SURVEYING INSTRUMENTS

GP1-2A

Gyro Station

OPERATOR'S MANUAL

- Thank you for selecting the GP1-2A.

- Please read this manual carefully before starting to use the instrument. Keep this manual near the instrument for easy reference.
- Verify that all equipment is included by referring to "3. Standard Equipment."
- Sokkia is continuously conducting research and development in order to make its products easier to use and enhance their precision. The specifications and general appearance of the instrument may be altered without prior notification.
- Sokkia bears absolutely no responsibility for any profits or losses created through the use of this system.
- Some of the diagrams and screen displays shown in this manual are simplified for easier understanding.

Always Follow Precautions for Safe Operation

- For the safe use of the product and prevention of injury to operators and other persons as well as prevention of property damage, items which should be observed are indicated by an exclamation point within a triangle used with WARNING and CAUTION statements in this operator's manual.
  The definitions of the indications are listed below.
  Be sure you understand them before reading the manual's main text.
  Some items in this manual may not correspond to the product you purchased depending on its model or type.

Definition of Indication

⚠ **WARNING** Ignoring this indication and making an operation error could possibly result in death or serious injury to the operator.

⚠ **CAUTION** Ignoring this indication and making an operation error could possibly result in personal injury or property damage.

General

⚠ **WARNING**

- Do not use the unit in areas exposed to high amounts of dust or ash, in areas where there is inadequate ventilation, or near combustible materials. An explosion could occur.
- Do not perform disassembly or rebuilding. Fire, electric shock or burns could result.
- Never look at the sun through the telescope. Loss of eyesight could result.
- Do not look at reflected sunlight from a prism or other reflecting object through the telescope. Loss of eyesight could result.

⚠ **CAUTION**

- Secure handle to main unit with locking screws. Failure to properly secure the handle could result in the unit falling off while being carried, causing injury.
- Do not place the instrument in a case with a damaged catch, belt or handle. The case or instrument could be dropped and cause injury.
- Do not use the carrying case as a footstool. The case is slippery and unstable so a person could slip and fall off it.
- Tighten the adjustment tribrach clamp securely. Failure to properly secure the clamp could result in the tribrach falling off while being carried, causing injury.
- Do not wield or throw the plumb bob. A person could be injured if struck.

Power Supply

⚠ **WARNING**

- Use only the specified battery charger to recharge batteries. Other chargers may be of different voltage rating or polarity causing sparking which could lead to fire or burns.
- Do not place articles such as clothing on the battery charger while charging batteries. Sparks could be induced leading to fire.
- Do not use batteries or the battery charger if wet. Resultant shorting could lead to fire or burns.
- To prevent shorting of the battery in storage, apply insulating tape or equivalent to the terminals. Otherwise shorting could occur resulting in fire or burns.
- Do not heat or throw batteries into fire. An explosion could occur resulting in injury.

- Do not use voltage other than the specified power supply voltage. Fire or electric shock could result.
- Do not use damaged power cords, plugs or loose outlets. Fire or electric shock could result.

⚠ CAUTION

- Do not touch liquid leaking from batteries. Harmful chemicals could cause burns or blisters.
- Do not connect or disconnect power supply plugs with wet hands. Electric shock could result.

Tripod

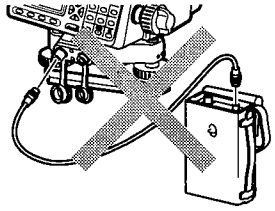
⚠ CAUTION

- When mounting the instrument to the tripod, tighten the centring screw securely. Failure to tighten the screw properly could result in the instrument falling off the tripod, causing injury.
- Tighten securely the leg fixing screws of the tripod on which the instrument is mounted. Failure to tighten the screws could result in the tripod collapsing, causing injury.
- Do not carry the tripod with the tripod shoes pointed at other persons. A person could be injured if struck by the tripod shoes.
- Keep hands and feet away from the tripod shoes when fixing the tripod in the ground. A hand or foot stab wound could result.
- Tighten the leg fixing screws securely before carrying the tripod. Failure to tighten the screws could lead to the tripod legs extending, causing injury.

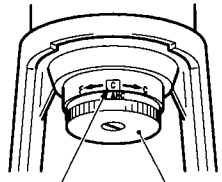
CONTENTS

PRECAUTIONS

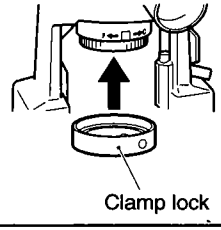
- Handle the GP1/SET3100 Gyroscopic Total Station with care and avoid heavy shocks or vibration.
- Do not connect the three pin cable connector (12V) to the SET External power source connector (6V) located in the lower part of the SET3100, as the voltage is different.
  The three pin cable should only 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.)

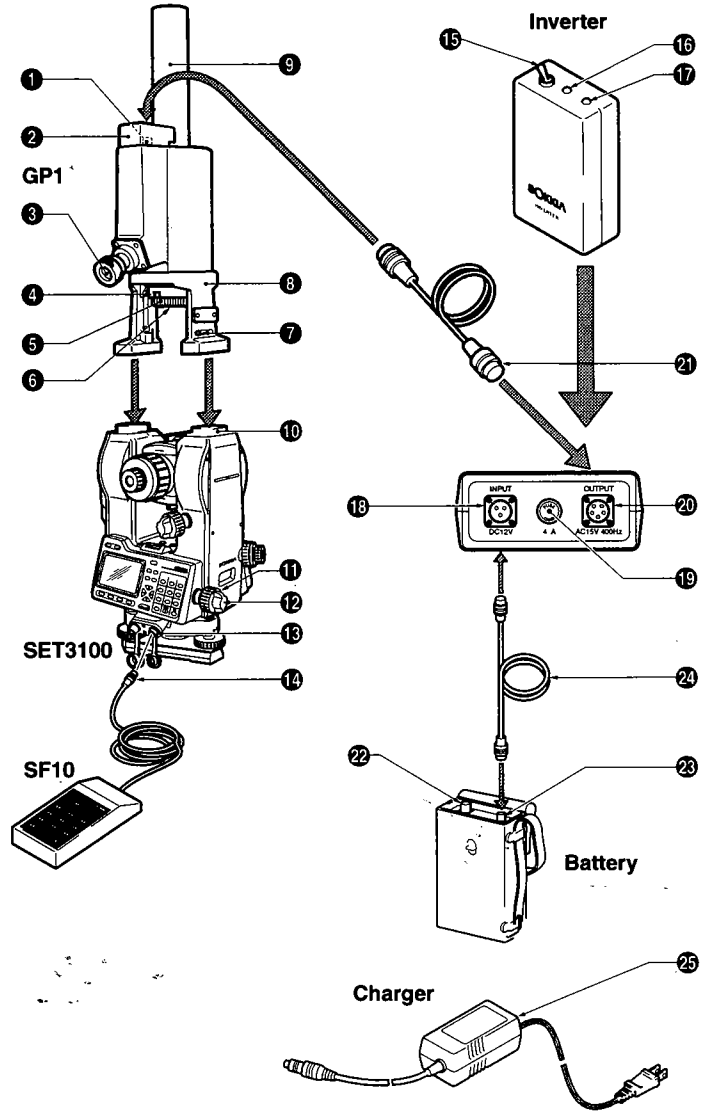


- When removing the battery from the GP1, ensure that the gyromotor has been clamped, and the power switched off.
- When storing the GP1, make sure that the clamping ring has been fully tightened and put the clamp lock over the clamping ring.



Please ensure that you are fully familiar with the SET3100 instrument and Operator's Manual before using this manual.

1. NAMES OF THE PARTS



GP1 Gyro unit

❶ Five pin cable connector
❷ Illumination lamp
❸ Eyepiece
❹ Clamping index
❺ Clamping ring
❻ Clamp lock
❼ Fixing lever
❽ Bridge
❾ Cover tube

SET3100 Total station

❿ GP1 Attachments
⓫ Horizontal fine motion screw
⓬ Horizontal clamp
⓭ SET3100 Connector

SF10 Keyboard

⓮ SF10 Cable

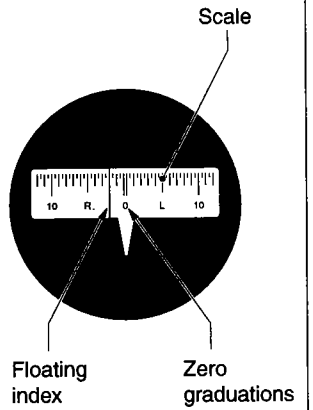
Inverter

⓯ GP1 Power switch
⓰ Motor start lamp
⓱ Battery low lamp
⓲ Input connector
⓳ Fuse
⓴ Output five-pin connector
㉑ Five-pin cable

