Topcon GB-1000 First Article Receiver Testing
September 29, 2004
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This document summarizes the changes requested by UNAVCO before the GB-1000 could be deemed fully acceptable as a campaign GPS system (acceptance of first article receivers). Please see the 'UNAVCO 2004 GPS Campaign System Testing' report located on the UNAVCO website at: http://www.unavco.org/facility/science_tech/dev_test/publications/publications.html for a complete description of the testing environment. The summary tables A.1 -A.3 contain all functionality tested and was meant as more of a summary for UNAVCO personnel.

The items listed below were discovered during the PBO Campaign System Testing of 2004. The following items were deemed unacceptable by UNAVCO for the Topcon GB-1000. A request was submitted to Topcon to rectify these items. This document summarizes compliance or non-compliance with each item in which modifications were requested.

Enclosures

1. **Item:** Original yellow transport case was not durable enough for shipping or field applications, and a sturdier and more robust case was requested.

Solution: Topcon has provided a more robust pelican case, model 1550, which can be used for shipping and field applications. UNAVCO will modify to suit specific applications.

Compliant: yes

Power

1. **Item:** The receiver power on and power off voltages were too low for UNAVCO campaign field use. A request was made to change these values to something resembling a 'representative UNAVCO field' setup which typically utilizes 12 Volt batteries. Please see the power section of the testing report for a detailed explanation of the power testing performed.

Solution: Topcon has rectified the power on and power off voltages of the receiver to accommodate UNAVCO's needs. The power table below shows that the average power on voltage is now 11.4 volts compared to a previous value of 6.3* V, while the power off voltage is 10.4 volts compared to 5.7* volts.

Table 1.0 - Topcon power on and power off voltages from recent and previous tests.

Receiver	Receiver s/n	Antenna	Power On New	Power On Old	Power Off New	Power Off Old
TPS GB-1000	220046	TPS PG-A1+GRNDPL	11.3	6.3*	10.4	5.7*
TPS GB-1000	220047	TPS PG-A1+GRNDPL	11.3	6.4*	10.4	5.7*

Compliant: yes

2. Item: The receiver did not power on again after a power failure until the input voltage to the receiver dropped below 2 Volts (a situation that would never occur). Please see the testing report for an explanation of why this situation would never occur.

Solution: The receiver now automatically powers on after a power failure, though it does not keep its previous configuration entirely. A minor detail was noted when testing this feature. If the LCD screen is off but the receiver is still logging data, and the receiver looses power, the LCD screen will come on when power is restored to the system. This does not require any modifications on Topcon's part. If the receiver was powered on with the LCD screen still off, this may give the false impression of a broken receiver to an unfamiliar user. Currently the amount of power saved while running the receiver with the LCD screen off is 0.088 Watts.

Compliant: yes

3. Item: Average power consumption of the GB-1000 was approximately 4.7 Watts with the old power boards. The first article systems were tested with the internal heaters on, and the internal heaters off.

Solution: The average power consumption with the internal heaters on is roughly 4.18 Watts, or 11.06 % less than the original value of 4.7 W. The average power consumption of the receiver with the internal heater off is 3.98 Watts, or 15.32 % less than the original value.

