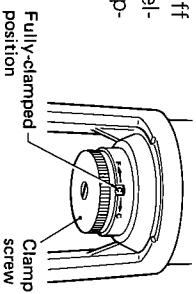
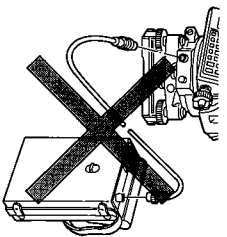


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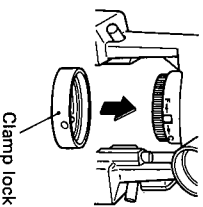
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PRECAUTIONS

- Handle the GP1/SET3 Gyroscopic Total Station with care and avoid heavy shocks or vibration.
- Do not connect the three pin cable connector (12V) to the SET External power source connector (6V) located in the lower part of the SET3, as the voltage is different. The three pin cable should only be used for connection between the Inverter and battery (BDC7).
- As the battery capacity is limited to about 3 hours for continuous measurement, it is advised that all the measurements at the same survey station are performed without switching the power off. (The running-up of the gyro uses a large amount of battery power.)
- Charge the battery after measurements, using the charger CDC7.
- Ensure that the gyromotor is fully clamped before switching on or off the GP1. (The suspension tape seldom breaks when the correct clamping procedure is followed.)

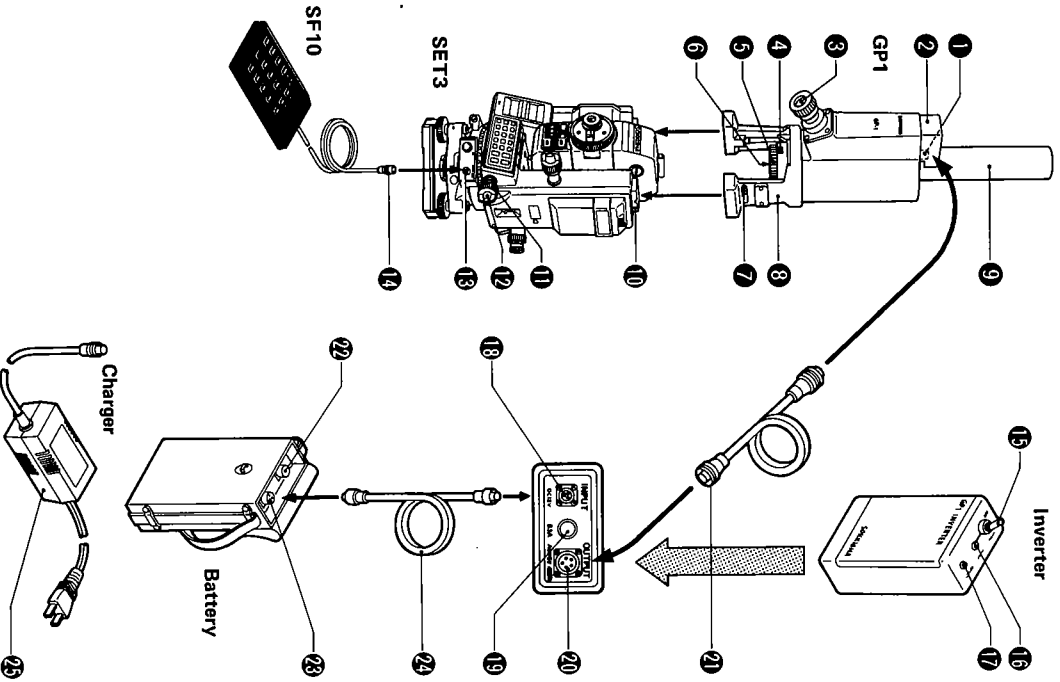


- When removing the battery from the GP1, ensure that the gyromotor has been clamped, and the power switched off.
- When storing the GP1, make sure that the clamping ring has been fully tightened and put the clamp lock over the clamping ring.



Please ensure that you are fully familiar with the SET3 instrument and Operator's Manual before using this manual.

