TOPCON

GB-500

Operator's Manual

PRECISION GPS

TOPCON
POSITIONING SYSTEMS

GB-500
Operator's Manual

Part Number 31-050506-01
Rev B

Topcon only sells GPS products into Precision Markets.
Please go to www.topcongps.com for detailed market information.

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Preface

Thank you for purchasing a TOPCON GNSS Receiver GB-500.

This instruction manual explains how to operate, inspect and adjust the GB-500, and other pertinent matters.

In order to use the GB-500 efficiently and safely, please read "Handling and Safety Precautions" on page B-1 before use, and then use it as prescribed. Also, please make sure that this manual is always near at hand.

User Information

1. This product is for professional use only!

   The user is required to be a qualified surveyor or have a good knowledge of surveying, in order to understand the user and safety instructions, before operating, inspecting or adjusting.
2. Wear the required protectors (safety shoes, helmet, etc.) when operating.

Exceptions from Responsibility

1. The user of this product is expected to follow all operating instructions and make periodic checks of the product's performance.
2. The manufacturer, or its representatives, assumes no responsibility for results of a faulty or intentional usage or misuse including any direct, indirect, consequential damage, and loss of profits.

3. The manufacturer, or its representatives, assumes no responsibility for consequential damage, and loss of profits by any disaster (earthquake, storms, floods, etc.).

   The manufacturer, or its representatives, assumes no responsibility for fire, accident, or any act by a third party, and/or usage under other usual conditions.
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6. The manufacturer, or its representatives, assumes no responsibility for damage caused by wrong movement or action due to connecting with other products.

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Regulatory Information

The following section provides information on this product's compliance with government regulations.

Community of Europe Compliance

We Topcon Corporation declare EC Conformity for the following product:

Product Identification:

Brand: Topcon

Model/Type: GEODETIC RECEIVER

Model Number: GB-1000/500

Manufacturer:

Name: Topcon Positioning Systems

Address: 5758 W. Las Positas Blvd., Pleasanton, CA 94588

Country: USA

Tel: 925-460-1300 Fax: 925-460-1336

Standards used:

EN 55024:1998, EN 55022/1997 class A, EN60950:2000

Means of Conformity:

The product is in conformity with Directive 89/336/EEC based on test results using harmonized standards in accordance with Article 10(1) of the Directive.

Manual Conventions

This manual uses the following conventions:

Example	Description
ENT	Press or click the **button or** key labeled **ENT**.
File ▸ Exit	Click the **File** menu and click **Exit**.
Connection	Indicates the name of a dialog box or screen.
Frequency	Indicates a field on a dialog box or screen, or a tab within a dialog box or screen.

TIP

Supplementary information that can help you configure, maintain, or set up a system.

NOTICE

Supplementary information that can have an affect on system operation, system performance, measurements, or personal safety.

CAUTION

Notification that an action has the potential to adversely affect system operation, system performance, data integrity, personal health.

WARNING

Notification that an action *will* result in system damage, loss of data, loss of warranty, or personal injury.

Introduction

Topcon Positioning System's GB-500 (Figure 1-1) is a dual-frequency, GPS+ receiver built to be the most advanced receiver for the surveying market. The GB-500 can receive and process both L1 and L2 signals, improving the accuracy of your survey points and positions. The dual-frequency and GPS+ features of GB-500 combine to provide the only real time kinematic (RTK) system accurate for short and long baselines. Several other features, including multipath mitigation and co-op tracking, provide under-canopy and low signal strength reception. The receiver provides the functionality, accuracy, availability, and integrity needed for fast and easy data collection.

Figure 1-1. GB-500 Receiver

The GB-500 is a multi-function, multi-purpose receiver intended for precision markets. Precision markets means markets for equipment, subsystems, components and software for surveying, construction, commercial mapping, civil engineering, precision agriculture and land-based construction and agriculture machine control, photogrammetry mapping, hydrographic and any use reasonably related to the foregoing.

GPS Surveying

Table 1-1 describes the methods of surveying and typical situations for each method that the GB-500 performs.

Table 1-1. Observation Methods with the GB-500

Surveying Method	Appropriate Situations
Static surveying	When the baseline calculated is long and/or the environment is severe (in terms of severe multipath, dense tree canopy, etc.)
Rapid static surveying	When the baseline is several kilometers long and survey conditions are “average” (in terms of multipath, residual ionosphere, number of satellites in view, etc.)
Stop & Go kinematic surveying	When the observation of multiple points within a relatively short range is required in a short occupation time.
Continuous kinematic surveying	Dynamic topographical surveying.
Real time kinematic surveying	Stakeout, topographical surveying, and other situations that require the observation of multiple points in real time.

Post-Processing Surveying

Post-processing surveying involves recording observation data to the GB-500's built-in memory, downloading the observation data into a computer using data download software (such as, Topcon Link), and analyzing the data using post-processing software to obtain precise baseline vector information (such as, Topcon Tools).

Surveying methods that work best for post-processing are:

- Static surveying
- Rapid static surveying
- Stop & Go kinematic surveying
- Continuous kinematic surveying

Remember that the method of observation, observation time, etc., differ for each surveying method.

Guidelines for Post-Processing Surveying

While conducting a survey for post-processing, remember to follow these guidelines:

- Base and rover receivers must collect raw data simultaneously.
- Base and rover receivers must collect data during the same recording interval.

Static Surveying

Static surveying is the most precise surveying method. With static surveying, the antenna is fixed at a point by means of a tripod or some other anchoring device. Using at least two receivers, one at a known point and the other at an unknown point, observation is conducted simultaneously, using the same recording interval, and with at least four common satellites.

While static surveying is the most precise surveying method, it also requires the longest observation time. Observation time can vary from less than an hour to several hours; recording intervals can range from a few seconds to half a minute or so. However, observation time will vary with observation conditions and the baseline distance.

While static surveying can be performed with single or dual frequency data, baselines measured with single frequency receivers are generally limited to 10km. Dual-frequency surveying will allow for baseline greater than 10km and eliminate most of the related ionospheric effects. For these longer baseline measurements, dual-frequency data options are necessary.

Static surveying requires simultaneous observation by at least two receivers. To increase the efficiency of the work, survey multiple observation points using multiple receivers to conduct the survey. With post-processing software, you can simultaneously analyze and process the observation data obtained using multiple receivers.

Compared to the other surveying methods, static surveying requires a longer observation time. By the same token, however, it enables such analysis-related problems as cycle slip and multipath to be solved and a high precision of accuracy to be obtained.

Rapid Static Surveying

Rapid static surveying is essentially the same as static surveying, except that observation can be carried out in a shorter time period and requires GPS dual-frequency receivers.

Generally, rapid static surveying is effective for vectors up to 10–15 miles long, observation time between 3 and 10 minutes, and data acquisition intervals varying between 1 and 5 seconds. However, the effective baseline distance and

observation time will vary with the number of satellites tracked, the DOP, the existence or absence of cycle slip or multi-path, other observation conditions, and with environmental conditions.

Thanks to its short observation time, rapid static surveying increases work efficiency. On the other hand, the quantity of observation data obtained is small, so the precision and reliability of the data may be less than with static surveying.

To increase the precision of the data obtained, use occupation planning software to confirm the number of satellites and that the time period for RDOP (relative dilution of precision), and other conditions, is good; conduct thorough preparations for the observation.

Kinematic Surveying

With kinematic surveying, the reference station conducts static surveying, just as with the static surveying method; however, the rover station observes while moving. There are two types of kinematic surveying: Stop & Go and Continuous.

Like static surveying, kinematic surveying requires that at least two receivers receive signals simultaneously from the same four or more satellites. One of the receivers serves as the reference station. As with static surveying, this station conducts static observation with a fixed antenna using a tripod or some other anchoring device. The other receiver is a rover; it conducts observation by way of an antenna that is held, affixed to a pole or other similar attachment, and moved. As with the other surveying methods, observation can be conducted simultaneously using multiple rovers and a shared reference station.

With Stop & Go kinematic surveying, the rover receiver remains on while moving from one survey point to another. As a result, the rover's trajectory consists of alternating static and kinematic occupations. The rover must continuously track satellites without losing a lock on the satellites when changing from kinematic to static observation, and vice versa. With Stop & Go surveying, static observation time is normally selected between 10 to 60 seconds, while the recording interval is selected so as to have at least a dozen measurement epochs over the static occupation. The longer the static observation time, the greater will be the precision of the data obtained. The analytical results obtained from this method correspond to the static observation site.

Continuous kinematic surveying is a non-stop surveying method used for obtaining the consecutive, precise trajectory of a moving body, etc. With this method, results are obtained for each recording interval.

Real Time Kinematic (RTK) Surveying

Real time kinematic (RTK) surveying is a method that returns positioning results obtained in real time, and requires a controller to download and save the results.

With RTK surveying, as with post-processing kinematic surveying, one receiver serves as the reference station and conducts observation with its antenna anchored using a tripod or some other device; while the other receiver functions as a rover and conducts observation using an antenna affixed to a pole and moved to observation points.

Unlike post-processing kinematic surveying, the reference station and rover are linked using a radio system or other communication system. The correction data of the carrier phase data, etc. obtained through observation at the reference station is transmitted to the rover via the modem. The rover, based on

this transmitted data and on its own observation data, immediately conducts baseline analysis inside the receiver and outputs the results.

In order to conduct RTK surveying, a receiver must be initialized for carrying out ambiguity fixing. The GB-500 is equipped with on-the-fly (OTF) technology, so, even while it is moving, initialization can be carried out.

Generally, OTF initialization requires at least five satellites and can last several minutes in less than ideal environments (that is, severe multipath, dense tree canopy, etc.).

Getting Acquainted

The GB-500 is a receiver that has been configured for surveying. Depending on the firmware options, it can be upgraded for dual-frequency and GPS/GLONASS reception. A graphic LED display and operating keys enable any user to easily operate it, conduct various kinds of surveying, check operating conditions, and more.

The GB-500 can be built with internal memory for recording survey data, and recorded data can be downloaded using the USB or RS232C port.

Figure 1-2 on page 1-8 shows the system configurations possible for the GB-500.

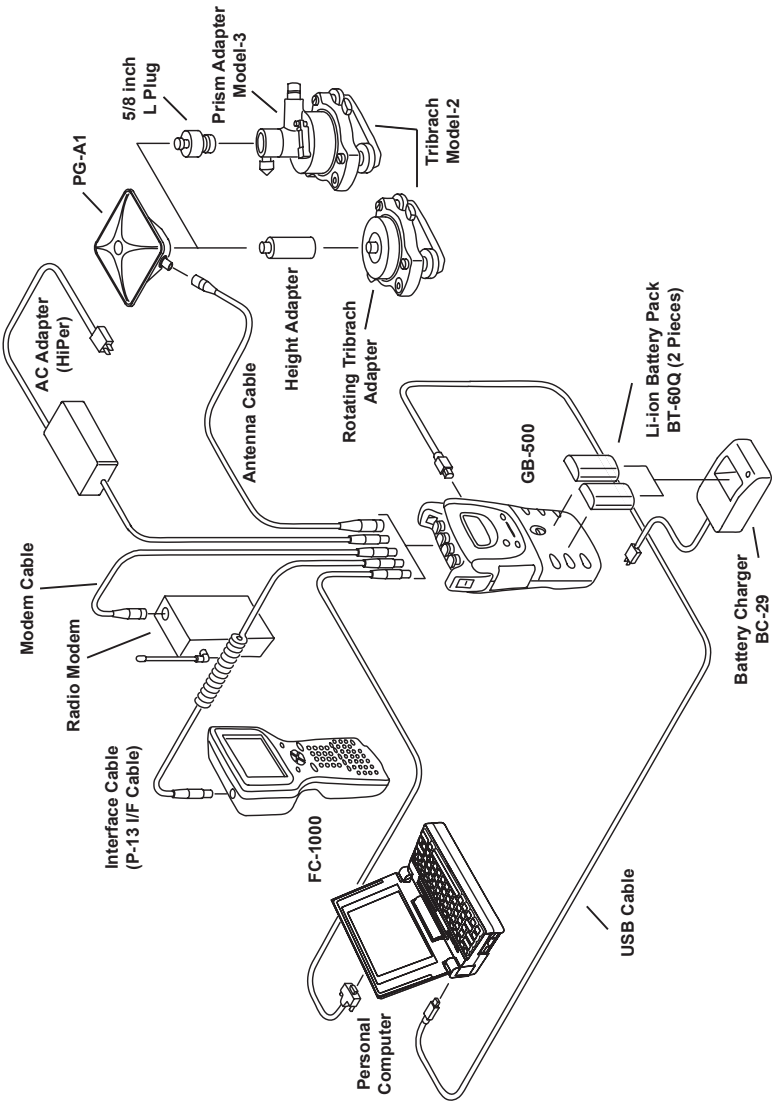


Figure 1-2. GB-500 System Configuration

GB-500 Receiver

Standard firmware options for the GB-500 receiver include the following:

- Dual-frequency – Enables reception of dual frequencies.
- GLONASS – Enables reception of signals from GLONASS satellites.
- RTK – Enables RTK processing (for the measuring interval, select either 1 Hz, 5 Hz, 10 Hz, or 20 Hz).
- AMR (Advanced Multipath Rejection) – Reduces multipath errors.
- Memory – Enables the use of the internal memory, from 8 MB to 1 GB.

The GB-500 receiver has a front panel for displaying information and controlling various receiver functions. The lever provides access to the battery compartment (Figure 1-3).

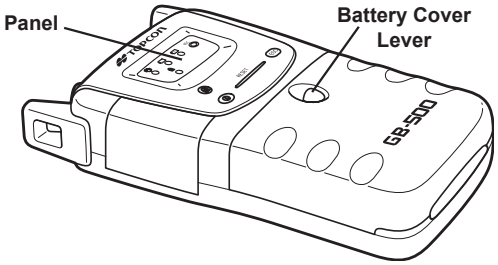


Figure 1-3. GB-500 Front

Holes for the carrying strap are located above the panel. The two batteries reside in the lower half of the front of the receiver (Figure 1-4).

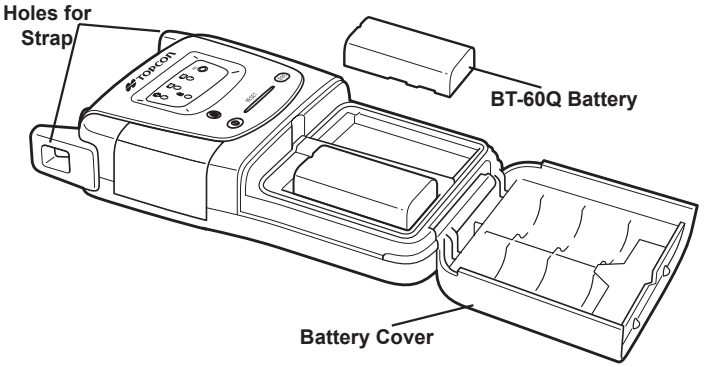


Figure 1-4. GB-500 Strap Holes and Batteries

The top of the receiver has ports for the antenna, power connection, and connection to external components. The USB port is located on the right side of the receiver. A hook on the back side allows the receiver to be attached to a tripod (Figure 1-5).

