INSTRUCTIONS FOR ESTABLISHING REFERENCE POINTS USING THE TOPCON GR-3

The Topcon GR-3 is a multi-frequency, GPS+ receiver that can be used to establish high-precision survey reference points, a procedure described in the Topcon manual as "Static Occupation" and "Static Surveying for Base Station." With two receivers (a stationary base receiver and a mobile rover receiver), it also can be used with less precision for topographic mapping. The system relies on radio signals from three (GPS, GLONASS, GALILEO) global navigation satellite systems to acquire positioning data, and these data are used to determine geographical, spherical coordinates (latitude-longitude), which can be transformed into two-dimensional, projected (e.g., UTM or State Plane) coordinates, and elevation. Accuracy of the derived points is dependent upon a number of variables, including number of satellites acquired, length of time data are received, and atmospheric conditions, but is advertised to be approximately 3 mm. Elevations are obtained with slightly less accuracy.

EQUIPMENT DESCRIPTION

The Topcon GR-3 consists of the following equipment stored in an instrument case, tripod bag, and red Leica case (marked GR-3). The *instrument case* contains two receivers (marked base and rover), two receiver antennae, two battery chargers and associated power cords, two quick disconnect adapters, a universal tribrach and tribrach adapter, a FC-200 data collector and charger cable, a USB cable for downloading files from the controller to a computer, and a measuring tape. Each receiver contains an SD memory card for storing data. The *tripod bag* contains a base station tripod (with a central rod for setting up over a fixed point) and a bipod for use with the mobile rover receiver. The *red case* contains miscellaneous cables and software for the GR-3, and it also contains two battery packs that each use four rechargeable or disposable AA batteries. The RLA also has a Topcon tripod with a detachable universal tribrach that can be used with the rover receiver to establish two survey reference points simultaneously.

BEFORE YOU BEGIN

Before going into the field, you should make sure that the batteries for each unit and the data controller are fully charged. You also should make sure that the receiver, or receivers if you plan to use both in tandem to establish two points simultaneously, contain SD memory cards.

Charging the Batteries

Each receiver contains two detachable batteries, located on opposite sides of the receiver base. These are easily removed by sliding down the gray button at the top and pulling them off the receiver. The two charging cradles permit the batteries from both receivers to be charged at the same time.

To set up a charger, plug the red-tipped cable from the switching power supply into one of the two receptacles at the top end of the charger (making sure that the red dot on the connector is oriented up so that the pins are properly aligned) and attach the black power cord to the other side of the switching power supply. (The seemingly complex cabling setup also allows you to use the charger as an external power supply in the field.) Now plug each battery into the charger, making sure that each is securely locked into place by sliding the gray buttons forward. Finally, plug the power cable into a power outlet.

When plugged in, the power indicator on the charger should illuminate red. The indicator LED above each battery will flash red, amber, or green, depending on the amount of charge left. A fully charged battery is indicated by a non-flashing green LED. When complete charged, all LEDs should go off. To verify a full charge, hold the status button down; both battery indicator LEDs should illuminate as solid green. Once charged, re-attach the batteries to the receiver.

A full charge to a fully depleted battery requires about 6 hours, and batteries cannot be over-charged. Each charged battery will provide between 4.5 hours and 8.5 hours of operation.

Charging the FC-200

Make sure that the FC-200 Data Collector, which will be used to control the operation of the receiver(s), is fully charged. To charge it, open the AC-DC adapter connector cap on the left side of the FC-200 and attach the adapter cable. When plugged in, the power LED on the front will illuminate red. When fully charged, it will illuminate green.

SD Memory Cards

To conduct a Static Occupation, which is the term used by Topcon for establishing a high-precision survey reference point, the receiver needs to store information to an internal SD memory card (1 GB maximum card capacity). This card occupies a card slot located on the left side of the receiver and is accessible when the battery has been removed from that side. (The opposite side contains a slot for a SIMM card.) Make sure that this card is present.

SETTING UP THE TRIPOD AND RECEIVER

Setting up the unit in the field is relatively easy and straightforward. First, position the tripod over an established point; second, attach the universal tribrach, quick disconnect adapter, and receiver onto the tripod; and third, measure the height of the receiver above the established point.

Positioning the Tripod

To place the tripod, loosen the knobs on the legs and center pole, and evenly space the legs at least one meter apart, making sure that the center pole is approximately plumb over the established point. The top of the tripod should be about eye level. Tighten the knobs on the legs but not the center pole. Then push each leg firmly into the ground with your foot, keeping the foot piece pointed upward. (This can be a little tricky since it will pivot downward when the

leg's knob is loosened.) Finally, adjust the height of each leg until the spirit level on the center pole indicates it is plumb (i.e., the bubble is within the center circle). The top plate on the tripod should be approximately level; if not, you will need to re-position the tripod.