1. NAMES OF THE PARTS



GP1 Gyro unit

- 1 Five pin cable connector
- 2 Illumination lamp
- 3 Eyepiece
- 4 Clamping index
- 5 Clamping ring
- 6 Clamp lock
- 7 Fixing lever
- 8 Bridge
- 9 Cover tube

SET3 Total station

- 10 GP1 Attachments
- 11 Horizontal fine motion screw
- 12 Horizontal clamp

SF10 Keyboard

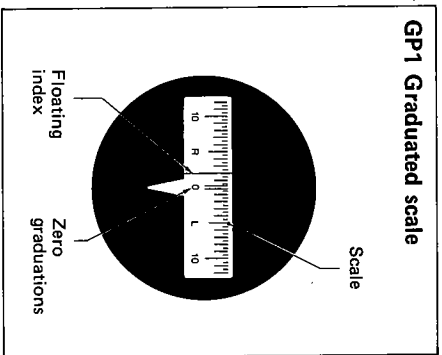
- 13 SET3 Connector
- 14 SF10 Cable

Inverter

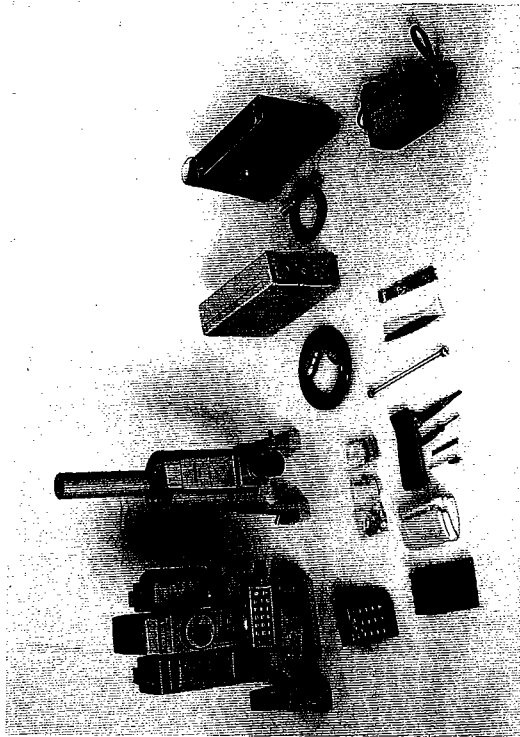
- 15 GP1 Power switch
- 16 Motor start lamp
- 17 Battery low lamp
- 18 Input connector
- 19 Fuse
- 20 Output five-pin connector
- 21 Five-pin cable

BDC7 Battery

- 22 Power connector
- 23 Output connector
- 24 Three pin cable
- 25 Charger (CDC7)



3. STANDARD EQUIPMENT



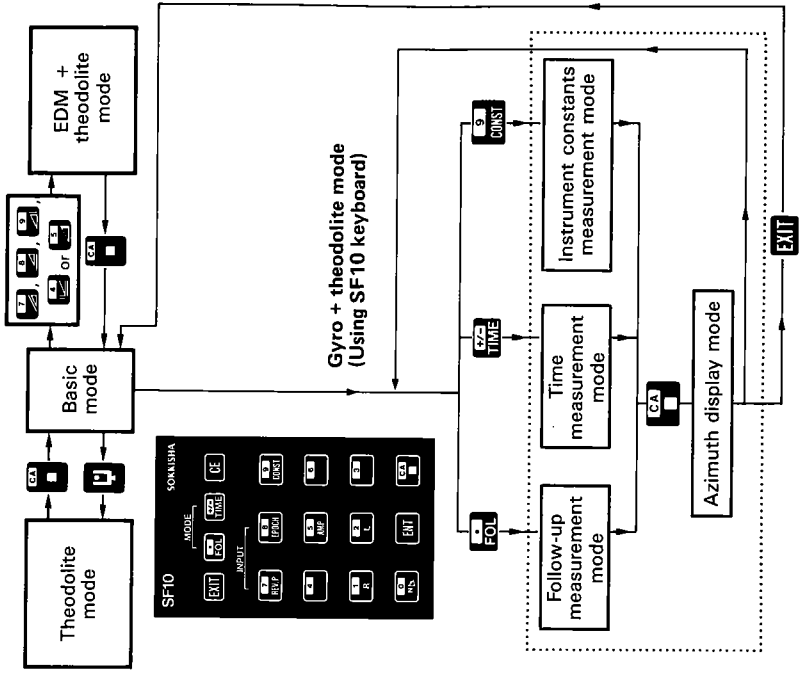
GP1 Gyroscope unit with bridge	1	Silicone cloth	1
Accessories (stored in the carrying case)	1	Vinyl cover	1
Suspension tapes	3	Clamp lock	1
Suspension jig	1	SF10 Keyboard	1
Pincettes	1	004-D0178 Inverter	1
Tool pouch	1	004-D0170 5-pin cable	1
Watch-maker's screwdrivers	2	Fuse (4A)	3
Adjusting pin, bent	1	BDC7, Battery	1
Adjusting pin, straight	1	004-D0171 3-pin cable	1
Lens brush	1	CDC7, Charger	1
Screwdriver	1	PFW1, Tripod	1
Lens hood	1	Operator's manual	1
Bulb (12V/3W)	3	Carrying case	1
GP1 Tubular compass	1	SET3 Total Station	1