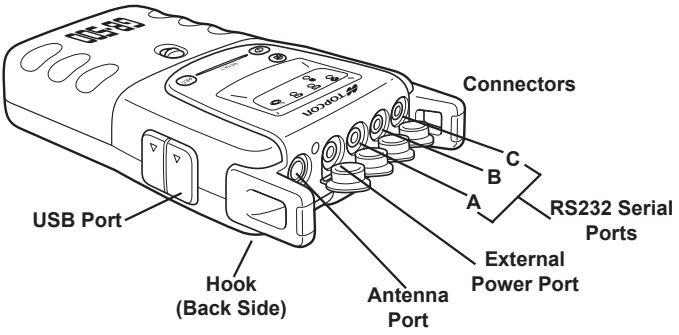


Figure 1-5. GB-500 Ports and Connectors

Front Panel

The front panel (Figure 1-6) has three operating keys and five LEDs that display the status of the batteries and certain functions. See Chapter 3 for details on the GB-500 front panel.

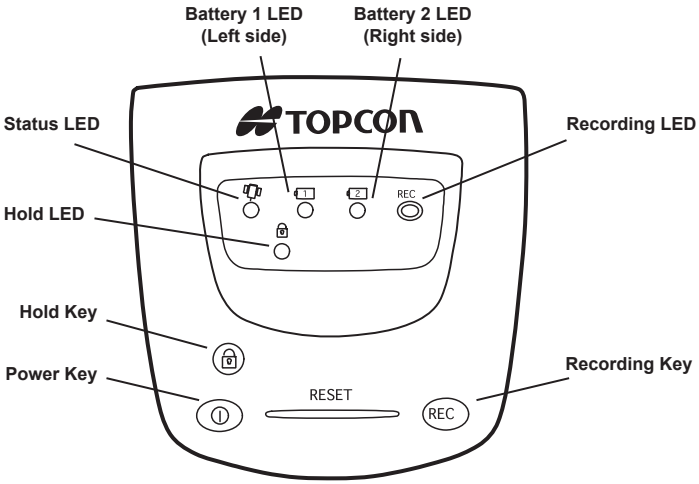


Figure 1-6. GB-500 Front Panel

PG-A1 Antenna

The PG-A1 antenna (Figure 1-7) is a precision dual-frequency, dual-constellation antenna featuring precision micro center technology and an integrated ground plane to help eliminate errors caused by multipath. The PG-A1 was designed to accompany Topcon modular receivers such as the GB-500.

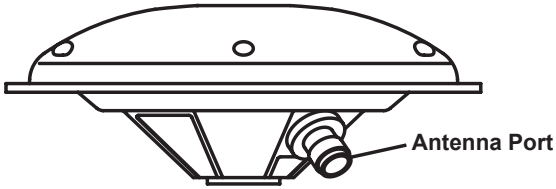


Figure 1-7. PG-A1 Antenna

Optional Accessories

- Tribrach adaptor 2-30 – Used with the Tribrach-20 and the horizontal spacer to secure the antenna to the tripod.
- Tribrach-20 – Used to secure the Tribrach adaptor 2-30 to the tripod.
- FC-1000 data collector– Used as a controller for the GB-500. Requires application software.
- FC-1000 bracket – Used to secure the FC-1000 data collector to the GPS RTK pole.
- AC adaptor – Power supply to run-charge connector.
- Extension cable (2 m) – Used to extend the power cable.
- Antenna cable (4m) – Used to connect the antenna and receiver.
- Data cable – Used to connect the GB-500 to a computer (DB 9-pin connector).
- Cigarette lighter cable – Used to connect to the cigarette lighter in an automobile and power the receiver via the power cable.
- Cable with clip connectors (alligator clips) – Used to connect a general-purpose battery and power the receiver via the power cable.

Storage Precautions

1. Always clean the instrument after use.

   Wipe off dust with a cleaning brush, then wipe off dirt with a soft cloth.
2. Store in a location with a temperature of -30° - +60°C, and no exposure to direct sunlight.
3. Use a clean cloth, moistened with a neutral detergent or water, to clean the receiver. Never use an abrasive cleaner, ether, thinner benzene, or other solvents.

4. Always make sure the instrument is completely dry before storing. Dry the receiver with a soft, clean cloth.
5. Check each part of the tripod after extended use. Parts (screws or clamps) may work free over time.

Option Authorization File (OAF)

Topcon Positioning Systems issues an Option Authorization File (OAF) to enable the specific options that customers purchase. An Option Authorization File allows customers to customize and configure the a receiver according to particular needs, thus only purchasing those options needed.

Typically, all receivers ship with a temporary OAF that allows the receiver to be used for a predetermined period of time. When the receiver is purchased, a new OAF activates desired, purchased options permanently. Receiver options remain intact when clearing the NVRAM or resetting the receiver.

The OAF enables the following kinds of functions. For a complete list of available options and details, visit the TPS website (www.topcongps.com/tech/index) or consult your TPS dealer.

- Type of signal (standard L1; optional L2)
- Memory (standard 0MB; optional 4MB up to 1GB)
- Update rate standard 1Hz (optional 5, 10, or 20Hz)
- RTK at 1Hz, 5Hz, 10Hz, and 20Hz
- RTCM/CMR Input/Output
- Event marker
- Co-Op tracking
- Advanced multipath reduction
- Wide Area Augmentation System (WAAS)
- Receiver Autonomous Integrity Monitoring (RAIM)
- 1 PPS (Pulse-Per-Second; a timing signal)

Notes:

Setup and Connections

This chapter describes powering the GB-500, and setting up and connecting the various components in preparation for observations.

Connecting and Charging the Batteries

The GB-500 is equipped with two replaceable, rechargeable batteries. Observation can continue even when removing one of the batteries. Moreover, if using the AC adaptor, the batteries can be recharged while still in the GB-500.

Using the BT-60Q Batteries

NOTICE *NOTICE*

Before shipping, the factory attaches an insulated sheet to the battery contacts. Remove this sheet before use.

A slight current flows inside the GB-500 even when power is off. Therefore, if storing the GB-500 for a long time with the batteries installed, the batteries will run down and the GB-500 may become inoperable. Remove the batteries if storing the GB-500 for two weeks or more.

Figure 2-1 on page 2-2 illustrate steps one through three for inserting the BT-60Q batteries.

1. Open the battery cover using the lever.
2. Insert the batteries, sliding them in the direction of the arrow shown in Figure 2-1.
3. Press the arrow on the battery cover, closing the cover.

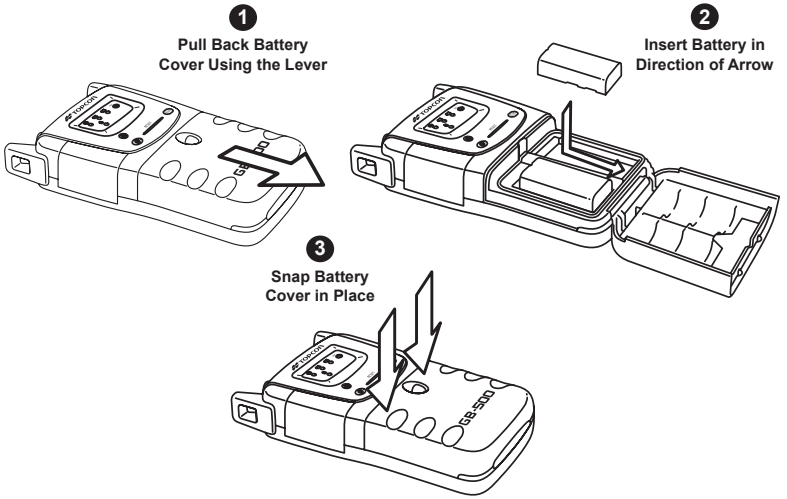


Figure 2-1. Inserting the Rechargeable BT-60Q Batteries

When two batteries are installed, the battery with the lower voltage will be used first. The status icons display the battery currently in use and its remaining capacity.

Charging the BT-60Q Batteries

When charging the BT-60Q batteries, remember the following precautions:

- Charge the batteries at a room temperature of +10°C to +40°C (+50°F to +104°F).
- To maintain the life of the batteries, observe the specified charging time to the extent possible.
- The batteries discharge even when not used, so be sure to charge them before using them.

- When the batteries are not used for a long time, completely charge them once every 15 days, and keep them in a place with a temperature no greater than 30°C. Should a battery completely discharge, its performance will decline and fully charging it will become impossible.
- During charging, the charger may become hot.
- Recharging a battery immediately after charging it may cause it to deteriorate.
- Charging batteries in quick succession could cause the battery and/or the charger to deteriorate.
- Let the charger rest for 30 minutes between chargings.

1. Place a BT-60Q battery in the BC-29 charger as see in Figure 2-2.
2. Plug the charger's power cord into a socket. Charging will commence and will last about 3 hours.

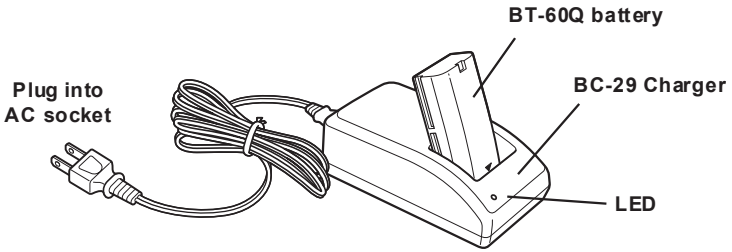


Figure 2-2. BT-60Q Battery in Charger

The LED indicator on the charger indicates the following, depending on the state of the battery:

- Steady red – fast charging under way
- Steady green – charging complete
- Blinking red – charging error
- No light – backup charging (charging by a small current prior to fast charging)

Charging with the AC Adaptor

The AC Adaptor supports charging-on-the-run for the receiver.

- With the adapter plugged into an AC outlet and the batteries installed, the batteries will also be charged.
- Without the batteries, the adapter is simply an AC adaptor.

Connect the AC Adaptor (p/n 22-034101-01) connector to the external power port on the GB-500 (Figure 2-3).

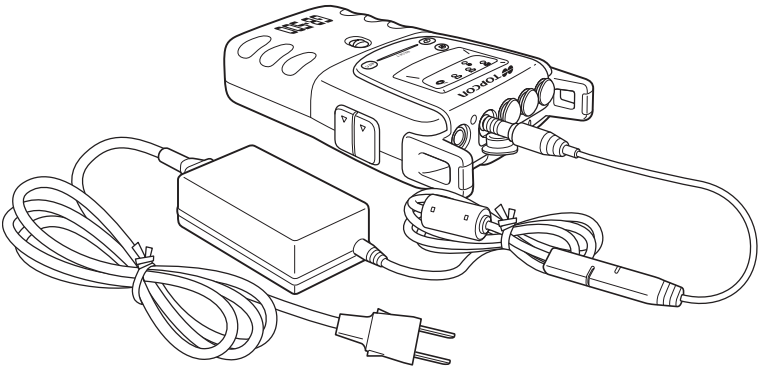


Figure 2-3. Charging the GB-500 with the AC Adapter

The receiver's charging status varies depending on the state of the batteries and power switch. Both battery LEDs use the same blink pattern while the corresponding battery charges. While charging, the battery LED for the charging battery blinks in one second intervals.

- Solid green light – battery charging is complete
- Green blink – battery charge is between 90% and 100%
- Yellow blink – battery charge is between 60% and 90%
- Red blink – battery charge is less than 60%
- No light – no battery installed, or batteries are pre-charging
- Rapid red blink – charging error

If the AC adaptor is connected when the GB-500 is turned off, charging-on-the-run will begin once the receiver is turned on. Check the battery LEDs for charging status (the percentage of battery charge). When charging completes, the battery LEDs are a solid green light.

If the GB-500 is turned off with the AC adaptor connected, the battery LEDs blink as the batteries continue to charge. When charging completes, power automatically switches off.

Battery Charging Order and Precautions

When both batteries are installed, the GB-500 will begin charging the battery with the least remaining capacity. When completely charged, the receiver begins charging the other battery.

- When powering the GB-500 from a car battery, the car battery may not supply sufficient voltage charge the batteries. To ensure proper battery charging, use the AC adaptor.
- Conduct charging at a room temperature +10°C to +40°C (+50°F to +104°F).
- Outdoors, the temperature may exceed the recommended range. Therefore, when using the AC adaptor (or a car battery, etc.) outdoors, check the ambient temperature.

Connecting the USB Cable

Connect the USB cable to the GB-500's USB port (Figure 2-4).

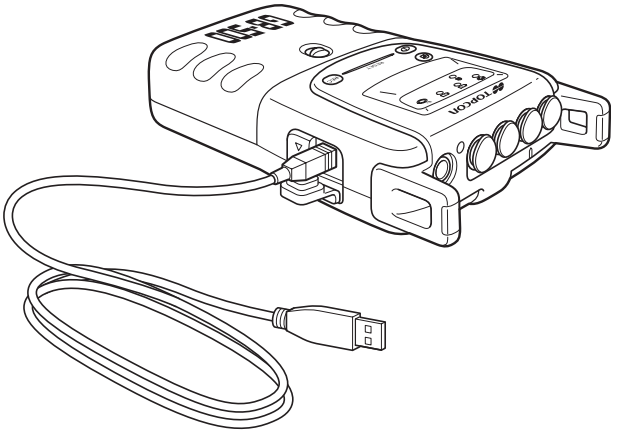


Figure 2-4. Connecting the USB Cable

NOTICE *NOTICE*

The USB port is not waterproof with an attached cable.

Connecting the Serial Cables

Connect the serial (RS-232C) cables for the FC-1000 data collector, computer, modem, etc., to the GB-500's serial ports. The receiver has three serial ports: A, B and C. Each serial port corresponds to a specific external device (Figure 2-5):

- Port A – FC-1000 controller
- Port B – Computer
- Port C – Modem

Above each port is a colored mark: yellow for port A, green for port B, and white for port C. The red mark indicates the power port.

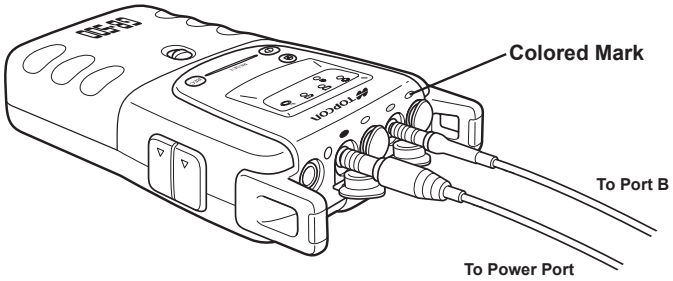


Figure 2-5. Connecting Serial Cables

TIP

Attach colored stickers to the cables that correspond to the colored mark above the receiver's serial ports.

