SPECTRACOM

GPS AGELESS® MASTER OSCILLATOR

MODEL 8194B, 8195B, 8197B

INSTRUCTION MANUAL

SPECTRACOM LIMITED WARRANTY

LIMITED WARRANTY

Spectracom warrants each new product manufactured and sold by it to be free from defects in software, material, workmanship, and construction, except for batteries, fuses, or other material normally consumed in operation that may be contained therein AND AS NOTED BELOW, for five years after shipment to the original purchaser (which period is referred to as the "warranty period"). This warranty shall not apply if the product is used contrary to the instructions in its manual or is otherwise subjected to misuse, abnormal operations, accident, lightning or transient surge, repairs or modifications not performed by Spectracom.

The GPS receiver is warranted for one year from date of shipment and subject to the exceptions listed above. The power adaptor, if supplied, is warranted for one year from date of shipment and subject to the exceptions listed above.

THE ANALOG CLOCKS ARE WARRANTED FOR TWO YEARS FROM DATE OF SHIPMENT AND SUBJECT TO THE EXCEPTIONS LISTED ABOVE.

THE TIMECODE READER/GENERATORS ARE WARRANTED FOR ONE YEAR FROM DATE OF SHIPMENT AND SUBJECT TO THE EXCEPTIONS LISTED ABOVE.

The Rubidium oscillator, if supplied, is warranted for two years from date of shipment and subject to the exceptions listed above.

All other items and pieces of equipment not specified above, including the antenna unit, antenna surge suppressor and antenna pre-amplifier are warranted for 5 years, subject to the exceptions listed above.

WARRANTY CLAIMS

Spectracom's obligation under this warranty is limited to in-factory service and repair, at Spectracom's option, of the product or the component thereof, which is found to be defective. If in Spectracom's judgment the defective condition in a Spectracom product is for a cause listed above for which Spectracom is not responsible, Spectracom will make the repairs or replacement of components and charge its then current price, which buyer agrees to pay.

Spectracom shall not have any warranty obligations if the procedure for warranty claims is not followed. Users must notify Spectracom of the claim with full information as to the claimed defect. Spectracom products shall not be returned unless a return authorization number is issued by Spectracom.

Spectracom products must be returned with the description of the claimed defect and identification of the individual to be contacted if additional information is needed. Spectracom products must be returned properly packed with transportation charges prepaid.

Shipping expense: Expenses incurred for shipping Spectracom products to and from Spectracom (including international customs fees) shall be paid for by the customer, with the following exception. For customers located within the United States, any product repaired by Spectracom under a "warranty repair" will be shipped back to the customer at Spectracom's expense unless special/faster delivery is requested by customer.

Spectracom highly recommends that prior to returning equipment for service work, our technical support department be contacted to provide trouble shooting assistance while the equipment is still installed. If equipment is returned without first contacting the support department and "no problems are found" during the repair work, an evaluation fee may be charged.

EXCEPT FOR THE LIMITED WARRANTY STATED ABOVE, SPECTRACOM DISCLAIMS ALL WARRANTIES OF ANY KIND WITH REGARD TO SPECTRACOM PRODUCTS OR OTHER MATERIALS PROVIDED BY SPECTRACOM, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Spectracom shall have no liability or responsibility to the original customer or any other party with respect to any liability, loss, or damage caused directly or indirectly by any Spectracom product, material, or software sold or provided by Spectracom, replacement parts or units, or services provided, including but not limited to any interruption of service, excess charges resulting from malfunctions of hardware or software, loss of business or anticipatory profits resulting from the use or operation of the Spectracom product or software, whatsoever or howsoever caused. In no event shall Spectracom be liable for any direct, indirect, special or consequential damages whether the claims are grounded in contract, tort (including negligence), or strict liability.

EXTENDED WARRANTY COVERAGE

Extended warranties can be purchased for additional periods beyond the standard five-year warranty. Contact Spectracom no later than the last year of the standard five-year warranty for extended coverage.

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1 General Information

1.1 Introduction

The patented Spectracom Ageless® Master Oscillator*, shown in Figure 1-1, is a highly accurate frequency source available in oven-stabilized crystal oscillator (OCXO) and Rubidium versions. Its outputs are locked to the United States Naval Observatory via the NAVSTAR Global Positioning System (GPS). Spectracom's field-proven Ageless Oscillator technology provides continual automatic frequency control. A long-term averaging algorithm compensates for oscillator aging and temperature drift.

The Spectracom Ageless Master Oscillator is ideally suited as a site master oscillator for communication systems. Typical transmitter applications include land mobile simulcast, SMR (Specialized Mobile Radio), paging simulcast, satellite/microwave communications links, cellular telephone, and broadcast television.
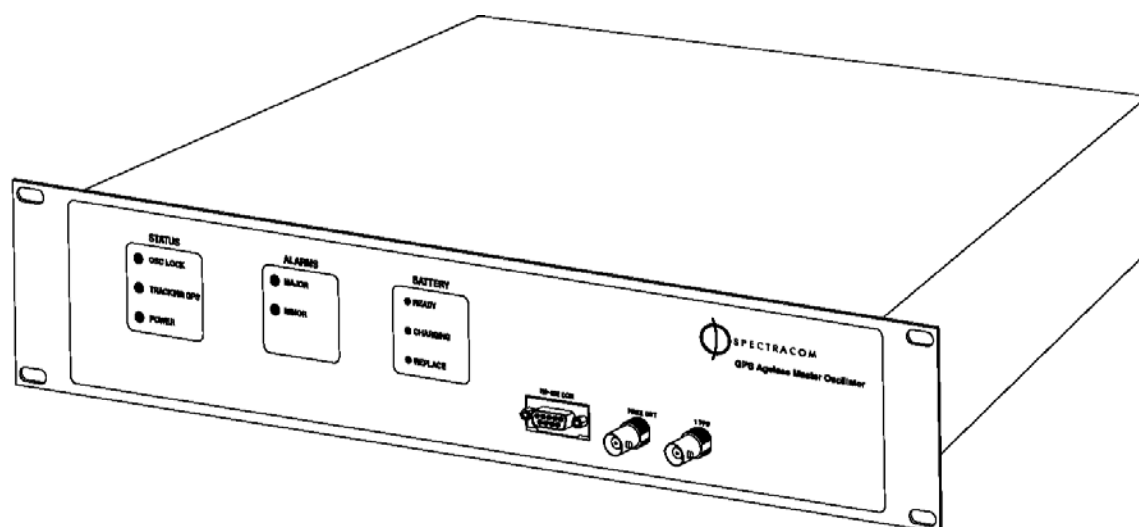
Figure 1-1 Spectracom Ageless Master Oscillator

1.2 Features

The Master Oscillator offers the following features:

- **Accuracy:** Continuous self-calibration to GPS provides ± 1.0 x 10^{-11} frequency accuracy with the OCXO versions and ± 1.0 x 10^{-12} frequency accuracy for Rubidium version.

- **Precise Offsets**: The Model 8194B/8195B disciplined 10 MHz outputs can be offset in precise steps to improve VHF - Hi simulcast.

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* PATENT NO. 4,525,685

- **Reliable Worldwide Operation:** The Master Oscillator can receive and track up to twelve satellites simultaneously. Receivers qualify the received GPS broadcast using T-RAIM. T-RAIM, Time Receiver Autonomous Integrity Monitoring is an algorithm that disqualifies a satellite from a solution if its message is not within a reasonable window of other satellites currently tracked.

- **Flexibility:** Several power and output options are available to suit various applications. Refer to Table 1-1 for a comparison of product features and available options.

S = Standard, O = Option Available, NA = Not Available

Ageless GPS Master Oscillator	Model 8195B	Model 8197B	Model 8194B
Standard Features			
Oscillator			
Quartz	S	NA	S
Rubidium	NA	S	NA
Front Panel			
(1) 10 MHz	S	S	S
(1) 1 PPS	S	S	S
(1) RS-232 Comm Port	S	S	S
Rear Panel			
(4) 10 MHz Output	S	S	S
(1) Timing Output 1544 kHz	S	S	NA
(1) Timing Output 2048 kHz	S	S	NA
(1) Data Clock Output (including disciplined 1 PPS)	S	S	S
(1) Data Sync Output	S	S	NA
(1) RS-485 Comm Port	S	S	NA
Software Features			
Simulcast Frequency Offset	S	NA	S
Fast Frequency Lock Recovery	S (w/ Opt 02)	NA	S (w/ Opt 02)
Available Options			
02 – Internal Battery	O (w/ AC only)	NA	O (w/ AC only)
03 – Internal Frequency Distribution Amplifier	O	O	O
06 – 12.8 MHz Outputs	O	O	NA
07 – 5 MHz Outputs	O	O	O
11 – Mounting Slides	O	O	O
14 – CTCSS Outputs One and Two	O	O	NA
16 – 1PPS on Third and Fourth Rear Panel Frequency Output	O	O	NA
17 – CTCSS Outputs Three and Four	O	O	NA
52 – 12 VDC Power	O	O	O
53 – 24 VDC Power	O	O	O
54 – 48 VDC Power	O	O	O
SP294 – Adds (2) DS1 outputs	O	O	NA
SP295 – Adds (2) E1 outputs	O	O	NA

Table 1-1 Product Comparison Table

1.3 Warranty Information and Product Support

Warranty information is found on the leading pages of this manual. This product includes component assemblies that are not manufactured by Spectracom Corporation.

The components listed below shall carry the original manufacturer's warranty.
- The GPS receiver carries a one-year warranty.
- The Rubidium oscillator carries a two-year warranty.

The remainder of the product is covered under Spectracom's five-year warranty. Should it become necessary to exercise the warranty, contact Spectracom Corporation to obtain a replacement or service.

Spectracom continuously strives to improve its products and therefore greatly appreciates any and all customer feedback given. Please participate in Spectracom's Customer Satisfaction Survey found on our web site:

http://www.spectracomcorp.com

Technical support is available by telephone, e-mail, or online. Please direct any comments or questions regarding application, operation, or service to Spectracom Customer Service Department. Customer Service is available Monday through Friday from 8:30 A. M. to 5:00 P.M. Eastern time.

Telephone Customer Service at: **585.321.5800**.

In addition, please contact Customer Service to obtain a Return Material Authorization Number (RMA#) before returning any instrument to Spectracom Corporation. Please provide the serial number and failure symptoms. Transportation to the factory is to be prepaid by the customer. After obtaining an RMA#, ship the unit back to the following address:

> **Spectracom Corporation**
> **Repair Department, RMA# xxxxx**
> **95 Methodist Hill Drive**
> **Rochester, NY 14623**

Product support is also available by e-mail. Questions on equipment operation and applications may be e-mailed to Spectracom Sales Support at:

sales@spectracomcorp.com

Repair or technical questions may be e-mailed to Spectracom technicians at:

techsupport@spectracomcorp.com

Visit our web page for product information, application notes and upgrade notices as they become available at:

http://www.spectracomcorp.com

1.4 Manual Errata and Special Documentation

Information concerning manual corrections or product changes occurring after printing is found in the Errata Section. The Errata Section, when required, is found at the end of this manual. Please review and incorporate changes into the manual whenever an Errata Section is included.

Spectracom will make instrument modifications on special request. A documentation packet associated with the modification will be provided in addition to this manual.

1.5 Unpacking

On receipt, carefully examine the carton and its contents. If there is damage to the carton resulting in damage to the unit, contact the carrier immediately. Retain the carton and packing materials in the event the carrier wishes to witness the shipping damage. Failing to report shipping damage immediately may forfeit any claim against the carrier. In addition, notify Spectracom Corporation of shipping damage or shortages to obtain a replacement or repair services.

Remove the packing list from the envelope on the outside of the carton. Check the packing list against the contents to be sure all items have been received, including an instruction manual and ancillary kit. Table 1-2 lists the items included in the various ancillary kits. Please note that all items included in the ancillary kit may not be required for some configurations of the product. For example, a line cord is not required on units equipped with DC input power Options 52, 53 and 54. Replace fuses with only the same type and rating as originally installed for the product configuration.

Description	Part Number	Standard	Option 03 Distribution
Fuse, 2.0A Slo-Blo	F012R0	1	1
Fuse, 1.5A Slo-Blo	F011R5	1	1
Fuse, 10.0A	F0010R	1	1
Fuse, 6.25A Slo-Blo	F016R0	1	1
Fuse, 3.0A Slo-Blo	F013R0	1	1
Line Cord	W01000	1	1
Terminal Block, 6-position	P13006	1	1
Terminal Block, 7 position	P13007	1	1
Terminator, 50-ohm	004492	4	0
Terminator, DC isolated	8140-0000-1000	0	4
RS-232 Cable	050008	1	1

Table 1-2 Ancillary Kits

1.6 Specifications

This section contains specifications for the standard Master Oscillator, Model 8225 GPS Antenna, Model 8226 Impulse Suppressor, and the Model 8227 Inline Amplifier. Specifications pertaining to the Master Oscillator options are found in Section 5. Some options and features are only available on certain models in the Spectracom Ageless Master Oscillator family. The details on the options and features available for each model are found in the Table 1-1 Product Comparison Table.

1.6.1 Receiver

Received Standard: L1 C/A Code transmitted at 1575.42 MHz

Satellites Tracked: Up to 12 simultaneously

Acquisition Time: Typically <20 minutes during initial installation or if the receiver has been moved to a new location. Acquisition time is reduced to one minute on subsequent power cycles.