4. KEY FUNCTIONS

4.1 CHANGE OF MEASUREMENT MODES

The SET3 functions as a total station using the SET3 keyboard. To enter the Gyro + theodolite mode, use the SF10 keyboard as follows:

SET3 operation (Using SET3 keyboard)



Note: In the gyro and theodolite mode, all SET3 key functions (except ) are ignored. However, in the EDM + theodolite mode (during distance measurement), pressing keys on the SF10 keyboard may cause the SET3 to malfunction.

4.2 KEY FUNCTIONS

Follow-up measurement mode

- FOL** Enter the follow-up measurement mode.
- REV** Enter the reversing (turning) point position.
- CA** End the follow-up measurement, compute the true north position and exit to the Azimuth display mode.
- CE** If at least 4 turning points have been stored: Delete the last turning point value, compute the true north position and exit to the Azimuth display mode.

Azimuth display mode

- NR** Transfer the measured azimuth angle (the angle from calculated true north) to the original horizontal angle value.
- EXIT** Exit from the Gyro + theodolite mode to the Basic mode.

Time measurement mode

- TIME** Enter the time measurement mode.
- EP** Enter the time that the floating index mark crosses the zero graduations of the gyro scale.
- TR** Select TR or TL (which side of zero the floating index is).
- AMP** Enter DR or DL (amplitude of the TR and TL turning points).
- CA** End the time measurement, compute the true north position and exit to the Azimuth display mode.
- CE** Delete the last input of the **TR** key (i.e. if the **TR** key has been pressed too early or late), and restart the time measurement procedure. See Note 1 on page 24.

Instrument constants measurement mode

- CONST** Enter the Instrument constants measurement mode.
- NR** When sighting the known true north position, set the instrument to this true north direction.
- TR** Finish measurement in each direction. (After 3rd direction measurement, K and R are calculated and displayed.)
- EP** Enter the time that the floating index mark crosses the zero graduations of the scale.
- TR** Select TR or TL (which side of zero the floating index is).
- AMP** Input DR or DL (amplitude of the TR and TL turning points).
- CA** End the instrument constants measurement and exit to the Azimuth display mode.
- CE** Delete the last input of the **TR** key (i.e. if the **TR** key has been pressed too early or late). See Note on page 38.

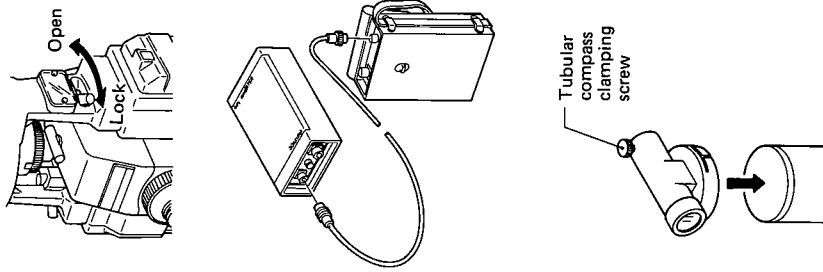
Keys used in all measurement modes for data entry:

- | | | | |
|----------------------|------------|-----------------------|------------------------------|
| 0 NR | Enter "0". | 7 REV | Enter "7". |
| 1 TR | Enter "1". | 8 EP | Enter "8". |
| 2 TR | Enter "2". | 9 CONST | Enter "9". |
| 3 TIME | Enter "3". | + TIME | Change the sign of the data. |
| 4 FOL | Enter "4". | FOL | Enter a decimal point. |
| 5 AMP | Enter "5". | CE | Clear displayed data |