Attaching the Receiver

Once the tripod is positioned, screw the universal tribrach onto the tripod head and then screw the quick disconnect adapter onto the tribrach. Then, attach the receiver to the disconnect adapter by lining up the two, squeezing the opposing buttons on the adapter, and sliding the receiver onto the adapter until it locks. Finally, attach the antenna to the top of the receiver (and be careful not to lose the red cap protecting the antenna mount).

Leveling the Receiver

Once the receiver is attached, adjust the thumbscrews on the tribrach to level the receiver. It is level when the bubble on the tribrach spirit level is centered within the circle.

Measuring the Receiver Height

Lastly, use the measuring tape to determine the height of the receiver above the established point. This is done by measuring the Slant Height, which is the distance between the established point and the bottom flat face edge of the gray rubble band around the outside of the receiver top. The receiver uses this measurement to calculate the coordinate of the antenna's phase center.

ACQUIRING SATELLITE DATA

Turn on the receiver by pushing the round button at bottom left of the MINTER (the panel with two buttons and six LED indicator lights). During normal operation, the LED lights should illuminate as follows:

- The blinking LEDs at far left and right indicate battery power and go from green to orange to red as power is depleted.
- The STAT LED indicates receiver status once it begins communicating with satellites. Red indicates the receiver does not have a satellite solution; green indicates tracking of GPS satellites (one blink per satellite); and orange indicates tracking of GLONASS satellites (one blink per satellite).
- The REC LED should illuminate solid green as the unit records data.
- The RXTX LED monitors activity of the receiver's radio modem, which is used for communication between the base and rover receivers (not applicable for Static Occupation which uses a single receiver). It should remain solid red during Static Occupation.
- BT indicates Bluetooth communication between the receiver and the FC-200 (flashing blue means connection not established; solid blue indicates connection).

Next, turn on the FC-200 by pushing the green button at lower right. If you see the main screen with icons, select Setup. A screen labeled Bluetooth Devices should appear (it may appear automatically when you turn on the FC-200). Highlight the appropriate device (Base or Rover) and click Select. With Bluetooth communication established, the blue LED on the receiver should now be solid blue. Click on Setup and then select Static Occup. Type in a name for the point you are set up on (for example, SC-RP1 for Smith Creek Reference Point 1). Then, enter the measured antenna height and select Slant as the method of measurement. Now click on Settings at the top of the screen. The appropriate settings should be File Name = User Defined, Log To = Receiver, and Logging Rate = 15.00 secs. Make any changes needed and click OK.

Before starting to collect data, check to make sure that an acceptable number of satellites has been acquired. This should take no more than a few minutes. Count the flashing green (GPS) and orange (GLONASS) LEDs to determine the number of acquired satellites. Four or more satellites provide optimal positioning.

You are now ready to beginning collecting data. Click on Start Occ to begin. You will be prompted to replace a default filename with another name. To avoid ambiguity, replace the default name with the name of the point you are set up on (e.g., SC-RP1). Then click OK. You should see the REC LED come on and stay green, and the STAT LED should alternate between a series of green flashes and amber flashes. You will need to let the receiver record data for about an hour. Once the appropriate time has elapsed, click Stop Occ to terminate the operation.

Once you have terminated the Static Occupation, turn off the receiver by depressing the power button for about three seconds.

DOWNLOADING DATA

Data files are downloaded from the receiver by removing the SD memory card, placing it in a card reader attached to your PC, and accessing it though TopconLink software. (Make sure the receiver is TURNED OFF before installing or removing the memory card.) A TopconLink CD should be located in the red case containing miscellaneous GR-3 equipment. You also can download it from ftp://ftp.earldudleyadvantage.com/transfer/Topcon/TopLink/.

Once installed, open TopconLink and place the SD memory card in your card reader. Don't panic if a Microsoft Windows message pops up telling you to format the disk before using it. Just close this window; DO NOT click Format Disk.

In TopconLink, select File | Import from Device. In the box at left, double-click on Topcon Memory Cards. (You may have to use the bottom slider to find this.) You should now see a disk drive letter for the card reader. Double-click on it and a list of the data files on the card will appear. If you double-click on a file name, it will be copied to the destination specified in the right-hand box. For example, if you want to copy a file to the desktop, first select Desktop on the right-hand side and then double-click on the filename in the lefthand box. A new window also will appear that gives information about the data in the file that you just copied, including antenna height which you will need to use before sending your data to be post-processed.

POST-PROCESSING DATA

The final step is to send the data file to OPUS (Online Positioning User Service) in order to process the raw satellite data. Each data file should represent a single reference point (i.e., receiver setup), and multiple files need to be uploaded separately. First, go to www.ngs.noaa.gov/OPUS/. In the top box, browse to the folder or Desktop where your file (*.tps) is located, and select it. Next, specify your antenna type. Do this by going to the dropdown list and selecting TPSGR3 (for Topcon Positioning Systems GR-3).