BDC7 Battery

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

GP1 Graduated scale



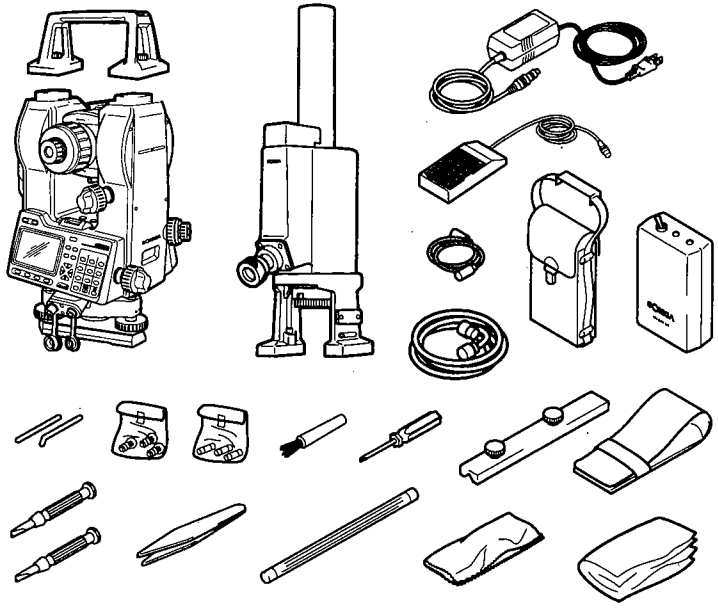
2. INTRODUCTION/FEATURES

The gyroscopic total station GP1-2A consists of a specially-adapted SET3100 electronic total station fitted with a GP1 gyroscope unit.

The GP1 gyroscope unit uses a suspended gyromotor which oscillates around the earth's meridian (true north) due to the principle of precession caused by the rotation of the earth. (For GP1 theory, see page 42.)

- The combination of the GP1 gyroscope and the SET3100 total station with special application software programs allows the true north position to be calculated by the SET3100 instrument.
- Two different measurement methods (follow-up or time measurement) can be used to determine the true north position.
- The true north measurement can be performed regardless of the magnetic conditions to a mean accuracy of ±20" (0.006 gon/0.10 mil).
- The calculated true north position can be easily transferred to the SET3100 horizontal circle.

3. STANDARD EQUIPMENT



GP1 Gyroscope unit with bridge 1

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

SET3100 Total Station

For SET3100 accessories, refer to the SET3100 operator's manual

4. KEY FUNCTIONS

• Preparations

Before using SF10, perform the communication setting of SET3100 as shown on the right.

```
Comms setup
Baud rate:[redacted]
Data bits:8bits
Parity   :Not set
Stop bit :1bit
Check sum:No
Xon/Xoff :Yes
```

• Displaying keys

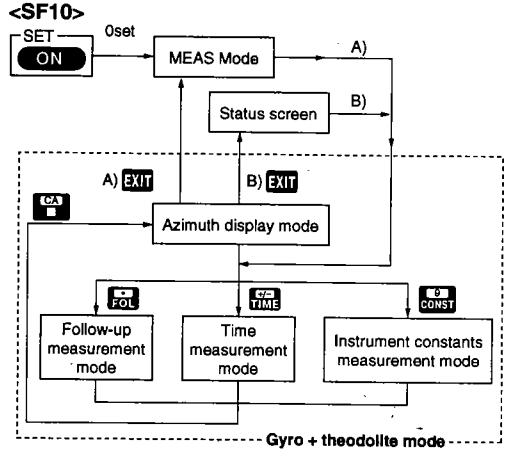
The SET3100 keyboard is displayed on the left side and the SF10 keyboard on the right side.

Example) SET3100 keys [CA] / SF10 keys [CA]

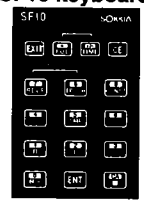
4.1 SWITCHING THE MODE

Switch the mode as follows using the SF10 and SET3100 keyboards.

Note: When the Gyro + theodolite mode is set, the Tilt correction and Collimation correction functions will automatically go off.



<SF10 keyboard>



A) When entering the Gyro + theodolite mode from the MEAS Mode, pressing the EXIT key in the Azimuth display mode returns to the MEAS mode.

B) When entering the Gyro + theodolite mode from the Status Screen, pressing the EXIT key in the Azimuth display mode returns to the Status Screen.

MEAS mode

```
Meas.          PC  -30
                ppm   0
                      ∎2
ZA   58°50'10"
HAR 356°00'00"
                      P1
SDIST ◢SHV HANG EDM
```

Status screen

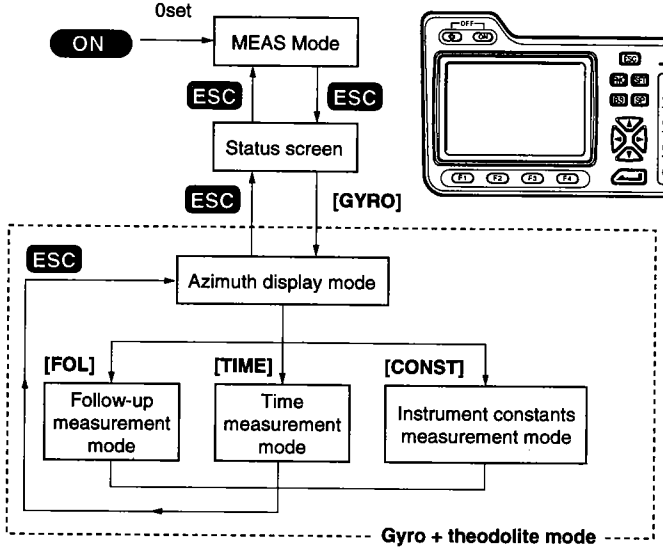
```
Apr-11-97    15:30:20

SET3100
No.XXXXXX
Ver.XXX-XX-XX
    XXX-XX-XX
Job JOB01
MEAS GYRO MEM CNFG
```

Azimuth display mode

```
Azimuth
                      ∎2
AZ  358°50'10"
HAR 359°00'00"
FOL TIME CONST N
```

<SET3100>



<SET3100 keyboard>

4.2 KEY FUNCTIONS

Follow-up measurement mode

[FOL] / FOL	Enter the follow-up measurement mode.
[REV.P] / 7 REV.P	Enter the reversing (turning) point position.
[CA] / CA	End the follow-up measurement, compute the true north position and exit to the Azimuth display mode.
[CE] / 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

[N] / 0 N	Transfer the measured azimuth angle (the angle from calculated true north) to the original horizontal angle value.
ESC / EXIT or CA	Exit from the Gyro + theodolite mode to the Status Screen.

Time measurement mode

[TIME] / +/- TIME	Enter the time measurement mode.
[EPOCH] / 8 EPOCH	Enter the time that the floating index mark crosses the zero graduations of the gyro scale.
▶ / 1 R	Select R (which side of zero the floating index is).
◀ / 2 L	Select L (which side of zero the floating index is).
[AMP] / 5 AMP	Enter DR or DL (amplitude of the R and L turning points).
[CA] / CA	End the time measurement, compute the true north position and exit to the Azimuth display mode.
[CE] / CE	Delete the last input of the [EPOCH] / 8 EPOCH key (i.e. if the [EPOCH] / 8 EPOCH 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] / 9 CONST	Enter the Instrument constants measurement mode.
[N] / 0 N⊵	• When sighting the known true north position, set the instrument to this true north direction. • Finish measurement in each direction. (After 3rd direction measurement, K and R are calculated and displayed.)
[EPOCH] / 8 EPOCH	Enter the time that the floating index mark crosses the zero graduations of the scale.
▶ / 1 R	Select R (which side of zero the floating index is).
◀ / 2 L	Select L (which side of zero the floating index is).
[AMP] / 5 AMP	Input DR or DL (amplitude of the R and L turning positions).
[CA] / CA	Delete the constant obtained by the measurement, and end the instrument constants measurement and exit to the Azimuth display mode.
[CE] / CE	Delete the last input of the **[EPOCH]** / 8 EPOCH key (i.e. if the **[EPOCH]** / 8 EPOCH key has been pressed too early or late). See Note on page 39.
[REC] / ENT	Memorize the constant obtained by the measurement in SET3100, end the instrument constant measurement and exit to the Azimuth display mode.

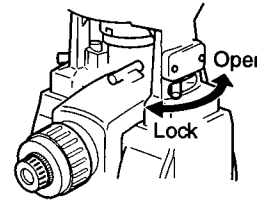
Keys used in all measurement modes for data entry:

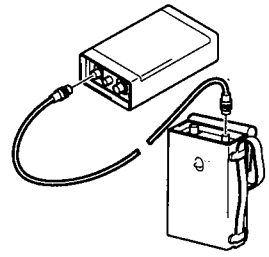
0 / 0 N⊵	Enter "0".	8 / 8 EPOCH	Enter "8".
1 / 1 R	Enter "1".	9 / 9 CONST	Enter "9".
2 / 2 L	Enter "2".	+/− / +/− TIME	Change the sign of the data.
3 / 3	Enter "3".		
4 / 4	Enter "4".	. / . FOL	Enter a decimal point.
5 / 5 AMP	Enter "5".	[CE] / CE	Clear displayed data.
6 / 6	Enter "6".	↵ / ENT	Enter data in constant memory.
7 / 7 REV.P	Enter "7".		