The GB-500's rubber caps function to maintain water proofing and are a little tight. When complete water proofing is required, be sure to push the caps all the way in.

Attaching the Strap

The strap for the GB-500 provides an easy solution for carrying the receiver around the jobsite while performing surveys.
Figure 2-6 illustrates the following steps:

1. Thread the strap through the strap holes.
2. Fold one end of the strap onto the velcro tape in the middle of the cover.
3. Fold the other end of the strap onto the velcro tape on the first end.
4. Firmly press the pieces of velcro tape together and snap the cover shut.

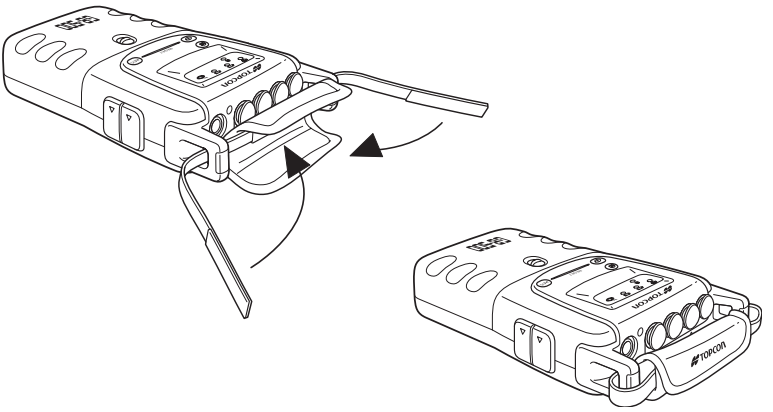


Figure 2-6. Attaching the Strap

NOTICE *NOTICE*

If the belt is not securely attached, the GB-500 could fall and become damaged.

Antenna Setup

The standard antenna for the GB-500 is the PG-A1 antenna (Figure 2-7) for precise geodetic use. The PG-A1 is a light, compact, and fully waterproof antenna designed to be used for both static and kinematic surveying.

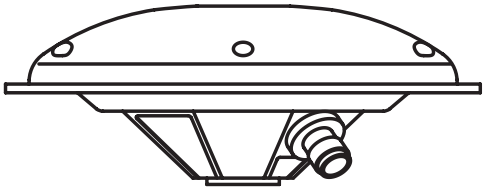


Figure 2-7. PG-A1 Antenna

When installing the antenna on a tripod, use the base, Tribrach adaptor 2-30 and horizontal spacer as described below.

Antenna on Tripod

For the tripod (Figure 2-8 on page 2-10), use the TOPCON Precision Wood Tripod or an expandable metal tripod.

1. Place the Tribrach-20 on the tripod and tighten the tripod screw, securing the tribrach in place.
2. Place the Tribrach adaptor 2-30 on the tribrach and tighten the bases locking screw.
3. Screw the horizontal spacer 1 into the PG-A1 antenna, then place the horizontal spacer 1 into the Tribrach adaptor 2-30.

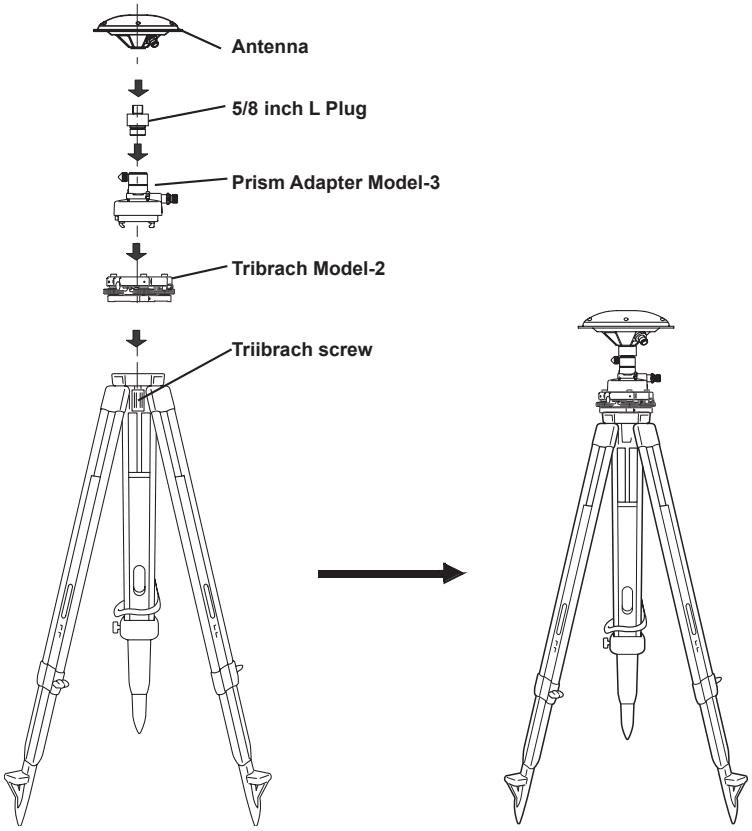


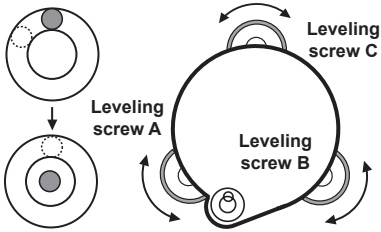
Figure 2-8. Antenna Setup on Tripod

Use the following reference to level the tripod.

1. Set Up the Tripod
Extend the extension legs to suitable lengths and tighten the leg-screws.

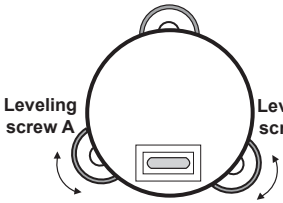
2. Attach the Antenna to the Tripod
Place the antenna on the tripod head and slide the antenna by loosening the tripod screw. If the plumb bob is positioned over the center of the point, slightly tighten the tripod screw.

3. Roughly Level the Antenna Using the Circular Level
Turn leveling screws A and B to move the bubble in the circular level. The bubble is now located on a line perpendicular to a line running through the center of leveling screws A and B

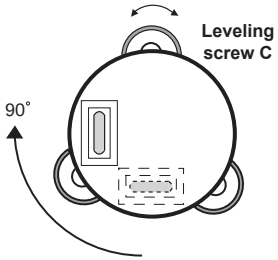


Turn leveling screw C to center the bubble in the circular level.

4. Center Using the Plate Level
Rotate the instrument horizontally using the Horizontal motion/clamp screw and place the plate level parallel with the line connecting leveling screws A and B. Turn leveling screws A and B to bring the bubble to the center of the plate level.

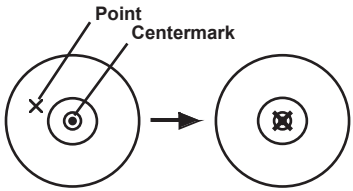


Rotate the instrument 90° (100g) around its vertical axis and turn leveling screw C to center the bubble once more.



Repeat step 4 for each 90° (100g) rotation of the instrument and check that the bubble correctly centers at all four points.

5. Center Using the Optical Plummet Telescope
Adjust the eyepiece of the optical plummet telescope to your eyesight. Slide the instrument by loosening the tripod screw, place the point on the center mark, and then tighten the tripod screw. Slide the instrument carefully to prevent any dislocation of the bubble.



6. Level the Instrument
Level the instrument as in step 4: Rotate the instrument, checking that the bubble is in the center of the plate level, regardless of telescope direction, then tighten the tripod screw to lock in position.

Antenna on RTK Pole

For the RTK pole (Figure 2-9), be sure to use one that is lightweight and mobile.

1. Screw the PG-A1 antenna onto the RTK pole's 5/8-inch screw.
2. Release the lock, adjust the pole's length, and fasten the lock again.

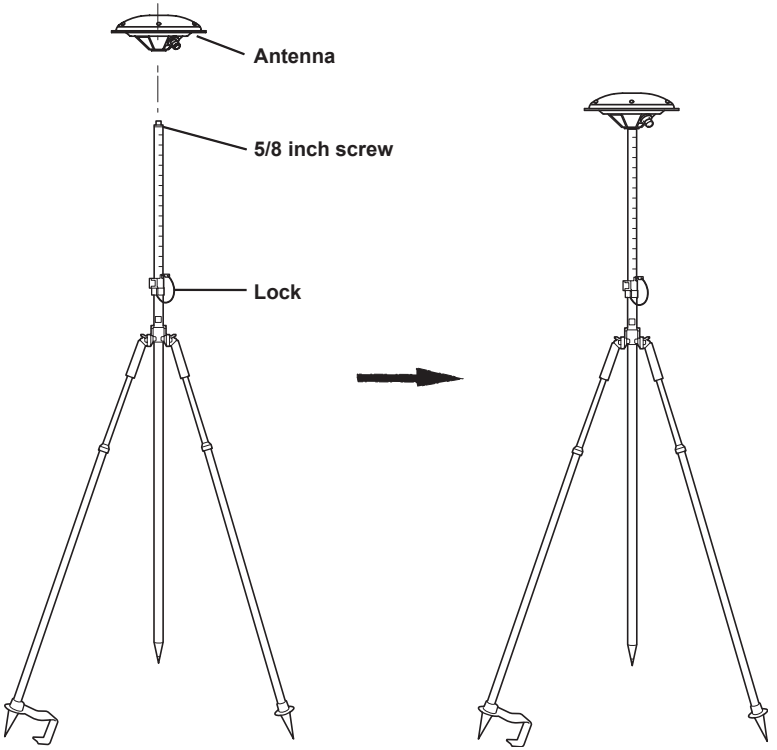


Figure 2-9. Antenna Setup on RTK Pole

Measuring Antenna Height

To accurately convert an observation taken at the antenna's position to a point on the ground, the antenna's height must be measured accurately. Inaccurate measurement of the antenna height will affect the vertical direction of the observation, and may affect the horizontal direction of the observation.

To measure the antenna height accurately:

- For the base station antenna, measure the vertical height between the observation point marker and the antenna reference point (ARP) or the slant height between the observation point marker and the antenna height measuring position (Figure 2-10).
- For the rover antenna, measure the vertical height between the tip of the RTK pole and the ARP.

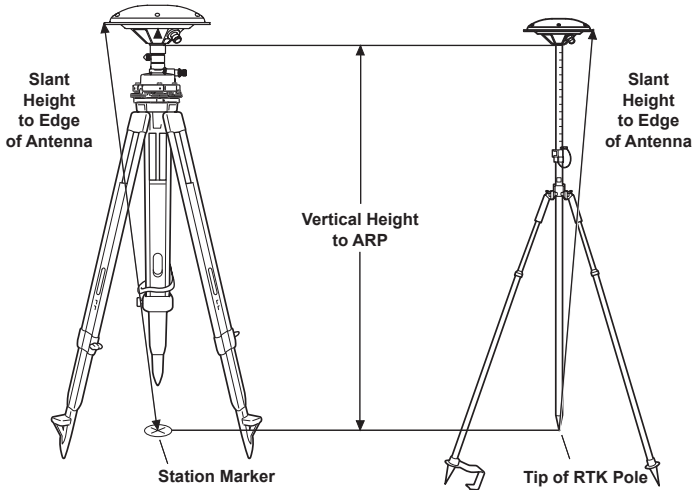


Figure 2-10. Measure Antenna Height

The actual point surveyed by the antenna is at the electrical phase center of the antenna, which is different from the ARP position. To calculate an accurate antenna height, add the offset (antenna constant) up to the phase center.

Antenna Offsets

Figure 2-11 shows the antenna height measuring position and antenna offsets for the PG-A1 antenna. L1 and L2 represent the antenna offsets for the L1 band and the L2 band, respectively.

The antenna height measuring position is the lower part of metal brim.

The following are antenna constants for the PG-A1:

- Electrical phase center from antenna reference point (ARP):

  a(L1)=54.3mm

  a(L2)=60.5mm

- Electrical phase center from antenna height measuring position:

  b(L1)=26.8mm

  b(L2)=33mm

- Antenna height measuring position from antenna reference point (ARP):

  c=27.5mm

- Distance between antenna center and measuring position:

  d=89.7mm

Normally, use b(L1) for the antenna offsets.

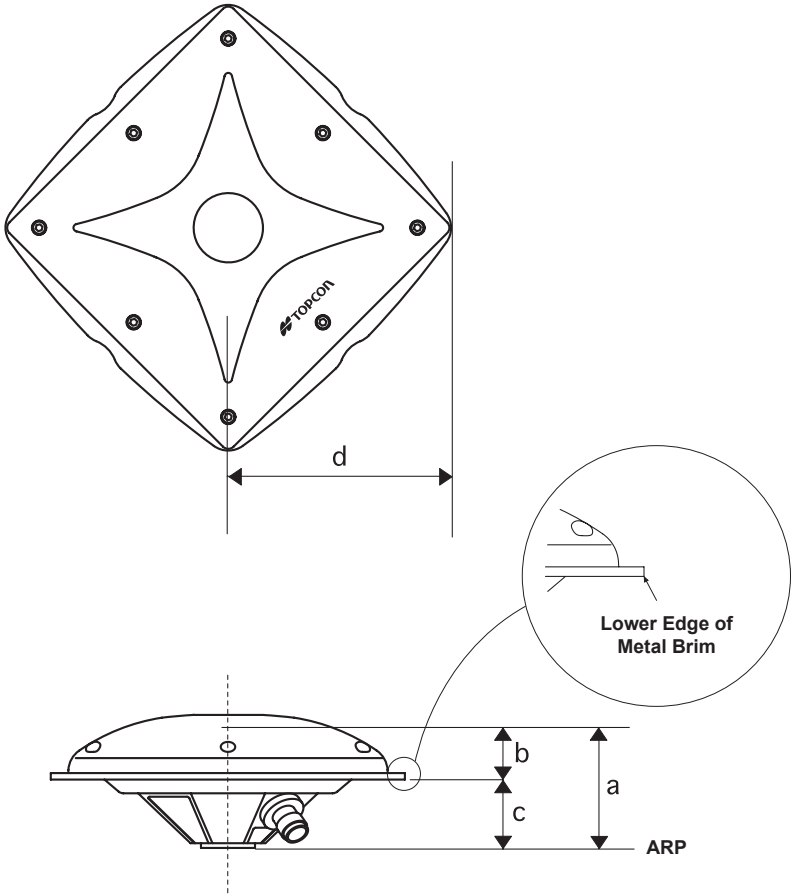


Figure 2-11. Measure Antenna Offset

Connecting the Antenna

Use the antenna cable to connect the GB-500 and antenna.

1. Connect the cable to the GB-500's antenna port (Figure 2-12).
2. Connect the cable to the PG-A1's antenna port (Figure 2-12).

Once connected, use the tripod hook on the back of the receiver to attach it securely to the tripod.