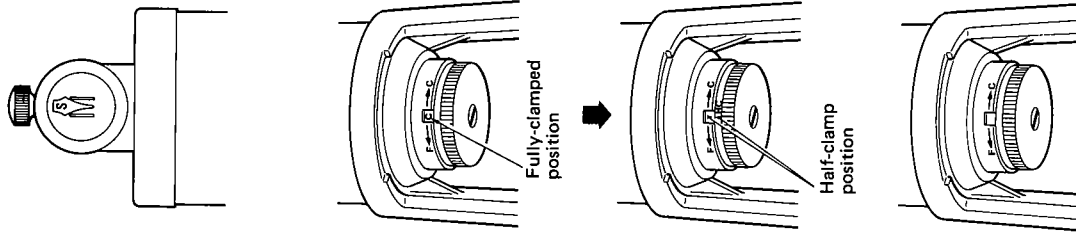
5. MEASUREMENT

5.1 PREPARATION FOR MEASUREMENT

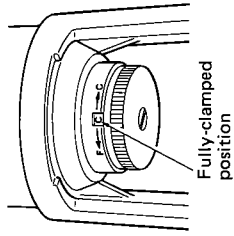
- 1) Set up the tripod over the measuring point and mount the SET3 on the tripod.
- 2) Level and centre the SET3 over the surveying point. Ensure that the SET3 has been correctly levelled. (Refer to SET3 operator's manual for more details.)
- 3) Set the GP1 fixing levers **7** to the open position. Lower the GP1 on to the SET3 and lock the fixing levers.
- 4) Connect the GP1 connector **1** to the inverter output connector **20** with the five-pin cable.
- 5) Connect the inverter input connector **18** to the battery output connector **23** with the three-pin cable.
Note: The inverter and battery can be mounted on the tripod legs.
- 6) Connect the SF10 keyboard to the SET3 data output connector.
- 7) Re-check the levelling and centring of the SET3.
Set the SET3 horizontal fine motion screw to the centre of its working range.
- 8) Mount the tubular compass on the top of the GP1 and align the compass body with the SET3 telescope. Loosen the tubular compass clamping screw.



- 9) Use the horizontal clamp and fine motion screw to turn the SET3 until the tubular compass needle is centred between the S index lines. The telescope of the SET3 is now pointing to approximate magnetic north. Adjust for magnetic declination in the area of use to obtain the approximate true north direction. (Where the compass is not usable, use any other information to determine the approximate true north direction; e.g. map, sun, time, etc.)
- 10) Do not switch on the gyromotor — first check that the movement of the pendulum is symmetrical about the zero index as follows:
 - a. Turn the GP1 clamping ring in the F direction; firstly until the ▼ mark appears in the clamping index **4**, and then further until the ▲HC mark is opposite the ▼ mark. This is the half-clamping position, where the gyromotor is only lightly clamped.
 - b. Wait for about 10 seconds at this position to allow the pendulum movement to settle. (Check the floating index movement.)
 - c. Slowly turn the clamping ring further in the F direction until it can turn no more. The gyromotor is now freely suspended.



- d. Observe the motion of the floating index mark and confirm that the movement is symmetrical about the zero graduations. If the movement is not symmetrical, see page 32: "Zero point adjustment".
- e. Re-clamp the gyromotor by turning the clamping ring fully in the C direction. (The C mark can be seen in the clamping index **4**).



- 11) Switch on the GP1 power switch **15**.

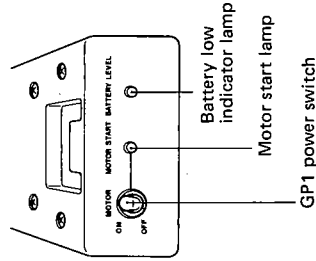
Check the battery power.

Note: When the battery power becomes low, the red indicator lamp on the inverter lights up.

When this occurs, recharge the battery or replace with a charged battery.

For battery charging procedures, see page 39.

- 12) After about 60 seconds, the green "MOTOR START" lamp **16** lights to show that the gyromotor has attained the correct operating speed.



The GP1 is now ready for true north measurement.

Note: To switch off the GP1 at any time, first ensure that the clamping ring is fully clamped, then switch the GP1 power switch **15** off. (If this procedure is not followed, the gyromotor suspension tape may be broken.)

5.2 SELECTION OF THE MEASUREMENT METHOD

Two methods may be used to make a true north measurement. These methods are the FOLLOW-UP (Reversal point) measurement and the TIME measurement methods.