Acquisition Sensitivity: -110 dBm to -137 dBm

Optimum Gain Range: 18 to 36 dB at receiver input

Timing Accuracy: <10 nanoseconds while in Position Hold mode

1.6.2 Standard Frequency Outputs

Signal: 10 MHz sine wave derived from GPS disciplined oscillator

Connector: BNC female, one front panel, four rear panel
Signal Level: 10 dB typical, 13 dB maximum into 50 ohms
(10 dB = 2Vpp = 750 mV RMS)

Impedance: 50 ohms

Harmonics: Better than 30 dB down

Spurious: Better than 40 dB down

Phase Noise (OCXO/Rb): <75 dBc @ 1 Hz
<115 dBc @ 10 Hz
<135 dBc @ 100 Hz
<145 dBc @ 1000Hz

Signature Control: The Frequency Outputs can be configured with Signature Control. Under Signature Control, the outputs are removed whenever a Major Alarm is asserted. The outputs are restored when the fault condition is corrected. The

Signature Control feature is set via the RS-232 communication port.

Simulcast Offsets: The 10MHz outputs on the 8195B and 8194B can be offset in precise steps to minimize co-channel interference. The offsets provide steps of ±3, 5, 7, 9 Hz at VHF-HI transmitter frequencies, and ±0.5, 1.0, 1.5, 2.0 Hz at UHF transmitter frequencies. Offsets are selected by software commands.

Output Options: The following options are available for the Spectracom Ageless Master Oscillator:

Option 03: Adds internal distribution amplifier that allows the Master Oscillator to drive Spectracom distribution products. This option adds a 12 Volt DC offset to the rear panel Frequency Outputs.

Option 06: Changes the rear panel Frequency Outputs and front panel 10 MHz output to 12.8 MHz.

Option 07: Changes the rear panel Frequency Outputs and front panel 10 MHz Output to 5.0 MHz.

Option 16: Changes the third and fourth rear panel Frequency Outputs from 10MHz to 1PPS.

1.6.3 Ovenized Oscillator Frequency Stability

Oscillator Type: 10 MHz OCXO, SC cut. For Model 8194B and 8195B

Locked Accuracy: $±1 \times 10^{-11}$, 24-hour average when locked to GPS and no frequency offsets selected.

$±1 \times 10^{-10}$, 24-hour average when locked to GPS and frequency offsets selected (8194B/8195B only).

Unlocked Accuracy: Corrections are applied to the oscillator based on learned oscillator aging characteristics. Holdover accuracy is <5 microseconds over 5 hours.

Recovery: During a power failure, the oscillator control value is retained and the connected standby supply provides power to the oscillator and GPS receiver. At power-on, the disciplined oscillator returns to the set frequency plus any incurred aging. Two hours from holdover to oscillator lock. Four hours from cold start. Recovery times are reduced with Option 02 Battery Backup.

Aging Rate:	Unit automatically corrects for oscillator aging when locked to GPS. After 30 days of continuous operation, when unlocked, <5 x 10^{-10}/day.

1.6.4 Rubidium Oscillator Frequency Stability

Oscillator Type:	10 MHz Rubidium. For Model 8197B
Locked Accuracy:	24-Hour Average accuracy is typically ±1 x 10^{-12} when locked to GPS
Unlocked Accuracy:	Corrections are applied to the Rubidium oscillator based on learned aging. Holdover accuracy is typically <2 microseconds/day.
Short Term:	3 x 10^{-11} / 1 second 1 x 10^{-11} / 10 seconds 3 x 10^{-12} / 100 seconds
Recovery:	During a power failure, the oscillator control value is retained and the connected standby supply provides power to the oscillator and GPS receiver. At power-on, the disciplined oscillator returns to the set frequency plus any incurred aging. Without standby power applied Rubidium lock < 4 minutes @ 25°C, Oscillator Lock < 4 hours. Retrace 5 x 10^{-11}.
Aging Rate:	Unit automatically corrects for oscillator aging when locked to GPS. If not locked to GPS, drift is 2 x 10^{-11}/day under constant ambient conditions.

1.6.5 1PPS Output

Signal:	1PPS derived from the 10 MHz GPS disciplined oscillator
Connector:	BNC female, front panel
Signal Level:	TTL compatible into loads >100 ohms
Duty Cycle:	20% ± 5%
Accuracy:	Leading edge synchronized to UTC typically within ±500 nanoseconds with SA off and in Position Hold

| Delay Control: | This output is made leading edge synchronized to the recovered GPS 1PPS. Using the 1PPS offset command, 1PO, the Data Clock 1PPS output can be offset from 0 to 1 second in 0.001 microsecond steps. The front panel 1PPS shall be synchronized within ±500 nanoseconds of other Master Oscillator receivers having the same 1PO offset. |

1.6.6   1544 kHz Timing Outputs

Signal:	1544 kHz, derived from the 10 MHz GPS disciplined oscillator
Connector:	RJ-11, rear panel
Signal Level:	RS-485
Duty Cycle:	50% ± 2%
Accuracy:	8195B: ± 1.0 x 10^{-11} when locked to GPS, 24-hour average, no frequency offsets selected
	8197B: ± 1.0 x 10^{-12} when locked to GPS, 24-hour average
Additional Outputs:	Major alarm relay contacts; C, NO, NC are provided

1.6.7   2048 kHz Timing Outputs

Signal:	2048 kHz, derived from the 10 MHz GPS disciplined oscillator
Connector:	RJ-11, rear panel
Signal Level:	RS-485
Duty Cycle:	50 ± 2%
Accuracy:	8195B: ± 1.0 x 10^{-11} when locked to GPS, 24-hour average, no frequency offsets selected
	8197B: ± 1.0 x 10^{-12} when locked to GPS, 24-hour average
Additional Outputs:	Major alarm relay contacts; C, NO, NC are provided on this connector

Optional Outputs: Option 06, 12.8 MHz outputs, changes the 2048 kHz output on this connector to 1600 kHz

1.6.8 Data Clock Timing Outputs

Signals: 1PPS, 9.6 kHz, 18.0 kHz, derived from the 10 MHz GPS disciplined oscillator

Connector: DB9 female, rear panel

Signal Level: RS-485

Duty Cycle: 1PPS: 20% ±5%
9.6 kHz, 18.0 kHz: 50% ±2%

Accuracy: The Data Clock 1PPS is made leading edge synchronized to the recovered GPS 1PPS. Using the 1PPS offset command, 1PO, the Data Clock 1PPS output can be offset from 0 to 1 second in 0.001 microsecond steps. The Data Clock 1PPS shall be synchronized within ±500 nanoseconds of other Master Oscillator receivers having the same 1PO offset. The 9.6 kHz output is leading edge synchronized to within ±150 nanoseconds of the Data Clock 1PPS output. The 18 kHz output is not leading edge synchronized.

Alarm Outputs: Major alarm status is provided on this connector. Under normal operation, the alarm pin is ground and high impedance when a Major Alarm is asserted.

Optional Outputs: Option 17, CTCSS Outputs, replaces the 9.6 kHz and 1 PPS signals on the Data Clock (DB9) connector with CTCSS#3 and CTCSS #4 respectively.

1.6.9 Data Sync Timing Outputs

Signals: $17\ ^2/_3$ Hz, $33\ ^1/_3$ (or $26^2/_3$) Hz, 18 kHz, 64 kHz, derived from the 10 MHz GPS disciplined oscillator

Connector: DB15 Female, rear panel

Signal Level: RS-485

Duty Cycle: 18 kHz, 64 kHz: 50% ± 2%
$17\ ^2/_3$: 888 microsecond pulse width
$33\ ^1/_3$: 208 microsecond pulse width
$26^2/_3$: 25% low, 75% high

Accuracy: The 17 $^2/_3$, 26$^2/_3$, and 33 $^1/_3$ Hz Data Sync outputs are leading edge synchronized to within ±400 nanoseconds of the Data Clock 1PPS output. Using the 1PPS offset command, 1PO, the Data Clock 1PPS output can be offset from 0 to 1 second in 0.001 microsecond steps. The Data Clock 1PPS shall be synchronized within ±500 nanoseconds of other Master Oscillator receivers having the same 1PO offset.

The 64 kHz and 18 kHz outputs are not leading edge synchronized.

Alarm Outputs: Major alarm relay contacts; NO, NC and common, are provided on this connector

Optional Outputs: Option 06, 12.8 MHz outputs, changes the 64 kHz output to 50 kHz

Option 14, CTCSS Outputs, replaces the 33-1/3 Hz and 17-2/3 Hz signals with CTCSS #1 and CTCSS #2 respectively

1.6.10 Indicator Lamps

Front panel status lamps when lit indicate the following:

Power: Primary power source is connected and switched ON.

Tracking GPS: Receiver is tracking at least four qualified GPS satellites.

Oscillator Locked: Oscillator is disciplined to the received GPS signal.

Major Alarm: Alarm condition classified as "major" is active.

Minor Alarm: Alarm condition classified as "minor" is active.

Optional Indicators: Receivers equipped with Option 2, Internal Battery Backup, include indicator lamps to communicate battery status: Ready, Charging, and Replace.

1.6.11 Alarms

Alarm relays allow remote monitoring of operational status. Relay contacts are provided for Major Alarms and Minor Alarms. Alarm status is also included in performance and status logs obtained using software commands.

1.6.11.1 Alarm Classifications

Major Alarm: A Major alarm is asserted when detected faults compromise output accuracy. The alarm relays reset when the fault condition is corrected. Faults and conditions listed below actuate a Major Alarm:

- **Frequency Error Alarm:** Measured oscillator frequency error exceeds 1×10^{-8} or whenever an AT2 Alarm is asserted. A Frequency Alarm is also asserted at Power On.

- **GPS Tracking Timeout 2:** The AT2 time period allotted for operation without tracking a minimum of four qualified satellites has expired. An AT2 Alarm is also asserted during start-up.

- **GPS Tracking Timeout 3:** The AT3 time period allotted for operation without tracking a minimum of four qualified satellites has expired. An AT3 Alarm is also asserted during start-up.

- **CPU Fault:** The CPU is unable to communicate with the GPS receiver.

- **Test Mode:** Unit has been manually placed in Test Mode operation from RS-232 communication port.

- **Free Run:** The automatic frequency control feature has been disabled (for factory testing only).

- **Short Gate:** Gate time is shortened for test purposes. Measurement resolution is reduced.

Minor Alarm: A minor alarm is asserted when failures detected do not immediately affect output accuracy. The alarm relays reset when the fault condition is corrected. Faults and conditions listed below actuate a Minor Alarm:

- **Output Fault:** No output is detected from one or more of the four-rear panel Frequency Outputs. Fault could be caused by a shorted cable, reflections due to an un-terminated cable or removed by a Major Alarm when Signature Control is enabled.

- **Oscillator Adjust:** Warns that oscillator is operating within 10% of the minimum or maximum control setting. The oscillator requires manual calibration and adjustment. Refer to the service information section for details on this.

- **GPS Tracking Timeout 1:** The AT1 time period allotted for operation without tracking a minimum of four qualified satellites has expired. An AT1 Alarm is also asserted during start-up.

- **Low Quality Alarm:** Warns of low GPS signal quality. The alarm is asserted whenever the "Q" value in Tracking Histogram is below 3000.

- **Replace Battery:** Internal battery pack, Option 02 only, has failed daily test, needs replacement.

- **Frequency Offset:** A new simulcast offset value is entered. The alarm remains active until the standard oscillator has corrected for the offset.

- **Test Mode:** Unit has been manually placed in Test Mode operation from RS-232 communication port.

- **Antenna Problem:** Warns that the antenna is not connected or a cable short or open is detected. It warns when the antenna power supply is under or over current. This alarm may also be asserted when the receiver is connected to an antenna splitter device that does not have a simulated load.

1.6.11.2 Tracking Alarm Classifications

Three configurable alarm tracking timeouts, AT1, AT2, and AT3, indicate how long the Master Oscillator has been unable to receive qualified GPS satellites. Countdown timers are started whenever the receiver is not tracking a minimum of four qualified satellites. As the period configured for each Alarm Timeout expires, the associated Tracking Alarm is asserted. The alarm timeouts are configured via the RS-232 and RS-485 communication ports. Timeout range is 1 second to 999 days.

Alarm tracking status is provided to the communication ports using the STAT and DAL commands.

AT1 (Alarm Tracking Timeout 1): Period of time the receiver has not tracked at least four qualified satellites has expired. Factory default is 1 minute. This is a Minor Alarm that also extinguishes front panel TRACKING GPS lamp. The AT1 Alarm resets on acquisition of at least four qualified satellites for one minute.

AT2 (Alarm Tracking Timeout 2): Period of time the receiver has not tracked at least four qualified satellites has expired. Factory default is 2 hours 30 minutes. This condition is classified as a Major Alarm. An AT2 alarm asserts a frequency alarm and extinguishes the OSC LOCK lamp. The AT2 Alarm resets when the receiver has reacquired a minimum of four qualified satellites for one minute.

AT3 (Alarm Tracking Timeout 3): Period of time the receiver has not tracked at least four qualified satellites has expired. Factory default is 30 days. This is a Major Alarm. The AT3 Alarm resets when the receiver has reacquired a minimum of four qualified satellites for one minute.

1.6.11.3 Alarm Interface

Alarm relay contacts are provided on the Alarm Outputs, Data Sync, Data Clock, 1544 kHz and 2048 kHz timing output connectors.

Alarm Outputs:	Major Alarm, Minor Alarm.
Connector:	7-position terminal block, rear panel
Contacts:	NO, NC, and Common
Contact Rating:	30 VDC, 2 Amps
Data Sync:	Major Alarm
Connector:	DB15 Female, rear panel
Contacts:	NO, NC and Common
Contact Rating:	30 VDC, 500 milliamps
Data Clock:	Major alarm
Connector:	DB9 Female, rear panel
Contact Rating:	30 VDC, 500 milliamps
1544 kHz:	Major alarm
Connector:	RJ-11, rear panel
Contacts:	NO,NC and Common
Contact Rating:	30 VDC, 250 milliamps
2048 kHz:	Major alarm
Connector:	RJ-11, rear panel
Contacts:	NO,NC and Common
Contact Rating:	30 VDC, 250 milliamps

1.6.12 Communication Ports

The Master Oscillator has a front panel RS-232 and a rear panel RS-485 communication port. The communication ports are used to monitor and set operational parameters.

