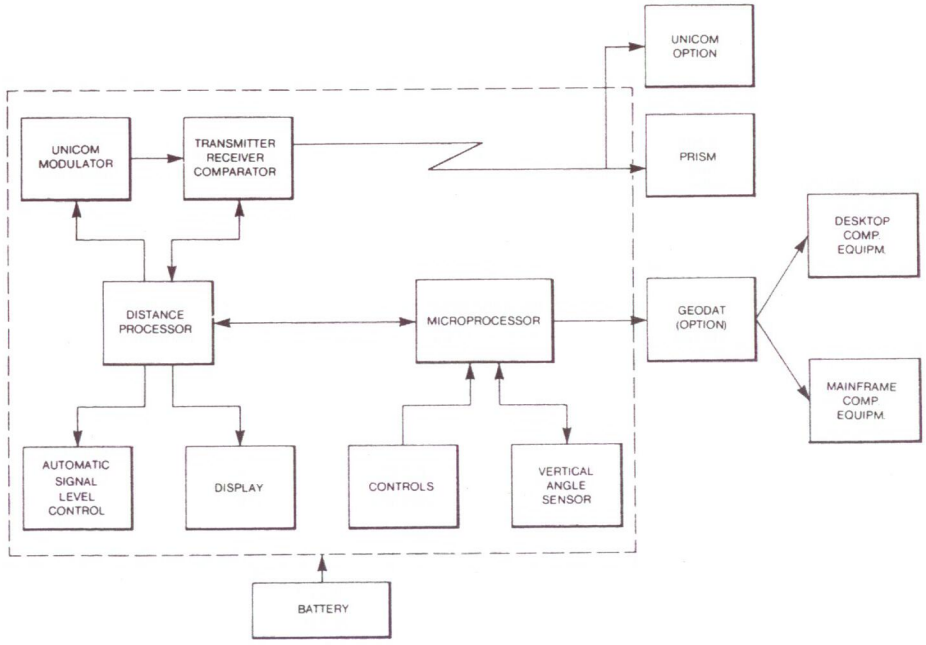


Fig. 1.4 Geodimeter 220 – Simplified Block Diagram

TECHNICAL SPECIFICATION FOR GEODIMETER 220

DISTANCE MEASUREMENT

Range at standard clear using Geodimeter prisms	1 prism – 2300 (1.4 miles) 3 prisms – 4000 (2.5 miles) 8 prisms – 5500 (3.4 miles)
Shortest measuring distance	0.2m (0.7ft)
Read-out	Liquid Crystal Display (LCD) Separate switches – 400gon or 360° metres (m) or feet (ft) face left or face right (see Operating Manual Page 1.2)
Distance accuracy	Standard measurement ▷ ±(5mm +5ppm) ±(0.02ft +5ppm) M.S.E. Arithmetic mean value: D ±(5mm +3ppm) ±(0.02ft +3ppm) M.S.E. Fast tracking up to 4m/s (13ft/s) ▷ ±(10 - 20mm +5ppm) ±(0.03 - 0.07ft +5ppm) M.S.E **Note:** To obtain the highest accuracy when tracking a period of 90 seconds should elapse between switch-on and measurement.
Distance reading	▷ Standard measurement 1mm (0.005ft) ▷ Fast tracking 10mm (0.01ft) D Arithmetic mean value: 1mm (0.005ft)
Measuring time	Short range: 5s Long range: 7s Fast tracking: 0.4s
Light source	Infrared GaAs diode
Beam divergence	2.5mrad (0.25m/100m) (2.5ft/1000ft)
Atmospheric correction	–60 to +195ppm continuously
Offset	±0.999m
UNICOM (option)	100% modulation in ▷-position Range 1600m (1 mile) 30% modulation in other positions

ANGLE MEASUREMENT

Automatic reduction sensor	Adjustable to theodolite within 2.5cc (0.25mgon/1") Angle adjust resolution 5cc (0.5mgon/2")
Angle accuracy	6mgon M.S.E. within ±20gon (±20" within ±18°) 15mgon M.S.E. within ±30gon (±50" within ±27°) ±50mgon M.S.E. within ±50gon (±2.7' within ±45°)
Angle reading	5cc/0.5mgon (2") within ±7.5gon (6.7°) 20cc/2mgon (6" - 8") within ±30gon (27°) 40cc/4mgon (12" - 14") within ±50gon (45°)

GENERAL

Elevation	±50gon (±45°)
Data output	Two way data communication, direct connection to Geodat. Interfaces are available for connection to HP-IL and RS232/V24
Operating temperature range	–20°C to +50°C (–5°F to +122°F)
Storage temperature	–40°C to +70°C (–40°F to +158°F)
Power consumption	3 - 4W
Battery	Rechargeable NiCd battery internal 12V, 0.45Ah for 1.5h continuous operation External batteries 12V, 2Ah for 6h or 12V, 6Ah for 18h operating time
Dimensions	175 × 90 × 110mm excluding mounting adapter (6.9 × 3.5 × 4.3 inch)