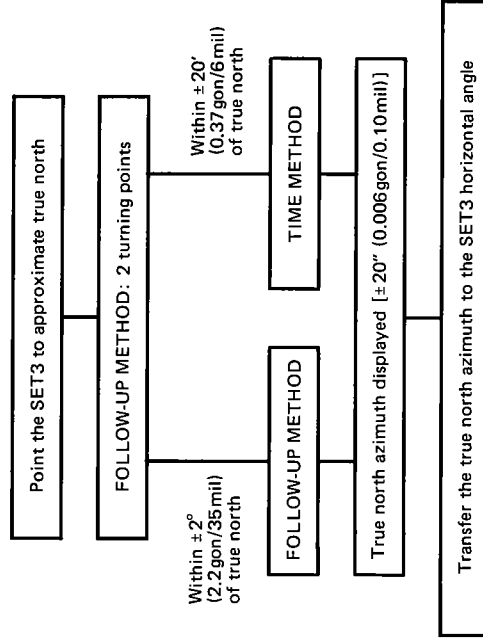
The FOLLOW-UP method may be used to quickly obtain an approximate true north position (using 2 turning points). (When the initial instrument true north pointing is not close to true north, repeat this procedure.)

The FOLLOW-UP method can also be used to determine an accurate true north position ($\pm 20''$ (0.006 gon/0.1 mil), using 3 or more turning points), after the instrument has been set to approximate true north (within $\pm 2^\circ$ (2.2 gon/35 mil)).

The TIME method requires the SET3 to be pointing to approximately true north (within $\pm 20'$ (0.37 gon/6 mil)) and determines an accurate true north position ($\pm 20''$ (0.006 gon/0.1 mil)).

Although the accuracy of the two methods is the same, the procedures are quite different and each method has its own merits.

It is recommended that the results obtained by each method should be compared to check the reliability of the measurements.



5.3 FOLLOW-UP MEASUREMENT MODE (2 or more turning points)

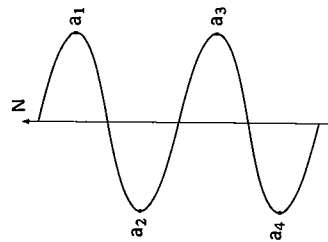
This method of measurement involves carefully turning the SET3 to keep the floating gyro index as close as possible to the zero graduations. As the floating index approaches its turning (reversal) point (e.g. points a_1, a_2, a_3 in the diagram below), it appears to slow down and stop, before changing direction. At this stopping point, the operator presses a key on the SF10 keyboard and the SET3 reads and stores the horizontal angle value.

When at least 2 successive turning points have been determined, the true north direction can be calculated by pressing a key on the SF10.

For accurate true north determination, the approximate true north position should already be known, and 3 or more successive turning points should be measured.

Note: When using this method, care must be taken to follow the floating point without disturbing the pendulum movement. The horizontal clamp should be used with care as sudden movements will affect the accuracy of the results.

Theory of the follow-up method:



When the number of turning points is 2:

$$N = \frac{a_1 + a_2}{2} + R$$

where:

a_1, a_2 = turning points

N = true north

R = alignment constant

When the number of turning points is greater than 2:

$$N = \frac{a_1 + a_3}{2} + a_2 + \frac{a_2 + a_4}{2} + a_3 + \dots + \frac{a_{n+2} + a_n}{2} + a_{n+1} \cdot \frac{1}{n-2} + R$$

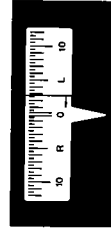
Determining the turning point

When the clamping ring is rotated to the half-clamp position, then carefully released, the image of the floating index is seen to move in the R or L direction across the graduated scale.

By rotating the SET3 using the horizontal clamp or fine motion screw, the floating index can be kept close to zero (centre of the graduated scale). To accurately follow the floating index and determine the turning point, care must be taken.

The following is a suggested method for following the floating index:

1) Assuming the floating index is moving in the LR direction as shown at right:



2) Wait until the floating index comes, for example to the 2nd (see Note below) graduation of the R side, then

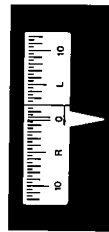


Turn the SET3

3) rotate the SET3 using the horizontal clamp or fine motion screw until the floating index is at the opposite 2nd division on the L side.

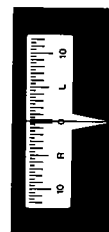


4) The floating index is seen to move in the LR direction again.



5) Repeat this procedure from 2) until the floating index movement slows down enough for the SET3 to be turned only one division, then half a division, and the fine motion screw can be used to keep the index centred in the zero graduations.