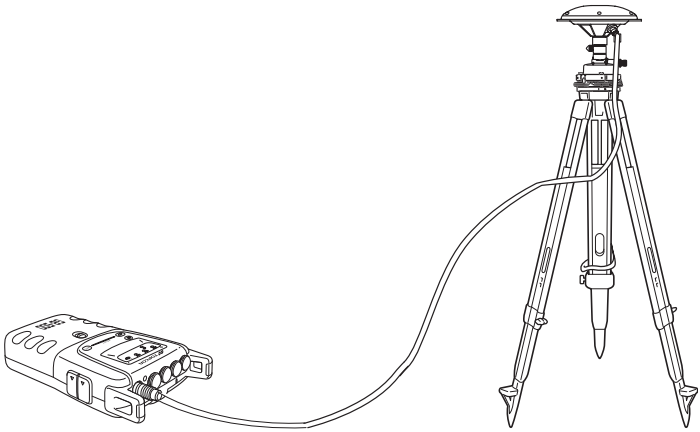


Figure 2-12. Connect GB-500 and Antenna

Collecting Almanacs

Each satellite broadcasts a message (almanac) which gives the approximate orbit for itself and all other satellites. If the receiver has an almanac, you can considerably reduce the time needed to search for and lock on to satellite signals.

The receiver regularly updates the almanac and stores the most recent almanac in its Non-Volatile Random Access Memory (NVRAM).

You will need to collect or update the almanac:

- If the receiver has been off for a long time.
- If the last known receiver position, stored in the NVRAM, is different from the present position by several hundred kilometers.
- After loading a new OAF.
- After loading new firmware.
- After clearing the NVRAM.
- Before surveying.

1. Set up the receiver in a location with a clear view of the sky.
2. Turn on the receiver.
3. Wait for about 15 minutes while the receiver collects almanac data from the satellites.

NOTICE *NOTICE*

If 15 minutes have passed and the receiver does not lock on to satellites, you may need to clear the NVRAM. See "Clearing the NVRAM" on page 3-19for this procedure.

Notes:

Operation and Data Management

Before operating the GB-500 receiver, use a computer or data collector and the appropriate software to set the various configuration parameters.

Operating the GB-500 Receiver

The GB-500 receiver's front panel uses keys to perform various functions and LEDs to display various information (Figure 3-1).

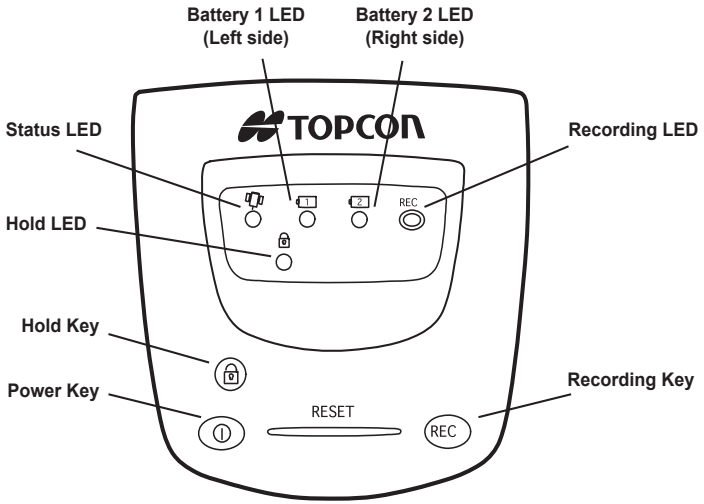


Figure 3-1. GB-500 Front Panel

Power Key

Pressing the **power** key turns the receiver on and off.

Hold Key and Hold LED

The Hold key locks the other keys against inadvertent operations.

The Hold LED blinks red when the receiver keys are in “hold” mode.

Status LED

The Status LED displays the status of tracked satellites:

- When the receiver is on and no satellites are tracked, the STAT LED will blink red.
- When satellites are tracked, the STAT LED will produce one blink for each tracked satellite (green for GPS, orange for GLONASS).

Battery LEDs

The color of the battery LEDs display the status of the remaining charge for the corresponding battery and is the same for both LEDs:

- Green – 60% to 100% remaining battery capacity
- Yellow – 20% to 60% remaining battery capacity
- Red – 2% to 20% remaining battery capacity
- No light – less than 2% remaining battery capacity or no battery installed

The blink interval and length of time lit of the battery LEDs display the status of the battery when in use:

- In use – a 0.5 second light in 5 second intervals
- Charging – a 0.1 second light in 1 second intervals
- Not in use – a 0.1 second light in 5 second intervals

See page 2-4 for details on the Battery LED status during charge.

REC Key and Record LED

The REC key begins data collection, or toggles between types of data collection.

The REC LED displays data recording statuses:

- Green or Orange – data recording started; blinks each time data is written to the memory
- Red – no free memory available to record data, or the receiver has a hardware problem

Table 3-1 on page 3-5 summarizes REC key functions and REC LED statuses.

- Pressing the **REC** key for less than one second switches the receiver between different information modes (normal and extended information), or between static and dynamic post-processing modes, depending on the receiver's configuration.

  During the first second of pressing the **REC** key, the REC LED is orange.

- Pressing the **REC** key for more than one and less than five seconds will start/stop data recording.

  During data recording the REC LED is green.

  If the REC LED is red, the receiver has run out of memory, has a hardware problem, or contains an improper OAF.

- The REC LED blinks green each time data is written to the internal receiver's memory.

  You set the data recording time interval using PC-CDU. Refer to the *PC-CDU User's Manual* for information on setting this function.

  Each time you turn off or on data recording, either a new file opens or data appends to a particular file. Refer to the *PC-CDU User's Manual* for information on setting this function.

- Pressing the **REC** key for more than five and less than eight seconds will turn the baud rate of serial port A to 9600. After about five seconds of pressing the **REC** key, the REC LED becomes red. Release the **REC** key while the REC LED is red (during the next three seconds).

  Pressing the **REC** key for more than eight seconds has no impact.

- After loading new firmware or clearing the receiver's NVRAM, the receiver checks its internal file system.

  During this operation, the REC LED flashes orange, and the file system is not accessible for CDU (control display unit) applications or for data recording. This operation may require from fractions of a second to several minutes, depending on the circumstances and the amount of internal memory.

Table 3-1. REC Key Functions and REC LED Status

REC Key	REC LED	Status
When data recording is off, and the REC key is...		
Not pressed	No light	No data recording.
	Orange blink	Internal file system test in progress.
	Red	No free memory; hardware problem with data recording.
Pressed for < 1 second	If REC key mode is “LED blink mode switch”	
	Orange	Release to change information mode.
	If REC key mode is “Occupation mode switch”	
	Orange	No function.
Pressed for 1–5 seconds	If REC key mode is “LED blink mode switch”	
	Green	Release to start data recording (post-processing occupation mode undefined).
	If REC key mode is “Occupation mode switch”	
	Green	Release to start recording (Kinematic or Static post-processing occupation mode)
Pressed for 5–8 seconds	Red	Release to turn serial port A baud rate to 9600 bps.
Pressed for > 8 seconds	No light	No function.

Table 3-1. REC Key Functions and REC LED Status

REC Key	REC LED	Status
When data recording is on, and the REC key is...		
Not pressed	Red	No free memory; hardware problem with data recording.
	If REC key mode is “LED blink mode switch”	
	Green	Data recording started (post-processing occupation mode undefined).
	If REC key mode is Occupation mode switch	
	Green	Data recording started (Kinematic post-processing occupation mode).
	Orange	Data recording started (Static post-processing occupation mode).
Pressed for < 1 second	If REC key mode is “LED blink mode switch”	
	Orange	Release to change information mode.
	If REC key mode is “Occupation mode switch”	
	Orange	Release to toggle between Static and Kinematic post-processing modes.
Pressed for 1–5 seconds	No light	Release to stop data recording.
Pressed for 5–8 seconds	Red	Release to turn serial port A baud rate to 9600 bps.
Pressed for > 8 seconds	No light	No function (data recording still on).

Managing Data

The GB-500 stores observation data in its internal memory. The following sections discuss accessing and managing these files.

Automatic Observation Data File

After the GB-500 has started recording observation data, it automatically determines a file name, unless otherwise specified by the controller or computer, and create a session file. File names are based on the observation date using the following format:

XXXXMMDDS

- XXXX – A specified character string (20 characters max.); the default is log.
- MM – the month of the observation (January = 01, December = 12).
- DD – the day of the observation (1st day = 01, 31st day = 31).
- S – the session number (a to z).

NOTICE *NOTICE*

This file name is managed in the GB-500. A different file name may be displayed depending on the controller, downloading software, etc.

Downloading Observation Data Files

The GB-500 records observation data as a file in the internal memory. To post-process the file, download it to a computer.

To download files, use either a serial port or the USB port and a computer with downloading software installed (such as PC-CDU or Topcon Link). The following procedure describes using PC-CDU to download files from the receiver to a computer.

If using the USB port, a dedicated USB driver is required. If needed, download the required USB driver from the TPS website (www.topcongps.com). For further details on downloading and installing the USB driver, refer to the user's manual for the software.

1. Connect the receiver and computer (Figure 3-2):
    - USB cable connected to the USB port on the receiver then to the USB port on the computer.
    - RS232C cable connected to a serial port on the receiver then to the applicable serial port on the computer.

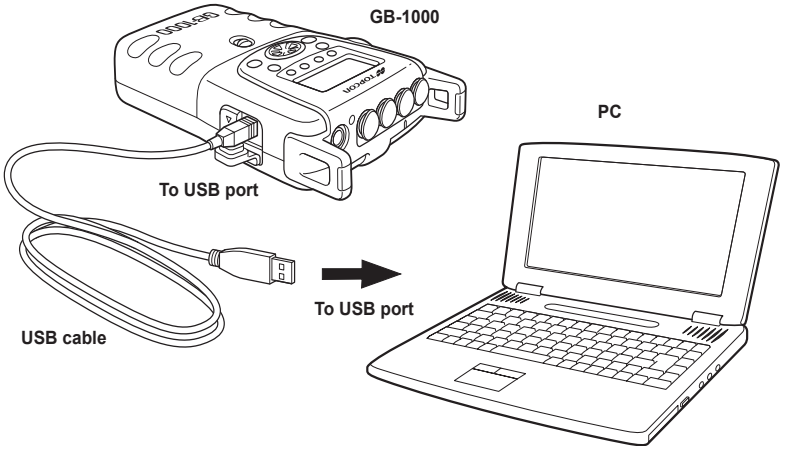


Figure 3-2. Example GB-500 and Computer Connection via USB

2. Once the receiver and a computer are connected, start PC-CDU on the computer. The PC-CDU main screen displays (Figure 3-3).

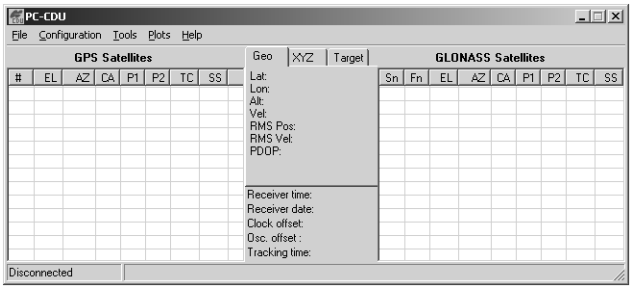


Figure 3-3. PC-CDU Main Screen

Notice that the lower-left hand corner shows the receiver status as “Disconnected”.

3. Click **File ▸ Connect** (Figure 3-4).

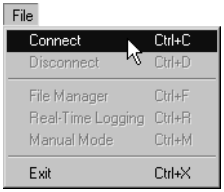


Figure 3-4. Click File ▸ Connect

4. On the ***Connection Parameters*** dialog box, select the following parameters and click **Connect**:

   - for RS232 connections (Figure 3-5 on page 3-10)

     –Set the Connection mode (Direct).

     –Set the port for your computer (typically COM1, COM2 for RS232 connection) from the *Port* drop-down list.

     –Set the communication rate between the receiver and the computer (usually 115200) from the *Baud rate* drop-down list.

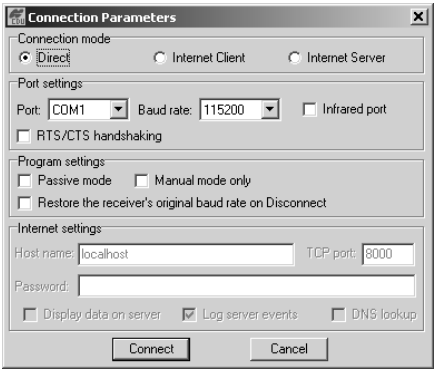


Figure 3-5. RS232 Connection Parameters

- for USB connections (Figure 3-6):

  –Set the Connection mode (Direct).

  –Set the port for your computer (USB) from the *Port* drop-down list.

  –Select the receiver's ID from the *Rec ID* drop-down list.

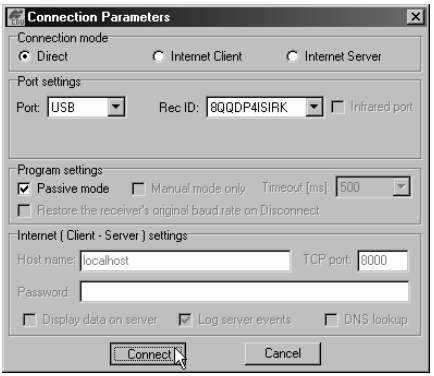


Figure 3-6. USB Connection Parameters

Once a PC-CDU connection with the receiver has been established, the current communications settings—such as, port name, baud rate (if applicable), and flow control (if applicable)—display in the lower-left corner of the main window of PC-CDU. A timer begins to count up in the lower-right corner as well (Figure 3-7).

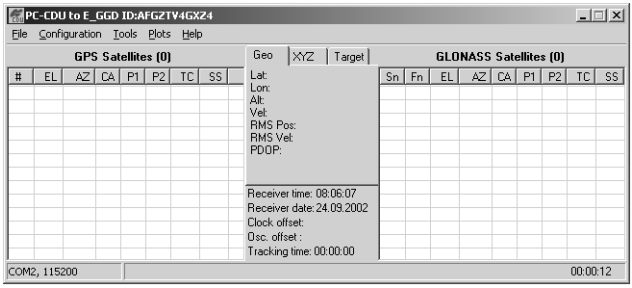


Figure 3-7. PC-CDU Connection Established

5. Click **File ▸ File Manager** (Figure 3-8).

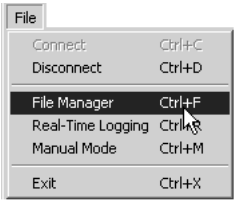


Figure 3-8. File ▸ File Manager

6. Click the **Download path** tab on the ***File Manager*** dialog box (Figure 3-9).

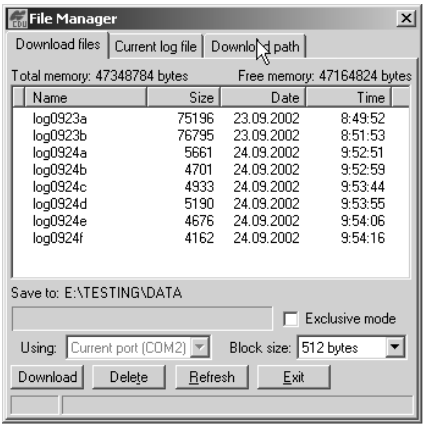


Figure 3-9. Find Files to Download

7. Navigate to and open the folder in which to download and store files. Or, type a new folder name and click **Create** to create a new folder in which to download and store files. Open this new folder.
8. Select the **Download files** tab and select the file(s) to download (Figure 3-10 on page 3-13).