STANDARD EQUIPMENT

Part No.	Description	Weight (kg)	Weight (lbs)
571 136 250	Geodimeter 220 The equipment comprises:		
571 136 252	Instrument unit	1.3	2.9
571 135 351	Front cover	0.05	0.1
571 136 420	Transport case with carrying straps	3.2	7.1
571 136 226	Internal batteries (2 pcs) × (0.25)	0.5	1.1
571 132 010	External battery 2Ah	1.0	2.2
571 136 264	Battery cable	0.05	0.1
571 125 016	Atmospheric Correction Disc	0.05	0.1
571 136 266	Tool kit	0.1	0.2
571 136 621	Operating Manual	0.05	0.1
571 136 631	Technical Manual	0.05	0.1
		6.35	14.0

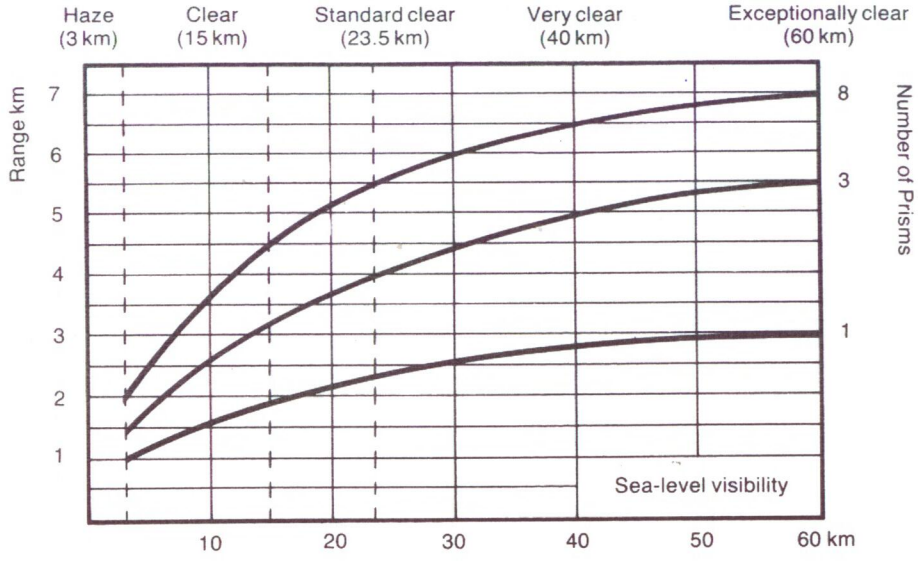


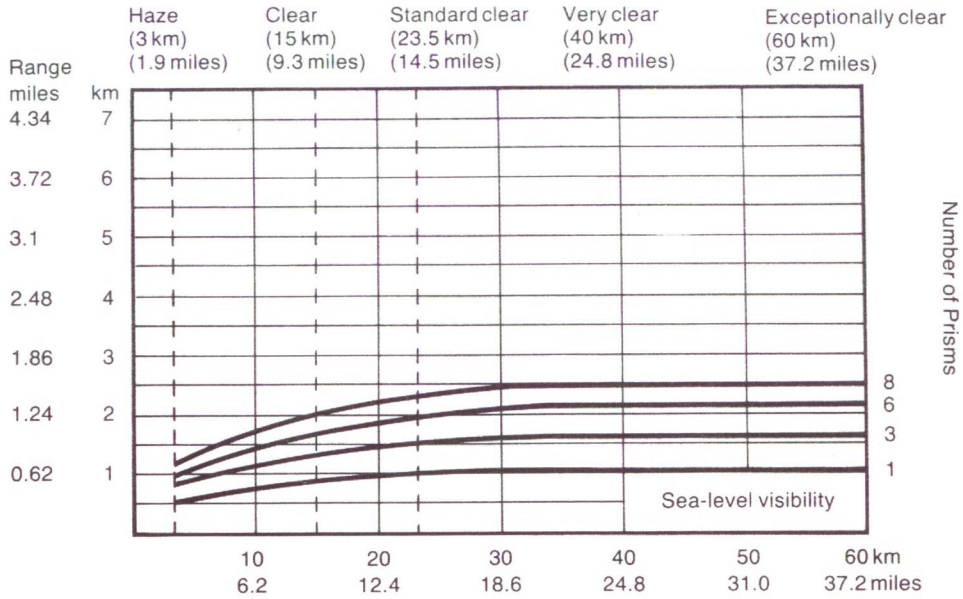
Fig. 1.5 Geodimeter 220 Visibility Specification Graph

Maximum range with Geodimeter prism (Part No. 571 125 021)
The range is also dependent on atmospheric conditions and background radiation.

TECHNICAL SPECIFICATION FOR GEODIMETER 216

DISTANCE MEASUREMENT

Range Standard Clear	1 prism – 1000m (0.6 miles) 3 prisms – 1600m (1.0 miles) 8 prisms – 2200m (1.4 miles)
Using Geodimeter Prisms 571 125 021	
Shortest possible range	0.2m (0.7ft)
Read-out	Liquid Crystal Display (LCD) Separate switches 400 gon or 360 degrees metres (m) or feet (ft)
Distance accuracy	Standard measurement: ▷ ± (5mm + 3ppm) ± (0.02ft + 5ppm) M.S.E. Fast tracking: ▷ ± (10.20mm + 5ppm) ± (0.03-0.07ft + 5ppm) M.S.E. **Note:** To obtain the highest accuracy, a period of 90 seconds should elapse between switch on and measurement



Maximum range with Geodimeter prism (Part No. 571 125 021)
The range is also dependent on atmospheric conditions and background radiation.