RS-232 Com

Signal:	RS-232C, DCE
Connector:	DB9 female, front panel
Bit Rate:	9600 Baud
Character Structure:	ASCII, 1 start, 8 data, 1 stop, no parity, xon/xoff flow control

RS-485 Com

Signal:	RS-485, 1 pair Transmit, 1 pair Receive
Connector:	RJ-11, rear panel
Impedance:	Hi Z /120 ohms, switch selectable
Bit Rate:	9600 baud
Address:	0 - 31, switch selectable
Character Structure:	ASCII, 1 start, 8 data, 1 stop, no parity
Message Format:	Start word, source address, destination address, message length, message, check word, stop word

1.6.13 Input Power

AC Input: 90 to 264 VAC, 50/60 Hz, 20 Watts for ovenized oscillator units, 60 Watts for Rubidium unit. Option 02, Internal Battery Backup, requires an additional 20 Watts

Option 03, Built-in Distribution Amplifier, requires an additional 25 Watts

Fuse: 1.5 Amp, 250V, Slo-Blo

Connector: 3-conductor, IEC 320 C-13, rear panel

DC Standby: Non-isolated +24 VDC ± 5%, 10 Watts. Powers the oscillator and internal GPS receiver module whenever AC power is removed

Fuse: 2 Amp, 250V, Slo-Blo

Connector: 6-position terminal block, rear panel

DC Power Options   Isolated Input Power
Option 52, ±12 VDC
Option 53, ±24 VDC
Option 54, ±48 VDC

Fuse: Option 52, 10.0 Amp, 250V, Fast
Option 53, 6.25 Amp, 250V, Slo-Blo
Option 54, 3.0 Amp, 250V, Slo-Blo

Connector: 6-position terminal block, rear panel

1.6.14 Mechanical

Dimensions: 3.5H x 19.0W x 12.5D inches
(89H x 483W x 315D mm)

Weight: 15 lbs.(6.8 kg) maximum

Shipping Weight: 20 lbs.   (9.1 kg).

Rack Mount: EIA 19", front panel drilled for two standard rack units

Optional: Option 11 Rack Mount Slides

1.6.15 Environmental

Operating Temperature: -30 to +60°C for 8195B and 8194B
-30 to +55°C for 8197B

Storage Temperature: -40 to +85°C.

Humidity: 95% R. H. non-condensing.

1.6.16 Agency Approval

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NOTE: Units equipped with DC input power Option 52 have not been tested for FCC compliance.

1.6.17 Model 8225 GPS Antenna Specifications

1.6.17.1 Electrical Specifications

Type:	Active.
Frequency:	1575.42 MHz.
Temperature Range:	-30° to 80° C (-22° to 176°F)
Gain:	30 dB
Connector:	N type, Female
Recommended Cable:	LMR-400
Maximum Cable Length:	200 feet or 12 dB cable loss before additional preamplifier is required
Power:	5 Volts, 27 milliamps, powered by receiver

1.6.17.2 Mechanical Specifications

Assembled Length:	24 inches (61 cm)
Housing Diameter:	3.5 inches (8.9 cm)
Housing Material:	PVC
Weight:	1.3 lbs. (.60 kg).
Mounting:	Hose clamps (furnished) on vent pipe

1.6.17.3 Model 8226 Impulse Suppressor

Connectors:	Type N Female
Turn On Time:	4 nanoseconds for 2 kV/ns
Turn On Voltage:	+7 V, -1 VDC
Frequency Range:	1.2 to 2.0 GHz
VSWR:	1.1:1 or better
Insertion Loss:	0.1 dB maximum
Mounting:	Optional mounting bracket available. Specify part number MP10-0000-0002.
	Optional grounding panel kit, includes MP10-0000-0002 bracket, specify part number 8226-0002-0600.

1.6.17.4 Model 8227 Inline Amplifier

Connectors:	Type N Female
Gain:	20 ±3 dB
VSWR:	≤1.5:1
Power:	3.6 - 15 VDC, 15 milliamps

2 Installation

2.1 Introduction

This section describes the installation of the Model 8225 GPS Antenna and related accessories. This section also describes the Master Oscillator preparation for use, initial operation, installation qualification and factory configuration.   To ensure proper operation, please read this section prior to equipment installation and usage.

Refer to the options and accessories section of this manual for information on installing the Option 11 Rack Mount Slides.

2.2 Model 8225 GPS Antenna

The Model 8225 is an active antenna tuned to receive the GPS 1575.42 MHz L1 band satellite broadcast. The received signals are passed through a narrow band pass filter and preamplifier within the antenna. The active antenna circuitry provides 30 dB of gain and requires +5 VDC at 27 milliamps. The Master Oscillator's receiver provides this over the antenna coax. Each antenna is terminated with a type "N" female connector. The Model 8225 features a compact weatherproof design measuring 3.5 inches in diameter.

2.2.1 Antenna Installation

The GPS antenna must be installed outdoors in a location where an unobstructed view of the sky exists. Rooftops generally make good locations due to clear overhead sky with views to the horizon. This type of location allows the antenna to see and track the maximum number of satellites throughout the day. Installations with obstructed views may prove operational, but can experience reduced reception quality and the inability to simultaneously track the maximum number of satellites. In addition to clear sky coverage, select a site, which would not allow the antenna to become buried in drifted or accumulated snow or ice. Avoid placing the GPS antenna in close proximity to broadcast antennas whenever possible.

Each antenna includes a mating PVC mast assembly and hardware used to simplify installation. The included hose clamps can be used to affix the mast assembly to a vent pipe. Spectracom offers an antenna base, Model 8213, for installations in which vent pipe mounting is not practical or desired. The Model 8213 is constructed of aluminum and is furnished with ballast for stability. For more information, refer to the instructions included with your antenna unit.
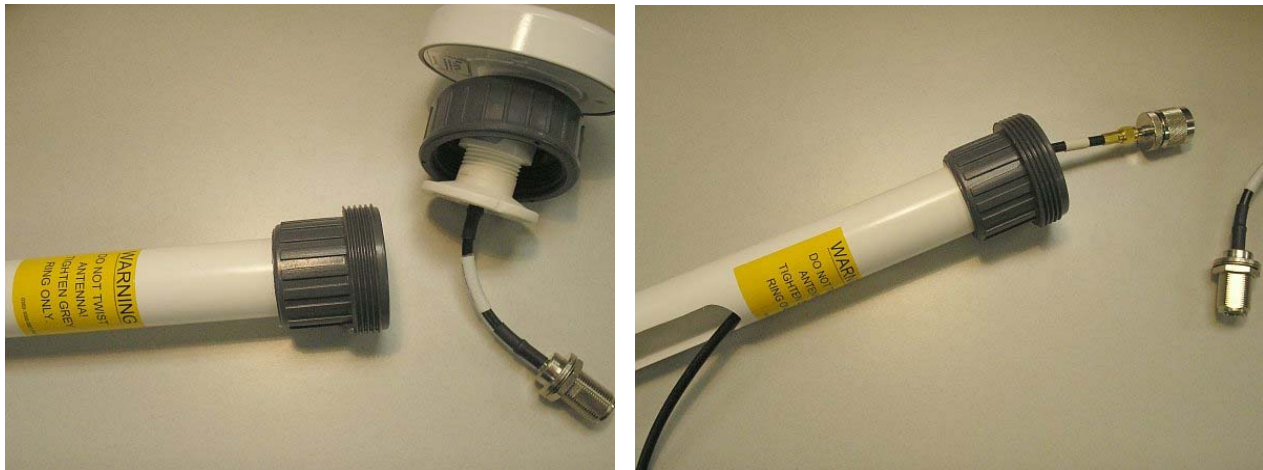
Figure 2-1 Connecting the Antenna to the PVC Mast

2.3 *Antenna Cable*

Spectracom recommends low loss coax, such as Times Microwave LMR-400, for the GPS antenna cable. To simplify the installation process, Spectracom offers GPS cable assemblies terminated with Type N Male connectors. Specify part number CAL7xxx, where xxx equals the length in feet.

If the antenna cable is purchased locally, select coax suitable for outdoor use. Consider the cable's weather ability, temperature range, UV resistance, and attenuation characteristics.

Do not allow the antenna cable to be placed in standing water, as water may permeate through the coax jacket over time. On flat roof installations, the coax can be suspended by cable hangers or placed in sealed PVC conduit. Apply a weather proofing sealant or tape over all outdoor connections.

Installation of a surge protection device in the antenna line is recommended to protect the Master Oscillator's receiver and connected devices from lightning damage. Spectracom offers the Model 8226 Impulse Suppressor to shunt potentially damaging voltages on the antenna coax to ground. Refer to Section 2.4 for a complete description of the Model 8226 impulse suppressor.

2.3.1 Cable Lengths

Using Spectracom CAL7xxx or LMR-400 coax, the maximum antenna cable length permitted is 200 feet. These cables attenuate the GPS signal by 5.4 dB per 100 feet of coax. Installations requiring longer antenna cables may use the Model 8227 Inline Amplifier or lower loss cable. Refer to Section 2.5 for additional information on the Model 8227 Inline amplifier.

When selecting alternate antenna cable sources, the attenuation characteristics at the GPS frequency of 1575.42 MHz must be known. To ensure optimum receiver performance, the total antenna cable attenuation must not exceed 12 dB. Cable attenuations greater than 12 dB require the use of a Model 8227 Inline Amplifier.

2.4 Model 8226 Impulse Suppressor

Spectracom recommends the use of an inline coaxial protector for all products with an outside antenna. Spectracom offers the Model 8226, Impulse Suppressor, to protect the receiver from damaging voltages occurring on the antenna coax. Voltages exceeding the impulse suppresser trip point are shunted to the system ground. The Model 8226 is designed to withstand multiple surges.

Install the suppressor indoors, preferably where the coax enters the building. Connect the largest gauge grounding wire available to the Model 8226 ground stud. The suppressor can be mounted to a grounding panel or bulkhead using the BF adapter bracket as shown in Figure 2-2 (Spectracom part # MP10-0000-0002).
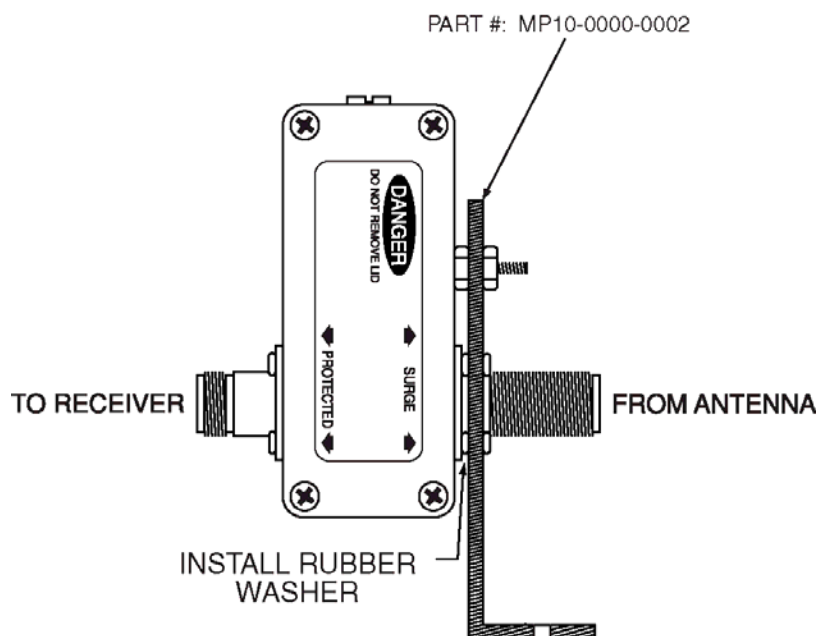
Figure 2-2 Model 8226 Impulse Suppressor

In addition, Spectracom offers a copper grounding panel kit, part number 8226-0002-0600, as a single point ground connection for the antenna surge suppressor, equipment rack, GPS receiver and other surge protection devices to a perimeter ground system. A single point ground system is recommended to provide optimum protection from lightning strikes.

Each grounding panel includes mounting hardware, hardware to secure protective devices to the copper plate, 20 feet of 1.5 inch wide copper strap, two strap clamps, the MP10-0000-0002 bracket and copper paste.