6) At the moment that the floating index appears to come to a standstill in the zero graduations, the SET3 is pointing to the turning point.



Note: When index movement is fast, the SET3 may have to be turned in 5 or 10 graduation steps to follow it.

Procedures for follow-up measurement mode

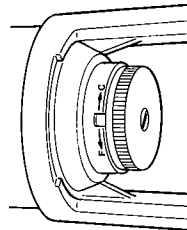
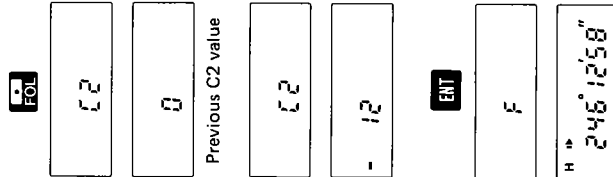
- 1) Switch on the SET3 and index the vertical circle. (Refer to the SET3 operator's manual for more details.)
- 2) Select the SET3 basic mode by pressing the **ENT** key on the SET3 keyboard.

- 3) Select the follow-up measurement mode by pressing the **FOL** key on the SF10 keyboard. The SET3 display prompts for the input of C2, the alignment constant R value.
- 4) The value for R can be seen on the constants card mounted on the GP1 bridging support. Input this value using the SF10 keyboard numerical keys. (For gon and mil value entry, see Note on page 41.)

- 5) Press **ENT** to enter the value in the memory.

- 6) Turn the clamping ring to the half-clamp position. Wait for about 10 seconds to allow the pendulum to settle, then slowly open the clamp to the fully open position.

Note: If the floating index, when released, does not have a steady movement, turn the clamping ring back to the half-clamp position, then release again. Repeat until the index has a steady movement.



- 7) Use the SET3 horizontal clamp and fine motion screw to keep the floating index mark centred in the zero graduations until the turning point is reached. (See suggested procedure on page 13.)

- 8) Press **REV** on the SF10 keyboard when the turning point is reached. The SET3 display prompts for the next turning point input.

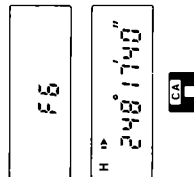
- 9) Continue to follow the floating index until the opposite turning point is reached. Press **REV** again at this turning point.

- 10) Repeat part 9) until the required number of turning points have been measured.

Note: Minimum 2 points; maximum 10 points.

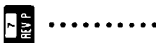
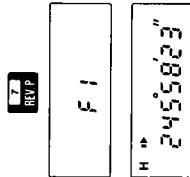
- 11) Press **CS** on the SF10 to end the measurement mode. After one long audio tone, the SET3 calculates the true north position and exits to the azimuth display mode. (See next page.)

e.g.



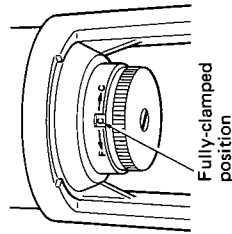
Note 1: After at least 4 turning points have been measured, the **CE** key can be used to delete the last-measured point, calculate the true north position from the remaining points, and exit to the azimuth display mode. (This is useful if the **REV** key has been pressed by mistake.)

Note 2: After the 10th turning point has been measured, the true north position is automatically calculated and the SET3 exits to the azimuth display mode.



12) Turn the clamping ring in the C direction to the half-clamp position, then to the full clamping position. If all measurements have been completed, the GP1 power can be switched off.

Note, however, that when more measurements are to be taken at the same station, it is better to take all the measurements without switching the power off, as the power-up of the gyromotor uses much battery power. (For continuous operation, the fully-charged battery will last approximately three hours.)



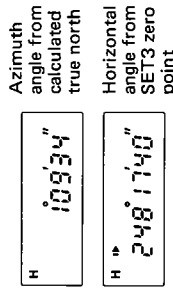
Azimuth display mode

In the azimuth display mode, the SET3 upper display shows the azimuth (angle from the calculated true north position) and the lower display shows the horizontal angle from the previous zero point. Both are displayed in real time i.e. the angles change as the theodolite is rotated.

The calculated true north position is stored in the SET3 memory, and can be re-determined even after using the OSET and hold functions.

However, note that:

- The stored true north position is lost when the SET3 is switched off, and
- The use of the SET3 lower clamp or lower fine motion screw will change the true north position.