Fig. 1.6 Geodimeter 216 Visibility Specification Graph

Distance reading	▷ Standard measurement: 1mm (0.005ft) ▷ Fast tracking: 10mm (0.01ft)
Measuring time	Short range: 5s Long range: 7s Fast tracking: 0.4s
Light source:	Infrared GaAs diode
Beam divergance	2.5mrad (25cm/100m) (2.5ft/1000ft)
Atmospheric correction	−60 to 195ppm continuously over the entire measuring range of the instrument
Off set	± 999mm (3.3ft)
UNICOM:	100% modulation in ⌾ position. Range 1000m (0.6 miles) 30% modulation in other positions

ANGLE MEASUREMENT

Automatic reduction sensor	Angle adjust resolution 20cc (2mgon/6") Adjustable to theodolite within 10cc (1mgon/3")

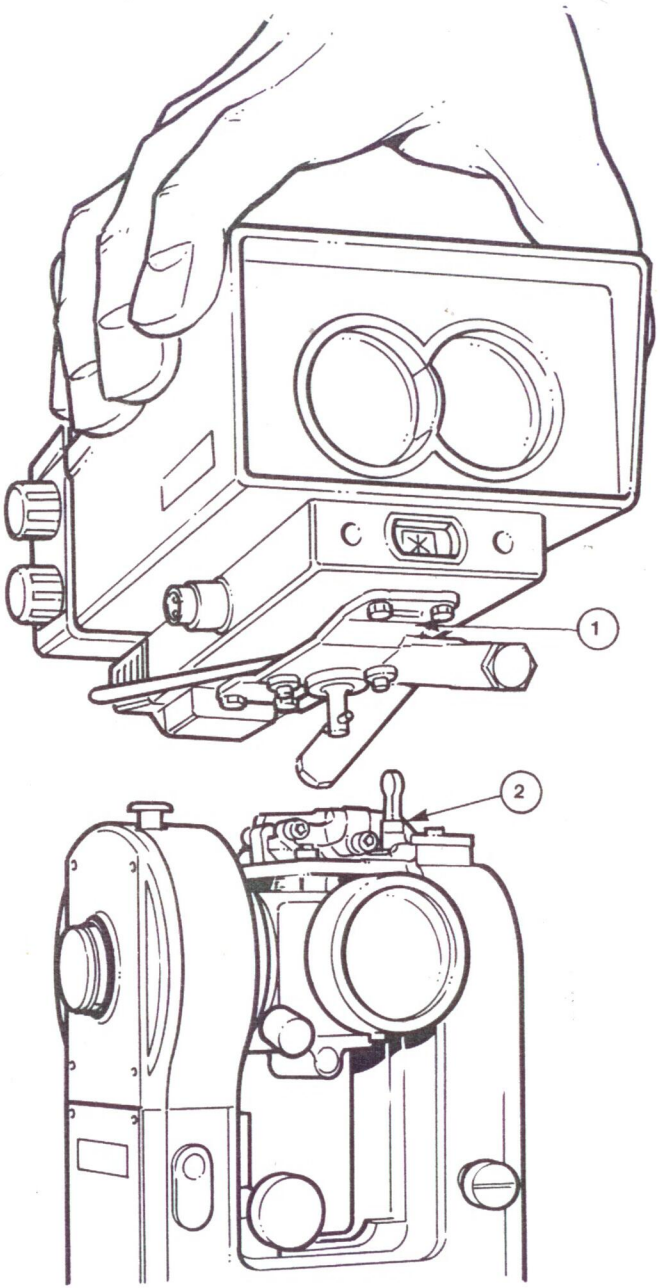


Fig. 2.1 Geodimeter 220 – General Mounting Detail

DESCRIPTION

Stable and easily adjusted adapters for assembling most common types of theodolites are available. Table 1 lists the most commonly used adapters.

The adapter consists of two main components: the instrument adapter (1) and the theodolite adapter (2). Fig. 2.1 details the general mounting detail.

Instrument Adapter

The instrument adapter, mounted beneath the instrument, is included in the standard equipment. The instrument adapter comprises a plate with locking function and a spring in a housing used to balance the instrument. Depending on the type of theodolite, the instrument can be positioned with the spring housing either to the right or to the left of the theodolite telescope. By loosening the four screws the adapter can be rotated 200g (180°). Both instrument balance springs can easily be changed by unscrewing the end plugs with a socket wrench (Fig. 2.2).

Theodolite Adapter

Mounting instructions accompany each theodolite adapter. The adapter comprises components, which vary in design depending on the theodolite with which they are to be used, and an adjustment plate which is the same for all adapters. The adjustment plate has two locking screws (marked with a dot) and two adjusting screws. Fig. 2.3 details the theodolite adapter.

In order to avoid parallax error, the adjustment plate should be kept free of dirt and grease.

IMPORTANT. Parallel alignment and adjustments should be checked regularly in order to obtain accurate measurements.

Table 1. Theodolite Adapter List

Theodolite	Part No.
Wild T1 and T16 (new)	571 125 042
Wild T2 (new)	571 125 044
Wild T1A and T16 (old)	571 125 046
Wild T2 (old)	571 125 048
Sokkisha T60d and TM-20 C	571 125 056
Sokkisha TM-1A	571 125 058
Zeiss Jena 010A/B, 015B and 020A/B	571 125 060
Kern DKM2A and DKM2AE	571 125 062
Kern K1-SE, K1M	571 125 064
Zeiss Th2	571 125 066
Zeiss Th42	571 125 078
Topcon TL-10F/TL-20E	571 125 142
Nikon NT-2A/NT-3A	571 125 162

Each adapter kit is delivered with complete mounting instructions. Alignment and adjustment details for the adapters are contained later in this Section.