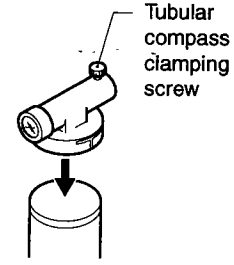
5. MEASUREMENT

5.1 PREPARATION FOR MEASUREMENT

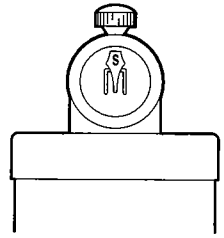
1) Set up the tripod over the measuring point and mount the SET3100 on the tripod.
2) Level and centre the SET3100 over the surveying point. Ensure that the SET3100 has been correctly levelled. (Refer to SET3100 operator's manual for more details.)
3) Set the GP1 fixing levers ❼ to the open position. Lower the GP1 on to the SET3100 and lock the fixing levers.
4) Connect the GP1 connector ❶ to the Inverter output connector ⓴ with the five-pin cable.
5) Connect the Inverter input connector ⓲ 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 SET3100 data output connector ⓭.
7) Re-check the levelling and centering of the SET3100.
   Set the SET3100 horizontal fine motion screw ⓫ 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 SET3100 telescope. Loosen the tubular compass clamping screw.





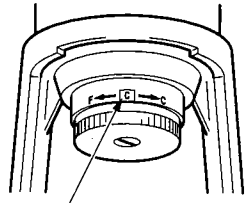


9) Use the horizontal clamp and fine motion screw to turn the SET3100 until the tubular compass needle is centred between the S index lines. The telescope of the SET3100 is now pointing to approximate magnetic north. Adjust for magnetic declination in the area of use to obtain the approximate true north direction. (Where the compass is not usable, use any other information to determine the approximate true north direction; e.g. map, sun, time, etc.)



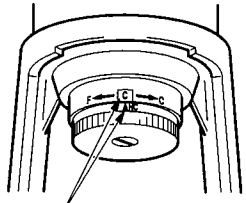
10) Do not switch on the gyromotor – first check that the movement of the pendulum is symmetrical about the zero index as follows:

a. Turn the GP1 clamping ring in the F direction; firstly until the ▼ mark appears in the clamping index ❹, and then further until the ▲ HC mark is opposite the ▼ mark. This is the half-clamped position, where the gyromotor is only lightly clamped.



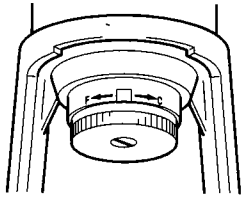
Fully-clamped position

b. Wait for about 10 seconds at this position to allow the pendulum movement to settle. (Check the floating index movement.)



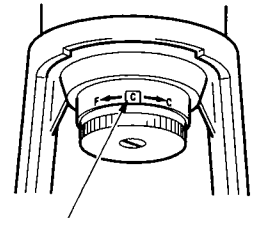
Half-clamped position

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."

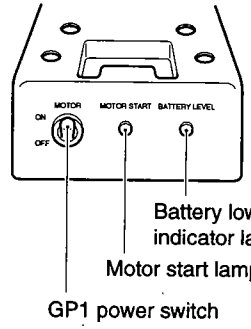
e. Re-clamp the gyromotor by turning the clamping ring fully in the C direction.
(The C mark can be seen in the clamping index ❹.)



Fully-clamped position

11) Switch on the GP1 power switch ⓯. 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 40.



Battery low indicator lamp

Motor start lamp

GP1 power switch

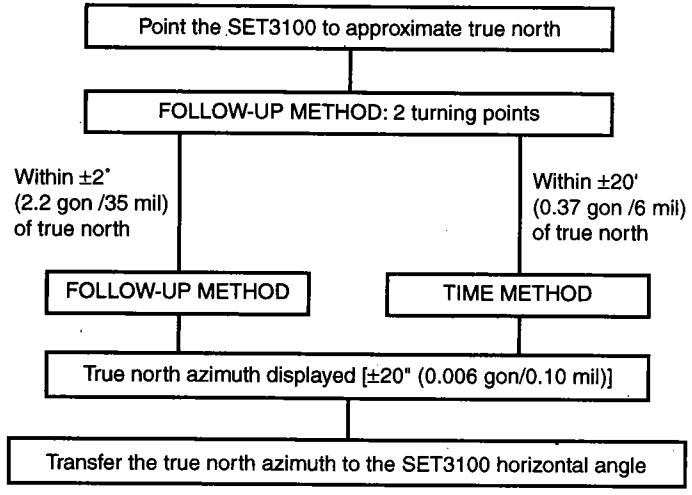
12) After about 60 seconds, the green "MOTOR START" lamp ⓰ lights to show that the gyromotor has attained the correct operating speed.

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 ⓯ 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 (±20" (0.006 gon/0.1 mil), using 3 or more turning points), after the instrument has been set to approximate true north (within ±2° (2.2 gon/35 mil)).
The TIME method requires the SET3100 to be pointing to approximately true north (within ±20' (0.37 gon/6 mil)) and determines an accurate true north position (±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.

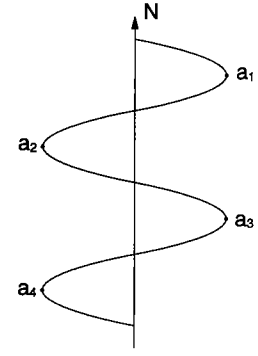


5.3 FOLLOW-UP MEASUREMENT MODE (2 or more turning points)

This method of measurement involves carefully turning the SET3100 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 SET3100 or the SF10 keyboard and the SET3100 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 SET3100 or 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

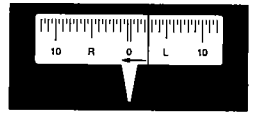
When the number of turning points is greater than 2:

$$N = \left(\frac{\frac{a_1 + a_3}{2} + a_2}{2} + \frac{\frac{a_2 + a_4}{2} + a_3}{2} + \ldots\ldots + \frac{\frac{a_{n-2} + a_n}{2} + a_{n-1}}{2} \right) \cdot \frac{1}{n-2} + R$$

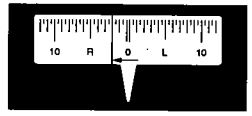
Determining the turning point

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 SET3100 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:

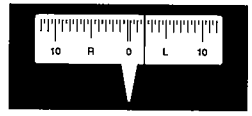


2) Wait until the floating index comes, for example to the 2nd (see Note below) graduation of the R side, then

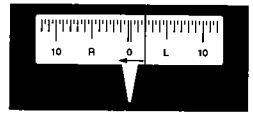


Turn the SET3100

3) rotate the SET3100 using the horizontal clamp or fine motion screw until the floating index is at the opposite 2nd graduation on the L side.

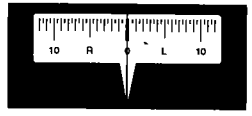


4) The floating index is seen to move in the LR direction again.



5) Repeat this procedure from step 2) until the floating index movement slows down enough for the SET3100 to be turned only one graduation, then half a graduation, 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 stand-still in the zero graduations, the SET3100 is pointing to the turning point.

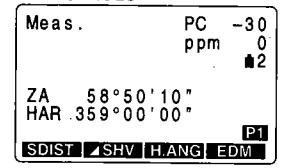


Note: When index movement is fast, the SET3100 may have to be turned in 5 or 10 graduation steps to follow it.

Procedures for follow-up measurement mode

1) Switch on the SET3100 and index the vertical and the horizontal circle. (Refer to the SET3100 operator's manual for more details.)

MEAS Mode

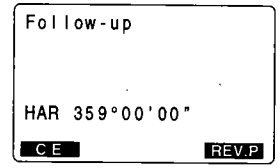


2) Shift to the follow-up measurement mode from the MEAS mode.

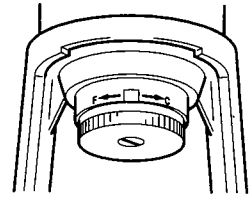
<When using the SF10 keyboard>
Press FOL.

<When using the SET3100 keyboard>
Press ESC, **[GYRO]**, **[FOL]**.

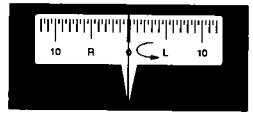
ESC [GYRO] [FOL] / FOL



3) 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.

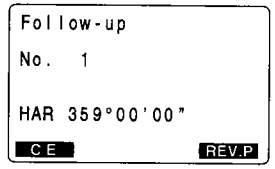


4) Use the SET3100 horizontal clamp and fine motion screw to keep the floating index mark centred in the zero graduations until the turning point is reached. (See suggested procedure on page 14.)



5) Press **[REV.P]** / REV.P on the SET3100 or the SF10 keyboard when the turning point is reached. The SET3100 display prompts for the next turning point input.