Mount the grounding panel indoors, preferably close to where the antenna coax enters the building and direct access to the system ground is available. Refer to Figure 2-3 for installation guidelines. The ground panel must be connected to a low impedance (both low resistance and low inductance) ground system to assure proper operation of the surge protection equipment. To minimize the inductance between the ground plate and system ground interconnection keep the copper grounding strap as straight as possible, limit bends to a radius of 8 inches or larger. Thoroughly clean the copper panel to remove any oxidation or contaminants prior to installation. Apply the supplied copper paste to all junctions on the copper panel to maintain a low impedance connection.
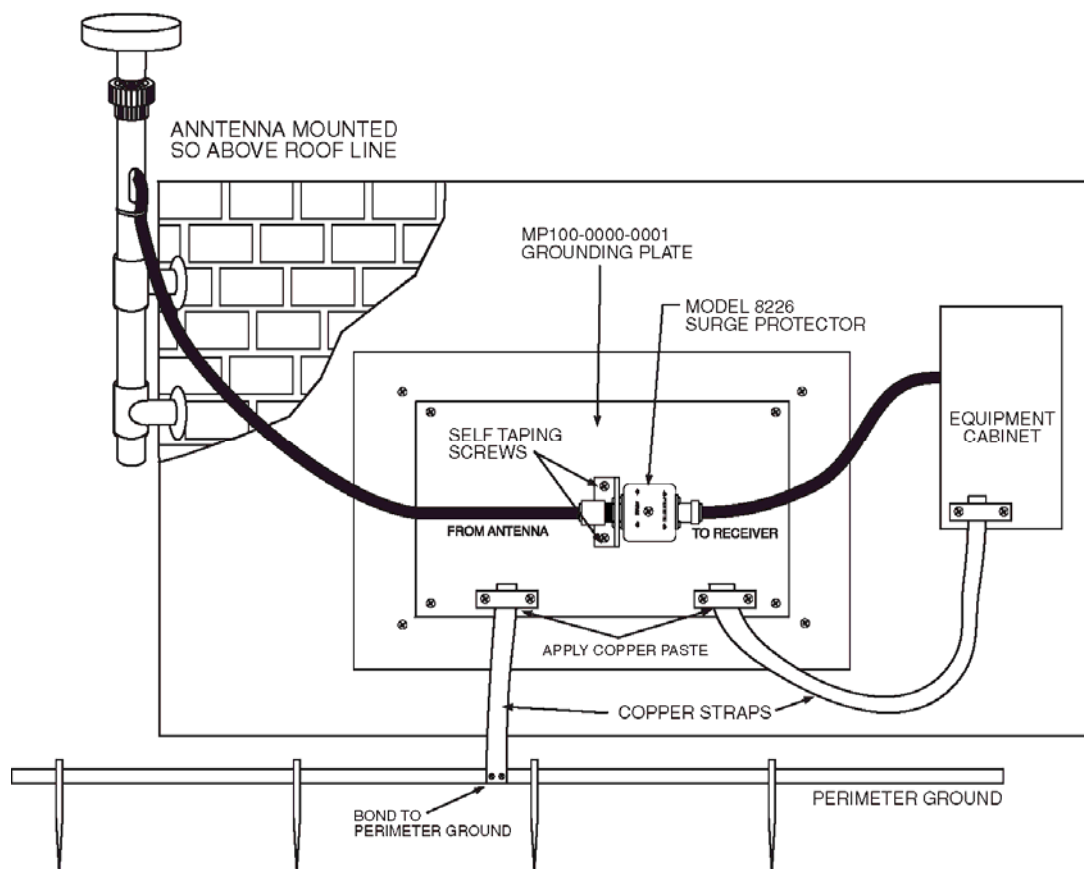
Figure 2-3 Grounding Panel Installation

Each Model 8226 includes two clamp type male N connectors. These connectors can be used to splice the Model 8226 into the antenna coax. The connectors are compatible with Spectracom CAL7xxx cable assemblies and Times Microwave LMR-400 equivalent coax. Connector assembly instructions are shown below in Figure 2-4.

Assembly Instructions
Part Number P051-0001-0100 Type N Connectors

The table below lists the recommended tools needed to assemble the connectors. Verify all parts of the connector have been received as shown in connector diagram below.

Tools Required
Sharp Knife / Razor Blade
Cable Cutter
Soldering Iron and Solder
Ruler
Wire Cutters/Scissors
5/8" Open End Wrench
11/16" Open End Wrench
Multimeter

Nut   Washer   Gasket   Clamp   Male Contact   Plug Body
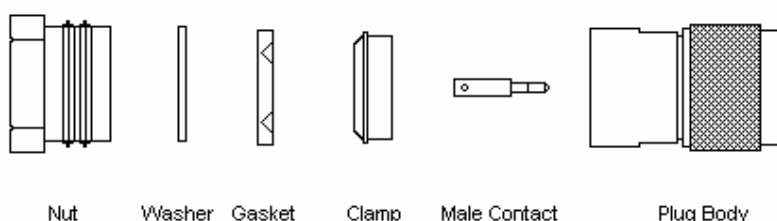
Step 1
Cut the cable end squarely and place the nut, washer, and gasket onto the cable as shown. Make certain the gasket's "V" groove is oriented towards the end of the cable. Cut the cable jacket back to dimension A of 0.359 inches (9.1 mm). Do not cut or knick the braid.
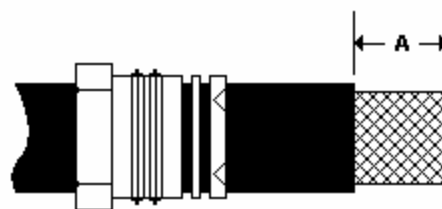
Step 2
Comb out the braid and fold back to expose the dielectric. Cut the dielectric back to dimension B of 0.234 inches (6.0 mm). Do not cut or knick the center conductor.
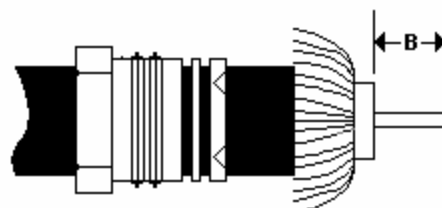
Step 3
Comb the braid forward and slide the clamp onto the cable as shown. Make certain that the beveled edge of the clamp is oriented towards the gasket "V" groove to form a weatherproof seal.

Step 4

Fold the braid back over the clamp. Comb the braid to evenly distribute it over the clamp and trim to the proper length as shown.

Step 5

Verify there is no braid or dielectric foil that may short against the center conductor. Tin the center conductor and then solder on the male contact as shown.
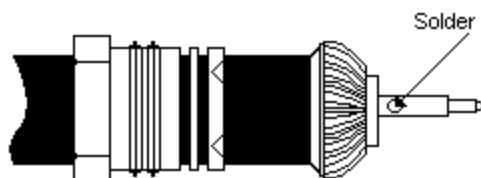
Step 6

Insert the cable assembly into the connector body. Verify the gasket "V" grooves fit into the clamp edges. Hold the body with the 11/16" wrench and tighten the nut using the 5/8" wrench. Using the multi meter, measure continuity of the center conductors on each end of the cable. It should be close to 0 Ω. Measure the continuity between the center conductor and connector body. It should be an open circuit.
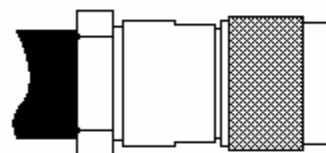
Figure 2-4 N Connector Assembly Instructions

2.5 Model 8227 GPS Inline Amplifier

An inline amplifier is required whenever GPS antenna cable lengths cause greater than 12 dB attenuation. Using Spectracom CAL7xxx or LMR-400 coax, an amplifier is needed whenever antenna cable lengths exceed 200 feet.

The Model 8227 GPS Inline Amplifier, shown in Figure 2-5, extends the maximum cable length to 600 feet. The Model 8227 provides 20 dB of gain and is powered by the GPS receiver.
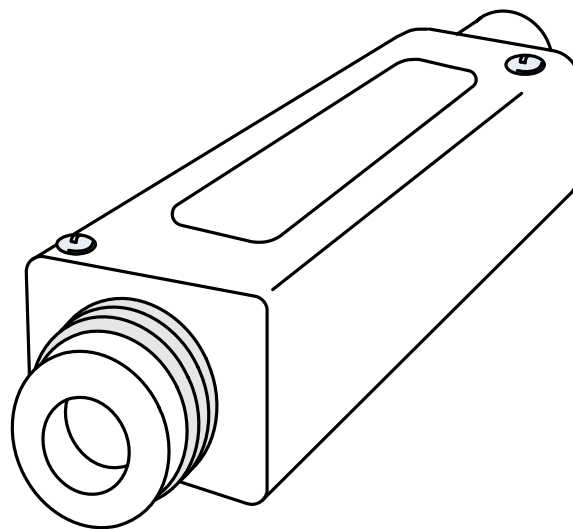
Figure 2-5 Model 8227 Inline Amplifier

Each Model 8227 includes two clamp type male N connectors. These connectors can be used to splice the Model 8227 into the antenna coax. The connectors are compatible with LMR-400 type coax such as Spectracom CAL7xxx or LMR-400. Refer to Figure 2-4 for connector assembly instructions.

A five-foot long coaxial cable is also provided with each Model 8227. This cable connects the amplifier to the Model 8226 surge suppressor. This cable is rated for indoor usage only.

Refer to Figure 2-6 for Model 8227 installation guidelines. The cable lengths shown in Figure 2-6 represent Spectracom CAL7xxx cable. The equivalent cable loss expressed in dB, is provided for use with other cables.

Place the inline amplifier within 200 feet (10 dB cable loss) of the antenna to optimize the signal to noise ratio. Whenever possible install the inline amplifier indoors and after the impulse suppressor. Connect the surge suppressor to the inline amplifier using the supplied 5-foot cable. The amplifier can be installed outdoors, providing care is taken to weatherproof the connections.
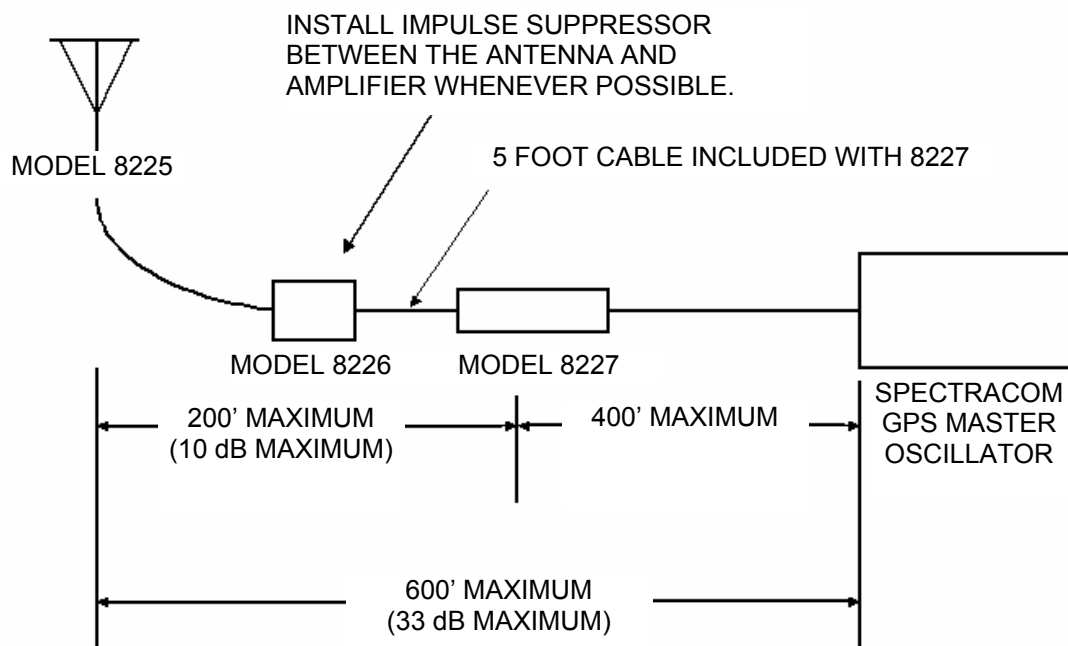
Figure 2-6 Cable Guidelines

2.6 Master Oscillator Preparation for Use

This section outlines the set-up procedure to prepare the Master Oscillator for operation.

2.6.1 Antenna Connection

Install the Model 8225 Antenna and related accessories as outlined previously in this section. Connect the antenna cable to the rear panel GPS ANT connector.

2.6.2 AC Power

The standard Master Oscillator receives primary power from a 90 to 264 VAC 50/60 Hz power source. A detachable line cord is furnished in the ancillary kit. The supplied line cord is compatible with AC receptacles (NEMA 5-15R) commonly found in the United States and Canada. Alternate type line cords may be obtained locally. Connect the line cord to the rear panel AC module and a properly grounded power receptacle.

NOTE: The Master Oscillator accepts the complete range of 90 to 264 VAC without a change in instrument setup. <u>DO NOT</u> change the AC fuse or line voltage selector.

On AC powered units, the DC power connector allows connection of a backup power source. Backup keeps the unit in standby. It is NOT operational. The backup source powers the oscillator and GPS receiver module whenever AC power is interrupted. Backup power speeds recovery time when AC power is restored by eliminating oscillator warm-up and retrace and GPS reacquisition time. The backup power source must be +24 VDC, non-ground isolated supply of 10 Watts maximum. When connecting the backup power source, connect a wire jumper from the negative (-) pin to the ground (G) pin as shown in Figure 2-7. The DC power connector is shown in Figure 2-8.

BACKUP POWER SOURCE   **DC POWER CONNECTOR**

PRIMARY SOURCE   **+24 VDC** ————————— | **1** | **+**
                    − GROUND ——————— | **2** | **−**
                                          | **3** | **G**

SECONDARY SOURCE **+24 VDC** ————————— | **4** | **+**
                    − GROUND ——————— | **5** | **−**
                                          | **6** | **G**
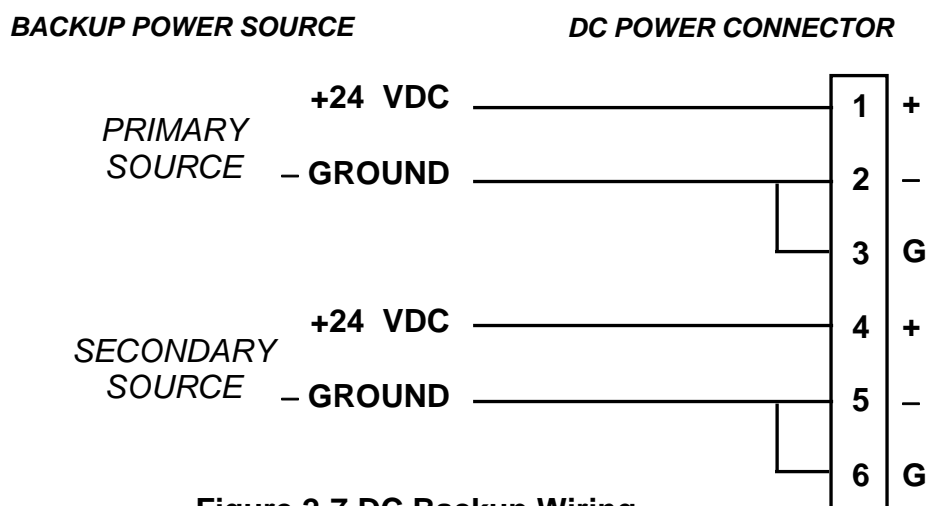
Figure 2-7 DC Backup Wiring

2.6.3   DC Power

DC power options allow operation from various DC power sources. Table 2-1 lists the DC power configurations available. Power is 20 Watts for 8195B units and 60 watts for Model 8197B units. DC power options are not available on the Model 8194B.