Assembly can be carried out by an authorised Geodimeter servicing agent or by the user.

Parallel Alignment

a) Connect the battery cable or insert the internal battery.

b) Lock Geodimeter 220 onto the theodolite adapter.

c) Level the theodolite carefully.

d) Set up a reflector with target approximately 100 - 150 metres from the instrument.

e) Turn the MODE selector (4) to ▶ (standard measurement).

f) Turn the DISPLAY selector (11) to ◢ (slope distance).

g) Loosen the adjustment plate lock screws.

h) Aim the Geodimeter instrument at the reflector using the alignment sight (located beneath the instrument).

Fine alignment is carried out by adjusting the theodolite's vertical and

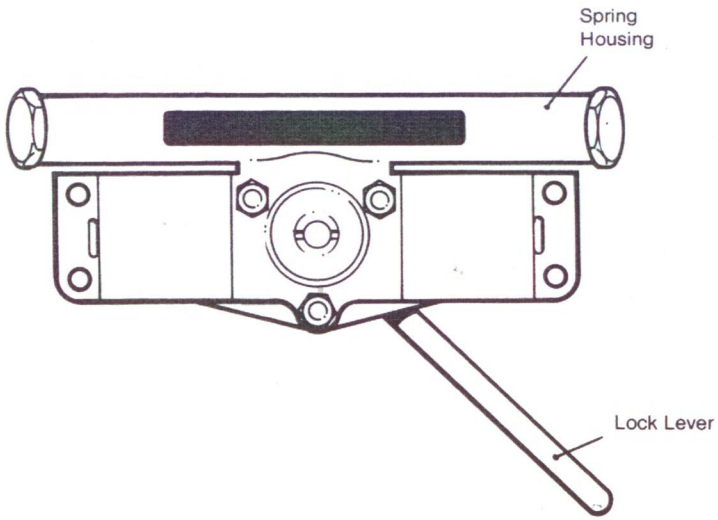


Fig. 2.2 Instrument Adapter

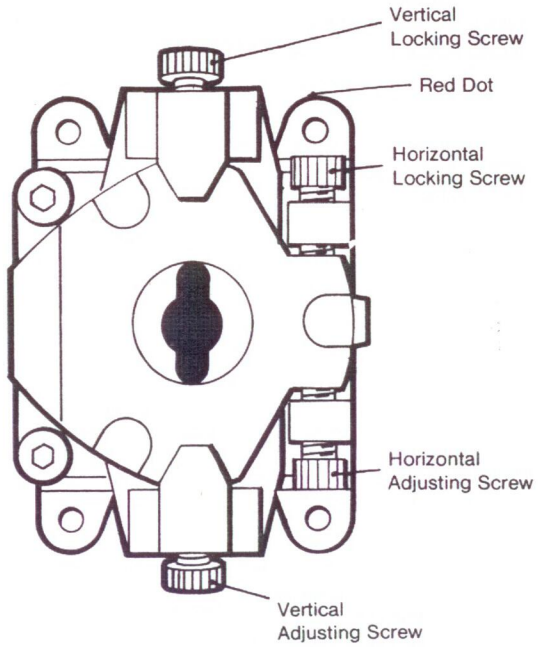


Fig. 2.3 Theodolite Adapter

horizontal adjusting screws. Establish the maximum signal strength by listening to the acoustic signal.

i) Use the theodolite to check the target location in relation to the cross-hairs.

k) Insert two Allen keys in the plate's horizontal adjustment and locking screws and make fine adjustments in the horizontal direction. Rotate the Allen keys carefully clockwise or counterclockwise, depending on whether the target is located to the right or to the left of the cross-hair. Continue turning until the acoustic tone fades.

l) Turn the theodolite's horizontal tangent screw until maximum signal strength is obtained once again.

m) Repeat this procedure until the vertical thread of the cross-hair is positioned at the centre of the target – coinciding with the acoustic tone maximum signal strength.

n) Insert the Allen keys in the plate's vertical adjustment and locking screws and make fine adjustments in the vertical direction. Repeat the above described procedure until the horizontal thread of the cross-hair is positioned at the centre of the target.

Note: Correct parallel alignment within 20mgon (1.1') is achieved when maximum signal strength is obtained in both the vertical and horizontal direction, and when the theodolite cross hairs are situated at the centre of the target.

p) Carefully lock the adapter plate's adjustment screws using the Allen keys.

q) If possible check the parallel alignment at a longer distance and fine adjust if required.

Checking Parallel Alignment

a) Aim the telescope of the theodolite at the sight on the target. Move the cross-hair from the centre of the target until the acoustic tone disappears.

b) Rotate the screw slowly back to the borderline between silence and tone.

c) Note the theodolite's angular value and write down the result.

d) Repeat the procedure a) to c) on the opposite side of the target.

e) Average the two angular values.

f) Set the mean value on the theodolite's angle scale with the aid of the fine adjustment screw.

g) Check in the eyepiece that the cross-hair is in the centre of the target within ±20mgon (1.1').