[REV.P] / REV.P

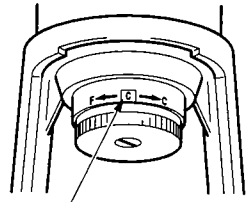


6) Continue to follow the floating index until the opposite turning point is reached. Press **[REV.P]** / REV.P again at this turning point.
7) Repeat step 6) until the required number of turning points have been measured.
   Note: Minimum 2 points; maximum 10 points.
8) Press ESC / CA on the SET3100 or the SF10 to end the measurement mode. After one long audio tone, the SET3100 calculates the true north position and exits to the azimuth display mode. (See next page.)

Note 1: After at least 4 turning points have been measured, the **[CE]** / 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.P]** / REV.P 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 SET3100 exits to the azimuth display mode.

9) Turn the clamping ring in the C direction to the half-clamped position, then to the fully clamped 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.)

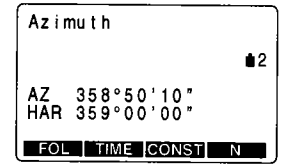


Fully-clamped position

Azimuth display mode

In the azimuth display mode on the SET3100 screen, the azimuth (angle from the calculated true north position) is displayed at "AZ." The horizontal angle from the previous zero point is displayed at "HAR." 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 SET3100 memory, and can be re-determined even after using the 0SET and hold functions.
However, note that:

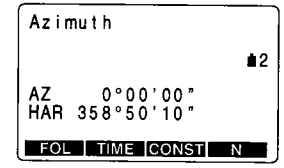
ESC / CA

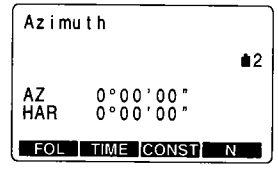


AZ: Azimuth angle from calculated true north.
HAR: Horizontal angle from SET3100 zero point.

10) **To transfer the azimuth angle to the horizontal angle:**
    Press **[N]** / 0 N on the SET3100 or the SF10 keyboard.
    The SET3100 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 SET3100 measurement modes and will continue to display the azimuth value.)

[N] / 0 N





The SET3100 telescope is sighting the measured true north direction.

11) **To continue true north measurement:**

a. Turn the SET3100 using the horizontal clamp ⑫ and fine motion screw ⑪ until the displayed azimuth value is 0 (measured true north).
   - Press **[FOL]** / FOL to repeat the follow-up measurement. See page 15 step 3).
   - Press **[TIME]** / TIME to enter the time transit measurement mode. See next page.

If all gyro measurements have been completed:

Press ESC ESC / EXIT to return to the SET3100 MEAS mode and switch off the GP1 power. Press EXIT and then press ESC when not in the MEAS mode.

Note: After return to SET3100 measurement modes:
When the azimuth angle is required again after the 0SET or hold functions have been used, first ensure that the SET3100 is in MEAS mode.

Press FOL (or TIME) to re-enter the gyro and theodolite mode, then press ESC / CA. This takes you to the azimuth display mode, where the **[N]** / 0 key can be used to re-transfer the azimuth angle to the horizontal angle. (Press ESC ESC / EXIT to return to the SET3100 MEAS mode.)
Press EXIT and then press ESC when not in the MEAS mode.

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

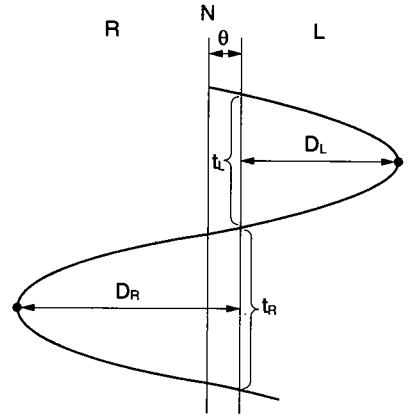
SET3100 MEAS mode → <SF10> FOL CA 0 EXIT <SET3100> ESC **[GYRO]** **[N]** ESC ESC → SET3100 MEAS mode

5.4 TIME MEASUREMENT MODE

When true north has been determined (within ±20' (0.37 gon/6 mil)), for example by using the follow-up method (2 turning points), the SET3100 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 SET3100 instrument.
By inputting the amplitude of the R and L turning points (DR and DL), and pressing a key on the SET3100 or the SF10 each time the floating index crosses the zero graduations, the SET3100 is able to calculate a true north position using the following formula:

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

K = Instrument constant
R = Alignment constant
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 ±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.

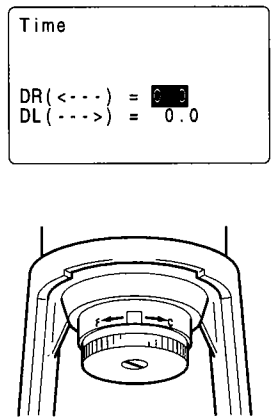
Time measurement procedure

1) For this procedure, true north should have already been approximately determined within ±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 (±20' (0.37 gon/6 mil)), and ensure that the SET3100 is switched on, indexed, and in the measurement mode.
2) Shift to the time measurement mode from the MEAS mode.

   <When using the SF10 keyboard>
   Press [TIME].
   The display now prompts for the input of the amplitude of the R turning point.

   <When using the SET3100 keyboard>
   Press [ESC] **[GYRO] [TIME].**
   The display now prompts for the input of the amplitude of the R turning point.

[ESC] **[GYRO] [TIME] / [TIME]**



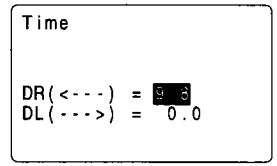
3) Turn the clamping ring to the half clamp position. Wait about 10 seconds to allow the gyromotor to settle, then slowly open the clamp to the fully open position.
   Note: If the floating index, when released, does not have a steady movement, turn the clamping ring back to the half-clamp position to damp the movements, then slowly release again.
   For accurate measurement, the index should have a steady movement.

Note: This measurement is most effective when the amplitude of the turning point values is approximately 8 to 10 divisions. The amplitude can be changed by re-clamping and releasing the clamping ring.

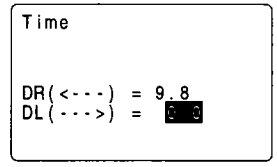
4) Read the amplitude of the turning point on the R side of the graduated scale (DR) to the nearest 0.1 graduation.
   Input this value using the SET3100 or the SF10 numerical keys.
   Example: When DR = 9.8

   <SF10> Press [9 CONST] [. FOL] [8 EPOCH].
   <SET3100> Press [9] [.] [8]

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



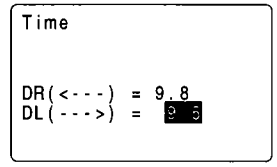
5) Press [ENT] to enter the value in the memory. The display now prompts for the input of the amplitude of the L turning point (DL).



6) Read the amplitude of the turning point on the L side of the graduated scale (DL) to the nearest 0.1 graduation.
   Input this value using the SET3100 or the SF10 numerical keys.
   Example: When DL = 9.5

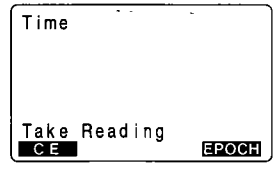
   <SF10> Press [9 CONST] [. FOL] [5 AMP].
   <SET3100> Press [9] [.] [5].

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



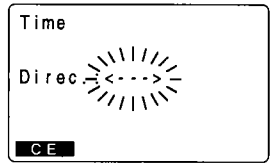
7) Press [ENT] to enter the value in the memory. The display now prompts for the input of the SET3100 **[EPOCH]** or the SF10 [8 EPOCH] key when the floating index crosses the zero graduations.

[ENT]



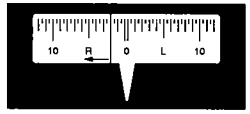
8) At the moment the floating index crosses the zero graduations, press **[EPOCH]** on the SET3100 or [8 EPOCH] on the SF10.

[EPOCH] / [8 EPOCH]

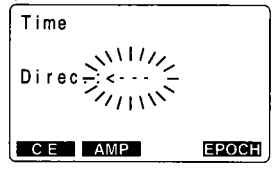


9) After input of the first zero-crossing, the <– – –> display symbol flashes, prompting for the input of the ▶ / [1 R] or ◀ / [2 L] keys, depending on which side of the scale the index now is. i.e. If the floating index is on the R side of zero after the crossing, press the ▶ / [1 R] key, and vice versa.
(After this input of the ▶ / [1 R] or ◀ / [2 L] key, the **[EPOCH]** / [8 EPOCH] key should be pressed each time the floating index mark crosses the zero graduations.
The <– – – or – – –> symbols will be displayed as a reminder of which side of zero the floating index is.)

Index on R side



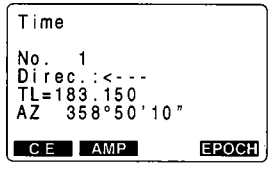
▶ / [1 R]



10) Press the **[EPOCH]** / [8 EPOCH] key at the moment the floating index crosses the zero graduation. The time taken for the half-cycle is displayed and the display prompts for the next crossing point input.