Power Option	Nominal Voltage	Input Range
Option 52	± 12 VDC	11.1 - 16.5 VDC
Option 53	± 24 VDC	22.1 - 33.1 VDC
Option 54	± 48 VDC	44.2 - 66.2 VDC

Table 2-1 DC Power Configurations

Connect the DC Power inputs to the 6-position terminal block as shown in Figure 2-8, DC Power Connector. The mating connector is included in the ancillary kit. Redundant power sources may be connected for improved system reliability. Be certain to observe the polarity markings when connecting power. The DC power Options, 52, 53, and 54, have isolated inputs, which permits operation from a positive or negative power source. To reduce RFI/EMI emissions use a shielded power cable. Connect the cable shield to the chassis ground pin labeled "G".

NOTE: Place the DC power switch in the OFF position when connecting DC power.
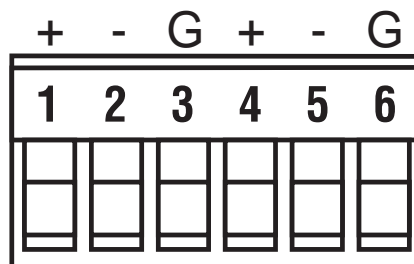
Figure 2-8 DC Power Connector

2.6.4   Chassis Ground

The chassis ground lug allows the unit's chassis to be connected to an earth ground in addition to the power line safety ground. Connecting the chassis to a single point ground system may be required in some installations to ensure optimum lightning protection. A separate earth ground is also recommended in installations where excessive noise on the power line degrades the unit's receiver performance.

2.7 Initial Operation

After completing antenna and power connections, switch on the power. Observe that the front panel POWER lamp turns on. The Major and Minor Alarm lamps are also turned on during initial operation. The receiver will now acquire and lock to GPS satellites currently in view of the antenna. The TRACKING GPS lamp turns on and the Minor Alarm lamp turns off when the receiver acquires a minimum of four satellites and has achieved a 3-D fix for one minute. This typically takes less than 20 minutes to accomplish during initial installation. Once the receiver has a 3-D fix in its new location, the position information is loaded into non-volatile RAM.   Having current position information greatly reduces the time to first fix on subsequent power cycles to less than one minute, or less than 10 seconds if a backup power source is present.

Models 8194B and 8195B require a minimum of 4 hours to reach operational temperature and stabilize and discipline to GPS. The Model 8197B may require up to 6 hours. The OSC LOCK lamp turns on and the Major Alarm lamp turns off when the oscillator is disciplined to the GPS reference. The unit will now operate in accordance with the specifications listed in this manual.

2.8 Qualifying the Installation

Typically, the front panel Tracking GPS lamp illuminates within 20 minutes of turn on. This lamp indicates that receiver is tracking at least 4 qualified satellites and a 3-D position fix has been obtained. If the Tracking GPS lamp does not turn on, a cable or reception problem may exist. Refer to Section 2.9 for troubleshooting assistance.

Reception quality can be evaluated using the performance and status logs provided by the receiver. Commands to retrieve operational information are issued through the front panel RS-232 Com port. To communicate with the receiver, a terminal or computer with terminal emulation software (i.e. ProComm Plus, Hyper-Terminal, etc.) is required. Configure the terminal for ANSI emulation, 9600 baud and a character structure of 1 start, 8 data, and 1 stop with no parity. Flow control is not required, though xon / xoff is supported.

2.8.1   GPS Signal Status

The **G**PS **S**ignal **S**tatus command, **GSS**, provides an instantaneous view of the GPS reception quality.   This command is used to verify proper antenna placement and receiver performance of an installation.   The GSS response indicates the number of satellites the receiver is currently tracking and their relative signal strength.   The resulting GPS quality and Position Fix Status are also included.   A complete description of the **GSS** command can be found in Section 4 of this manual.
Issue the GSS command as shown below.

> Type: ***GSS <ent>***

An example response is shown below:

```
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
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
11      00      00      000     0000
12      00      00      000     0000
```

Tracking: The receiver must track at least 4 qualified satellites to operate. Typically the receiver shall track 6 or more satellites.

GPS State: Under normal operation the receiver will indicate either 3-D Fix or Position Hold. A Searching or 2-D Fix message indicates that fewer than 4 qualified satellites are currently tracked.

DOP: Dilution of Precision indicates the degree of uncertainty of a Position Fix. The DOP value shall be $0 \leq DOP < 10$ when in 3-D Fix mode and 0.0 when in Position Hold mode.

Quality: A passed message indicates the receiver is tracking at least 4 qualified satellites. A failed message indicates the received GPS signals did not meet minimum requirements.

Satellite Data: Data on each satellite currently tracked is provided in table form.

> The **CHAN** column represents the GPS Receiver Channel Number, 1 through 12.

> **VID** is the Vehicle (satellite) Identification Number, 1 through 37.

> The **MODE** column provides the Channel Tracking Mode for each satellite. The GPS qualifying algorithm accepts only satellites having a Mode value of 08.

> The relative signal strength of each satellite currently tracked is found in the **STREN** column. The minimum acceptable level is 40. The maximum level is 55.

> The satellite status flag code is found in the **STAT** column. Typically the STAT value is 0A80.

If the receiver does not meet the minimum requirements described above, refer to Section 2.9 for troubleshooting assistance.

2.8.2 Tracking Histogram

The **D**isplay Tracking **H**istogram command, **DH**, is used to evaluate the long-term reception quality. The tracking histogram records the number of satellites tracked and qualified every second. At the end of the hour, a log is created and the counters are restarted. The command responds with the last four hourly entries and the histogram currently in process. A complete description of the **DH** command is found in Section 4 of this manual.

NOTE: Allow the receiver to operate for at least 5 hours before evaluating the tracking histogram.

Issue the DH command as shown below:

> Type: *DH <ent>*

An example response is shown below:

```
TIME= 12:00:00 DATE= 2004-03-24
 0= 00000   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= 03600

TIME= 13:00:00 DATE= 2004-03-24
 0= 00000   1= 00000   2= 00000  3= 00000  4= 00000
 5= 00000   6= 00016   7= 01004  8= 02580  9= 00000
10= 00000  11= 00000  12= 00000  Q= 03600

TIME= 14:00:00 DATE= 2004-03-24
 0= 00000   1= 00000   2= 00000  3= 00000  4= 00000
 5= 00000   6= 00000   7= 00067  8= 03430  9= 00103
```

```
10= 00000  11= 00000  12= 00000  Q= 03600


TIME= 15:00:00 DATE= 2004-03-24
 0= 00000   1= 00000   2= 00000  3= 00000  4= 00000
 5= 00000   6= 00000   7= 00000  8= 02678  9= 00580
10= 00342  11= 00000  12= 00000  Q= 03600


TIME= 15:01:59  DATE= 2004-03-24
 0= 00000   1= 00000   2= 00000  3= 00000  4= 00000
 5= 00000   6= 00000   7= 00000  8= 00000  9= 00027
10= 00091  11= 00000  12= 00000  Q= 00118


END OF LOG
```

In this example, the receiver tracked six satellites for 19 seconds, seven satellites for 1537 seconds, and eight satellites for 2044 seconds for the hour ending 12:00:00. The "Q" value of 3600 indicates the receiver had tracked at least four qualified satellites for the entire hour (3600 seconds). Note the partial histogram shown in the time stamp of 15:01:59.

For optimum performance, the receiver should consistently track four or more satellites. The Q value should typically be 3600 for most entries. Occasional drops below 3600 are considered acceptable. If the majority of the histograms show tracking less than four satellites, or Q values less than 3000, the receiver may not provide reliable operation. Refer to Section 2.9.2 for recommendations.

2.9 Reception Troubleshooting

Please review this section prior to calling the Spectracom Customer Service Department. If the reception problem cannot be solved following the guidelines outlined in this section, please call for Customer Service at 585.321.5800.

2.9.1 No Reception

Cable or connector problem: 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 2-2 for typical resistance values of the antenna and inline amplifier alone and when combined.

DEVICE	RESISTANCE
8225	~ 65 ohms
8227	open
8225 and 8227	~ 65 ohms

Table 2-2 Typical Antenna Cable Resistance Values

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.

Cable length: Excessively long or improper cable type may prevent the receiver from tracking satellites. Refer to Section 2.3 for GPS antenna cable recommendations.

Antenna location: The antenna must be installed outdoors and have a good view of the sky. Refer to Section 2.2.1 for antenna installation guidelines.

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 to issue the GPS Reset command. Issue the GPS Reset command, **RGPS**, as shown below:

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.

2.9.2 Low GPS Quality

Cable Length: Excessively long or improper cable type may cause low GPS quality due to cable attenuation. Long GPS antenna lengths may require an inline amplifier. Refer to Section 2.3 for GPS cable recommendations and Section 2.5 for 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 Section 2.2.1 for antenna installation guidelines.

Local interference: One reason for poor reception is harmonics from a local broadcast interfering with the GPS L1 carrier of 1575.42 MHz. Certain television or FM radio broadcasts, while operating within their frequency allocation, can cause GPS jamming due to harmonics of the carrier.

The unit can be configured to operate in low GPS quality conditions by selecting an alternate GPS qualifying algorithm. Refer to Appendix A for additional information.

2.10 Default Factory Configuration

Several of the unit's outputs and operational parameters are configurable using the RS-232 communication port and set-up DIP switches. Table 2-3 lists the selectable parameters, factory default, and if it is command or switch selectable. Refer to Section 3, Operation, for a complete description of the various outputs and set-up switches. Refer to Section 4, Software Commands, for information on the various commands.

FUNCTION	FACTORY DEFAULT	COMMAND OR SWITCH
Antenna Cable Delay	No Delay	Command, ACD
Alarm Timeout AT1	1 Minute	Command, AT1
Alarm Timeout AT2	2.5 Hours	Command, AT2
Alarm Timeout AT3	30 Days	Command, AT3
Baud Select	33 1/3	Command, BS
CTCSS Tone	67.00 Hz (Option 14 & 17)	Command, CTC
Event Output	OFF	Command, EO
Signature Control	OFF	Command, SC
Set Mode	OFF	Command, SM
Test Mode	OFF	Command, TM
Time Zone Offset	No Offset	Command, TZO
10 MHz Offset	No Offset	Command, 1FO
One PPS Offset	No Offset	Command, 1PO
RS-485 Address	00	Switch selectable
RS-485 Baud Rate	9600	Switch selectable
RS-485 Termination	ON	Switch selectable

Table 2-3 Default Setting

3 Operation

3.1 Introduction

This section describes the front and rear panel functions, and operational information for the Spectracom GPS Ageless Master Oscillator.

3.2 Front Panel Functions

The front panel (with the battery option) is shown in Figure 3-1. The paragraphs below describe the indicators and connectors found on the front panel.

3.2.1 Status Lamps

Power
This green lamp indicates that the unit is connected to the primary power source and is turned on.

Tracking GPS
During initial operation the TRACKING GPS lamp turns on when the receiver has tracked at least four qualified satellites for one minute. The lamp turns off when fewer than four qualified satellites are tracked and Alarm Timeout 1, AT1, expires. The lamp turns back on when at least four satellites are reacquired and qualified for one minute.

Oscillator Locked
The green OSC LOCKED lamp is off during start-up. The lamp turns on when the standard oscillator is phase locked to the GPS reference. Entering a new frequency offset, an Alarm Timeout 2 (AT2) or Frequency alarm turns this lamp off until oscillator phase lock is achieved.

3.2.2 Alarm Lamps

The Master Oscillator divides alarm conditions into two categories, Major and Minor. A Major Alarm is asserted when fault conditions exist which affect the operation or accuracy of the unit. A Minor Alarm warns of conditions having no immediate effect on total operation, but may require corrective action.

Major and Minor Alarm conditions are communicated by the front panel lamps and relay contacts on the rear panel Alarm Output connector. In addition Major alarm relay contacts are found on the 1544 kHz, 2048 kHz, Data Clock and Data Sync output connectors. Alarm status may also be monitored using the front panel RS-232 or rear panel RS-485 communication ports. Refer to Section 4 for a complete listing of alarm status and alarm clearing commands.

3.2.2.1   Major Alarm Lamp

This lamp turns on when any of the Major Alarm condition is present. The lamp turns off when the fault condition is corrected. A Major Alarm is asserted when the following conditions exist:

Frequency Error: Measured oscillator frequency error exceeds1 x 10^{-8} or whenever an AT2 Alarm is asserted. A frequency alarm is also asserted during start-up.

GPS Tracking Timeout 2:   The period of time (AT2) allotted for operation without tracking a minimum of four qualified satellites has expired. Factory default period is 2.5 hours. An AT2 Alarm is also asserted during start-up.

GPS Tracking Timeout 3:   The period of time (AT3) allotted for operation without tracking a minimum of four qualified satellites has expired. Factory default period is 30 days. An AT3 Alarm is also asserted during start-up.

CPU Fault: The CPU is unable to communicate with the GPS receiver.

Test Mode: Unit has been placed in TEST MODE operation.

