TROUBLESHOOTING GPS RECEPTION ISSUES WITH THE SPECTRACOM MODELS 8194/8194B, 8195/8195A/8195B, AND 8197/8197B

There are a few factors that can inhibit GPS reception in Spectracom equipment. This GPS reception Application Note is intended to aid in the troubleshooting of GPS reception-related issues concerning the Spectracom series 8194, 8195, and 8197 frequency reference oscillators.

- **Section 1** of this document describes how to determine whether a GPS reception issue exists.
- **Section 1A** covers how to send equipment logs to Spectracom for review.
- **Section 2** of this document applies to scenarios in which no GPS reception is present (tracking 0 satellites).
- **Section 3** of this document applies to scenarios involving low GPS quality/reduced GPS reception.

REQUIRED TEST EQUIPMENT

- Analog or Digital Multimeter with test leads.
- PC with either Microsoft HyperTerminal or Procomm installed (the PC must have a DB9 serial port or will require the use of a USB-to-serial adapter).
- Straight-thru DB9M to DB9F serial cable (minimum pin-out of this cable is pin 2 to 2, pin 3 to 3, and pin 5 to 5). Null-modem cables and some data cables supplied with bench-top UPS power supplies will not work for communication with the Spectracom equipment.

TABLE OF CONTENTS

SECTION 1: IDENTIFYING A GPS RECEPTION ISSUE

The Spectracom Models 8194, 8195, and 8197 series master oscillators provide built-in indicators of a GPS reception issue with the equipment. These include front panel indications and built-in logs that can be obtained using the front panel setup port.

The front panel GPS lock light should be illuminated within 20 minutes of equipment power-up, provided the GPS antenna is connected and installed outdoors with an unobstructed view of the horizon (the Osc lock light takes a minimum of 2.5 hours to turn green after the GPS lock turns green).

If the GPS lock light fails to indicate green within 20 minutes of power-up (with the antenna connected), or if the light goes out at any time thereafter, this indicates that a GPS reception issue may exist. The front panel Minor and Major alarm lights may also indicate a GPS reception issue. Entries in the alarm log and the quality of the data in the Display Histogram logs will also indicate if a GPS reception issue exists.

The first step in troubleshooting a reception issue is to determine if the GPS reception is reduced or is non-existent. If the Minor/Major lights are illuminated and the front panel GPS lock light has not illuminated

within 20 minutes or so after initial installation, or if the lock light is no longer illuminated (the unit has not been power-cycled within the last 20 minutes or so), there is a reception issue.

If a GPS reception issue is present, connect to the unit's front panel RS-232 Setup port (DB9F serial connector) using a straight-thru standard serial cable (not a null-modem cable). Connect the other end of the cable to a serial comm port of a PC running HyperTerminal (or to a USB to RS-232 converter if the PC does not have a DB9 serial port).

The comm port properties for the HyperTerminal session are **9600 baud , No parity, 8 bit, 1 stop bit** (flow control setting does not matter). For additional assistance with HyperTerminal, refer to the Application Note at: http://www.spectracomcorp.com/portals/0/support/pdf/using_hyperterminal.pdf

NOTE: The Spectracom equipment will need to be placed in Test Mode to retrieve extended data. When the unit is placed in Test Mode, the Minor and Major alarm relays will both be activated. Other equipment monitoring the alarm relay outputs located on the rear panel may be affected when turning on Test Mode.

Once connected with HyperTerminal, perform the following commands to retrieve the logs:

- **STAT command (DS command in Model 8195)** — Retrieve the current status of the unit by typing STAT <enter> (or DS <enter> on a Model 8195). The unit will respond with the current status of the unit, including current active alarms and the reason for the alarms.

If the response displays "GPS SIGNAL = NOT QUALIFED", a reception issue exists.

If the response contains "Antenna Problem", a short or open in the antenna cable likely exists.

NOTE: The Model 8195 (no letter "A" or "B" following the "8195") and earlier versions of the Models 8195A and 8197 used a GPS receiver that did not have the antenna sense circuit. Refer to section 2 for more information on how to determine if the unit has the antenna sense circuit.

- **DSS/SS Command** — For Models 8195A/B and 8197, type DSS <enter> to display the number of satellites currently being tracked (for Model 8195, type TM ON <enter> and then SS <enter>). A sample DSS response is shown on the next page.