For antenna height, you will first need to convert the Slant Height, which you specified when you began collecting data, to the height of the Antenna Reference Point (ARP). This reference point is located at the base of the receiver where it attaches to the quick disconnect adapter, and is 168 mm below the vertical height represented by the slant height (see accompanying drawing). Obtain the ARP height from the Slant Height using the Pythagorean theorem as follows:

ARP Height = a – 168 mm,

where

$a = \sqrt{c^2 - b^2}$
b = 78.3 mm
c = slant height

Thus, if the slant height is 1.640 m (1640 mm), then the ARP height is 1.470 m.

An Excel worksheet (ARP_Vertical_Height_Calculator_for_GR-3.xlsx) is provided to perform this calculation. Once calculated, enter the ARP height into OPUS.

Finally, provide an email address where you wish to receive your solution from OPUS. If your raw data were collected during a time interval >15 minutes and <2 hours, click the button labeled Upload to Rapid-Static; if data were collected for a longer period of time, click the button labeled Upload to Static. Turnaround time is dependent upon OPUS's workload, but can be as little as 5-10 minutes.

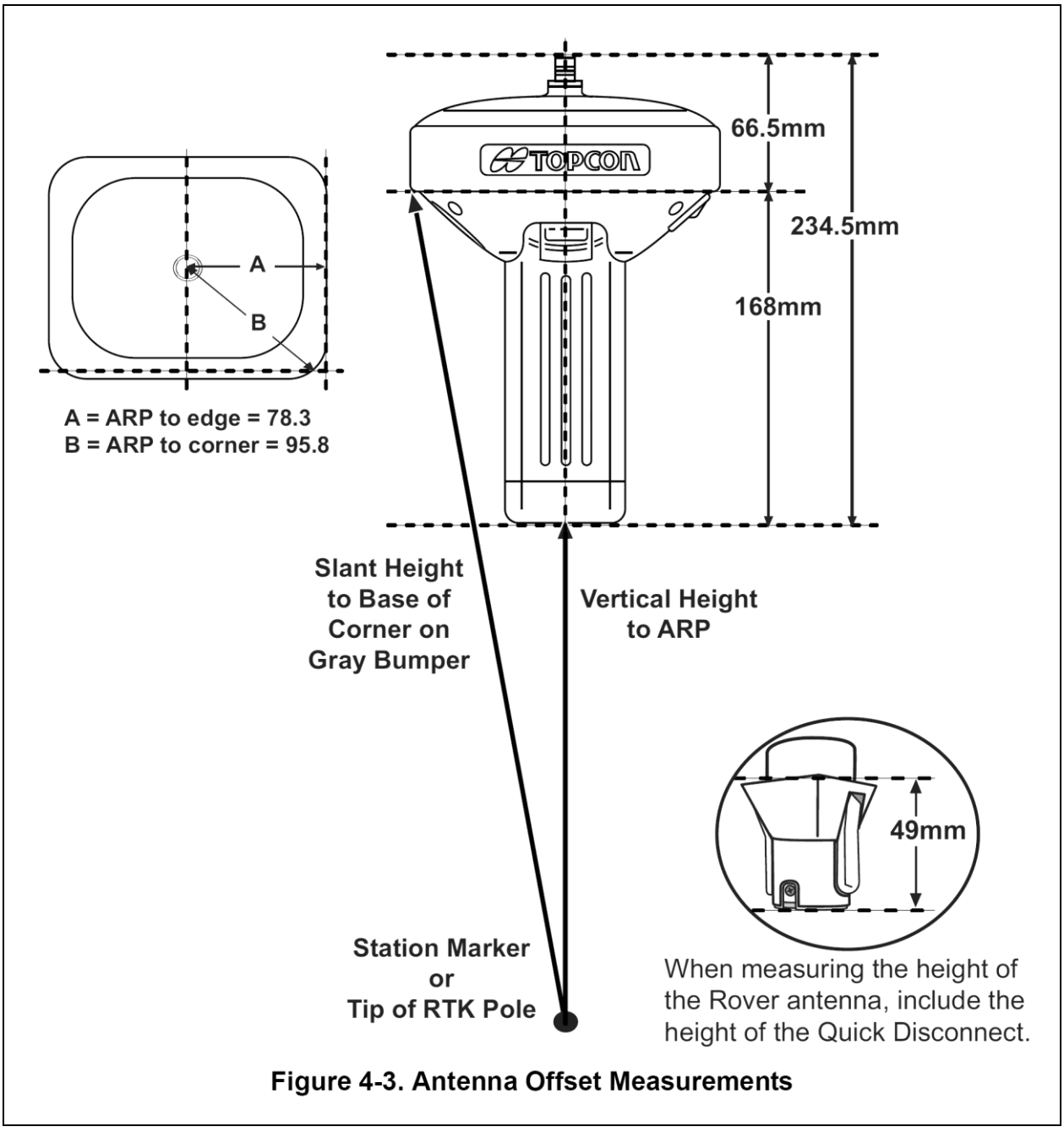

Figure 4-3. Antenna Offset Measurements

Diagram from the Topcon GR-3 Manual Showing Antenna Height Reference Points and Offsets.

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