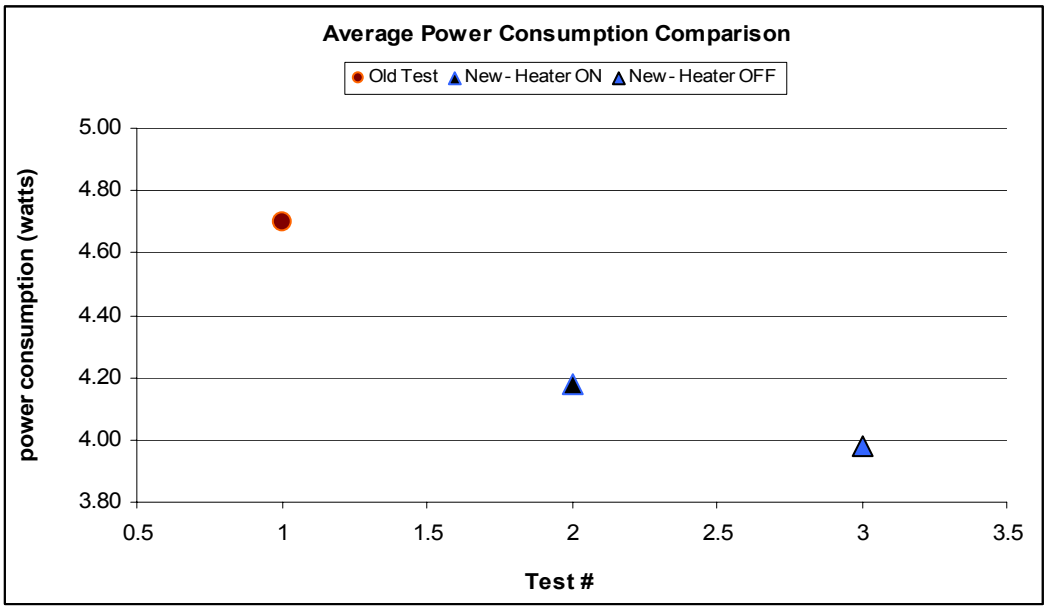


Figure 1.0 - Graph of old power consumption, new value with heater on, and new power consumption value with heater off.

Table 1.1 - Comparison of new and old average power consumption values.

Receiver	Antenna	Previous Power Cons	Previous Sigma	New power - heater ON	New Sigma - heater ON	New power - heater OFF	New Sigma - heater OFF
TPS GB-1000	TPS PG-A1+GRNDPL	4.70	0.078	4.18	0.018	**3.98**	**0.029**

Compliant: yes

Keyboard Commands

1. **Item:** Implementation of a keyboard command to turn the LCD screen on and off.

Solution: The user can depress the power button for a moment, the receiver will emit 1 beep, this will turn the LCD screen off but the receiver will still be functioning. When the LCD is off, a beep will be emitted by pressing any key without function. This is used to check if the receiver is on. To turn the LCD screen back on, the user must press F1 and F4 simultaneously until the LCD turns on. To turn the GB-1000 off, the user can hold the power button down, one beep turns the LCD screen off, and then four more beeps (total of five beeps) will be emitted at which point the receiver will be powered down.

Compliant: yes

2. **Item:** Implementation of a keyboard command to turn the heater on and off.

Solution: The user is able to use the keys on the GB-1000 to turn the heater on and off. The ability to turn the heater on and off remotely using a GRIL command is requested but not mandatory.

Compliant: yes

Data Logging

1. **Item:** Ability to log directly to removable compact flashcard.

Solution: External compact flashcard logging is available when you start with the STATIC or RAPID STATIC menu on the LCD screen. See attached document provided by Topcon for instructions on how to do this. An identified problem was an instance when multiple receivers are run at the same time and the user wants to transfer the data logged to a PC. If the user removes the card from one of the receivers, and places it in a compact flashcard reader, inserts that into a PC, and copies the data to the hard disk; the filename is non-unique. It is not what the user input via the front panel interface. If the user is unsuspecting or not paying attention, the first data file obtained from one of the cards will be overwritten by the second data file read from a different card because they both have the same name. The filenames that were entered by the user via the front panel interface do not show up (take effect) until the raw data is translated into rinex using the TPS2RIN GUI. Only at translation of the raw data files would the rinex files assume the unique filenames input by the user. It is desirable to have raw data files written to the external compact flashcard in the same manner as the raw data files are written to the internal compact flashcard with each file having a unique name.

Compliant: no

2. **Item:** Receiver Security and BINEX implementation

Solution: Delivery date has been changed to January 2005.

Compliant: n/a

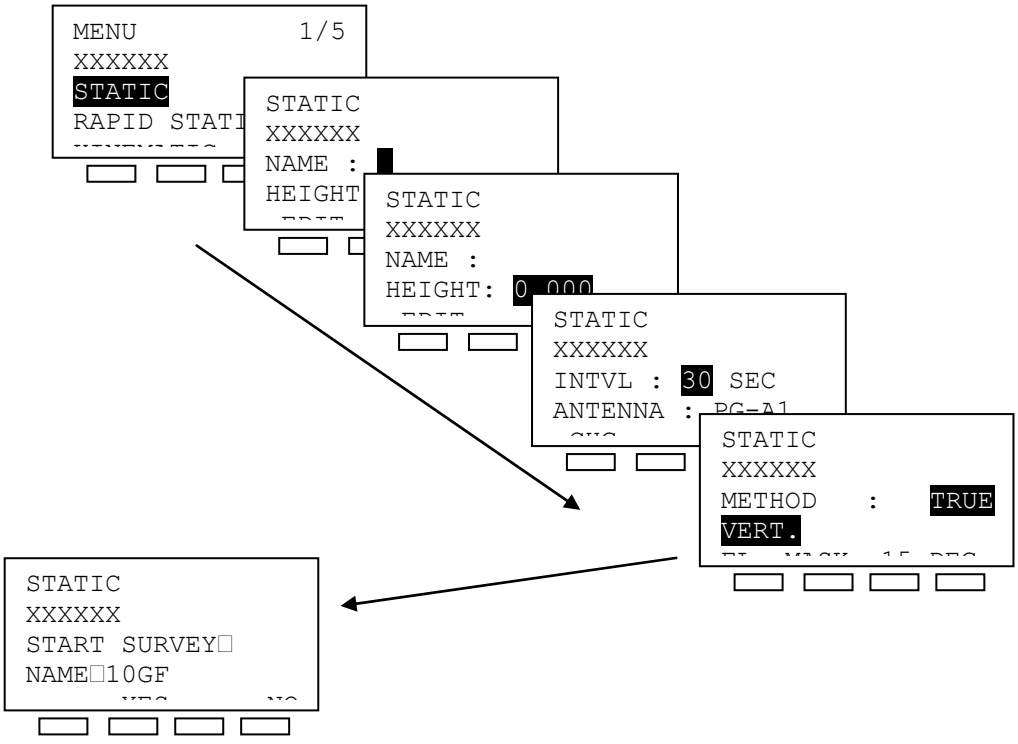
Appendix A - Topcon implemented changes for GB-1000