   To select multiple files, hold down the **Shift** key and click on non-sequential files to select several files at once; or, hold down the **Ctrl** key and click on individual files.

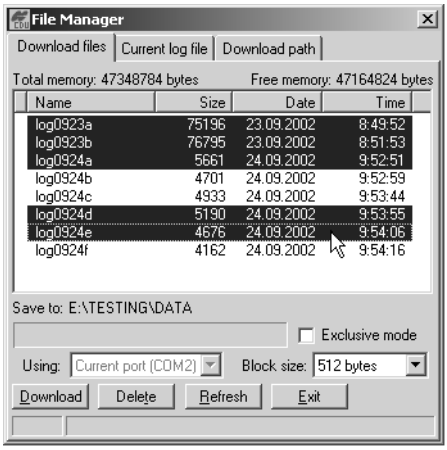


Figure 3-10. Download Files

9. Click the **Download** button. During the download, status indicators display next to each file (Figure 3-11).
   - Blue indicator – file in queue for downloading.
   - Red indicator – file currently downloading.
   - Green indicator – file has successfully downloaded.

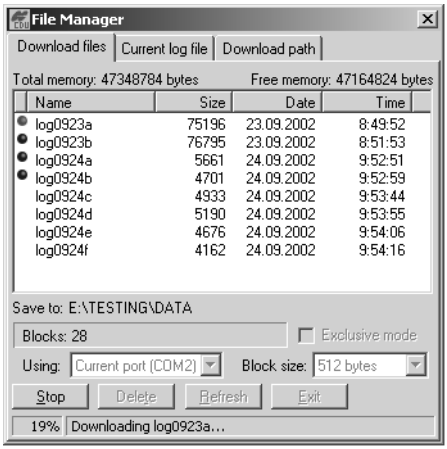


Figure 3-11. Download Files – Status Indicators

10. Once the download completes, click **Exit** on the ***File Manager*** dialog box. Continue with other operations, or click **File ▸ Disconnect**, then **File ▸ Exit** to quit PC-CDU (Figure 3-12).

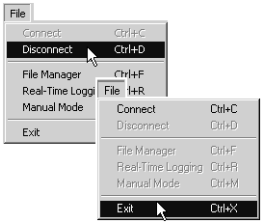


Figure 3-12. Click Disconnect then Exit

Deleting Files from the Receiver

To delete files, use either a serial port or the USB port and a computer with downloading software installed (such as PC-CDU or Topcon Link). The following procedure describes using PC-CDU to delete files from the receiver.

1. Follow step 1 on page 3-8 to step 5 page 3-11.
2. On the *Download files* tab or *Current log files* tab, select the file(s) you want to delete (Figure 3-13 on page 3-15).

   To select multiple files, hold down the **Shift** key and click on non-sequential files to select several files at once; or hold down the **Ctrl** key and click on individual files.
3. Click **Delete** (Figure 3-13 on page 3-15).
4. Click **Yes** at the ***delete files confirmation*** dialog box. The selected files are deleted.
5. Click **Exit** on the ***File Manager*** dialog box.

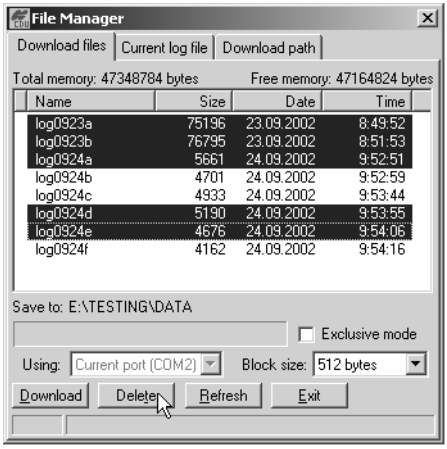


Figure 3-13. Delete Files

6. Continue with other operations, or click **File ▸ Disconnect**, then **File ▸ Exit** to quit PC-CDU (Figure 3-14).

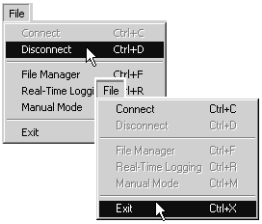


Figure 3-14. Click Disconnect then Exit

Checking Options

You can check the status of your receiver's options, and load any new OAF, using the RS232 or USB cable, a computer, and receiver management software (such as, PC-CDU or Topcon Link). The following procedure describes using PC-CDU to the receiver's OAF.

For a complete list of options and their details, visit the Topcon website.

1. Connect the receiver and computer using an RS232 or USB cable and start PC-CDU. Click **File ▸ Connect**, select the desired connection parameters, and click **Connect**.
2. Click **Tools ▸ Receiver Options** (Figure 3-15).

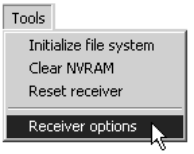


Figure 3-15. Tools ▸ Receiver Options

The ***Option Manager*** screen displays (Figure 3-16 on page 3-17) and contains the following information:

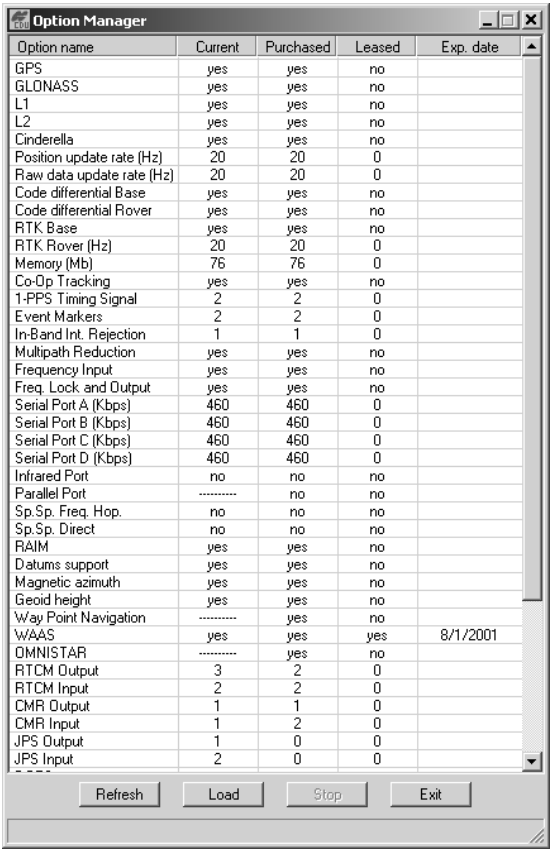
- Option name – a name/description of the option
- Current – the current status of the option
- Purchased – if the option is purchased or not
- Leased – if the option is leased or not
- Expiration date – the date the option will be disabled, if applicable

Since Options can be both purchased and leased, the "Current" status of the option displays the currently effective value. Option values can be:

- -1 or "-----" – the firmware version does not support this option.

- 0 – the receiver option is disabled.
- positive integer – the option is enabled.
- yes or no – the option is either enabled or disabled.

3. When finished, click **Exit** on the ***Option Manager*** screen, then click **File ▸ Disconnect** to prevent conflicts with serial port management.



Option name	Current	Purchased	Leased	Exp. date
GPS	yes	yes	no	
GLONASS	yes	yes	no	
L1	yes	yes	no	
L2	yes	yes	no	
Cinderella	yes	yes	no	
Position update rate (Hz)	20	20	0	
Raw data update rate (Hz)	20	20	0	
Code differential Base	yes	yes	no	
Code differential Rover	yes	yes	no	
RTK Base	yes	yes	no	
RTK Rover (Hz)	20	20	0	
Memory (Mb)	76	76	0	
Co-Op Tracking	yes	yes	no	
1-PPS Timing Signal	2	2	0	
Event Markers	2	2	0	
In-Band Int. Rejection	1	1	0	
Multipath Reduction	yes	yes	no	
Frequency Input	yes	yes	no	
Freq. Lock and Output	yes	yes	no	
Serial Port A (Kbps)	460	460	0	
Serial Port B (Kbps)	460	460	0	
Serial Port C (Kbps)	460	460	0	
Serial Port D (Kbps)	460	460	0	
Infrared Port	no	no	no	
Parallel Port	----------	no	no	
Sp.Sp. Freq. Hop.	no	no	no	
Sp.Sp. Direct	no	no	no	
RAIM	yes	yes	no	
Datums support	yes	yes	no	
Magnetic azimuth	yes	yes	no	
Geoid height	yes	yes	no	
Way Point Navigation	----------	yes	no	
WAAS	yes	yes	yes	8/1/2001
OMNISTAR	----------	yes	no	
RTCM Output	3	2	0	
RTCM Input	2	2	0	
CMR Output	1	1	0	
CMR Input	1	2	0	
JPS Output	1	0	0	
JPS Input	2	0	0	

Figure 3-16. Option Manager

Loading an OAF

Topcon Positioning System dealers provide customers with OAF files. For any OAF related questions, E-mail TPS at options@topconps.com. Please have your receiver ID number available (see “Checking Firmware Version” on page 3-20).

1. To load a new OAF, follow steps one and two in “Checking Options” on page 3-16.
2. Click **Load** at the bottom of the ***Option Manager*** screen (see Figure 3-16 on page 3-17).
3. Navigate to the location of the new Option Authorized File. OAFs have .jpo or .tpo extensions and are unique to each receiver (Figure 3-17).

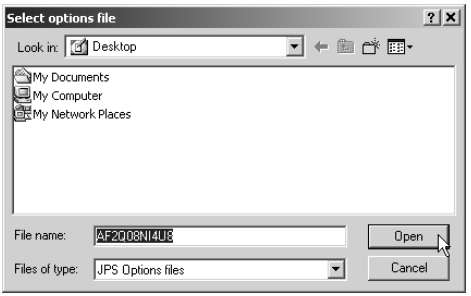


Figure 3-17. Load OAF

4. Select the appropriate file and click **Open** (Figure 3-17). The new receiver option loads onto the receiver and the Option Manager table updates.
5. When finished, click **Exit** on the ***Option Manager*** screen, then click **File ▸ Disconnect** to prevent conflicts with serial port management.

Clearing the NVRAM

The receiver's Non-Volatile Random Access Memory (NVRAM) holds data required for satellite tracking, such as ephemeris data and receiver position. The NVRAM also keeps the current receiver's settings, such as active antenna input, elevation masks and recording interval, and information about the receiver's internal file system.

Even though clearing the NVRAM is not a common (nor normally a recommended) operation, there are times when clearing the NVRAM can eliminate communication or tracking problems. Clearing the NVRAM in your receiver can be interpreted as a "soft boot" in your computer. Clearing the NVRAM of your receiver will not delete any files already recorded in your receiver's memory. However, it will reset your receiver settings to factory default values.

After clearing the NVRAM, your receiver will require some time to collect new ephemerides and almanacs (around 15 minutes). Note that after clearing the NVRAM, the receiver's STAT LED will flash orange for a few seconds indicating that the receiver is scanning and checking the file system.

Use Receiver Keys to Clear NVRAM

1. Press and release the **power** key to turn off the receiver.
2. Press and hold the **REC** key.
3. Press and hold the **power** key for about one second. Release the **power** key while continuing to hold the **REC** key.
4. Wait until the STAT and REC LEDs are green.
5. Wait until the STAT and REC LEDs blink orange.
6. Release the **REC** key while the STAT and REC LEDs blink orange.

Use PC-CDU to Clear NVRAM

1. Connect the receiver and computer using an RS232 or USB cable and start PC-CDU. Click **File ▸ Connect**, select the desired connection parameters, and click **Connect**.
2. Click **Tools ▸ Clear NVRAM** (Figure 3-18). The REC LED rapidly flashes green and red; the STAT LED flashes red.

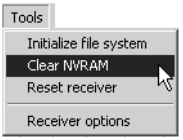


Figure 3-18. Tools ▸ Clear NVRAM

The receiver automatically disconnects from PC-CDU once the NVRAM is cleared.

Checking Firmware Version

You can use PC-CDU to check the firmware version of your receiver.

NOTICE

The receiver should be loaded with firmware version 2.3 or later.

CAUTION

Do not use firmware versions 2.2p3 or older.

1. Connect the receiver and computer using an RS232 or USB cable and start PC-CDU. Click **File ▸ Connect**, select the desired connection parameters, and click **Connect**.

2. Click on **Help ▸ About** (Figure 3-19).

Figure 3-19. Help ▸ About

The ***About PC-CDU*** dialog box opens (Figure 3-20).

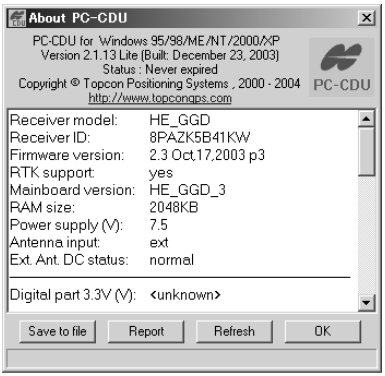


Figure 3-20. About PC-CDU – GB-500

About PC-CDU lists important information about the different hardware accessories and software properties. This list includes the following, which you will need if you contact TPS or your dealer:

- Receiver model
- Receiver ID
- Firmware version

3. When finished, click **OK**, then click **File ▸ Disconnect** to prevent conflicts with serial port management.

Loading New Firmware

Base and Rover receivers must be loaded with the same firmware version. Use the latest firmware version, available for download from the TPS website, to ensure your receiver has access to the most recent updates.

Receiver firmware is released as a compressed file that you download and decompress. This file contains the following two files:

- ramimage.ldr – the Receiver board RAM file
- main.ldp – the Receiver board Flash file

NOTICE *NOTICE*

You must load both files when loading new firmware. These files must come from the same firmware package.

The receiver uses FLoader, a Windows®-based utility, to load firmware onto the receiver and power boards. You can download FLoader to your computer from the TPS website. For more information, refer to the *FLoader User's Manual*, also available on the TPS website.

1. Download and install FLoader, if applicable. Download and unzip the new firmware package(s) to your computer.
2. Connect the receiver and computer using an RS232 or USB cable and activate FLoader (Figure 3-21 on page 3-23).