DSS

TRACKING **08** SATELLITES

GPS STATE= POS-HOLD DOP= 00.0

LATITUDE= N 43 07 01.942 LONGITUDE= W 077 29 15.050 HEIGHT= +00095 METERS

QUALITY= PASSED

Indicates total number of satellites currently bring tracked. In this example, 8 satellites are being tracked.

CHAN	VID	MODE	STREN	STAT
01	08	08	050	08A0
02	27	08	049	08A0
03	31	08	052	08A0
04	03	08	048	08A0
05	15	08	051	08A0
06	18	08	051	08A0
07	13	08	049	08A0
08	19	08	042	08A0
09	00	00	000	0000
10	00	00	000	0000

Indicates which receiver channels are tracking GPS satellites, the mode of satellite reception, and the strength of the satellites being tracked.

11	00	00	000	0000
12	00	00	000	0000

NOTE: Some units will have 8 channels listed in the table, while others will list 12 channels, depending on the version of the unit and the installed GPS receiver.

If the unit responds with "Tracking **00** satellites", refer to Section 2 for troubleshooting loss of all GPS satellites.

The minimum number of qualified satellites is 4 at all times. If the unit responds with Tracking **01**, **02**, or **03** satellites, refer to Section 3 for troubleshooting reduced GPS reception.

- **DAL command** — Type DAL <enter> to display the Alarm Log (or DP <enter> in a Model 8195). For more history on the Alarm log, place the unit in Test Mode first by typing TM ON <enter > before typing DAL P <enter> (where the letter "P" pages the entries for ease in reviewing the log).

The Alarm log/Display Performance log entries will provide a history of the Minor and Major alarms the unit has experienced and the reason for the alarms. Recent and past log entries can be used in identifying reception issues and can also be used to help troubleshoot these issues. Following are the possible Alarm log entries that are related to reception issues:

ALARM LOG ENTRIES RELATING TO GPS

Antenna Problem Alarm (Minor alarm) — Indicates the presence of an open or short in the antenna cable between the GPS receiver and the antenna. This alarm may also be present if the receiver has been damaged by a power surge. Refer to Section 2 for troubleshooting.

NOTE: The Model 8195 (no letter "A" or "B" following the "8195") and earlier versions of the Models 8195A and 8197 used a receiver that did not have the antenna sense circuit on the receiver. To determine whether the GPS receiver has the sense circuit installed, type TM ON <enter> and then VER <enter>.

A. If the unit responds with "8 channel VP receiver" — The receiver does not have the sense circuit and will not generate the Antenna Problem alarm if a short or open in the cable exists.

B. If the unit responds with either "8 channel UT" receiver or "12 channel M12" receiver – the receiver does have the antenna sense circuit and should generate the "Antenna Problem" alarm if a short or open in the cable exists. The alarm may also be present if the receiver has been damaged by a power surge, even if the antenna cable is OK.

Tracking Alarm 1 (Minor alarm) — Indicates that all GPS reception has been lost for at least 1 minute but less than 2.5 hours. Refer to Section 2 for troubleshooting.

Tracking Alarm 2 (Major alarm) — Indicates that all GPS reception has been lost for at least 2.5 hours but less than 30 days. Refer to Section 2 for troubleshooting.

Tracking Alarm 3 (Major alarm) — Indicates that all GPS reception has been lost for at least 30 days. Refer to Section 2 for troubleshooting. Presence of Tracking Alarms 1, 2, and 3 at the same time indicates the unit was power cycled at that time.

Low GPS Quality (Minor alarm) — Indicates that during that particular hour, 3000 out of the 3600 seconds in the hour did not meet the minimum qualification for GPS reception (at least 4 satellites with greater than the minimum signal strength values). The "Q" value in The Tracking Histogram log will be 3000 or below for that particular hour. Refer to Sections 2 and 3 for troubleshooting.

- **DH command** — Type DH <enter> to display the Histogram log. For more history on the Histogram log, place the unit in Test Mode first by typing TM ON <enter > before typing DH P <enter> (where the letter "P" pages the entries for ease in reviewing the log).

The DH command (Display Histogram) provides an hourly log count of the number of satellites that were tracked during each particular hour. This log is useful in determining If a GPS reception issue is continuous, sporadic, or has a pattern to it (all of these are possible).