This check should be carried out for both the horizontal and vertical axes.

h) Remove and replace Geodimeter 220 in the theodolite adapter and check that parallel alignment has not altered.

j) Adjust if necessary as previously described.

k) If desired, parallel alignment of Geodimeter 220 can be carried out by an authorised Geodimeter service shop.

CORRECTION FOR EARTH CURVATURE AND REFRACTION

If projected distances and heights are computed only by multiplying the measured slope distance by the sine and the cosine of the measured zenith angle, the errors can be considerable due to earth curvature and refraction. Therefore, the internal electronics have been designed to perform corrections for these errors according to the following equations:

$$VD = SD \cos Z + \frac{(SD)^2 \sin^2 Z}{2\,Re}(1 - K)$$

$$HD = SD \sin Z - \frac{(SD)^2 \sin 2Z}{2\,Re}\left(1 - \frac{K}{2}\right)$$

Definitions are shown in Fig. 3.1.

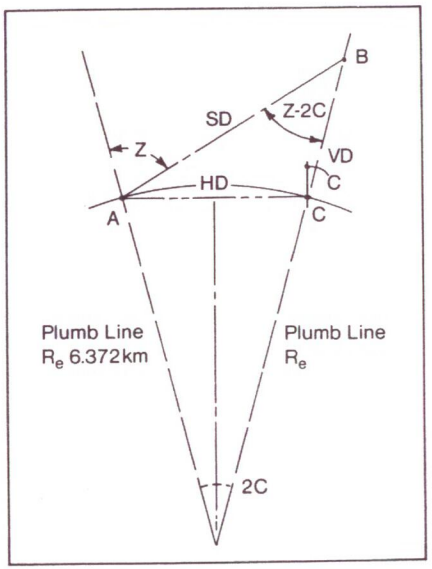


Fig. 3.1 Earth Curvature Correction

HD = Horizontal distance
VD = Vertical distance
SD = Slope distance
Re = Earth radius mean value 6372km
K = Refraction constant, mean 0.142

The corrections have been applied to both the horizontal and vertical distance when they are displayed.

Note 1: Vertical angles and slope distances have no correction when displayed or recorded.

Note 2: If a different value from K is used, measurements should always be made initially in Slop Dist, then the calculation carried out on completion. It should also be noted that either Re or K can be changed dependent on the geographical location.

Example 1

Correction of Vertical Distance (VD) close to Horizontal Plane

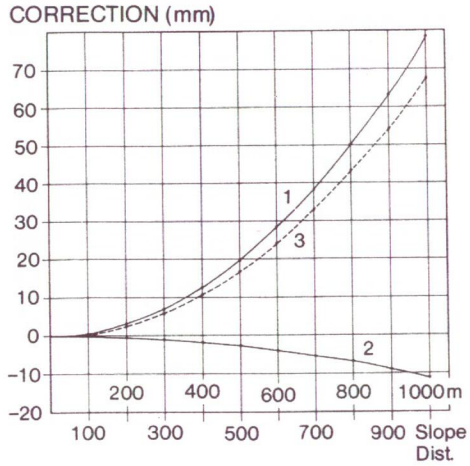


Fig. 3.2 Correction of Vertical Distance (example)

Curve 1 represents the earth curvature correction, curve 2 the correction for the refraction as a function of slope distance. Curve 3 is the resultant correction to be applied to the height obtained by multiplying the slope distance by cos Z.

This correction changes relatively slowly with the deviation from the horizontal plane. At 20^g deviation ($Z = 80^g$) the corrections will have decreased 10%.

Example 2

Correction of Horizontal Distance

The correction for earth curvature and refraction to be applied to the horizontal distance obtained by multiplying the slope distance by sin Z follows the curves shown in Fig. 3.3. The correction is proportional to the square of the slope distance and approximately directly proportional to the deviation from the horizontal plane for moderate elevations.

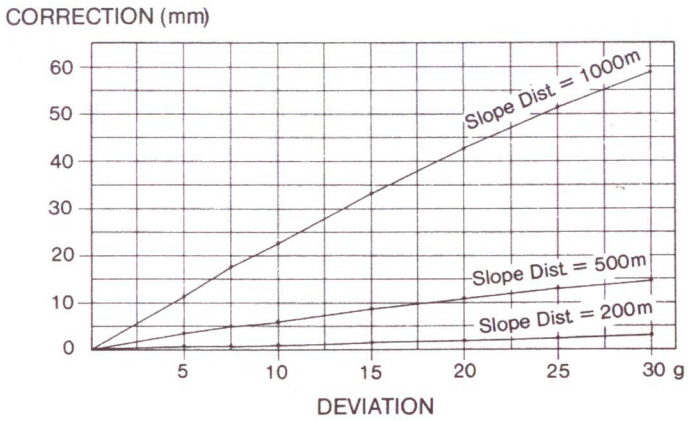


Fig. 3.3 Correction of Horizontal Distance (example)

ECCENTRICITY CORRECTION

Geodimeter 220 is mounted approximately 115mm above the centre of the theodolite's telescope.

In measurements using the setting-out reflector (part no. 571 125 198) and Prism Holder Assembly (part no. 571 125 012), eccentricity is automatically eliminated by computation within the microprocessor.

Eccentricity is eliminated when using a Tiltable Target (part no. 571 125 026). This is achieved using the coarse sight and aiming the target towards the instrument.

When Geodimeter 220 is used with other makes of reflectors eccentricity can occur and must be corrected.

Figs. 3.4 and 3.5 detail both types of reflector.