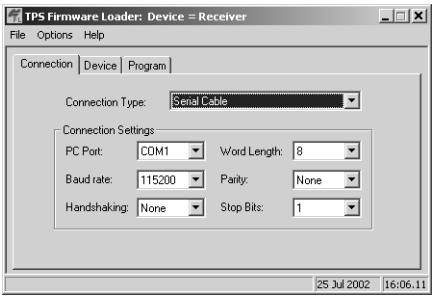


Figure 3-21. FLoader Main Screen

3. On the *Connection* tab, select the COM port on your computer that connects with your receiver and select its speed (usually 115200) (Figure 3-21).
4. Click the **Device** tab and set the *Device Type* as Receiver (Figure 3-22).

Figure 3-22. Get Device Type

5. Click **Get from Device** for device information (Figure 3-22).

6. Click the **Program** tab and set the *Capture Method* to Soft Break Capture (recommended) (Figure 3-23).

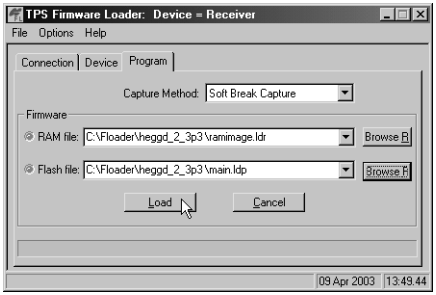


Figure 3-23. Program Tab Settings

7. Browse for and select the receiver board's RAM and Flash files (Figure 3-23).
8. Click **Load** and wait until 100% of the files load into the receiver.

NOTICE *NOTICE*

If you selected an incorrect RAM or Flash file, an error message displays at the bottom of the dialog box. Reselect the correct file.

9. Click **File ▸ Exit**.
10. Clear the receiver's NVRAM (see "Clearing the NVRAM" on page 3-19) and update the almanac (see "Collecting Almanacs" on page 2-17) after loading new firmware.

Note on COCOM Restriction

The GB-500 will stop the calculation of any position and speed, as well as the output and recording of any observation data, if it exceeds the range specified by COCOM (if the moving velocity of the GB-500 exceeds 1,000 knots or its altitude exceeds 18,000 meters).

Troubleshooting

In general, as long as you follow the maintenance and safety instructions provided in this manual, you should have few problems with your receiver. This chapter describes possible error message that may display, as well as how to obtain technical support.

WARNING

Do not attempt to repair equipment yourself. Doing so will void your warranty and may damage the hardware.

Check This First

Before contacting TPS Customer support about any problems with the receiver, try the following:

- First, check all external receiver connections carefully to ensure correct and secure connections.
- Second, double check for worn or defective cables.
- Next, see the sections below for more specific solutions.

If the problem persists, try the following:

- Reset the receiver using PC-CDU (**Tools ▸ Reset receiver**).
- Restore default settings using PC-CDU (**Configuration ▸ Receiver**, then click **Set all parameters to defaults**).
- Clear the NVRAM (see “Clearing the NVRAM” on page 3-19).
- Initialize the file system (click **Tools ▸ Initialize file system**; this will erase all files inside the receiver).

Power Problems

The following are some of the most commonly encountered power problems.

Problem	
The receiver does not power up.	
Causes	**Solutions**
If no external power source used, batteries may be discharged.	Connect a fully charged external power source and retry. See “Connecting and Charging the Batteries” on page 2-1.
The receiver has an external power source, but internal batteries are discharged.	Charge the batteries overnight. See “Connecting and Charging the Batteries” on page 2-1.
The receiver may have a defective charger or defective internal batteries.	If after charging your internal batteries, and your receiver does not power up, contact TPS Customer Support for advice.

Receiver Problems

The following are some of the most commonly encountered receiver problems.

Problem	
The receiver cannot establish a connection to a computer or external controller.	
Causes	**Solutions**
The cable is not properly plugged in.	• Check that the cable connector is attached to the correct serial port. • Unplug the cable, then securely and properly reconnect it to the receiver. • See “Connecting the Serial Cables” on page 2-7 and “Port Configurations” on page C-4 for information on the receiver’s connectors.
The cable is damaged	Use an undamaged cable. Contact your Dealer to replace the cable.
The receiver port used for connection is not in Command mode.	1. Connect your receiver and a computer using a free port (see “Connecting the Serial Cables” on page 2-7) and start the configuration software. 2. Change the Input for the serial port used for connection to Command.
Problem	
The receiver does not lock on to satellites for a long period of time.	
Causes	**Solutions**
The receiver has an old almanac.	• Update the almanac. • See “Collecting Almanacs” on page 2-17.

Problem	
The receiver tracks too few satellites.	
Causes	**Solutions**
The elevation mask value is too high (e.g., above 15 degrees).	Lower the elevation mask using a connected controller/computer and receiver configuration software.
The survey is conducted near obstructions (tree canopy, tall buildings, etc.).	• Check that the Multipath Reduction boxes have been enabled when configuring receiver parameters. • Move to an area free of obstructions, if applicable.
Problem	
The receiver cannot obtain Code Differential and/or RTK solutions.	
Causes	**Solutions**
Incorrect Base coordinates entered.	Specify the correct coordinates for the Base station using suitable field data collection software.
The receiver is not configured as a Base or Rover.	Ensure the receiver has the proper configuration for it's function (that is, as a Base or Rover receiver).
The corresponding receiver options may be disabled or expired.	• Check the receiver's current options using the configuration software. • Enable or prolong the validity of the corresponding receiver options by ordering a new OAF with the desired options activated.

There are not enough common satellites. In order to obtain a fixed solution, the Base and Rover should track at least five common satellites.	• Ensure that both the Rover and Base receivers use the same, and updated, almanac. • Check the elevation masks of the Rover and Base receivers; they should be the same.
Poor satellite geometry (PDOP/GDOP values are too high).	Conduct your survey when PDOP values are low.
The elevation mask is above 15 degrees.	Lower the elevation mask.
The receiver and the antenna have a poor connection.	• Ensure the cable is undamaged. • Check the cable connector attachment to the receiver. Remove and reattach the cable connector to ensure a secure connection.
The Base and Rover modems are set to different radio channels.	Set the Base and Rover receivers to the same radio channel.
A discrepancy exists between the differential standards used at the Base and Rover receivers.	Use a controller/computer and receiver configuration software to ensure the Base and Rover receivers use the same corrections input/output format.
The distance between Base and Rover is too far.	• Close the distance between the Base and Rover. • Use repeaters to increase radio coverage.

Problem	
The receiver does not start data logging.	
Causes	**Solutions**
The receiver has no free space for files.	• Download receiver files to a computer (if needed) and delete files (see "Downloading Observation Data Files" on page 3-8). • Delete unnecessary files (see "Deleting Files from the Receiver" on page 3-14).
Problem	
One or both Battery LEDs rapidly blink red.	
Causes	**Solutions**
The batteries have a charging error.	• Check that the batteries are properly installed. • Check that the AC adapter is undamaged. • If the error continues, contact TPS customer support.
Problem	
One or both Battery LEDs do not light up.	
Causes	**Solutions**
No battery is installed.	• Install the batteries. • Check that the batteries are properly installed.

Obtaining Technical Support

If the above solution fail to remedy the problem, contact TPS Customer Support.

Before contacting TPS customer support, try clearing the NVRAM See “Clearing the NVRAM” on page 3-19 for details.

Phone

To get in contact with TPS Customer Support by phone, call 1-866-4TOPCON (1-866-486-7266).

E-mail

To get in contact with TPS Customer Support by e-mail, use the electronic mail addresses shown in Table 4-1.

Table 4-1. Technical Support E-mail

For Questions Related To...	Use...
Hardware (receivers, antennas, firmware)	hardware@topcon.com
GPS+ and 3DMC	psg@topcon.com
OAF (Option Authorization File)	options@topcon.com
RTK	rtk@topcon.com

If in doubt about which e-mail address to use for your particular question, e-mail the support group (support@topcon.com).

Website

The Topcon Positioning Systems website provides current information about Topcon’s line of products. The support area of the website provides access to frequently asked questions, configuration procedures, manuals, e-mail support, etc.

To access the TPS website home page, use: www.topconpositioning.com

To visit the support area, use: www.topcongps.com/support/

Notes:

Base Checks & Adjustments

NOTICE *NOTICE*

Your kit may not include one or more of the devices mentioned in this chapter. Contact your Topcon dealer for more information on purchasing any of these devices.

Pointers on adjustment:

1. Adjust the eyepiece of the telescope prior to any checking operation that involves sighting through the telescope.

   Remember to focus properly, with parallax completely eliminated.
2. Carry out the adjustments in the order of indicated, as the adjustments are dependent one upon each other. Adjustments carried out in the wrong sequence may nullify previous adjustment.
3. Always conclude adjustments by tightening the adjustment screws securely; but do not tighten them more than necessary, to prevent striping the threads, twisting off the screw, or placing undue stress on the parts.

   Furthermore, always tighten by revolving in the direction of tightening tension.
4. Tighten the attachment screws sufficiently, upon completion of adjustments.
5. Always repeat checking operations after making adjustments, in order to confirm results.

Notes on the tribrach:

An insecure or loose installation of the tribrach may directly affect measure precisions.

Adjusting the Base

To eliminate slack between the leveling screws and the base (Figure A-1),

1. Loosen the set screw of the holding ring.
2. Tighten the holding ring with the adjusting pin until it is properly adjusted.
3. Re-tighten the set screw upon completing the adjustment.

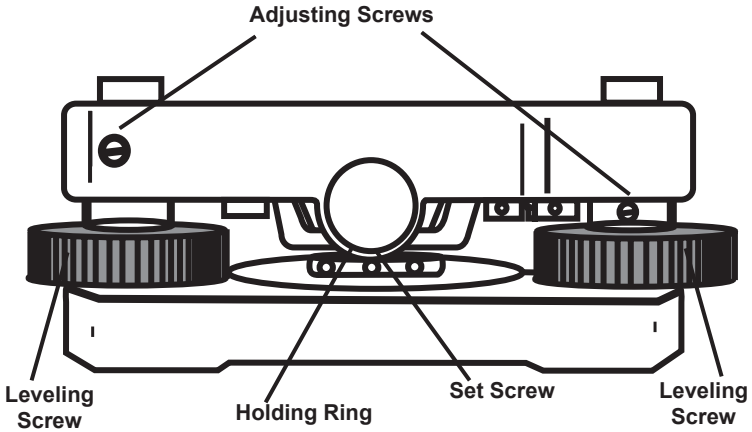


Figure A-1. Base Components

Checking & Adjusting the Plate Level

The plate level will need to be adjusted if the axis of the plate level is not perpendicular to the vertical axis.

Checking the Plate Level

1. Place the plate level parallel to a line running through the center of two leveling screws; for example, leveling screws A and B (Figure A-2).
2. Use only these two leveling screws to place the bubble in the center of the plate level.
3. Rotate the instrument 180° or 200g around the vertical axis and check bubble movement of the plate level (Figure A-2). If the bubble has been displaced, then adjust the plate level as seen in “Adjusting the Plate Level” on page A-4.

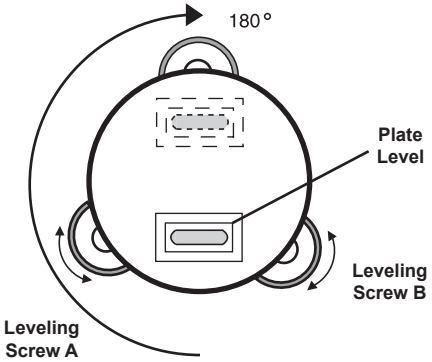


Figure A-2. Checking the Plate Level

Adjusting the Plate Level

1. Adjust the level adjustment capstan screw, with the accessory adjusting pin and return the bubble to the center of the plate level. This corrects only half of the displacement (Figure A-3).
2. Correct the remaining half of the bubble displacement with the leveling screws as described above.
3. Rotate the instrument 180° or 200g around the vertical axis once more and check bubble movement (Figure A-2 on page A-3). If the bubble is still displaced, then repeat the adjustment.

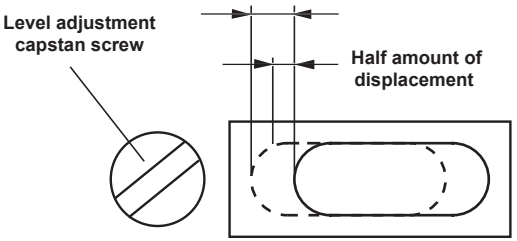


Figure A-3. Adjusting the Plate Level

Checking & Adjusting the Circular Level

Adjustment is required if the axis of the circular level is not perpendicular to the vertical axis.

Checking the Circular Level

Carefully level the instrument with the plate level. If the bubble of the circular level is centered properly, adjustment is not required (Figure A-4). Otherwise, proceed with the following adjustment.

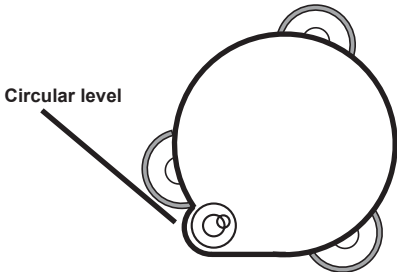


Figure A-4. Checking the Circular Level

Adjusting the Circular Level

Using the accessory pin to adjust the three capstan adjustment screws located on the bottom surface of the circular level, shift the bubble to the center of the circular level (Figure A-5).

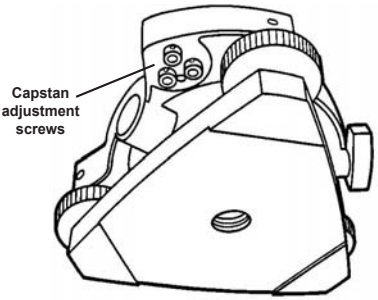


Figure A-5. Adjusting the Circular Level

Checking & Adjusting the Optical Plummet Telescope

Adjustment is required to make the line of sight of the optical plummet telescope coincide with the vertical axis; otherwise, the vertical axis will not be in the true vertical above the reference point when the instrument is optically plumbed.

Checking the Optical Plummet Telescope

1. Align the center mark and the point.
2. Rotate the instrument 180° or 200g around the vertical axis and check the center mark.

   If the point is properly centered in the center mark, adjustment is not required. Otherwise, adjust in the following manner.

Adjusting the Optical Plummet Telescope

1. Take off the adjustment section cover of the optical plummet telescope eyepiece. This will expose four capstan adjustment screws which should be adjusted with the accessory adjusting pin to shift the center mark to the point. However, only half of the displacement is corrected (Figure A-6).