UNAVCO firmware operating manual

072804Alan

1. External CF card logging

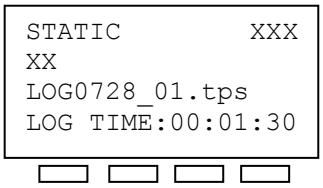
The External CF card logging is available when you start with STATIC or RAPID STATIC menu on LCD screen.



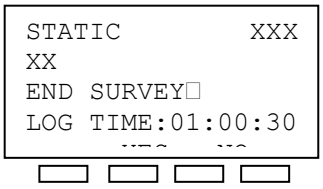
If you want to record the raw data to the External CF card, please press LOG. (When the external CF card is accessed the first time, it may take some time to enable the CF card.)

If you want to record to internal memory, please press YES.

During the external CF card logging, The LCD show the file name and Logging time. The file is LOGMMDD_XX.TPS (MM:month, DD:day, XX: number) The icon field shows the battery(1 and 2) status, CF memory remaining, the number of GPS and GLONASS satellites.



When you want to finish the logging, please press END. The LCD show the confirmation. Then press YES.



2. LCD off

You can turn off the LCD at any time. The LCD is turned off by pressing the Power button for one moment. The beep sounds one time.

When the LCD is off, a beep sounds by pressing any key without function. This is used to check if the receiver is ON.

When you want to turn on the LCD, press the F1 and F4 button simultaneously until the LCD turns on.

3. Power off (notice)

When you turn off the GB-1000 receiver, you can turn off by pressing and holding the Power button for few seconds.

When pressing the Power button, first the LCD is turned off after one beep, and then the GB-1000 is turned off after Four beeps. (Totally of 5 beeps until power off.)

4. Input power voltage.

Input Voltage: 12 ~ 28VDC

Table A.1 - Summary of category I GPS receiver requirements and validation thereof.

Category 1 Requirements for Topcon GB-1000 (mandatory at time of testing)	Validated	Problem if not validated	Comments
All receivers must be post-processed kinematic enabled and RTK base enabled.	Yes		Used GB-1000 as base for demo of RTK equipment by Topcon in July 2004
Dual frequency 12 channel GPS receiver able to track L1 C/A code and/or L1 P and L2 P code (with P code observations recovered under anti spoofing), and L1 and L2 phase observables. Unsmoothed pseudorange must be recoverable from the receiver.	Yes		
Receivers must be able to simultaneously track 12 channels L1 and 12 channels L2. Receivers must track all available satellites, even if SV is unhealthy, to an elevation angle of 0 degrees.	Yes		
L1, L2 SNR in dB Hz referenced to a 1 Hz (or better) bandwidth SNR (amplitude) discretization should be better than 0.5% of full scale. Each manufacturer must supply a written statement explaining how SNR is defined.	Yes		
Receiver memory must be removable and capable of recording 370+ days of data at a 30 second sampling interval with a minimum of 9SVs.	No		Single raw data file tracking 12 SV's with 30 sec. sample rate is approx 2.1 Mb. Therefore, receiver memory (1 Gb internal) meets this requirement. A raw file with only 9 SV's would most likely be less than 2 Mb.
File system must accommodate a minimum of 500 data files.	In Process		Currently being evaluated
Total Expected and Observed data – In the 10 -90 deg elevation range receiver must have at least 99% observed to expected data.	Yes		
MP1 and MP2 Tracking Statistics - In the elevation range 10-90 deg, the receiver must have MP1 and MP2 values of less than 0.8 m.	Yes		
Observations per Slip – Over the elevation range 10-90 deg the receiver should have greater than 20,000 observations per slip (total number of observations recorded divided by the total number of slips).	Yes		
Short Baseline Precision Tests – Short baseline solution precision must be no larger than 0.5 mm in the north and east components, and no larger than 1.0 cm in the vertical component for L1, L2, and L3.	Yes		
Power consumption must be less than 5 W while tracking all available satellites.	Yes		
Receivers must automatically restart after loss of power and must power up in same configuration when powered down or upon loss of power (AC and DC).	Yes		Did not pass at time of campaign system testing (first test), first article receivers pass
Receiver must have 2 data ports with standard serial DB9 or USB connector OR 2 data ports with custom connector and custom connector to serial DB9 or USB.	Yes		
Receiver must have a total of 2 power ports for 12V DC external batteries and AC power.	No	Receiver has 2 power ports but they are internally connected, resulting in the possibility of a high current traveling across the receiver if one dead battery were installed with one fully charged battery.	Internal power port wiring may not be an issue if receiver is used in semi-permanent (longer term) occupation as internal batteries would be removed.