11) At the next crossing point, press **[EPOCH]** / [8 EPOCH]. The time taken for this half-cycle and the calculated azimuth angle is displayed.

[EPOCH] / [8 EPOCH]

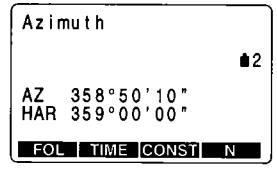


12) Continue to press the **[EPOCH]** / [8 EPOCH] key for the rerquired number of index crossings. (The maximum number of crossings is 255. After the input of the 255th crossing, the true north position is automatically calculated, and the SET3100 exits to the azimuth display mode.)

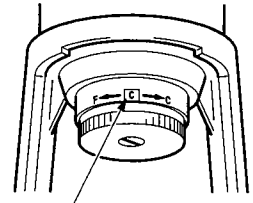
Note: If the **[EPOCH]** / [8 EPOCH] key is pressed by mistake (too early or too late), the **[CE]** / [CE] key can be used to delete the last data input. See page 24.

13) To end the time measurement, press [ESC] on the SET3100 or [CA] on the SF10. After one long audio tone, the SET3100 calculates the final true north position and exits to the azimuth display mode.

[ESC] / [CA]



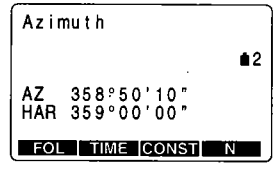
14) Turn the clamping ring in the C direction to the half-clamp position, and then to the full-clamp position. If all measurement has been completed, the GP1 power can be switched off.



Fully-clamped position

Azimuth display mode

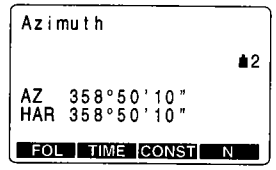
At the SET3100 screen, the azimuth (angle from the calculated true north position) is displayed at "AZ". The horizontal angle from the previous zero point is displayed at "HAR". Both angles are displayed in real time (the angles change as the theodolite is rotated).



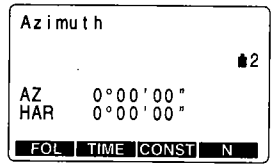
The calculated true north position is stored in the SET3100 memory, and can be re-determined even after using the 0SET and hold functions.

15) **To transfer the azimuth angle to the horizontal angle:**
Press **[N]** / [0 N] on the SET3100 or the SF10 keyboard.
The SET3100 now displays the azimuth angle value from the calculated true north direction as its horizontal angle. (The theodolite can be returned to the normal SET3100 measurement modes and will continue to display the azimuth value as the horizontal angle.)

[N] / [0 N]



16) **To continue true north measurement:**
a. Turn the SET3100 until the displayed azimuth value is 0 (measured true north).
- Press **[TIME]** / [+/- TIME] to repeat the time measurement. See page 20, step 2), or
- Press **[FOL]** / [FOL] to enter the follow-up measurement mode. See page 15, step 2).



The SET3100 telescope is sighting the measured true north position.

If all gyro measurements have been completed:
Press [ESC] [ESC] / [EXIT] to return to the SET3100 MEAS mode, and switch off the GP1. Press [EXIT], and press [ESC] when not in the MEAS mode.

Note: After the SET3100 0SET or hold functions are used, the horizontal angle is no longer related to true north. To recover the calculated azimuth, see Note on page 18.

Note 1: Deleting a wrong input of the crossing (**[EPOCH]** / [8 EPOCH]) point using the **[CE]** / [CE] key.
If the **[EPOCH]** / [8 EPOCH] key has been pressed by mistake (too early or too late), the last-input value can be deleted by pressing **[CE]** / [CE].
- To compute the true north position from the remaining crossing points (if more than 2 points are stored in the memory), press [ESC] / [CA]. The true north position is computed, then the instrument exits to the azimuth display mode.

- To continue with the time measurement mode, the SET3100 prompts for the R (DR) and L (DL) turning point amplitudes, which can be re-read and input as in step 4) to 7).
From this point onwards, the procedure is the same as step 8) onward. Note that the previously-stored crossing points are retained in the memory and will be used in the true north calculation.

Note 2: After entering the time measurement mode as described in step 2), input the DR and DL turning point amplitudes as 0 [⏎] / [ENT] and 0 [⏎] / [ENT] respectively. The display then prompts for the first crossing point input.
Press **[EPOCH]** / [8 EPOCH] when the floating index crosses the zero graduations. As in step 9), press the [▶] / [1 R] or [◀] / [2 L] key depending on which side of the scale the floating index now is.
At the turning point, read the amplitude value of the direction and input it using the **[AMP]** / [5 AMP] key:

e.g. Press **[AMP]** / [5 AMP] (amplitude value) [⏎] / [ENT].

Press **[EPOCH]** / [8 EPOCH] when the next crossing point occurs.
At the next turning point, read the amplitude value and input it using the **[AMP]** / [5 AMP] key:

e.g. Press **[AMP]** / [5 AMP] (amplitude value) [⏎] / [ENT].

Continue the measurement procedure from step 11).
Note that, if the turning point values are not input by the end of the first measurement cycle, the previously-stored turning point values will be used in the calculation.

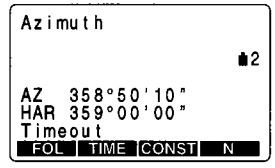
6. SELF DIAGNOSIS

6.1 SELF DIAGNOSIS I: ERROR MESSAGES

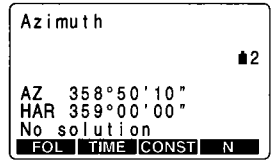
During measurement, the error messages shown in the displays below table may be displayed.

1. Horizontal angle count error
E100 (Horizontal angle field)

2. T_L/T_R timeover error
Timeout · · · · If **[EPOCH]** / [8 EPOCH] is not input within 5 minutes during the measurement of T_L/T_R, the time measurement mode and instrument constants measurement mode is forcibly ended, and the azimuth display mode is set. In the time measurement mode, set the azimuth angle if it can be calculated.



3. Calculation error
No solution · · · · When divided by 0 or the constant calculated exceeds the range in the instrument constants measurement mode, the instrument constants measurement mode is ended and the azimuth display mode is set. The constant/azimuth angle measured before is effective.



6.2 SELF DIAGNOSIS II

The Inverter unit is provided with the following indication lamps.
Level lamp ..... A red lamp lights when the battery voltage is lower than the required level.
Start lamp..... A green lamp lights when the gyromotor reaches the correct rotation speed.

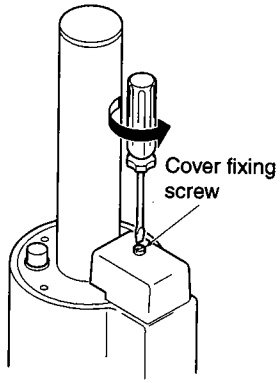
6.3 TROUBLE SHOOTING

Check the instrument as follows when it does not work normally.

1) When the gyromotor does not run:
   (The rotation sound cannot be heard.)
   - Check if the red battery low lamp ⑰ is lit.
     If so, make sure the clamping ring is clamped, switch off the GP1, then remove the battery and recharge. See page 40.
   - Check if the cables are firmly connected.
     If not, connect the cables in the correct way.
   - Check if the fuse of the Inverter is blown.
     If so, replace the fuse (4A) with a new one.
   - Check if any cables are broken.
     If so, replace the broken cable.
2) When the index mark does not move:
   - Check if the SET3100 is levelled correctly.
     If not, level the SET3100 by referring to the SET3100 operator's manual. (Measurement cannot start when the SET3100 is badly off level.)
   - Check to see if the suspension tape is broken.
     If so, replace the tape, referring to page 30.
3) During observation, the speed of the index movement increases.
   - Check if the battery low lamp ⑰ is lit.
     If so, make sure the clamping ring is clamped, switch off the GP1, then remove and recharge the battery. See page 40.
4) When the graduations cannot be seen.
   - Check if the bulb has blown.
     If so, replace the bulb according to the procedure on the next page.

Replacing the bulb

a. Loosen the fixing screw for the illumination cover, and remove the cover.
b. Replace the bulb (12V/3W) with a new one.
c. Replace the illumination cover.
d. If the lamp still does not light, check if the battery low lamp ⓱ is lit. If so, charge the battery by referring to page 40.