Each hourly log entry provides a count of the total number of satellites that were tracked during that particular hour (not which satellite IDs were tracked). The numbers before each of the "=" signs indicates the number of satellites tracked during the hour. The numbers after each of the "=" signs indicates the number of cumulative seconds that the receiver was tracking the number of satellites indicated before each "=" sign. The "Q" value at the end of each hourly log entry indicates the total number of seconds of qualified GPS reception. As there are 3600 seconds in an hour, a full hour of GPS reception will result in a Q value of Q=3600. The Q value is deducted by one for every second of non-qualified GPS reception. A Q value of 0 indicates no qualified reception occurred during the entire hour.

Example:

```
TIME= 12:00:00 DATE= 2004-03-24
 0= 00050   1= 00000   2= 00000  3= 00000  4= 00000
 5= 00000   6= 00019   7= 01537  8= 02044  9= 00000
10= 00000  11= 00000  12= 00000  Q= 03550
```

The above example DH log entry indicates the unit tracked 0 satellites for a total of 50 seconds during the 12:00 (UTC time) hour, 6 satellites for a total of 19 seconds, 7 satellites for a total of 1537 seconds, and 8 satellites for a total of 2044 seconds during this particular hour. This results in a Q value of 3550, as the unit tracked a combined total of 3550 seconds of qualified satellites.

TO ANALYZE THE DH LOG DATA

The DH log is a great tool for analyzing when GPS reception problems are occurring. The log can help determine if the cause of the reception issue is intermittent, predictable, or continuous, which can help identify the cause of the issue.

Unless the unit is placed in Test Mode, only the last five hours of reception data will be displayed in the log. For an accurate analysis of the reception history, place the unit in Test Mode by typing TM ON <enter>. The unit will respond with "Test Mode ON". The unit will now display several days of GPS reception history.

The easiest way to analyze the DH log is to look for log entries where the Q value is less than 3600. Each hourly entry with a Q value less than 3600 indicates a potential reception issue during that particular hour. If the Q value is consistently less than 3600, the cause of the reception issue is continuous. If there is no obvious pattern to the times of the log entries where the Q value is less than 3600, the reception issue is sporadic (such as caused by a poor cable crimp or connection).

GPS antennas with blocked views of the horizon often result in a cyclic 12 or 24 hour pattern of Q values less than 3600. If the logs that are dropping below 3600 are occurring every 12 or 24 hours, the issue is likely due to the antenna having a blocked view of the horizon. The 12 or 24 hour intervals occur because the satellites are in a 12 hour orbit of the earth. Blocked views of the horizon can result in a cyclic pattern in which the GPS satellites are blocked from the view of the antenna.

SECTION 1A: SENDING LOGS TO SPECTRACOM FOR REVIEW

The built-in unit logs can be emailed to Spectracom Technical Support for review and evaluation, if you wish. The logs can be captured to a file and then the file sent as an attachment.

HyperTerminal data should be captured to a file and then the file emailed to us. (Do not take screenshots. Screenshots of HyperTerminal can scramble the data, making it difficult to analyze.) To send the logs to us for review, in HyperTerminal, select "Transfer" on the top of the page and then select "Capture Text" from the drop-down. Choose a temporary file location to store the logs (this will be the file to email to us). Click Start. Type the following commands in HyperTerminal (followed by the <enter> key after each command) to capture the internal logs:

For the Models 8194/8194B, 8195A/B or 8197/8197B:
STAT DSS DOL TM ON VER DH DAL (hit the enter key after each command)

For the Model 8195:
DS SS TM ON DH DP (hit the enter key after each command)

Once the commands have been entered, in HyperTerminal, click Transfer/Capture and then Stop to stop the data capture. Then email the saved file to us at techsupport@spectracomcorp.com along with your contact information. We will be happy to evaluate the logs for you and let you know what we find.

SECTION 2: NO GPS RECEPTION (TRACKING 0 SATELLITES)

This section covers troubleshooting conditions in which the GPS receiver is dropping to 0 satellites for periods of time, or never tracking a single satellite.