Table A.1 cont. - Summary of Category I GPS receiver requirements and validation thereof.

Category 1 Requirements for Topcon GB-1000 (mandatory at time of testing)	Validated	Problem if not validated	Comments
Receiver must be able to work with an L1/L2 Dorne & Margolin antenna element (or similar) mounted on a Choke Ring designed by the Jet Propulsion Laboratory (JPL) and designated as type T (JPL D/M+crT). If an adapter is needed in order for the receiver to	No		Output voltage from receiver is 5 Volts - Receiver would not power a Trimble Choke Ring antenna, it would power an Ashtech choke ring
RINEX V2.0 translator software must accompany receiver. RINEX output must be compatible with teqc and include all available observables including L1 and L2 SNR as described above.	Yes		
Operating temperature: -40 deg C - + 65 deg C, Humidity: 100%, fully sealed,	No		Receiver is not fully sealed
Shock: 1m drop to hard surface.	No		Manual indicates receiver compliance
The receiver Mean Time Between Failure (MTBF) must be at least 57,500 hours according to the Bellcore “Ground Benign” specifications.	Yes		Contained within response from Topcon to initial RFP
Receiver must have remote data download capability	No		All testing has been via direct connection, no remote download testing has been done
The receiver must have a front panel interface that indicates that data are being logged and the number of satellites that are being tracked.	Yes		
RTK systems must support RTCM SC104 v2.2 input and output.	No		no RTK systems have been purchased yet

Table A.2 – Summary of Category II GPS receiver requirements

Category 2 Requirements for Topcon GB-1000	Validated	Problem if not validated	Comments
Firmware upgrade to be delivered January 2005, implementing simultaneous logging and streaming of BINEX GPS observables as defined in Attachment 8 of subcontract	n/a	deadline for implementation is January 2005	
Logged BINEX observables must include the ability to write selected, time configurable (e.g. every 5 minutes) selected records 0X00 such as: antenna height, station name (to be defined after award).	n/a	deadline for implementation is January 2005	
Keyboard command to turn LCD screen on / off **	Yes		2 beeps while depressing power button will turn off LCD, 5 beeps will power receiver off completely, depressing power button once while receiver is off will power receiver on
Direct logging to external compact flashcard **	Yes		When data is logged directly to the external CF on multiple receivers simultaneously, both filenames have the same name until translated using tps2rin. Once files have been translated from raw into rinex, filenames are unique. Raw data file transfer creates the possibility of overwriting data files.
Replacement Hard-shell transport case **	Yes		Pelican 1550 will be substituted
Correct Power on/off voltages **	Yes		Power on/off voltages were deemed too low from previous testing
Lower average power consumption **	Yes		New power boards in receiver indicate approximately 12% less power consumption than previous testing (with heaters off)
Implement encrypted login method for Ethernet capability - January 2005 **	n/a	deadline for implementation is January 2005	Due to availability of Ethernet port on receiver, which was not a requirement, Topcon has agreed to implement receiver security as defined in Attachment 7 of the subcontract - to be delivered January 2005

** - Requested by UNAVCO after initial testing

Table A.3 - Summary of Category III GPS receiver requirements.

Category 3 Requirements for Topcon GB-1000 (desired but not mandatory)	Validated	Problem if not validated	Comments
Front panel interface allowing configuration of receiver without a handheld controller.	yes		
Receiver support for the input and output of MET/tilt measurements a) as a serial pipe using an NMEA string and b) be recorded in receiver data file.	No	Not required, not tested yet	