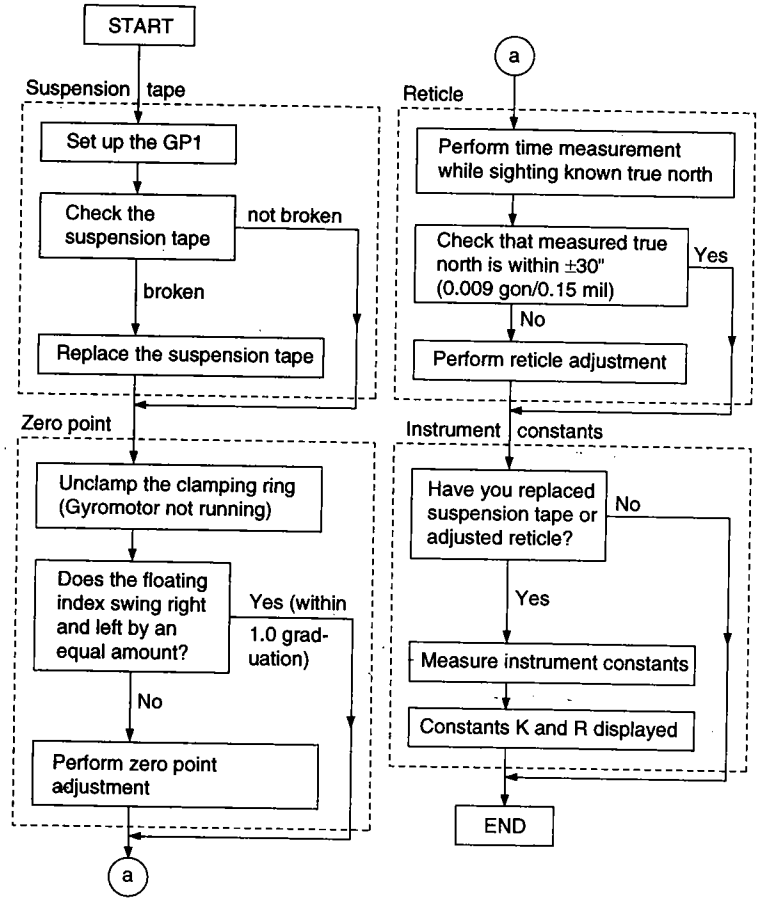


5) When the motor start lamp does not light:
Check if the battery low lamp is lit. (If so, recharge the battery by referring to page 40.)

6) If the SET3100 measurement mode cannot be changed to the MEAS mode:
Check if the SET3100 vertical circle has been indexed. (If not, index the SET3100 vertical circle by referring to the procedures in the SET3100 operator's manual.)

7. CHECKS AND ADJUSTMENTS

After replacing the suspension tape, or if the measuring station is greatly different in latitude from the previous one, perform the following checks and adjustments.
However, as it is necessary to know the true north position before checking (except for the zero point check), and to perform the checks precisely, it is recommended that a Sokkia agent performs these checks.

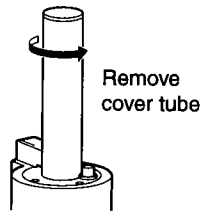


7.1 REPLACING THE SUSPENSION TAPE

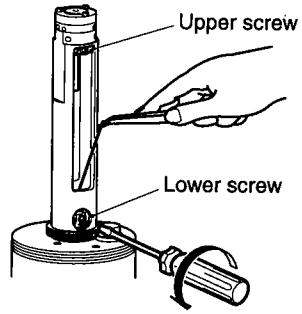
1) Set up the GP1 on the SET3100.

2) Sight the telescope on the known true north position.

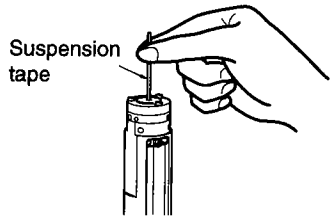
3) Unscrew and remove the GP1 cover tube.



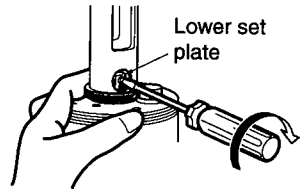
4) Loosen the screws on the upper and lower set plates.
Remove the broken tape using the pincettes.



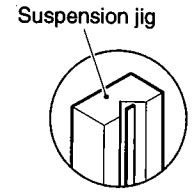
5) Insert a new suspension tape from the top of the suspension piece, then insert the tape in the gap in the lower set plate.



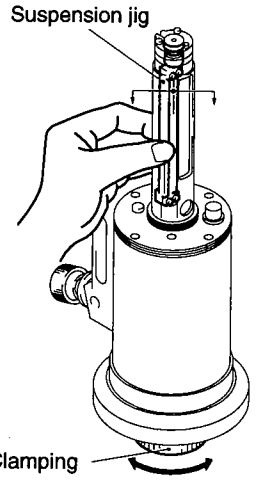
6) Secure the suspension tape by tightening the screws of the lower set plate so that the tape is at the centre of the plate.



7) Put the suspension jig on the lower set plate, then rotate the clamping ring ❺ to move the pendulum down until the suspension jig will fit into the space between the upper and lower suspension pieces.
Note: Take care that the pendulum does not catch the tension absorbing spring when the pendulum is set free.



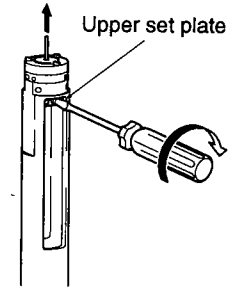
8) Insert the suspension jig in the space between the upper and lower suspension pieces.



9) Rotate the clamping ring so that the pendulum moves up, holding the suspension jig between the upper and lower suspension pieces.

10) Make sure that the suspension tape is aligned with the V-groove of the suspension jig.

11) While pulling the top end of the suspension tape, secure it with the upper set plate by tightening the screws so that the suspension tape is at the centre of the V-groove.



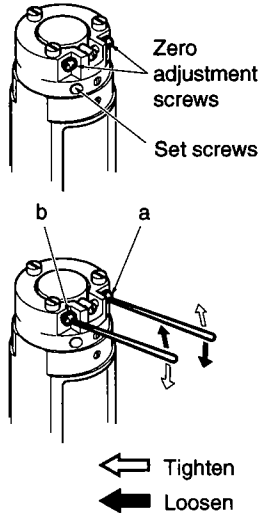
12) Rotate the clamping ring to move the pendulum down, and remove the suspension jig.

13) Adjust the zero point from step 4) on the following page.

7.2 ZERO POINT ADJUSTMENT

This adjustment is necessary if the oscillation of the floating index is not symmetrical within 1.0 scale division. (Gyromotor not running.)

1) Set up the GP1 on the SET3100.
2) Turn the telescope to the approximate true north position.
3) Remove the cover tube.
4) Unclamp the gyroscope pendulum by turning the clamping ring ❺ fully in the F direction.
5) Half-loosen the three set screws on the top of the suspension piece. Adjust the zero adjustment screws while watching the floating index as follows:
   When the R amplitude is larger than the L amplitude, loosen the right-side adjusting screw slightly and tighten the left-side adjusting screw by the same amount.
   The screw adjusting procedure should be reversed if the L amplitude is larger than the R amplitude.
   DO NOT OVER-TIGHTEN THE ADJUSTING SCREWS.



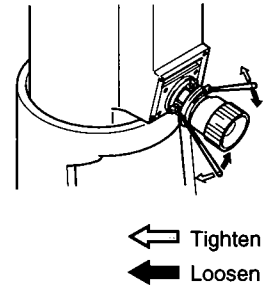
6) The adjustment is complete if the oscillation is symmetric within 1.0 division about the zero point.
7) Tighten the upper three set screws and replace the cover tube.

7.3 RETICLE ADJUSTMENT

This adjustment is necessary if the alignment constant R is larger than 30" (0.009 gon/0.15 mil) after performing the instrument constant measurement, or it the difference between known and measured true north is greater than 30" (0.009 gon/0.15 mil).

1) When the instrument is sighted on the known true north position, perform the time measurement several times (input the R constant value as zero) and determine the difference between the measured and known true north positions.
   Turn the clamping ring to C to clamp the gyromotor.
2) To adjust, unscrew and remove the eyepiece cover and read the floating index position.
3) Adjust the reticle adjusting screws, considering that the amount of the shift is 0.1 divisions per 1' (0.02 gon/0.3 mil):

   When the measured value is between 30" and 1°00'00" (0.009 and 1.1 gon/0.15 and 18 mil), slightly loosen the adjusting screw on the left side and tighten the one on the right side by the same amount.
   When the measured value is between 359°00'00" and 359°59'30" (398.9 and 399.991 gon/6382 and 6399.85 mil), loosen the adjusting screw on the right side and tighten the one on the left side by the same amount.



4) Replace the eyepiece cover.
5) Perform the zero point adjustment. See previous page.
6) Repeat the time measurement three times after the adjustment (with constant R = 0) to determine the new measured – true north value. If the new value is greater than ±30" (0.009 gon/0.15 mil) repeat the above procedure from step 2).

Note: After this adjustment, the instrument constants measurement procedure should be performed. See next page.

7.4 INSTRUMENT CONSTANTS DETERMINATION

This procedure should be performed after the suspension tape has been replaced or if the measuring location is greatly different in latitude from the previous location.
The instrument constant K and alignment constant R can be obtained by this method when an accurate true north position is known.
Three measurements are taken: one at true north, and one each at 10' (0.2 gon/3 mil) east and 10' (0.2 gon/3 mil) west.