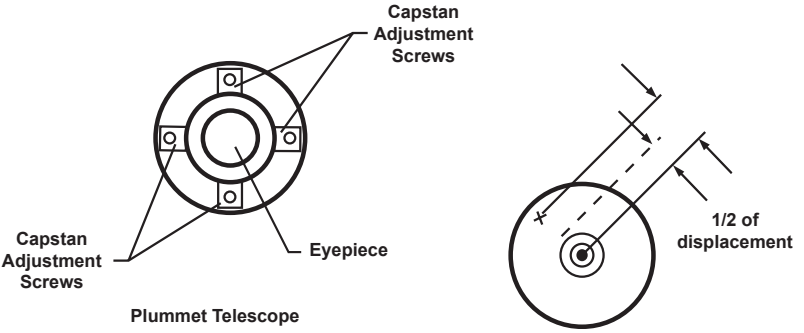


Figure A-6. Adjusting the Optical Plummet Telescope

2. Use the leveling screws to align the point and center mark, correcting the other half of the displacement.
3. Rotate the instrument 180° or 200g around the vertical axis once more and check the center mark (Figure A-2 on page A-3). If it aligns to the point, further adjustment is not required. Otherwise, repeat the adjustment.

TIP

First, loosen the capstan adjustment screw on the side to which the center mark must be moved. Then tighten the adjustment screw on the opposite side by an equal amount, leaving the tension of the adjustment screws unchanged. Revolve counter clockwise to loosen and clockwise to tighten, but revolve as little as possible.

Notes:

Handling and Safety Precautions

Before starting work or operation, be sure to check that the instrument is functioning correctly with normal performance.

General Handling Precautions

- **Water Resistance and Dust Resistance:**

  Do not submerge the GB-500 in water.

  The GB-500 conforms with Protection Class IP66.

  The GB-500 can withstand ordinary rain, etc. However, its water resistance cannot be guaranteed if submerged.

- **Mounting the instrument on a Tripod:**

  When mounting the GB-500 on a tripod, use a wooden tripod whenever possible.

  A metal tripod can produce vibrations that affect the precision of measurement.

  Also, be sure to firmly tighten all tripod screws.

- **Installing the tribrach:**

  Any looseness in the tribrach might affect the precision of measurement. Therefore, inspect the various base adjustment screws occasionally and make sure that they are tight.

- **Guarding the instrument against shocks:**

  When transporting or carrying the GB-500 receiver, use cushions to protect it from impacts to the extent possible.

- **Checking the batteries:**

  Before using the instrument, check the remaining capacity in the batteries.

- **Checking the internal memory:**

  Before using the instrument, check the remaining capacity of the internal memory.

- **Backup battery:**

  So that the GB-500 can retain its settings, almanac information, etc., it is equipped with a built-in backup battery. This battery always emits a slight current. Depending on the conditions of use, the backup battery will normally last for about 10 years from the time of manufacture. If battery capacity should be depleted, the GB-500 will be unable to retain its settings, almanac information, etc.

  If settings return to the default settings when power is turned on, or if, at the start of satellite reception, satellite tracking and positioning are always slow (cold start), the problem could be that the capacity in the backup battery has run out.

  For replacing the backup battery, please contact TPS or your local distributor.

- **About the almanac:**

  Before using the GB-500 for the first time, before using it after a long period of non-use, or after resetting the NVRAM, track satellites for about 15 minutes in order to obtain new almanac information.

- **An external controller accesses the GB-500:**

  When accessing the GB-500 from a personal computer or some other external controller, a D port will exist among the serial ports. The D port is for internal control only. Therefore, do not change the communication speed or other parameters of port D from the external controller/computer.

Safety Cautions

WARNING

A risk of fire, electric shock or physical harm exists if you attempt to disassemble or repair the instrument yourself. This is only to be carried out by TOPCON or an authorized dealer.

WARNING

High temperature may cause fire. Do not cover the charger while it is charging.

WARNING

Risk of fire or electric shock.

–Do not use damaged power cable, plug and socket.

–Do not use a wet battery or charger.

–Do not use any power voltage except the one given in the manufacturer's instructions.

WARNING

Battery can ignite explosively. Never use an instrument near flammable gas or liquid matter, and do not use in a coal mine.

WARNING

Battery can cause explosion or injury. Do not dispose in fire or heat.

WARNING

Battery can cause outbreak of fire. Do not use any charger other than the one specified.

WARNING

Risk of fire. Do not use any power cable other than the one specified.

WARNING

A short circuiting battery can cause a fire. Do not short circuit the battery when storing it.

CAUTION

Do not connect or disconnect equipment with wet hands, you are at risk of electric shock if you do!

CAUTION

Risk of injury by overturning the carrying case. Do not stand or sit on the carrying cases.

CAUTION

Please note that the tips of tripod can be hazardous, be aware of this when setting up or carrying the tripod.

CAUTION

Risk of injury or damage from falling instrument or case. Do not use a carrying case with damaged belts, grips or latches.

CAUTION

Do not allow skin or clothing to come into contact with acid from the batteries. If this does occur, wash off with copious amounts of water and seek medical advice.

CAUTION

A plumb bob can cause injury to a person if used incorrectly.

CAUTION

Ensure that you mount the Tribrach correctly, failing to do so may result in injury if the tribrach were to fall over.

CAUTION

A falling instrument can be dangerous, check that you fix the instrument to the tripod correctly.

CAUTION

A falling tripod and instrument can cause injury. Always check that the screws of tripod are securely tightened.

Specifications

This TPS product is a 40-channel GPS+ receiver in a rugged housing complete with display, user-keys, and cable connectors.

Receiver Specifications

Table C-1 lists receiver component details.

Table C-1. Receiver Specifications

Component	Details
Channel	
Number of channels	40 L1 20 L1/L2
Receiving frequency	Normal model GPS L1 (L1 C/A code) Dual Frequency option model GPS L1/L2 (L1/L2 C/A,P code) Dual Frequency+ GLONASS model GPS/GLONASS L1/L2 (L1/L2 C/A,P code)

Table C-1. Receiver Specifications (Continued)

Component	Details
Survey Accuracy (1 sigma D: measuring distance in mm) Precisions vary depending on number of satellites, satellite geometry, multi-path, ionosphere, and atmospheric conditions.	
Static, Fast Static	For L1+L2 – H: 3mm + 0.5ppm (x baseline length); V: 5mm + 0.5ppm (x baseline length) For L1 – H: 5mm + 1.4ppm (x baseline length); V: 7mm + 1.9ppm (x baseline length)
Kinematic, RTK	For L1+ L2 – H: 10mm + 1.0ppm (x baseline length); V: 15mm + 1.0ppm (x baseline length) For L1 – H: 15mm + 2.0ppm (x baseline length); V: 20mm + 2.5ppm (x baseline length)
Physical	
Dimensions	W:150 x H:257 x D:63mm
Weight	1.0Kg (without batteries) 1.2Kg (with batteries)
Protection against water and dust	IP66 (based on IEC60529)
Battery	Two internal
LEDs	5 LEDs indicating “hold” status, recording status, and battery status
Keys	3 keys for turning the receiver on/off, enabling/ disabling “hold”, and starting/stopping data recording
Internal memory	Optionally upgradable to 1 Gb maximum
Data recording time	74 hours subject to 8 Mb, 15-second interval, L1/L2, and 5 satellites
Ports	
Antenna	Lemo coaxial cable 50ohm x 1port
External power	ODU 5pin x 1port

Table C-1. Receiver Specifications (Continued)

Component	Details
Serial	ODU 7pin x 3ports
USB	Type B connector (USB1.1) x 1port
Environment	
Operating temperature	-20°C to +55°C
Storage temperature	-30°C to +60°C
Power	
Consumption	3.4W (with PG-A1 antenna and batteries)
Maximum operating time	Approximately 9 hours (at +20°C and using two BT-60Q batteries)
Input voltage	DC6 to 28V (when charging DC9 to 28V)
Formats	
DGPS recording format	RTCM 2.3 (1,2,3,9,16,31,32,34,36)
RTK data format	RTCM 2.3 (3,16,18,19,20,21,22,36), CMR2/CMR+
NMEA output format	NMEA 2.3 (GGA, GLL, GNS, GBS, GSA, GST, GSV, HDT, RMC, VTG, ZDA
Communication	
Baud rate	460, 800 / 230, 400 / 153, 600 / 115, 200 / 57, 600 / 38, 400 / 19, 200 / 9, 600 / 4, 800 / 2,400 / 1,200 / 600 / 300 (Default: 115,200)
Data bit	7, 8 (Default: 8) Parity – none, odd, even (Default: none) Stop bit – 1, 2 (Default: 1)

Port Configurations

The GB-500 is equipped with three serial ports (RS-232C), an external power port, a GPS antenna port, and a USB port. The pin assignment on each port is shown below.

Serial Port (RS-232)

For ports A, B, and C. The RS-232 connectors (Figure C-1) are sealed receptacle, 7 pin, ODU ports.

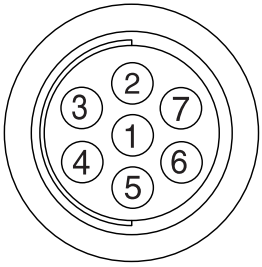


Figure C-1. RS-232 Serial Port – Ports A, B, and C

Table C-2 gives the RS232 cable connector specifications for Port A.

Table C-2. RS232 Connector Specifications for Port A

Number	Signal Name	Dir	Details
1	Power_OUT	P	Power Output (Supplied Voltage)
2	GND	I/O	Signal ground
3	CTS	I	Clear to send
4	RTS	O	Request to send
5	RXD	I	Receive data
6	TXD	O	Transmit data
7	-	-	Not used

Table C-3 gives the RS232 cable connector specifications for Port B. To use serial port B, install the appropriate firmware option.

Table C-3. RS232 Connector Specifications for Port B

Number	Signal Name	Dir	Details
1	Power_OUT	P	Power Output (Supplied Voltage)
2	GND	I/O	Signal ground
3	CTS	I	Clear to send
4	RTS	O	Request to send
5	RXD	I	Receive data
6	TXD	O	Transmit data
7	EVENT	I	Event marker input

Table C-4 gives the RS232 cable connector specifications for Port C.

Table C-4. RS232 Connector Specifications for Port C

Number	Signal Name	Dir	Details
1	Power_OUT	P	Power Output (Supplied Voltage)
2	GND	I/O	Signal ground
3	CTS	I	Clear to send
4	RTS	O	Request to send
5	RXD	I	Receive data
6	TXD	O	Transmit data
7	PPS	O	PPS signal output

External Power Port

Pins 1 and 2 and pins 3 and 4 on the external power port are internally short-circuited. To connect any external unit, check the pin assignment on that unit.

The power connector (Figure C-2) is a sealed receptacle, 5 pin, ODU port.

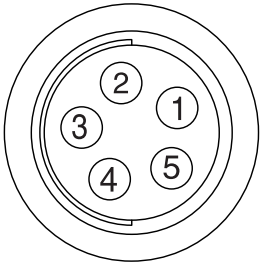


Figure C-2. External Power Port

Table C-5 gives the external power connector specifications.

Table C-5. External Power Connector Specifications

Number	Signal Name	Dir	Details
1	Power_INP	P	Power input
2	Power_INP	P	Power input
3	Power_GND	P	Power ground
4	Power_GND	P	Power ground
5	-	-	Not used

USB Port

The USB port (Figure C-3) provides connection through a USB cable to a computer.

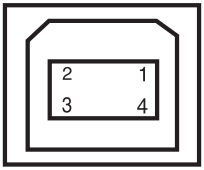


Figure C-3. USB Port

Table C-6 gives the USB port specifications.

Table C-6. USB Port Specifications

Number	Signal Name	Dir	Details
1	USB_PWR	P	Bus power input
2	USB D-	I/O	Data minus
3	USB D+	I/O	Data plus
4	GND	GND	Ground

Antenna

The PG-A1 antenna is for precise geodetic use. Table C-7 lists antenna component details.

Table C-7. Antenna Specifications

Component	Details
Type	Micro strip GPS/GLONASS; Micro-Center antenna
Connector	50ohm : TNC
Ground plane	Optional extended external ground plane
Dimension	W:141.6 x H:141.6 x D:53.7mm

Table C-7. Antenna Specifications (Continued)

Component	Details
Weight	492g
Protection against water and dust	IP66 (Based on IEC60529)
Operating temperature	-40°C to +55°C
Input voltage	DC 2.7 to 12V

BT-60Q Battery

The battery life varies depending upon the ambient temperature and the usage conditions of the GB-500. Table C-8 lists battery component details.

Table C-8. Battery Specifications

Component	Details
Type	Lithium ion
Rated voltage	DC7.4V
Capacity	2000mAh
Charging time	Approx. 3 hours
Dimensions	W:38 x D:20 x H:72(H)mm
Weight	100g

The life of the rechargeable lithium ion battery may be shortened depending upon the method of use. The following sections describe electric discharge, storage, and recharging cycle, which are related to the battery life.

Discharge Characteristics

The discharge characteristics of the battery at high temperature is the same as that at room temperature. However, when discharge occurs at low temperature, the capacity of the battery tends to decrease.

The capacity of the battery at a temperature of minus 20 degrees Celsius will decrease to 80% of the capacity at room temperature (20 degrees Celsius).

Excessive discharge will shorten the battery life.

Storage Characteristics

The deterioration characteristics of the battery accelerate as the storage temperature increases. The battery should be stored below room temperature.

The battery will deteriorate faster when stored in a fully recharged state. For long-term storage, lower the remaining capacity (charge) of the battery.

Recharge/Discharge Cycle Characteristics

Repeated recharging/discharging cycles will cause the battery to deteriorate. After about 500 recharge/discharge cycles, the remaining capacity of the battery will decrease to below 60%.

BC-29 Charger

Table C-9 lists charger component details.

Table C-9. Charger Specifications

Component	Details
Input voltage range	AC100 to 240V
Charging output voltage	8.4V ± 0.1V (Current for charging is 0.9 A)

Table C-9. Charger Specifications (Continued)

Component	Details
Frequency	50/60Hz
Charging temperature	+10°C to +40°C
Dimensions	W:70 x D:120 x H:40 mm
Weight	140g

AC Adapter

Table C-10 lists adapter component details.

Table C-10. Adapter Specifications

Component	Details
Size	W:60 x L:112 x H:36 mm
Weight	235 g
Operating Temperature	0°C to +40°C
Storage Temperature	-40°C to +85°C
Input	AC 100 to 240 V 1A (110 V AC) 50 to 60 Hz
Output	DC 12 V 2.5 A (30 W)
Connectors	Input (AC): Standard 3-pins AC receptacle Output (DC): SAE
Battery charge time	7 hours for Full Charge 6 hours for 90% Charge

NMEA Standards

NMEA-0183 is a standard intended to facilitate the connectivity and compatibility between equipment manufactured by different manufacturers. This standard defines the data exchange protocol, message type, and data transmission specification between the transmitting and receiving terminals, and is widely used in many applications.

General NMEA Format

Each NMEA message has the following format:

$AACCC,c-c*hh<CR><LF>

$:	Start of the message
AACCC:	Address field
	The first 2 characters are the identifier of transmitting terminal.
	The last 3 characters are the identifier of the message type.
c-c:	Data block
*:	Checksum separator
hh:	Checksum
<CR><LF>:	End of message (carriage return, line feed)

For each NMEA message, a NULL field will be used when one or more parameters are not reliable or not available. This field is described with 2 commas (,,) or a comma and an asterisk (,*) depending on the message position.