13) To transfer the azimuth angle to the horizontal angle:

Press **GA** on the SF10 keyboard. The SET3 now displays the azimuth angle value from the calculated true north direction as its horizontal angle. (The theodolite can now be returned to the normal SET3 measurement modes and will continue to display the azimuth value.)

14) To continue true north measurement:

a. Turn the SET3 using the horizontal clamp **H** and fine motion screw **F** until the displayed azimuth value is 0 (measured true north).

● Press **FOI** to repeat the follow-up measurement. See page 14 part 3).

● Press **TIME** to enter the time transit measurement mode. See next page.

If all gyro measurement has been completed:

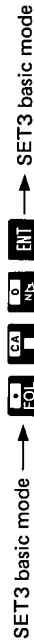
Press **ENT** to return to the SET3 basic mode and switch off the GP1 power.

Note: After return to SET3 measurement modes:

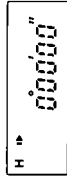
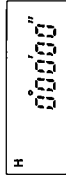
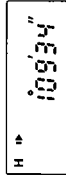
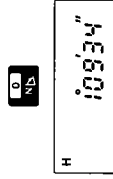
When the azimuth angle is required again after the OSET or hold functions have been used, first ensure that the SET3 is in basic mode.

Press **FOI** (or **TIME**) to re-enter the gyro and theodolite mode, then press **GA**. This takes you to the azimuth display mode, where the **GA** key can be used to re-transfer the azimuth angle to the horizontal angle. (Press **ENT** to return to the SET3 basic mode.)

i.e. To re-determine the azimuth from the calculated true north position, press:



The SET3 telescope is sighting the measured true north direction.



5.4 TIME MEASUREMENT MODE

When true north has been determined (within $\pm 20'$ (0.37 gon/6 mil)), for example by using the follow-up method (2 turning points), the SET3 should be turned to sight that direction and the horizontal clamp should be tightened. When the GP1 clamping ring is released, the floating index will be seen to precess within the range of the scale. i.e. Both R and L turning points will occur on the graduated scale without moving the SET3 instrument.

By inputting the GP1 instrument constants (K and R) and the amplitude of the R and L turning points (DR and DL), and pressing a key on the SF10 each time the floating index crosses the zero graduations, the SET3 is able to calculate a true north position using the following formula:

$$\theta = -(K \cdot D \cdot dt + R)$$

K = Instrument constant (C1)

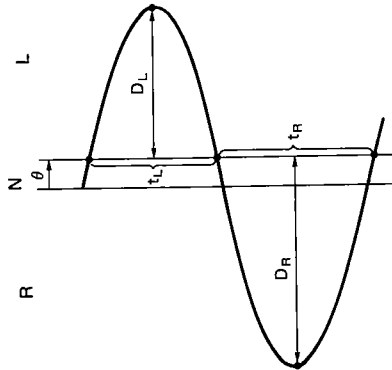
R = Alignment constant (C2)

D = $(D_R + D_L)/2$: Average of the R and L amplitude values.

dt = $t_R - t_L$: Time difference between successive zero crossings.

By this method, true north can be determined with a maximum mean error of $\pm 20''$ (0.006 gon/0.1 mil).

Take care not to subject the instrument to shock or vibration as it will affect the measurement accuracy.



Time measurement procedure

- 1) For this procedure, true north should have already been approximately determined within $\pm 20'$ (0.37 gon/6 mil) using the follow-up measurement (2 turning points). Point the telescope to Azimuth 0° in the azimuth display mode and clamp the horizontal circle.
 - * When the 2-point follow-up measurement has not been performed, face the telescope to true north ($\pm 20'$ (0.37 gon/6 mil)), and ensure that the SET3 is switched on, indexed, and in the basic mode.

- 2) Press **TIME** to enter the time measurement mode. The SET3 display prompts for the input of the value of instrument constant K (C1).
- 3) The K constant value can be seen on the plate mounted on the GP1 bridging support. Input this value using the SF10 numerical keys. (For gon and mil value entry, see Note on page 41.)

Example: When K = 3.42

Press **3** **EQ** **4** **2** **L**.

(To correct a mis-input, press **CE** and re-input the value.)

- 4) Press **ENT** to enter the value in the memory. The display then prompts for the input of the alignment constant R (C2) value.

H 00000"

H → 00000"

The SET3 telescope is sighting the measured true north direction.

TIME

C 1

0000

Previous C1 value

C 1

3.42

ENT

C 2

- 12

Previous C2 value