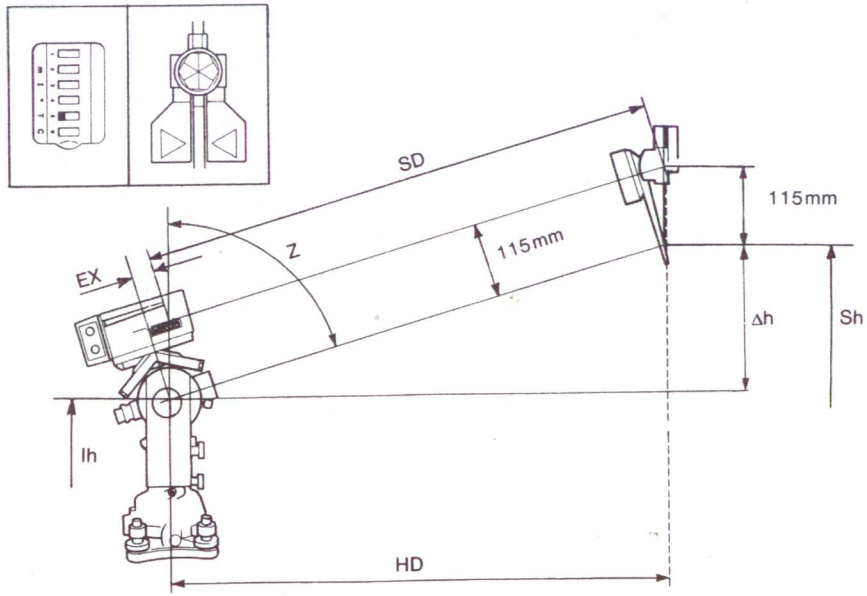


Fig. 3.4 Geodimeter 220 using the Setting Out Reflector

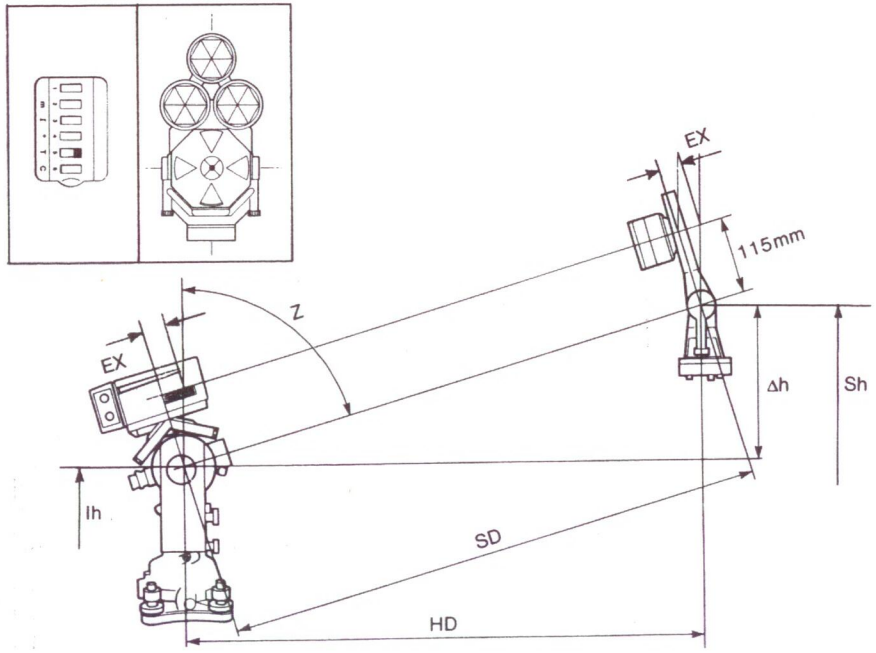


Fig. 3.5 Geodimeter 220 using the Tiltable Target

Adjustments for different types of Theodolites and Measurement Systems

A set of switches under the rubber cover on the left side of the instrument is used to adapt Geodimeter 220 to various measurement systems (see Fig. 3.6). The switches can be set by means of a pen, pencil or pointed object. Care should be exercised when changing the switch position.

Calibration of the Vertical Angle Sensor

Calibration of the Vertical Angle Sensor is carried out at the factory before delivery.

Changes in gravity caused by changes in altitude and latitude affect the automatic reduction sensor. When the instrument is transported over distances in excess of 1000km in a north/south direction or approximately 500m in altitude between two measurements it should be recalibrated.

a) Check that the theodolite adapter is adjusted correctly by aiming the instrument at a reflector with target to establish that the maximum signal strength is obtained (within ±20mgon) (see Section 2).

b) Set switch no. 6 under the rubber cover to C position (see Fig. 3.6).

c) Ensure that CAL 20 is displayed.

d) Tilt the theodolite telescope 20g (20°) above horizontal level (e.g. 320g) and press the A/M button.

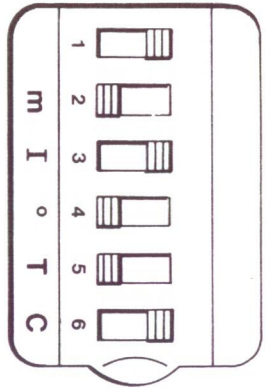
e) CAL-20 will be displayed.

f) Tilt the theodolite telescope 20g (20°) below the horizontal level (e.g. 280g) and press the A/M button.

g) CAL END will be displayed.

h) Set switch 6 to the normal position (see Fig. 3.6). The above adjustment is normally carried out at the factory and should therefore only be checked periodically.