Free Run: While in Test Mode, the automatic frequency control feature has been disabled.

Short Gate: While in Test Mode, gate time has been configured for 10 seconds, measurement resolution is reduced.

3.2.2.2   Minor Alarm Lamp

This lamp turns on whenever a Minor Alarm condition is present. The lamp turns off when the fault condition is corrected. A Minor Alarm is asserted when:

Output Fault: No output is detected from one or more of the four rear panel frequency outputs.   A shorted cable could cause the fault, reflections due to an un-terminated cable or Signature Control removed the outputs.

Oscillator Adjust: Warns that oscillator is operating within 10% of the minimum or maximum control setting. The oscillator requires manual adjustment. Refer to Section 6, Service Information, for the oscillator adjustment procedure.

GPS Tracking Timeout 1:   The period of time (AT1) allotted for operation without tracking a minimum of four qualified satellites has expired. Factory default =1.0 minute. An AT1 Alarm is also asserted during start-up.
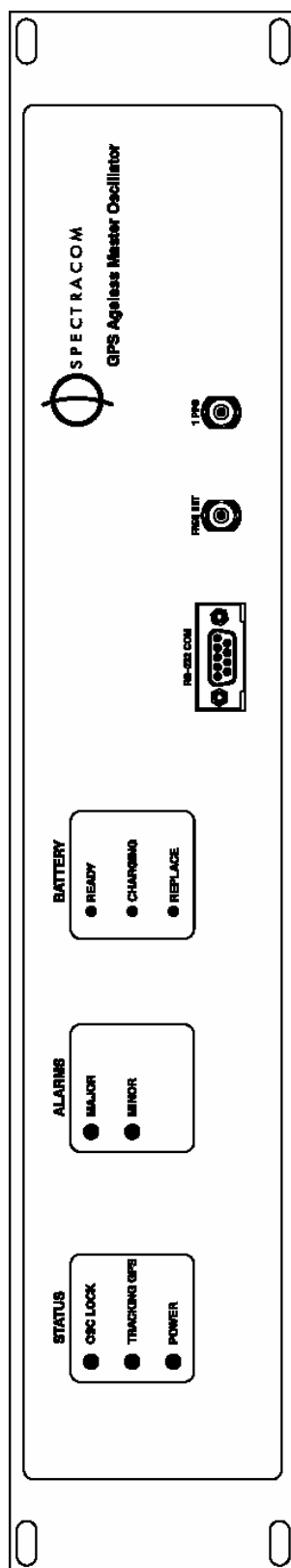
Figure 3-1 Spectracom Master Oscillator Front Panel

Low Quality Alarm: Warns of low GPS signal quality. The alarm is asserted whenever the "Q" value in the Tracking Histogram is below 3000.

Replace Battery: Internal battery pack, Option 02 only, has failed daily test, needs replacement.   Refer to Section 6, Service Information, for battery replacement instructions.

Frequency Offset: A new simulcast offset value is entered. The alarm remains active until the standard oscillator has corrected for the offset.

Antenna Problem: Antenna sense circuitry warns when the antenna is not connected or a cable short or open is detected. It warns when the antenna power supply is under or over current. This alarm may also be asserted when the receiver is connected to an antenna splitter device that does not have a simulated load.

Test Mode: Unit is placed in Test Mode operation.

3.2.3 Battery Lamps (Option 02 only)

These lamps monitor the status of the optional internal battery backup. Refer to Section 5, Options and Accessories, for additional battery information.

Ready Lamp
This green lamp is on when the battery is OK and fully charged.

Charging Lamp
This yellow lamp is on when the battery is charging.

Replace Lamp
This red lamp turns on and a Minor Alarm asserted when the battery has failed its daily test.   The battery must be replaced; refer to Section 6, Service Information. Refer to the Options and Accessories section for details on the battery daily test.

3.2.4 RS-232 Com

This is the RS-232 serial communication port.   Commands to configure selectable parameters, output operational status and events, and Test Mode functions are entered here.   Refer to Section 4.3 for a complete description of the RS-232 commands and responses.

The RS-232 COM connector is a 9-pin series D female. Connector pin numbering is shown in Figure 3-2. Pin assignments are listed in Table 3-1.
The RS-232 Com port transmits and receives ASCII characters at 9600 baud structured as 1 start, 8 data, 1 stop, no parity and xon / xoff flow control.
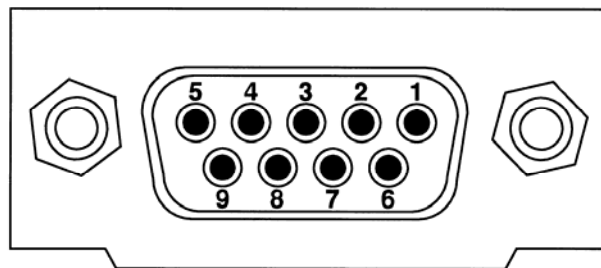
Figure 3-2 RS-232 Com Pin Numbering

PIN	SIGNAL	I/O	DESCRIPTION
2	RXD	O	Receive Data
3	TXD	I	Transmit Data
5	GND	-	Signal Common
6	DSR	O	Data Set Ready
7	RTS	*	Request to Send
8	CTS	*	Clear to Send

* Pins 7 and 8 are connected together internally.

Table 3-1 RS-232 Com Pin Assignments

The RS-232 Com port is configured as data communication equipment (DCE). Data is output on Pin 2, RXD and commands are input on Pin 3, TXD. When interfacing to data terminal equipment, DTE, (i.e. a personal computer) a one-to-one cable is used. Interfacing to a DCE requires reversing Pins 2 and 3 or a null modem connection. The RS-232 COM port does not require hardware handshaking. The Request to Send and Clear to Send signals are internally connected together, and the DSR signal are held high through a pull-up resistor.

3.2.5 10 MHz Output

This BNC connector outputs a 10 MHz sine wave signal derived from the disciplined oscillator. The 10 MHz output can be user-configured for simulcast operation. Refer to the Frequency Offset command, 1F0, found in Section 4.3 for additional information. This output is changed to 12.8 MHz when equipped with Option 06, and 5 MHz with Option 07 units.

3.2.6 1PPS Output

This BNC connector outputs a one pulse-per-second TTL-compatible signal. The signal is derived from the GPS disciplined 10 MHz oscillator. The leading edge of the signal is the on time point adjusted by any cable or offset delays that have been user-configured. Refer to the Antenna Cable Delay command, ACD, and the One PPS Offset command, 1PO, descriptions found in Section 4.3 for additional information.

3.3 Rear Panel Functions

The Model 8195B and 8197B rear panel is shown in Figure 3-3. The Model 8194B rear panel is shown in Figure 3-4. The following paragraphs describe each of the rear panel functions that are available for the Spectracom Master Oscillator Family. Note that the Model 8194B does not have all of the rear panel functions. Refer to the Product Comparison Chart for details on the different features and options that are available for each model in the Spectracom Master Oscillator family. The Product Comparison Chart can be found in Section 1.2.

3.3.1 GPS Antenna

This type N connector is the antenna input to the GPS receiver. The Model 8225 GPS Antenna and the Model 8227 Inline Preamplifier receive operational power, +5 VDC, from this connector.

3.3.2 Frequency Outputs

The Frequency Outputs are derived from the GPS disciplined oscillator. Four BNC outputs at 10.0 MHz are provided. The signal is a 750 mV rms sine wave into a 50-ohm load. The harmonic suppression is 30 dB.

3.3.2.1   Signature Control

The Frequency Outputs may be placed under signature control. Signature Control removes the outputs whenever a Major Alarm occurs. The outputs return when the fault condition is cleared. The unit is shipped with this feature disabled. The Signature Control feature may be enabled using the front panel RS-232 Com port. Refer to the Signature Control command, SC, found in Section 4, Software Commands.

3.3.2.2   Simulcast Offsets

In simulcast radio systems, it is desirable to cover large geographic areas with multiple base station transmitters. Simulcasting requires precise control of transmitter frequencies to reduce interference between adjacent transmitters on the same channel.

Ineffective transmitter frequency control can reduce system coverage and cause "dead spots," "false pages," and message distortion. These adverse effects are reduced or eliminated by providing a carrier frequency offset between adjacent transmitters. The offset values are selected to minimize co-channel interference. To assure maximum performance of the system, periodically checking and adjusting the transmitter oscillators to maintain the desired frequency offsets must neutralize the effects of transmitter oscillator "aging".
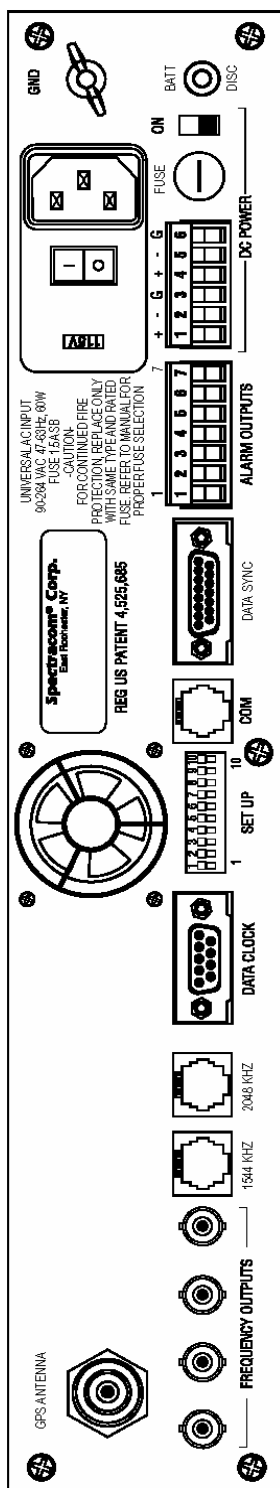
Figure 3-3 Spectracom Master Oscillator Model 8195B and 8197B Rear Panel
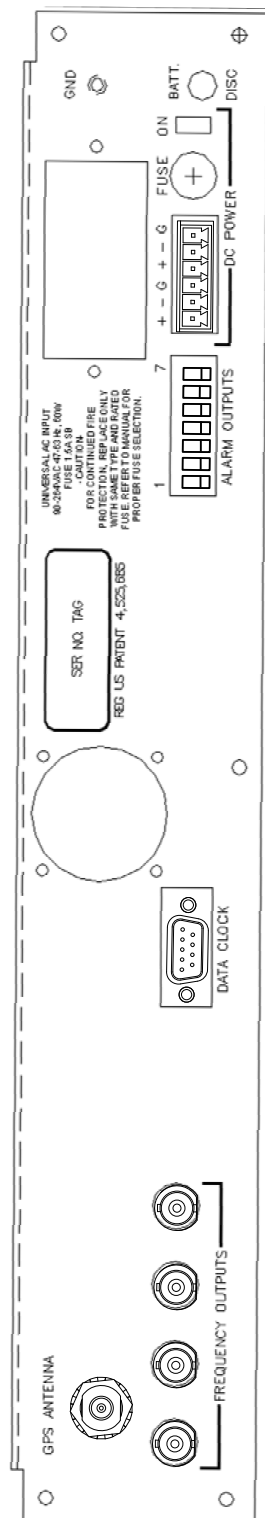
Figure 3-4 Spectracom Master Oscillator Model 8194B Rear Panel

The Spectracom Master Oscillator Simulcast Transmitter Offset provides an accurate, controlled frequency reference that is continuously "frequency locked" to GPS. This reference can be used by synthesized transmitters to provide "ageless" frequency control, including offsets, at an accuracy of $\pm 1.0 \times 10^{-10}$.

The simulcast offsets are divided into two groups; Simulcast 1 (SC1) and Simulcast 2 (SC2). Simulcast 1 has offset steps sized for UHF as listed in Table 3-2. Simulcast 2 has offset steps sized for VHF Hi as listed in Table 3-3. Within each group exist four positive offset steps and the complimentary negative offset steps.

The simulcast offsets are selected using software commands. Refer to the 10 MHz Offset command, 1F0, found in Section 4 for additional information.

Offset Name	Offset Δf_s	Output Frequency	Offset @ 450 MHz
SC1 + 1	+1.1E-9	10,000,000.011 Hz	+0.5 Hz
SC1 + 2	+2.2E-9	10,000,000.022 Hz	+1.0 Hz
SC1 + 3	+3.3E-9	10,000,000.033 Hz	+1.5 Hz
SC1 + 4	+4.4E-9	10,000,000.044 Hz	+2.0 Hz
SC1 - 1	-1.1E-9	9,999,999.989 Hz	-0.5 Hz
SC1 - 2	-2.2E-9	9,999,999.978 Hz	-1.0 Hz
SC1 - 3	-3.3E-9	9,999,999.967 Hz	-1.5 Hz
SC1 - 4	-4.4E-9	9,999,999.956 Hz	-2.0 Hz

Table 3-2 UHF Simulcast Offsets

Offset Name	Offset Δf_s	Output Frequency	Offset @ 150 MHz
SC2 + 1	+2.0E-8	10,000,000.200 Hz	+3.0 Hz
SC2 + 2	+3.4E-8	10,000,000.340 Hz	+5.0 Hz
SC2 + 3	+4.7E-8	10,000,000.470 Hz	+7.0 Hz
SC2 + 4	+6.0E-8	10,000,000.600 Hz	+9.0 Hz
SC2 - 1	-2.0E-8	9,999,999.800 Hz	-3.0 Hz
SC2 - 2	-3.4E-8	9,999,999.660 Hz	-5.0 Hz
SC2 - 3	-4.7E-8	9,999,999.530 Hz	-7.0 Hz
SC2 - 4	-6.0E-8	9,999,999.400 Hz	-9.0 Hz

Table 3-3 VHF HI Simulcast Offsets

The frequency offset at the carrier frequency is determined by the formula:

$$\Delta f_C = F_C \times \Delta f_S$$

where: Δf_C = carrier offset

F_C = carrier frequency

Δf_S = offset of 10 MHz standard (from the tables)

3.3.2.3   Output Options

Several output options are available to configure the Frequency Outputs for various applications. The output options are listed below. Refer to Section 5, Options and Accessories, for a complete description.