Cable or connector problem: Using a multimeter, measure the antenna cable resistance to verify the integrity of the cable and connectors. Remove the antenna cable from the rear panel of the receiver and measure the resistance from the coax center to shield. Refer to Table 1-1 for typical resistance values of the antenna and inline amplifier, alone and when combined.

DEVICE	RESISTANCE
8225 GPS Antenna (Model Number “CCAB32AST01”)	180 ohms
8225 GPS antenna (Model Number “SA-300”)	62 ohms
8227 preamplifier (Circular case)	165 ohms
8227 preamplifier (Square case)	91 ohms
8225 (Model Number “CCAB32AST01”) and 8227	85 ohms
8225 (Model Number “SA-300”) and 8227	179 ohms

Table 1-1 Typical Antenna Cable Resistance Values

NOTE: If the impedance measurement of the cable is correct, but the Antenna Problem alarm is active with the antenna cable connected, this indicates that the internal GPS receiver’s sense circuit was likely damaged by a power surge/lightning strike. Depending on the severity of the surge, while in this state the GPS receiver may or may not be able to track satellites. The sense circuit is located in the RF input section of the GPS receiver, which means the RF section may also have been affected by the surge (preventing the unit from being able to track satellites).

No +5VDC output voltage: The GPS receiver outputs +5VDC to the rear panel antenna jack to power the antenna. Verify this voltage is present. With the antenna cable removed from the rear panel of the receiver, measure the DC voltage from the coax center to shield. There should be 5VDC $\pm$ 0.3VDC present.

***Failed impulse suppressor*:** The Model 8226 has a high impedance when measuring from the center conductor to ground and a low throughput resistance. A failing impulse suppressor may be tripping prematurely. The easiest way to test the Model 8226 is to temporarily replace it with a Type N barrel connector. If the receiver begins tracking satellites within 20 minutes, the impulse suppressor has failed and must be replaced.

Failed GPS Inline Preamplifier (If Installed)

The chance of a Model 8227 GPS inline preamplifier being faulty is extremely small. However, the preamplifier can be verified as OK by making an impedance check on the output connector.

NOTE: As of May, 2008, there are two variations of the Model 8227 preamplifier. If the preamplifier case is circular, it is the older style. If the case is square, it is the newer style. When disconnected from the GPS antenna and measured on the equipment side, the newer (square) preamplifier has an impedance of about 91 kohms. When the preamp is measured with the antenna connected to the input side, however, the impedance is about 179 ohms. This load of 179 ohms simulates the normal load of a GPS antenna, so it can simulate an antenna connected even if a short or open exists between the GPS antenna and the preamplifier (it can provide a false indication that the cable is fine even though a cable issue exists).

With the GPS antenna cable disconnected, measure the continuity (ohms) between the center pin of the "GPS out" end of the preamplifier and the threaded outer portion of the connector. The meter should indicate approximately 152 ohms (Round preamplifier) or 91 kohms (Square preamplifier). This indicates the preamplifier is likely OK. Refer to Figure 1A and Figure 7B.

Figure 1A: Older style Model 8227 Inline Preamplifier

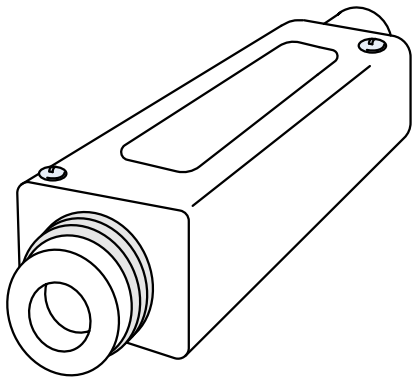

Figure 2B: Newer style Model 8227 Inline Preamplifier

NOTE: Both preamplifier labels indicate which end should be connected to the GPS antenna. Make sure the preamplifier is not installed backwards, as this will prevent the GPS receiver from being able to track satellites.

***Cable length*:** Excessively long or improper cable type may prevent the receiver from being able to track any satellites (cable loss is too high). Refer to the appropriate instruction manual for GPS antenna cable recommendations.

***Antenna location*:** The antenna must be installed outdoors and have an unobstructed view of the sky. Refer to the appropriate installation manual for antenna installation guidelines. Tracking 0 satellites may indicate that the antenna has a completely blocked view of the sky.