Note: Normal adjustment instructions for the vertical sensor prior to measurement can be found in Section 2 of the Operating Manual.



Switch Positions			
1	–	Not used	
2	m	Metre	Feet
3	I	Face 1 (left)	Face 2 (right)
4	°	Degrees	Grads
5	T	Setting out reflector	Tiltable Target
6	C	Angle sensor calibration	Measurement (normal)

Fig. 3.6 Geodimeter 220 Switch Positions

Offset

Reference to the Operating Manual, page 2-2, details the offset function. This function allows pre-setting other prism constants if prisms of other makes than Geodimeter are used.

Note: Geodimeter prisms always have a constant of zero.

Atmospheric Correction

Due to the fact that the speed of light varies slightly when passing through different air pressures and temperatures, an atmospheric correction must be applied in order to achieve the correct distance.

The atmospheric correction factor is calculated according to the formula.

$$ppm = 275 - 79.55 \cdot \frac{p}{273 + t}$$

Where p = pressure in millibars
t = air temperature in °C

1013 millibars corresponds to 760mm Hg or 29.9 in Hg

For Example an atmospheric correction of −6 ppm indicates that the displayed distance has been reduced by 6mm per kilometre (or 0.6mm per 100m).

Reference for Atmospheric Correction is also contained in the Operating Manual, page 2-1.

SECTION 4

Power Supplies

ERROR INFORMATION

The following information details errors that will be displayed in the event of incorrect operation or instrument faults.

Error	Description	Possible Reason
Error 5	Incorrect mode of operation	This error is displayed when trying to operate R.O.E. in setting other than ▰ or using 100% modulation ⊳ when measuring in $\bar{D}$
Error 7	Overrange	This error is displayed when:- The instrument is tilted in excess of $\pm 50^g$ (45°). If the angle adjust value differs by more than $\pm 0.2^g$ (10.8′), when entered by the SET control or from Geodat. A setting out distance or a height value exceeding 99,999.999 or –9999.999 metres or feet is entered into the instrument.
Error 8	Calibration Error	This error is displayed when the vertical angle sensor is calibrated at an angle differing by more than 0.2^g (10.8′) from specified angle.
Error 20	For authorised service only	Error 20 and above indicates an instrument error.

Note: The list of errors are common for other Geodimeter instruments, the errors listed above are applicable to Geodimeter 220.