- Option 03, Built-in Distribution Amplifier

- Option 06, 12.8 MHz Outputs

- Option 07, 5 MHz Outputs

- Option 16, 1PPS on the third and fourth rear panel frequency outputs

3.3.3   1544 kHz and 2048 kHz Timing Outputs

Each of these RJ-11 receptacles provide an RS-485 Timing Output of the indicated frequency. The output signals, 1544 kHz and 2048 kHz, are synthesized from the 10 MHz GPS disciplined oscillator. Major Alarm relay contacts are included on each output connector.

NOTE: Simulcast Offsets affects the accuracy of the timing outputs.

The connector pin numbering is shown in Figure 3-5 and pin assignments listed in Table 3-4.
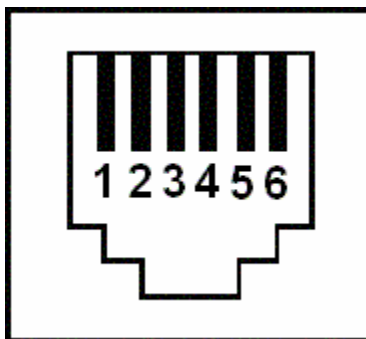
Figure 3-5 Timing Output Connector

PIN	SIGNAL	NOTES
1	+ Frequency	RS-485 B Terminal
2	- Frequency	RS-485 A Terminal
3	Ground	Cable Shield/Relay Ground
4	MAJOR C	Common
5	MAJOR NO	Normally Open
6	MAJOR NC	Normally Closed

Table 3-4 Timing Output Pin Assignments

NOTE: A units equipped with Option 06, 12.8 MHz outputs, changes the 2048 kHz output to 1600 kHz.

3.3.3.1 RS-485 Outputs

RS-485 is a balanced differential transmission requiring twisted pair cabling. Refer to Figure 3-6 for a schematic representation of the RS-485 output driver. Relative to RS-485 specifications, the A terminal (Pin 2) is negative with respect to the B terminal (Pin 1) for a Binary 1. The A terminal is positive relative to the B terminal for a Binary 0.
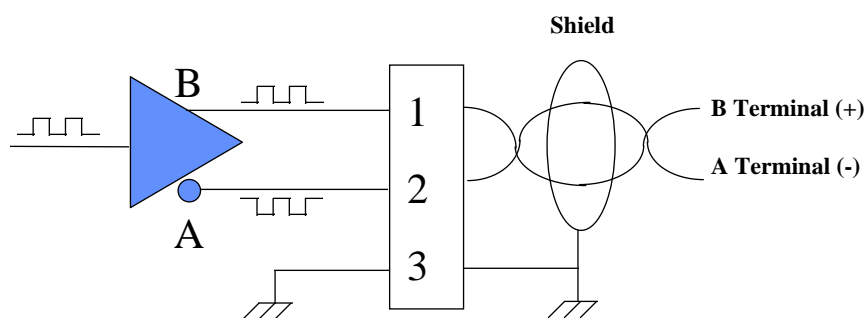
Figure 3-6 RS-485 Output

The RS-485 output driver can provide a TTL-compatible clock signal when connected in a single-ended configuration. Connect as shown in Figure 3-7 for a TTL clock reference.

The 100-ohm termination resistor is required at the cable destination to prevent ringing and reflections.
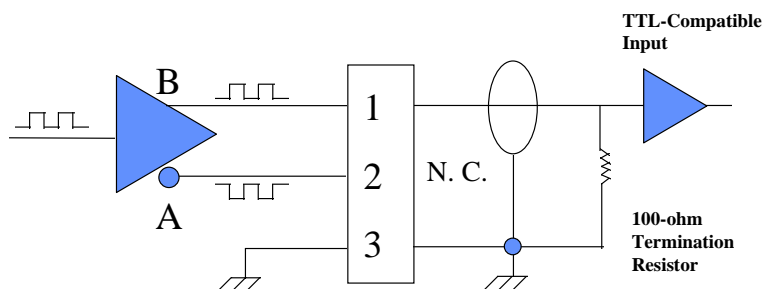
Figure 3-7 Single-Ended Connection

3.3.3.2 Major Alarm Contacts

Major Alarm relay contacts are found on Pins 4, 5 and 6 of each timing output connector. During normal operation the Major Alarm relay is energized causing continuity between Pin 4 and Pin 6. When a Major Alarm is asserted the relay is deactivated causing continuity between Pin 4 and Pin 5. The relay remains in alarm condition until the condition causing the alarm is corrected or is reset by the clear alarm, CA, command. Refer to section 3.2.2.1 for a complete description of Major Alarms.

3.3.4 Data Clock Timing Outputs

This connector provides RS-485 clock signals of one pulse per second (1PPS), 9.6 kHz, 18 kHz and Major Alarm relay contacts. The connector is a 9-pin series D numbered as shown in Figure 3-8. Data Clock pin assignments are listed in Table 3-5.
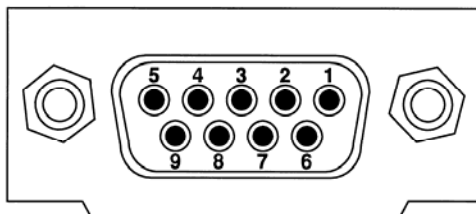
Figure 3-8 Data Clock Connector

PIN	SIGNAL	NOTES
1	+ 9.6 KHZ	RS-485 B TERMINAL
2	+18 KHZ	RS-485 B TERMINAL
3	+ 1 PPS	RS-485 B TERMINAL
4	MAJOR ALARM	GROUND = NORMAL
5	GROUND	CABLE SHIELD
6	- 9.6 KHZ	RS-485 A TERMINAL
7	-18 KHZ	RS-485 A TERMINAL
8	- 1 PPS	RS-485 A TERMINAL
9	GROUND	CABLE SHIELD

Table 3-5 Data Clock Pin Assignments

The Data Clock timing signals are derived from the 10 MHz GPS disciplined oscillator. The 1PPS and 9.6 Hz outputs are leading edge synchronized to the GPS 1 PPS output. Using the 1PPS offset command; 1PO, the outputs can be offset from 0 to 1 second in 0.001 microsecond steps. Refer to Section 4 for additional information on the 1PO Command. The 18 kHz output is not made leading edge synchronized.

NOTE: Option 17, replaces the 9.6 kHz and 1PPS signals with the selected CTCSS outputs #3 and #4 respectively

3.3.4.1 RS-485 Outputs

RS-485 is a balanced differential transmission requiring twisted pair cable. Cable lengths up to 4000 feet are possible when using cables specifically designed for RS-485 applications, like Belden 9844 or equivalent. These cables have a braided shield, nominal impedance of 120 ohms, and a capacitance of 12 to 15 picofarads per foot. Refer to Figure 3-9 for a schematic representation of an RS-485 line driver. Relative to RS-485 specifications the A Terminal (-) is negative with respect to the B Terminal (+) for a Binary 1. The A Terminal (-) is positive to the B Terminal for a Binary 0.
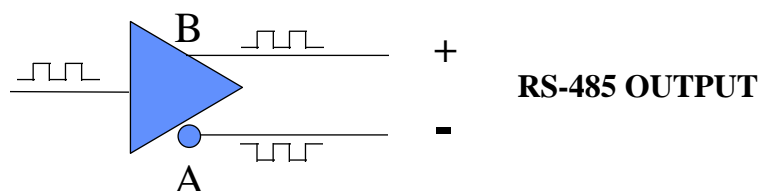
Figure 3-9 RS-485 Line Driver

3.3.4.2 Major Alarm Relay

Major Alarm status can be monitored using Pin 4 of this connector. Under normal operation, Pin 4 is connected to ground. When a Major Alarm is asserted, Pin 4 becomes a high-impedance (open circuit). Refer to Section 3.2.2.1 for a complete description of Major Alarms.

3.3.5 Set Up Switches

The Set-Up Switches configure the RS-485 address, baud rate and termination.

3.3.5.1   RS-485 Address

The Address switches give each unit installed on an RS-485 bus a unique identity. The address may range from 0 – 31, DIP-switches 1 through 5 enter the binary equivalent of the selected address. Table 3-6 lists the RS-485 addresses and the corresponding DIP-switch settings.

The RS-485 protocol includes address source and destination information.

RS-485 ADDRESS	DIP SWITCH					RS-485 ADDRESS	DIP SWITCH				
	1	2	3	4	5		1	2	3	4	5
0	0	0	0	0	0	16	0	0	0	0	1
1	1	0	0	0	0	17	1	0	0	0	1
2	0	1	0	0	0	18	0	1	0	0	1
3	1	1	0	0	0	19	1	1	0	0	1
4	0	0	1	0	0	20	0	0	1	0	1
5	1	0	1	0	0	21	1	0	1	0	1
6	0	1	1	0	0	22	0	1	1	0	1
7	1	1	1	0	0	23	1	1	1	0	1
8	0	0	0	1	0	24	0	0	0	1	1
9	1	0	0	1	0	25	1	0	0	1	1
10	0	1	0	1	0	26	0	1	0	1	1
11	1	1	0	1	0	27	1	1	0	1	1
12	0	0	1	1	0	28	0	0	1	1	1
13	1	0	1	1	0	29	1	0	1	1	1
14	0	1	1	1	0	30	0	1	1	1	1
15	1	1	1	1	0	31	1	1	1	1	1

1 = SWITCH ON, 0 = SWITCH OFF

Table 3-6 Address Selection

3.3.5.2   RS-485 Baud Rate

DIP-switch 6 is reserved for future implementation of 19200 baud operation of the RS-485 COM port. To ensure proper operation, place this switch in the OFF position. This configures the COM port for 9600 baud.

3.3.5.3   Spares

DIP Switches 7, 8, and 9 are reserved for test and future expansion. To ensure proper operation, place these switches in the OFF position.

3.3.5.4 Termination

Switch 10 terminates the RS-485 Receive line with 120 ohms. Place Switch 10 in the ON position when the unit is installed at the end of the RS-485 bus. Place this switch in the OFF position when the unit is not the last device on the bus.

3.3.6 RS-485 COM

The RS-485 communication port permits remote configuration control and monitoring of performance and status. The RS-485 Com port uses a protocol and command set described in Section 4.2 of this manual. The Com connector pin numbering is shown in Figure 3-10. Table 3-7 lists the Com pin assignments.
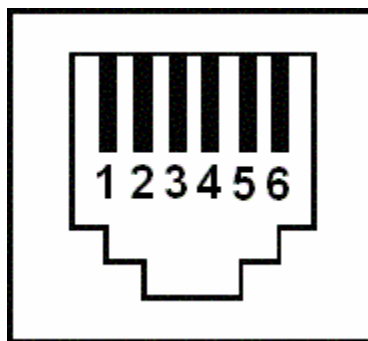
Figure 3-10 RS458 COM Connector

PIN	SIGNAL	NOTES
1	- Transmit	RS-485 A terminal
2	+ Transmit	RS-485 B terminal
3	- Receive	RS-485 A terminal
4	+ Receive	RS-485 B terminal
5	Ground	Cable Shield
6	Ground	Cable Shield

Table 3-7 RS-485 COM Pin Assignments

The rear panel DIP-switch selects the RS-485 address and termination as described in previous paragraphs. Transmitted characters are in ASCII form with a bit structure of 1 start, 8 data, 1 stop and no parity, data rate is 9600 baud.

RS-485 is a balanced differential transmission requiring twisted pair cable. The RS-485 standard defines the A terminal (-) to be negative with respect to the B terminal (+) for a Binary 1 (MARK or OFF) state. The A terminal (-) is positive to the B terminal (+) for a Binary 0 (SPACE or ON) state. Figure 3-11 illustrates the relationship between the A and B terminals for the Transmit and Receive connections.
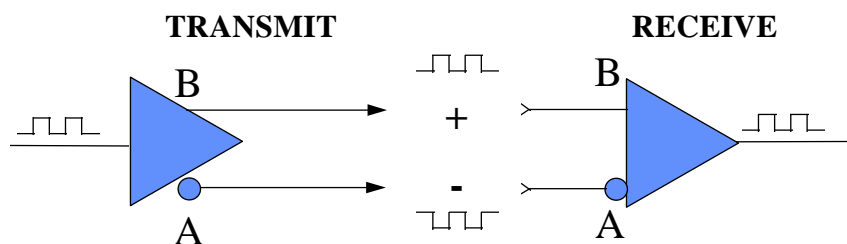
Figure 3-11 RS-485 Connection

3.3.7 Data Sync Timing Outputs

This connector provides RS-485 clock signals of 17 $^2/_3$ Hz, 33 $^1/_3$ Hz / 26$^2/_3$, 18 kHz, 64 kHz, and Major Alarm relay contacts. The connector is a 15-Pin series D female numbered as shown in Figure 3-12. Data Sync pin assignments are listed in Table 3-8.
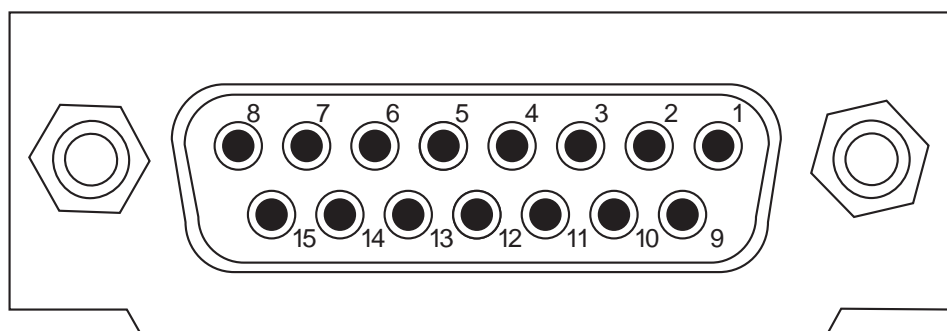
Figure 3-12 Data Sync Connector

PIN	SIGNAL	DESCRIPTION
1	+ 64 kHz	RS-485 B Terminal
2	-64 kHz	RS-485 A Terminal
3	+18 kHz	RS-485 B Terminal
4	-18 kHz	RS-485 A Terminal
5	+ 17 $^2/_3$ Hz	RS-485 B Terminal
6	-17 $^2/_3$ Hz	RS-485 A Terminal
7	+33 $^1/_3$ / 26$^2/_3$ Hz	RS-485 B Terminal
8	-33 $^1/_3$ / 26$^2/_3$ Hz	RS-485 A Terminal
9	Ground	Cable Shield
10	Major - C	Common Contact
11	Major - NO	Normally Open
12	Major - NC	Normally Closed
13	Ground	Cable Shield
14	Ground	Cable Shield
15	Ground	Cable Shield

Table 3-8 Data Sync Pin Assignments

NOTE: Option 06, 12.8 MHz outputs, changes the 64 kHz output to 50 kHz.