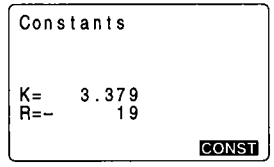
7.4.1 Enter the instrument constants measurement mode

1) Set up the instrument as for section 5.1.

2) Shift to the instrument constants measurement mode from the MEAS mode.

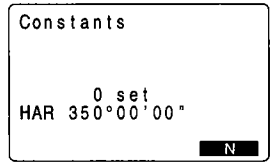
<When using the SF10 keyboard>
press [9 CONST].
The instrument constants measurement mode will be set.
<When using the SET3100 keyboard>
press [ESC] **[GYRO] [CONST]**.
The instrument constants measurement mode will be set.

[ESC] [GYRO] [CONST] / [9 CONST]



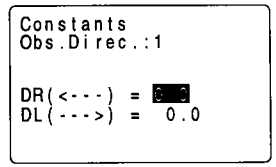
3) Then press **[CONST]** / [9 CONST] twice in quick succesion. (Blinks on first press.)

[CONST] [CONST] / [9 CONST] [9 CONST]



4) True north direction entry.
Sight known true north and press **[N]** / [0 N].
(It is unnecessary to reset the horizontal angle display to zero before the true north direction entry.)
After pressing **[N]** / [0 N], the measurement should be performed in the first direction. (The first direction should always be the known true north direction.)

[N] / [0 N]

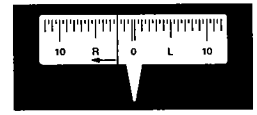


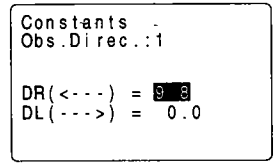
7.4.2 The first direction measurement (to true north)

5) Turn the clamping ring to the half-clamp position. Wait about 10 seconds to allow the index movement to settle, then slowly open the clamp to the fully open position.
Note: If the floating index, when released, appears to have short-term oscillations, half-close the clamping ring to damp these movements, then slowly release again.
For accurate measurement, the index should have a steady movement, and have a R and L amplitude of 8 to 10 graduations.
(The amplitude can be changed by re-clamping and releasing the clamp.)

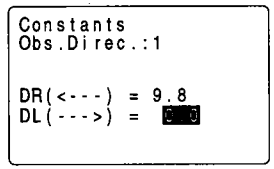
6) Read the amplitude of the turning point on the R (or L) side of the graduated scale where the floating index now is. (Read the amplitude to the nearest 0.1 graduation.)
Input this value using the SET3100 or the SF10 numerical keys.
Example: When DR = 9.8
<SF10> Press [9 CONST] [• FOL] [8 EPOCH].
<SET3100> Press [9] [•] [8].
(To correct a mis-input, press **[CE]** / [CE] and re-input the value.)

Index on R side





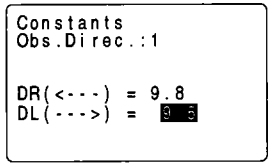
7) Press ↵ / ENT to enter the value in the memory.



8) Read the amplitude of the turning point on the L (or R) side of the graduated scale to the nearest 0.1 graduation.
Input this value using the SET3100 or the SF10 numerical keys.
Example: When DL = 9.5

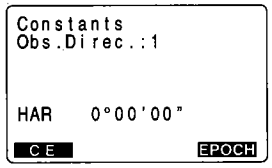
<SF10> Press 9 CONST FOL 5 AMP.
<SET3100> Press 9 . 5.

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



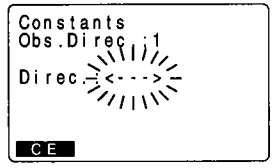
9) Press ↵ / ENT to enter the value in the memory. The display prompts for the input of the SET3100 or the SF10 **[EPOCH]** / 8 EPOCH key when the floating index crosses the zero graduations.

↵ / ENT



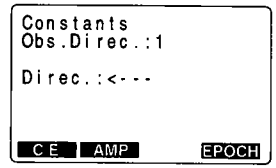
10) At the moment the floating index crosses the zero graduations, press **[EPOCH]** / 8 EPOCH on the SET3100 or the SF10.

[EPOCH] / 8 EPOCH



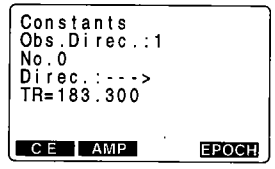
11) After input of the first zero-crossing, the <---> display symbol flashes, prompting for the input of the ▶ / 1 R or ◀ / 2 L keys, depending on which side of the scale the index now is. i.e. If the floating index is on the R side of zero after the crossing, press the ▶ / 1 R key, and vice versa.
After this input of the ▶ / 1 R or ◀ / 2 L key, the <--- or ---> symbols will be displayed as a reminder of which side of zero the floating index is. The display now prompts for input of the SET3100 or the SF10 **[EPOCH]** / 8 EPOCH key when the floating index crosses the zero graduations.

▶ / 1 R



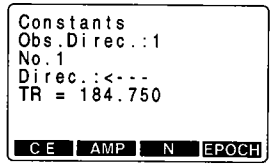
12) At the moment that the floating index crosses the zero graduations, press **[EPOCH]** / 8 EPOCH on the SET3100 or the SF10.
The time taken for the half-cycle is displayed and the display prompts for the next crossing point input.

[EPOCH] / 8 EPOCH



13) Press the **[EPOCH]** / 8 EPOCH key at the moment the floating index crosses the zero graduations.
The time taken for this half-cycle is displayed.
After this input of the full cycle, an audio warning is given approximately 20 seconds before the floating index is due to cross the zero graduations. This eliminates the need for the operator to constantly watch the movement of the floating index.

[EPOCH] / 8 EPOCH



14) Continue to press the **[EPOCH]** / 8 EPOCH key for the required number of zero crossings. Maximum = 10. (After 10 inputs, the display automatically prompts for the 2nd direction measurement.)
Note: If the **[EPOCH]**/ 8 EPOCH key is pressed by mistake (too early or too late), the **[CE]** / CE key can be used to delete the last input data. See Note on page 39.

15) Press **[N]** / 0 N when the required number of zero crossings have been input for this direction. The display prompts for the start of the 2nd direction measurement.

[N] / 0 N

```
Constants
Obs.Direc.:2

DR(<---) = 0.0
DL(--->) = 0.0
```

16) Turn the clamping ring in the C direction to the half-clamp position, and then to the full-clamp position.

7.4.3 The second and third direction measurement

17) Turn the telescope to the second direction of either 10' (0.2 gon/3 mil) east or west.

```
Constants
Obs.Direc.:2

HAR   0°10'00"
CE                EPOCH
```

18) Repeat the measurement in the same way as step 5) to 16) for the second, and then the third directions.

19) After pressing **[N]** / 0 N on the SET3100 or the SF10 at the end of the third measurement, a long audio tone sounds and the SET3100 calculates and displays the values of instrument constants K and R.

[N] / 0 N

```
Constants

K=  3.224
R=   -19"
                  REC
```

Note: If R > ±30" (0.009 gon/ 0.15 mil), see page 33.

20) If all measurements have been completed, ensure that the clamping ring is fully clamped, then switch off the GP1 power.

21) Write the values of K and R on the instrument constants card and insert it in the GP1 constants card holder.

22) To exit from the instrument constants measurement mode:
a. To return to the Azimuth display mode, memorize the constant obtained by the measurement in SET3100, and press **[REC]** / ↵.
b. To return to the Azimuth display mode, delete the constant obtained by the measurement, and press **[CA]** / CA.

[REC] / ENT

```
Azimuth
                    ▮2
AZ
HAR 359°00'00"
FOL  TIME  CONST  N
```

Note: Deleting a wrong input of the crossing (**[EPOCH]** / 8 EPOCH) point using the **[CE]** / CE key.
If the **[EPOCH]** / 8 EPOCH key has been pressed by mistake (too early or too late), the last-input value can be deleted by pressing **[CE]** / CE.
a. To continue with the measurement in this direction, re-confirm the R (DR) and L (DL) turning point amplitudes, then the procedure is the same as from step 9) onward.
Note that the previously-stored crossing points are retained in the memory and will be used in the final computation of the true north position.
b. To end the measurement in this direction, press **[N]** / 0 N. The display prompts for the start of the next direction measurement.

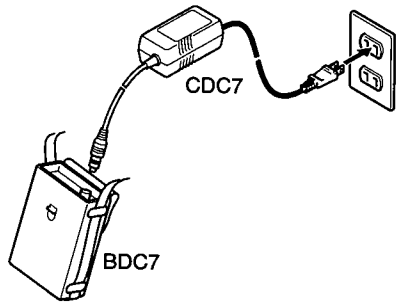
8. BATTERY CHARGING

Precautions

1) Charge the battery at a temperature between 10°C and 40°C. The higher the temperature, the longer the charging time will be.
2) The battery charger normally becomes warm while charging.
3) Do not use the charger to charge more than three batteries successively.

Procedure

1) Connect the charger CDC7 power plug to the power source.
2) Connect the charger CDC7 to the battery BDC7.
3) Make sure the pilot lamp is on.
4) About 15 hours are required for charging.
5) When charging is over, remove the charger from the battery and the power source.