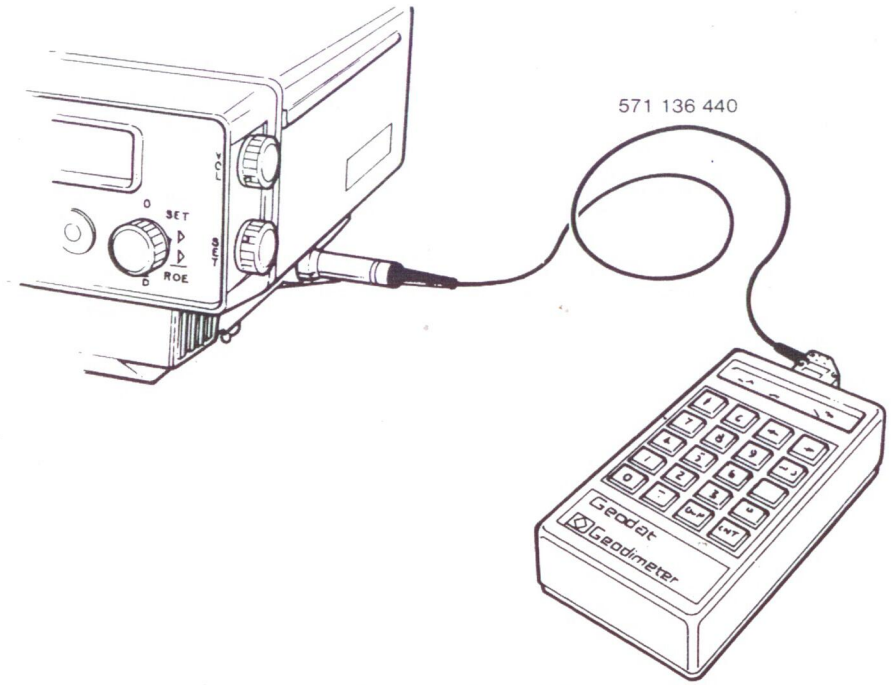


Fig. 6.1 Geodat connected with Cable and Internal Battery

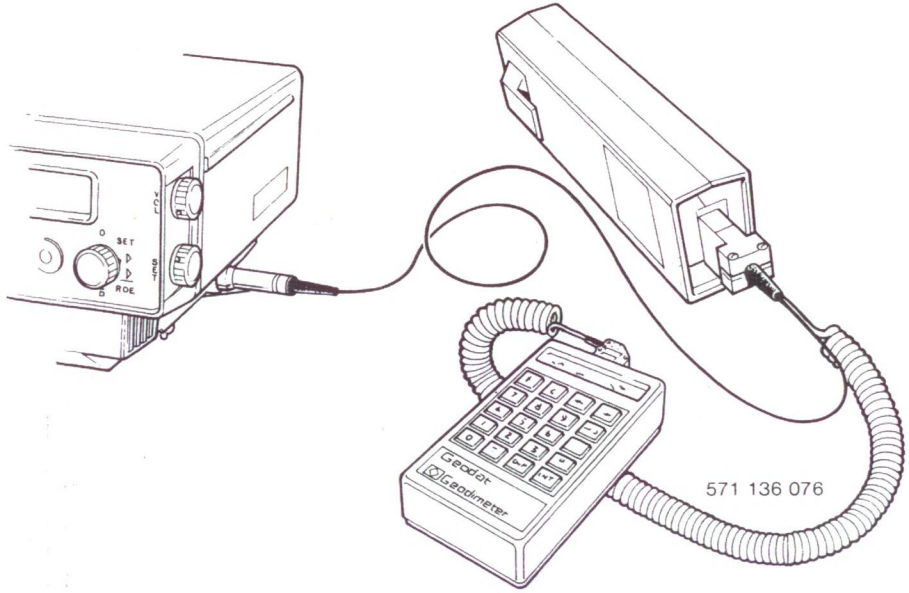


Fig. 6.2 Cable Connections for External Battery and Geodat

GEODAT INFORMATION

An essential component of the Geodimeter system is the Geodat (option) recording unit. Connected to Geodimeter it automatically records and stores up to 1000 points. Geodat can be connected to various types of computer equipment for further processing of the measurement data. Detailed information can be obtained from the Geodat Operating Manual.

Information can also be transmitted from Geodat to Geodimeter 220 using the following functions.

Operation

f20 ENT	Offset/Prism Constant. Up to a maximum ±0.999m can be transmitted and added to the measured slope distance. Transmission can only take place when the instrument is in SET mode and OFS is displayed. The constant entered will be stored in the continuous memory.
f28 ENT	Setting Out Distance. Horizontal distance to be set out can be entered. The difference between entered and measured distance is displayed and calculated down to zero when the setting out point is reached. The distance entered will be erased when the instrument is switched off.
f30 ENT	Atmospheric Correction. The PPM value calculated with the atmospheric correction disc can be transmitted when the instrument is in SET mode and P is displayed. The PPM limits are between −60 and +195ppm. The PPM value will be stored in the continuous memory.
f31 ENT	Vertical Angle Adjust. The vertical angle of the instrument can be set to the theodolite value, by entering the Theodolite angle value, when both the angle and Angle Adjust is displayed. The entered value will be stored in the continuous memory.
f34 ENT	Height (Z) of station point.
f35 ENT	Instrument Height (IH).
f36 ENT	Signal Height (SH).

When entering f34, f35 and f36, the absolute height of a measured point will be displayed by Geodimeter 220 with the display selector set to

Absolute height = ΔH measured + Z + IH − SH

The heights can be entered in aim mode, when displaying vertical angle, or when measuring heights in tracking or R.O.E. Entered heights are erased when the instrument is switched off.

Note: In the R.O.E. position the signal height (SH) is not taken into the calculation (but can be entered). As height measurements are normally made to points without a reflector, only Z and IH are added. The signal height is used only when measuring to a Geodimeter target.

Note: The list of entries are common for other Geodimeter instruments, the entries listed above are applicable to Geodimeter 220.

Geodat Cables

Two special cables for data communication between Geodimeter 220 and Geodat are available. Cable (part no. 571 136 440) can be used when Geodimeter 220 is used with the internal battery (see Fig. 6.1). Cable (part no. 571 136 076) connects the Geodimeter instrument with Geodat and the external battery, see Fig. 6.2 (this cable can also be used with the internal battery). When connected Geodat is powered either by the internal or the external battery.

Temperature Fluctuation

The automatic reduction sensor can be affected by large temperature fluctuations.

When Geodimeter 220 is moved from a high ambient temperature environment to low or vice versa, the instrument must be given time to adapt in order to perform efficiently and according to specification.

Measurement in Turbulence

The range and accuracy given in the specification apply under normal atmospheric conditions.

In turbulent air, both the range and accuracy are reduced.

In order to improve accuracy of such measurements, the MODE selector can be set to position $\overline{D}$. This minimises random error.

Background

Under unfavourable conditions, strong background light can affect Geodimeter 220. In order to overcome this problem the instrument and reflector positions should be reversed.

Never point the instrument and the theodolite through glass, this causes a disturbing glare. Avoid making measurements where glass, road signs made of reflecting material etc. are located immediately behind the reflector.

Control Measurements with Geodimeter Instruments

When control measurements are carried out, bases with a minimum length of 80 metres should be used in order to achieve satisfactory results. For maximum accuracy in control measurement, the MODE selector should be set to position $\overline{D}$.
Cyclical error is checked by measuring intervals of 2.5 metres over a total distance of 10 metres. Always carry out measurements using maximum signal strength.

Simple Fault Tracing

If the signal is too weak, this could be due to one of the following factors:

a) The Geodimeter instrument is not securely mounted on the adapter.

b) Lenses and/or reflectors are dirty, dusty or covered with condensation.

c) Excessive distance, visibility too poor or turbulence is weakening the signal.

d) The light beam is being interrupted by some obstacle.

e) Parallel alignment is poor, which results in both poor range and false aiming.

If the instrument is inoperative when the MODE selector is rotated to SET, one of the following factors could be the cause.

a) Incorrect battery connection.

b) The battery is discharged or defective.

c) The display selector is set in the ▷ position.