***GPS reset*:** In rare occasions, the GPS receiver may require a reset to set the receiver to default values. The receiver must be placed in Test Mode before you may issue the GPS Reset command. Issue the GPS Reset command, **RGPS**, as shown:

Type: TM ON <ent>

The unit will respond with a message stating Test Mode has been enabled. During Test Mode operation, the Major and Minor alarms are asserted.

Type: RGPS <ent>

After an approximate 10 second delay, the receiver responds with a reset status message. Allow 20 minutes for the receiver to begin tracking satellites.

Receiver location: Setting the current receiver position may assist in obtaining a satellite fix. To enter a new location. place the clock in *Set Mode* and issue the ***LOC*** command as follows:

Type: SM ON <ent>
Response: SET MODE = ON

Type: LOC [N:S] [DD MM SS.SSS][E:W] [*DDD MM SSS.SSS*]<ent>
Where:N = North Latitude
S = South Latitude
D MM SS.SSS = Latitude Degrees:Minutes:Seconds
E = East Longitude
W = West Longitude
DDD MM SSS.SSS = Longitude Degrees:Minutes:Seconds

NOTE: The approximate location is adequate; zeros may be used for the seconds values.

Allow 20 minutes for the receiver to begin tracking satellites.

SECTION 3: LOW GPS QUALITY

This section covers troubleshooting conditions in which the GPS receiver is not dropping to 0 satellites, but is not always tracking the minimum of at least 4 qualified satellites (less than four satellites that meet the minimum signal strength requirements are being received).

***Cable length*:** Excessively long or improper cable type may cause low GPS quality caused by cable attenuation. Long GPS antenna lengths may require an inline amplifier. Refer to the appropriate instruction manual for GPS cable recommendations and inline amplifier information.

***Antenna location*:** The antenna must have an unobstructed overhead view of the sky with views to the horizon. Nearby obstructions can reduce the receiver's ability to track the maximum number of satellites available. Refer to the appropriate instruction manual for antenna installation guidelines
.
***Local interference*:** Harmonics from local broadcasts may interfere with the GPS L1 carrier (1575.42 MHz). Certain television and FM radio broadcasts, while operating within their frequency allocations, can cause GPS jamming because of the harmonics of the carrier.

Table A-1 lists the potential problem television stations and their respective GPS harmonics.

CHANNEL	HARMONIC
66	2nd
23	3rd
10	8th
7	9th
6	18th & 19th
5	20th

TABLE A-1: TELEVISION STATIONS WITH GPS JAMMING POTENTIALFM radio stations, while lower in radiated power, may cause GPS jamming also. Table A-2 lists the potential problem radio frequencies and their respective GPS harmonics.

FREQUENCY	HARMONIC
104.8 - 105.2	15th
98.3 - 98.7	16th
92.5 - 92.9	17th
87.3 - 87.7	18th

TABLE A-2: FM RADIO FREQUENCIES WITH GPS JAMMING POTENTIAL

NOTE: The unit can be configured to operate in low GPS quality conditions.

The operation of dish–style transmitting antennas (such as those used for weather radar), Hughes Network dish antennas for Internet service, and VPN/IP phones in proximity to the receiver may also interfere with GPS reception. The GPS antenna should be located away from the line-of-sight transmission of these other devices to prevent local interference.

GQA command

If the GPS reception characteristics at the site cannot be improved, the reception condition can be "acknowledged" and the minimum requirements for qualified reception of the GPS signal can be reduced by selecting an alternate GPS qualifying algorithm (QQA).

The GQA value determines the minimum number of satellites required. The factory default is GQA=1 for four qualified satellites. To change the minimum to minimum of only one qualified satellite, change the GQA value to 3. The unit will require four satellites initially to obtain a 3-D fix, but is then reduced to only one thereafter.

To change to GQA=3:

Type TM ON <enter>

Type GQA 3<enter>

Refer to the appropriate instruction manual for additional information on the GQA value.

TECHNICAL SUPPORT

If you have any questions about your Spectracom equipment, please contact Spectracom Technical Support for assistance. Technical Support is available Monday through Friday from 8:00 a.m. to 5:00 p.m. EST. Support is available by phone and through e-mail. Contact Keith Wing at US +1.585.321.5823, Dave Lorah at US +1.585.321.5824, or via e-mail at **techsupport@spectracomcorp.com**.