TOPCON receivers support the following transmission identifiers:

- GP – Global Positioning System (GPS)
- GL – GLONASS
- GN – Global Navigation Satellite System (GNSS)

In general, the transmission identifier notifies the receiving terminal whether the position information included in the message is generated by GPS alone, GLONASS alone, or the combination of GPS with GLONASS. Among actual NMEA messages, however, there are some messages that do not show the satellite used for positioning. (For further details, see “Supported Messages” on page D-3.)

Fields

Latitude and Longitude

The latitude is shown as DDMM.MMMM and the longitude as DDDMM.MMMM.

DD and DDD represent a degree and MM.MMMM is an arcminute with a decimal point.

Direction

The characters representing the north latitude, south latitude, east longitude, and west longitude are N, S, E, and W, respectively

Time

Time is expressed as UTC in the format of HHMMSS.

HH denotes hours between 00 and 23, MM denotes minutes between 00 and 59, and SS denotes seconds between 00 and 59.

Supported Messages

Table D-1 lists NMEA messages the GB-500 receiver supports.

Table D-1. Supported NMEA Messages

Message	Description
GGA	Data on time, position, and positioning
GLL	Position and positioning mode
GNS	Data on time, position and positioning of GPS+GLONASS (GNSS)
GRS	Residual error of distance for each satellite
GSA	Operation mode, satellite used, and DOP of GNSS receiver
GST	Statistics of position errors
GSV	Number of satellites, satellite number, elevation angle, azimuthal angle, and SNR
HDT	Heading
RMC	Positioning time, date, position, course, and speed
VTG	Course and speed
ZDA	UTC, day, month, year, and local time zone

GGA Message

This message outputs data on time, position and positioning, and is described in Table D-2.

Table D-2. GGA Message Ouputs

Field	Description
1	UTC time of position fix (first two digits designate hours, the next two designate minutes, and the remaining digits designate seconds)
2	Latitude in selected datum (first two digits designate degrees and the remaining digits designate minutes of arc)
3	Latitude hemisphere: N - northern, S - southern
4	Longitude in selected datum (first three digits designate degrees and the remaining digits designate minutes of arc)
5	Longitude hemisphere: E - eastern, W - western

Table D-2. GGA Message Ouputs (Continued)

Field	Description
6	GPS quality indicator 0: Fix not available or invalid. 1: GPS SPS Mode (single point mode), fix valid 2: Differential GPS SPS Mode, fix valid 3: GPS PPS Mode (single point mode), fix valid 4: RTK Fix solution 5: RTK Float solution 6: Estimated (dead reckoning) mode 7: Manual input mode 8: Simulator mode
7	Number of satellites used for position computation
8	Horizontal dilution of precision (HDOP) [-]
9	Altitude above geoid in selected datum [meters]
10	Symbol “M” (denotes that altitude is in meters)
11	Geoidal separation: the difference between the earth ellipsoid and geoid defined by the reference datum [meters]
12	Symbol “M” (denotes that geoidal separation is in meters)
13	Age of differential GPS data [seconds]
14	Differential reference station ID (an integer between 0000 and 1023)
15	Checksum

- The transmission identifier of the GGA message is always set to GP, regardless of whether positioning is calculated with GPS only, GLONASS only, or a combination of GPS and GLONASS.
- When the GB-500 uses GPS+GLONASS data for RTK and DGPS positioning, the age of differential GPS data and the differential reference station ID will be shown regarding the GPS data.

  In contrast, when the GB-500 uses GLONASS data only, the age of differential GPS data and the differential reference station ID will be shown regarding the GLONASS data.

- In general, when operating a GPS/GLONASS receiver, use the GNS message rather than the GGA message. The GGA message is used mainly for GPS only receivers.

GLL Message

This message outputs data on the current latitude/longitude and positioning state, and is described in Table D-3.

Table D-3. GLL Message Ouputs

Field	Description
1	Latitude in selected datum (first two digits designate degrees and the remaining digits designate minutes of arc)
2	Latitude hemisphere: N - northern, S- southern
3	Longitude in selected datum (first three digits designate degrees and the remaining digits designate minutes of arc)
4	Longitude hemisphere: E - eastern, W - western
5	UTC time of position (first two digits designate hours, the next two digits designate minutes, and the remaining digits designate seconds)
6	Status field V: Invalid for all values of positioning system mode indicator A: Autonomous D: Differential P: Precise R: RTK with fixed integers F: RTK with floating integers
7	Positioning system mode indicator A: Autonomous. Satellite system used in non-differential mode in position fix D: Differential. Satellite system used in differential mode in position fix E: Estimated (dead reckoning) mode M: Manual input mode S: Simulator mode N: Data not valid
8	Checksum

GNS Message

This message outputs data on time, position, and positioning of GPS+GLONASS (GNSS), and is described in Table D-4.

Table D-4. GNS Message Ouputs

Field	Description
1	UTC time of position fix (first two digits designate hours, the next two digits designate minutes, and the remaining digits designate seconds)
2	Latitude in selected datum (first two digits designate degrees and the remaining digits designate minutes of arc)
3	Latitude hemisphere: N - northern, S - southern
4	Longitude in selected datum (first three digits designate degrees and the remaining digits designate minutes of arc)
5	Longitude hemisphere: E - eastern, W - western
6	Mode indicator: variable length valid character field type with the first two characters currently defined. The first character indicates the use of GPS satellites, the second character indicates the use of GLONASS satellites. The indicators are: N: No fix. Satellite system not used in position fix, or fix not valid A: Autonomous. Satellite system used in non-differential mode in position fix D: Differential. Satellite system used in differential mode in position fix P: PPS independent positioning R: RTK Fix solution F: RTK Float solution E: Estimated position mode M: Manual input mode S: Simulator mode
7	Total number of satellites used for position computation
8	Horizontal dilution of precision (HDOP) [-]
9	Altitude above geoid in selected datum [meters]
10	Geoidal separation: the difference between the earth ellipsoid and geoid defined by the reference datum [meters]
11	Age of differential data [seconds] (see the note below)
12	Checksum

When the GB-500 is performing RTK or DGPS positioning using GPS alone or GLONASS alone, one GNS message will be output for the positioning result. When the GB-500 is performing RTK or DGPS using GPS+GLONASS, three serial GNS messages will be output for each positioning result.

The first one of three serial GNS messages outputs the majority of information and plays the most important role. The other two messages output the respective information on GPS and GLONASS (in particular, the number of satellites, the age of differential data, and reference station ID).

Shown below is an example of three serial GNS messages:

$GNGNS,122310.20,3722.425671,N,12258.856215,W,DD
,14,0.9,1005.543,6.5,,*74<CR><LF>

$GPGNS,122310.20,,,,,,7,,,,5.2,23*4D<CR><LF>

$GLGNS,122310.20,,,,,,7,,,,3.0,23*55<CR><LF>

GRS Message

This message outputs the residual error of distance, is used to support RAIM, and is described in Table D-5.

Table D-5. GRS Message Ouputs

Field	Description
1	UTC time (the first two digits designate hours, the next two digits designate minutes, and the remaining digits designate seconds)
2	Mode 0: residuals were used to calculate the position given in the matching GGA or GNS sentence 1: residuals were recomputed after the GGA or GNS position was computed Currently, the receiver uses only the first mode (Mode = 0)
3	A sequence of range residuals (in meters). Sequence length depends on the number of satellites used in the position solution. Order must match order of satellite ID numbers in GSA. When GRS is used, GSA and GSV are generally required. If the range residual exceeds 99.9 meters, then the decimal part is discarded, resulting in an integer (-103.7 becomes -103). The maximum value for this field is 999.
4	Checksum

The NMEA standard is as follows:

- When either GPS or GLONASS is used, the transmission identifier will be set to GP or GL, respectively.
- If GPS and GLONASS are used together, the GB-500 will create 2 GRS messages. The first message indicates the residual error of distance for GPS and the next message indicates the residual error of distance for GLONASS. The transmission identifier of each message uses GN, which represents the residual error of distance for GNSS.

GSA Message

This message outputs the operation mode of the GNSS receiver, the satellite used for positioning, and DOP, and is described in Table D-6.

Table D-6. GSA Message Ouputs

Field	Description
1	Switching mode M: Manual; forced switching of 2D/3D mode A: Auto; automatic switching of 2D/3D mode
2	Positioning mode 1: Positioning is invalid 2: 2D 3: 3D
3	A sequence of satellite ID numbers. Sequence length is variable (depending on the amount of satellites used in the solution) 1 to 32: GPS PRN numbers 1 to 24: GLONASS slot numbers 1 to 32: NMEA satellite ID numbers 65 to 68: NMEA satellite ID numbers
4	Position dilution of precision (PDOP)
5	Horizontal dilution of precision (HDOP)
6	Vertical dilution of precision (VDOP)
7	Checksum

The NMEA standard is as follows:

- When either GPS or GLONASS is used, the transmission identifier will be set to GP or GL, respectively.
- If GPS and GLONASS are used together, the GB-500 will create two GSA messages once. The first message is for GPS and the next message for GLONASS. Each message uses the same transmission identifier, GN, and has the same DOP value (DOP is a value calculated using a series of linked satellites).

GST Message

This message outputs the statistics of position errors, and is described in Table D-7.

Table D-7. GST Message Ouputs

Field	Description
1	UTC time of position (the first two digits designate hours, the next two digits designate minutes, and the remaining digits designate seconds)
2	Estimated standard deviation of the range input's error. “SV Range input”, which is used in the navigation process, includes this satellite‘s pseudo-range and the corresponding DGNSS correction [meters].
3	Semi-major axis of error ellipse [meters]
4	Semi-minor axis of error ellipse [meters]
5	Orientation of semi-major axis of error ellipse [degrees from true north]
6	RMS latitude error [meters]
7	RMS longitude error [meters]
8	RMS altitude error [meters]
9	Checksum

GSV Message

This message outputs the number of satellites, satellite number, elevation angle, azimuthal angle, and SNR, and is described in Table D-8.

Table D-8. GSV Message Ouputs

Field	Description
1	Total number of messages, 1 to 3
2	Message number, 1 to 3
3	Total number of satellites in view
4	Satellite ID number (see GSA for ID numbers), elevation in degrees, azimuth in degrees and C/A signal-to-noise ratio (SNR) in dB*Hz
5	Checksum

The number of sets consisting of satellite number, elevation angle, azimuthal angle, and SNR is variable (up to four sets for each message).

If the number of satellites exceeds four, multiple messages will be output. The first field indicates the total number of messages and the second field indicates the order of this message.

GPS and GLONASS messages are separately output. The identifier of the GPS message is GP and that of the GLONASS is GL.

The number of satellites may exceed 12. However, the NMEA standard specifies that only three messages are permitted for one epoch and that data on 12 satellites maximum can be output. If the number of satellites exceeds 12, some satellites may not be included in the epochs for which the GSV message has been given.

Examples of 1 epoch with the GSV message are shown below:

$GPGSV,3,1,10.....<CR><LF>

$GPGSV,3,2,10.....<CR><LF>

$GPGSV,3,3,10.....<CR><LF>

$GLGSV,2,1,7.....<CR><LF>

$GLGSV,2,2,7.....<CR><LF>

HDT Message

This message outputs the direction and is described in Table D-9.

Table D-9. HDT Message Ouputs

Field	Description
1	True Heading in degrees
2	Symbol “T” indicates true heading
3	Checksum

RMC Message

This message outputs time, date, position, course and speed data provided by a GNSS navigation receiver, and is described in Table D-10.

Table D-10. RMC Message Ouputs

Field	Description
1	UTC time of position fix (first two digits designate hours, the next two designate minutes and the remaining digits designate seconds)
2	Positioning state A: Data valid V: Navigation receiver warning
3	Latitude in selected datum (first two digits designate degrees and the remaining digits designates minutes of arc)
4	Latitude hemisphere: N - northern, S - southern
5	Longitude in selected datum (first three digits designate degrees and the remaining digits designate minutes of arc)
6	Longitude hemisphere: E - eastern, W - western
7	Speed over ground (horizontal speed) [knots]
8	Course over ground (true course) [degrees]
9	Date (day/month/year)
10	Magnetic variation [degrees]
11	Magnetic variation direction: E - eastern, W - western
12	Positioning mode A: Autonomous. Satellite system used in non-differential mode in position fix D: Differential. Satellite system used in differential mode in position fix E: Estimated (dead reckoning) mode M: Manual input mode S: Simulator mode N: Data not valid
13	Checksum

VTG Message

This message outputs the traveling direction and velocity, and is described in Table D-11.

Table D-11. VTG Message Ouputs

Field	Description
1	True course [degrees]
2	Symbol “T” indicates True course
3	Magnetic course [degrees]
4	Symbol “M” indicates Magnetic course
5	Horizontal speed [knots]
6	Symbol “N” indicates that horizontal speed is given in knots
7	Horizontal speed [km/h]
8	Symbol “K” indicates that horizontal speed is given in km/h
9	Positioning system mode indicator A: Autonomous. Satellite system used in non-differential mode in position fix D: Differential. Satellite system used in differential mode in position fix E: Estimated (dead reckoning) mode M: Manual input mode S: Simulator mode N: Data not valid
10	Checksum

ZDA Message

This message outputs UTC, day, month, year, and local time zone and is described in Table D-12.

Table D-12. ZDA Message Ouputs

Field	Description
1	UTC time (first two digits designate hours, next two digits designate minutes and the remaining digits designate seconds)
2	Day (varies between 01 to 31)
3	Month (varies between 01 to 12)
4	Year
5	Local zone hours (varies from -13 to +13)
6	Local zone minutes (varies from 00 to 59)
7	Checksum

The local time zone hour and minute refers to the difference from UTC.

Warranty Terms

TPS laser and electronic positioning equipment are guaranteed against defective material and workmanship under normal use and application consistent with this Manual. The equipment is guaranteed for the period indicated, on the warranty card accompanying the product, starting from the date that the product is sold to the original purchaser by TPS' Authorized Dealers.[1]

During the warranty period, TPS will, at its option, repair or replace this product at no additional charge. Repair parts and replacement products will be furnished on an exchange basis and will be either reconditioned or new. This limited warranty does not include service to repair damage to the product resulting from an accident, disaster, misuses, abuse or modification of the product.

Warranty service may be obtained from an authorized TPS warranty service dealer. If this product is delivered by mail, purchaser agrees to insure the product or assume the risk of loss or damage in transit, to prepay shipping charges to the warranty service location and to use the original shipping container or equivalent. A letter should accompany the package furnishing a description of the problem and/or defect.

The purchaser's sole remedy shall be replacement as provided above. In no event shall TPS be liable for any damages or other claim including any claim for lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, the product.

1. The warranty against defects in Topcon battery, charger, or cable is 90 days.

Notes:

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