Battery and Charger specifications

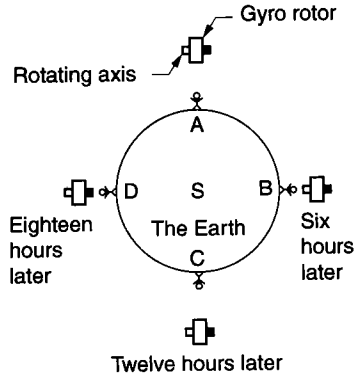
BDC7	Output voltage:	12V DC
	Capacitance:	3400 mAh
	Size:	140 x 45 x 230 mm
	Weight:	2.0 kg

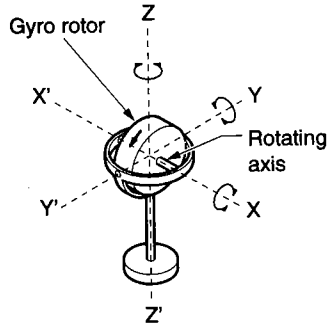
CDC7	Used for charging:	BDC7
	Input voltage:	100V AC , 50/60 Hz, 12VA
	Output voltage:	14.5V DC
	Output current:	350 mA
	Input cable length:	1.5 m
	Output cable length:	1 m
	Temperature fuse:	125°C
	Charging time:	15 H
	Charging lamp:	Provided
	Size:	60 x 50 x 116 mm
	Weight:	0.5 kg
CDC7A		120V AC, 50/60 Hz, 12VA
CDC7B		220V AC, 50/60 Hz, 12VA All other specifications are the same as the CDC7.

APPENDIX 1: PRINCIPLE OF THE GP1

The GP1 pendulum-type gyroscope consists of a gyroscopic motor suspended by a tape and housed in a cylindrical body, which is mounted on the SET3100 electronic total station.
The pendulum oscillates around the earth's meridian. This oscillation (called precession) is observed by the use of a mirror attached to the pendulum and can be followed without applying any torque to the suspension tape by slowly turning the theodolite (follow-up mode). Both turning points of the precessional oscillation can be read on the horizontal circle of the total station and the SET3100 can calculate the centre of the precession (true north). When the optical axis of the theodolite is coincidental with the direction of the centre of precession, the instrument telescope is sighting true north.

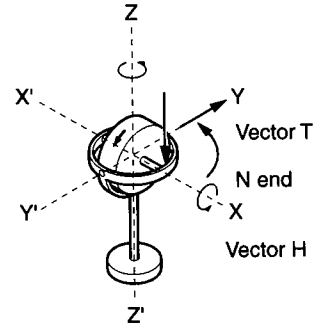
[Theory of the gyroscope]
The gyroscope is really a motor having a large moment of inertia, and spinning rapidly. When the angular momentum of the rotor is high, and the rotor is freely suspended, the direction of the rotating axis is kept unchanged in space. The Earth is seen from the south. Suppose a gyroscope started to oscillate over the arbitrary point A on the equator. It is assumed that the gyroscope has freedom in three axes as shown below.



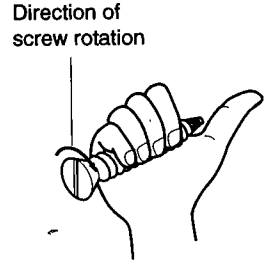


[Degree of freedom in three axes]
The three axes are defined as shown. If the rotating axis of the gyroscope can freely change direction around the XX', YY', and ZZ' axes, the gyroscope is said to have freedom in three axes.

Six hours later, the rotation of the earth will cause point A to reach point B. At that moment, the N end of the rotating axis faces the same direction as it did at point A. Similarly, 12 hours later, at point C and 18 hours later at point D, the direction of the axis will remain unchanged. Although an observer on the axis will perceive the direction of the axis to be changing, it must be remembered that, as described above, a gyroscope maintains its original rotating direction.
Besides the ability to maintain axis direction, the gyroscope has another important characteristic. When torque (twisting moment to change the axis direction) is applied to the rotating axis, the rotating axis starts moving in the direction of the torque vector due to precession.

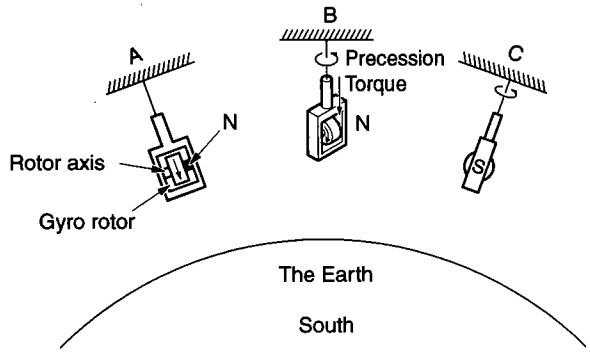


If torque is applied to the rotating axis, lowering the N end of the rotating axis, while the gyro, which has freedom in three axes, is rotating clockwise as viewed from X', the gyroscope will start rotating counterclockwise on the ZZ' axis as viewed from Z.
The original rotation of the rotor and the torque applied to the rotor which moves the N end downward are expressed as vectors H and T, respectively, based on the right-hand screw law.
The rotating vector H rotates in the direction of torque vector T, and this rotating motion is called precession.



[Right-hand screw law]
The four fingers represent the direction of screw rotation, while the thumb indicates the advancing direction of the screw. Torque vector is defined as the direction of the thumb. The direction and amount of rotation are thus represented by a vector shown by the right-hand screw law.

[Pendulum gyroscope]
If the motor of a pendulum gyroscope is rotated clockwise viewed from end S of the rotating axis with another end N of the rotating axis facing east at an arbitrary point Q, the gyroscope changes its position from A to B, then B to C (see below) and finally the N end faces true north, i.e., the rotating axis aligns itself with the meridian by precession. Here it is assumed that the torque around the suspension tape is nil. Let us consider what causes the northward rotation of the N end.



Even though the axis has a property which allows it to maintain its direction unchanged, end N of the axis must go down because of the rotation of the earth. In other words, when the Earth's gravity applies torque to the pendulum, its vector faces north. Therefore, end N of the axis (vector of rotor) starts a precession toward the north. Until end N precesses to the north, the torque caused by gravity is applied and the precession continues. The speed of precession is greatest in the north direction. After end N passes north, gravity applies torque to lower the new end N (old end S) downward. Therefore, the speed of precession decreases. When the new S end precesses to the same bearing at this end, a movement back to the north starts. Because the rotation of the Earth never stops, the back and forth motion around north will continue as long as the motor continues to rotate. This is the precession of a pendulum gyroscope.

SPECIFICATIONS

1) GP-1 main unit

Standard deviation of measurements:	±20" (0.006 gon/0.10 mil)
Running-up time:	Approx. 60 sec
Half period (at middle latitudes):	Approx. 3 min
Minimum interval between main divisions:	Approx. 10' (0.185 gon/3 mil)/div.
GP-1 mounting accuracy:	±5" (0.002 gon/0.025 mil)
External dimensions:	Approx. 145(W) x 200(D) x 416(H) mm
Weight:	Approx. 3.8 kg

2) Power supply units

Inverter

Input:	12V DC
Output:	115V AC, 400 Hz
External dimensions:	Approx. 240 x 130 x 55 mm
Weight:	Approx. 2.4 kg

Battery (BDC7)

Voltage:	12V DC
Capacity:	4A hours
Operating time:	3 hours
External dimensions:	Approx. 250 x 140 x 50 mm
Weight:	Approx. 2.0 kg

Charger (CDC7/7A/7B)

Input:	100/120/220V AC
Output:	14.5V DC
Charging time:	15 hours
External dimensions:	Approx. 120 x 60 x 50 mm
Weight:	Approx. 0.5 kg

Cables

004-D0170 (5 pin):	1.5 m
004-D0171 (3 pin):	1.0 m

3) Keyboard (SF10)

Measurement modes:	Follow-up
	Time
	Instrument constants
Power supply:	Supplied from the SET3100
External dimensions:	58 x 110 x 13 mm
Weight:	0.11 kg
Cable length:	1.5m

4) SET3100 Electronic Total Station

Including special mounting attachments, case and software.
Some communication commands are deleted, and only the following communication commands can be used.

A	B	Ea	Ee	Gd	Gf
/B	/Db	/Dc	/De		
Xf	Xg	Xk	%		

Refer to the SET3100 operator's manual for other specifications.

5) Optional accessory

An AC adaptor is available.

MAINTENANCE

1) The gyromotor should be overhauled three years after the purchase date, or after 3000 hours of use, whichever occurs sooner.
2) Wipe off moisture completely if the instrument gets wet during survey work.
3) Always clean the instrument before returning it to its case.
4) For SET3100 maintenance, refer to the SET3100 operator's manual.

The specifications and general appearance of the instrument may be altered or improved at any time and may differ from those appearing in catalogues and operator's manuals.

MEMO

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