Option 14, CTCSS Outputs, replaces the 33-1/3 Hz and 17-2/3 Hz signals with the selected CTCSS outputs #1 and #2 respectively.

Refer to Section 5, Options and Accessories, for additional information on Options 06 and 14.

The 64 kHz and 18 kHz Data Sync outputs are derived from the 10 MHz GPS disciplined oscillator.

The 17 $^2/_3$ Hz and 26$^2/_3$ / 33 $^1/_3$ Hz outputs are derived from the 10 MHz GPS disciplined oscillator and are triggered by the GPS 1PPS output. Using the 1PPS offset command, 1PO, these outputs can be offset from 0 to 1 second in 0.001 microsecond steps. Refer to Section 4 for additional information on the 1PO command. The leading edges of the 17 $^2/_3$ Hz and 26$^2/_3$ / 33 $^1/_3$ Hz outputs are synchronized within ±400 nanoseconds of the Data Clock 1PPS output.

3.3.7.1   RS-485 Outputs

RS-485 is a balanced differential transmission requiring twisted pair cable.   Cable lengths up to 4000 feet are possible when using cables specifically designed for RS-485 applications, like Belden 9844 or equivalent.   These cables have a braided shield, nominal impedance of 120 ohms, and a capacitance of 12 to 15 picofarads per foot.

Refer to Figure 3-13 for a schematic representation of an RS-485 line driver.   Relative to RS-485 specifications the A Terminal (-) is negative with respect to the B Terminal (+) for a Binary 1.   The A Terminal (-) is positive to the B Terminal for a Binary 0.
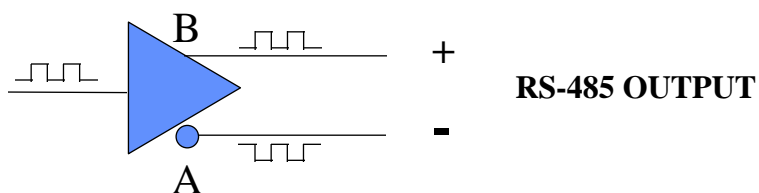
Figure 3-13 Data Sync Drivers

3.3.8 Major Alarm Contacts

Major Alarm relay contacts are found on Pins 10, 11 and 12 of the Data Sync connector. A Major Alarm is asserted whenever any of the following alarm conditions exist: Frequency, Tracking Alarm 2, Tracking Alarm 3, CPU or the unit is placed in Test Mode.

During normal operation the Major Alarm relay is energized.   The energized relay causes continuity between the common contact, Pin 10 and the normally open contact, Pin 11.

A Major Alarm or power failure de-activates the relay causing continuity between common, Pin 10 and normally closed, Pin 12.   The relay remains in alarm condition until the fault is corrected or reset by the clear alarm, CA, command.

3.3.9 Alarm Outputs

The Alarm Outputs connector provides relay contact closures for Major and Minor alarms.   Relay contacts are rated at 2 Amps, 30 VDC.   The mating 7-position terminal block, shown in Figure 3-14, is furnished in the ancillary kit.
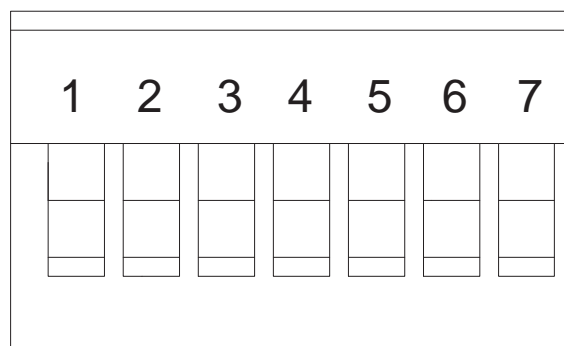
Figure 3-14 Alarm Outputs Terminal Block

A Major Alarm is asserted when any of the following Alarm conditions exist: Frequency, Tracking Alarm 2, Tracking Alarm 3, CPU or the unit is placed in Test Mode. During normal operation the Major Alarm relay is energized. The energized relay causes continuity between common contact, Pin 2, and the normally open contact, Pin 3.

A Major Alarm or power failure de-activates the relay causing continuity between common, Pin 2, and the normally closed contact, Pin 1.

A Minor Alarm is asserted when any of the following alarm conditions exist: Output Fault, Adjust Oscillator, Tracking Alarm 1, Replace Battery, Low GPS Quality, Antenna Problem, Frequency offset or the unit is placed in Test Mode operation. During normal operation the Minor Alarm relay is de-activated. This causes continuity between common, Pin 5, and the normally closed contact, Pin 6.

When a Minor Alarm is asserted the relay is activated causing continuity between common, Pin 5, and the normally open contact, Pin 4.

Table 3-9 lists the Alarm status and the corresponding contact status. The relay contacts remain in the alarm condition until the fault is corrected. If a minor alarm is caused by a replace battery alarm, it will remain until a Clear Alarm, CA, command is issued.

ALARM STATUS	PINS SHORTED*	PINS OPEN*
Major Alarm Off	2 , 3	1 , 2
Major Alarm On	1 , 2	2 , 3
Minor Alarm Off	5 , 6	4 , 5
Minor Alarm On	4 , 5	5 , 6

*Ground is found on Pin 7

Table 3-9 Alarm Operation

3.3.10 DC Power

The DC Power connector provides primary or backup power to the unit

On AC powered units, the DC power connector allows connection of a backup power source. The backup source powers the oscillator and GPS receiver module whenever AC power is interrupted. Backup power speeds recovery time when AC power is restored by eliminating oscillator warm-up and retrace and GPS reacquisition time. The backup power source must be +24 VDC, non-ground isolated supply of 10 Watts maximum. When connecting the backup power source, connect a wire jumper from the negative (-) pin to the ground (G) pin as shown in Figure 3-15. The DC power connector is shown in Figure 3-16.

BACKUP POWER SOURCE   **DC POWER CONNECTOR**
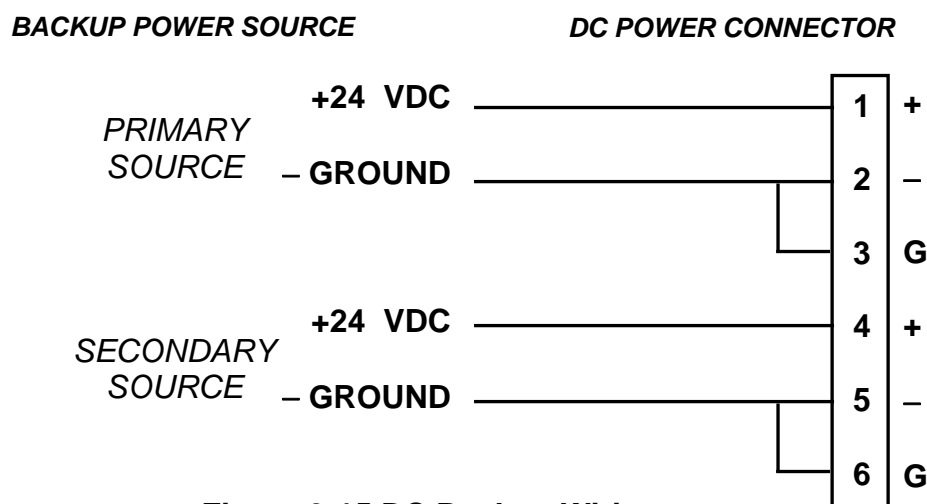
Figure 3-15 DC Backup Wiring

DC power options allow operation from alternate power sources. Table 3-10 lists the various DC power configurations available. Power is 20 Watts for Model 8195B and 60 Watts for Model 8197B.

Power Option	Nominal Voltage	Input Range	Fuse
Option 52	± 12 VDC	11.1 - 16.5 VDC	10.0 A
Option 53	± 24 VDC	22.1 - 33.1 VDC	6.25 A Slo-Blo
Option 54	± 48 VDC	44.2 - 66.2 VDC	3.0 A Slo-Blo

Table 3-10 DC Power Configurations

Connect the DC power inputs to the 6-position terminal block as shown in Figure 3-16, DC Power Connector. The mating connector is included in the ancillary kit. Redundant power sources may be connected for improved system reliability.   Be certain to observe the polarity markings when connecting power.

DC power options, 52, 53, and 54, have isolated inputs, which permits operation from a positive or negative power source. To reduce RFI/EMI emissions use a shielded power cable. Connect the cable shield to the chassis ground pin labeled "G".

NOTE: Place the DC power switch in the OFF position prior to connecting DC power.

<div align="center">

+ - G + - G

1	2	3	4	5	6

</div>
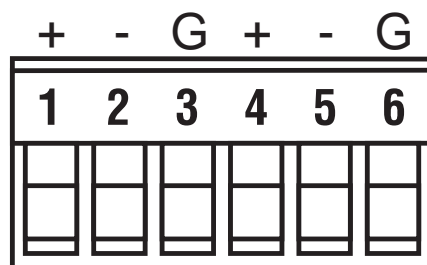
Figure 3-16 DC Power Connector

3.3.11 AC Power

The standard Master Oscillator receives primary power from a 90 to 264 VAC 50/60 Hz power source. A detachable line cord is furnished in the ancillary kit. The supplied line cord is compatible with AC receptacles (NEMA 5 - 15R) commonly found in the United States and Canada. Alternate type line cords may be obtained locally. Connect the line cord to the rear panel AC module and a properly grounded power receptacle.

The AC power module is equipped with a power switch, line voltage selector, EMI filtering, and a fuse. Figure 3-17, AC Power Module, illustrates fuse replacement. The AC fuse requires a 1.5 Amp, 250V Slo-Blo fuse. A spare is found in the ancillary kit.

NOTE: The unit accepts the complete range of 90-264 VAC without a change in instrument setup. Do not change the AC fuse value or line voltage selector. The '115' label must appear in the cover cutout.
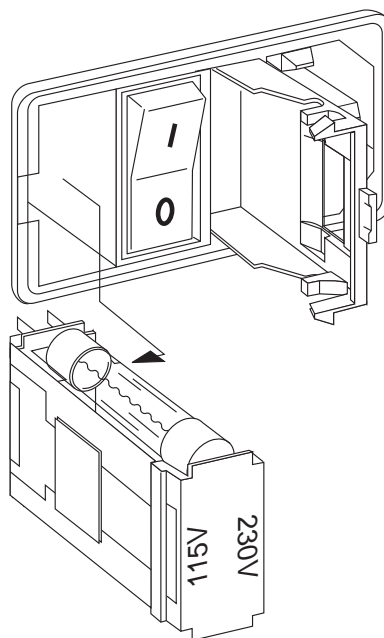
Figure 3-17 AC Power Module

3.3.12 Cooling fan

Cooling fan operation is microprocessor controlled. The fan is turned on when the internal temperature measures 50°C and off when the temperature reaches 30°C.

3.3.13 Chassis Ground

The chassis ground lug allows the unit's chassis to be connected to an earth ground in addition to the power line safety ground. Connecting the chassis to a single point ground system may be required in some installations to ensure optimum lightning protection. A separate earth ground is also recommended in installations where excessive noise on the power line degrades the unit's receiver performance.

3.3.14 Battery Disconnect Switch

Depressing this switch removes the backup battery power from the GPS receiver and ovenized oscillator. The Battery Disconnect switch is operational only on units equipped with Option 02 and when AC power is removed. This feature prevents battery discharge when shipping or storing the unit.

NOTE: The internal battery must be disabled prior to shipment or storage. Failing to disable the battery may result in reduced capacity and shortened battery life.

NOTE: The Battery Disconnect Switch is populated on all versions of the Model 8195B. The switch is only operational on units equipped with Option 02.

4 Software Commands

4.1 Introduction

This chapter describes commands that are asserted through the front panel RS-232 COMM and the rear panel RS-485 COMM connectors.

4.2 RS-232 Commands

From the front panel RS-232 COMM port the user may configure, control and monitor the unit. Table 4-1 lists the RS-232 commands available to provide user access to the operation of the unit.   These commands contain a hierarchy of Read, Set and Test modes. Figure 4-1 illustrates the Master Oscillator command structure.   Read Mode is the base level and when in Read Mode the user may access standard commands. From Read Mode the user may select to enter Test or Set Mode. Set Mode allows the user to not only access standard commands, but in addition, allows them to make changes to certain functions.   Test Mode allows the user access to special test commands, as well as all standard commands. After entering Set Mode or Test Mode, the unit will time out and return to Read Mode after 15 minutes of inactivity.
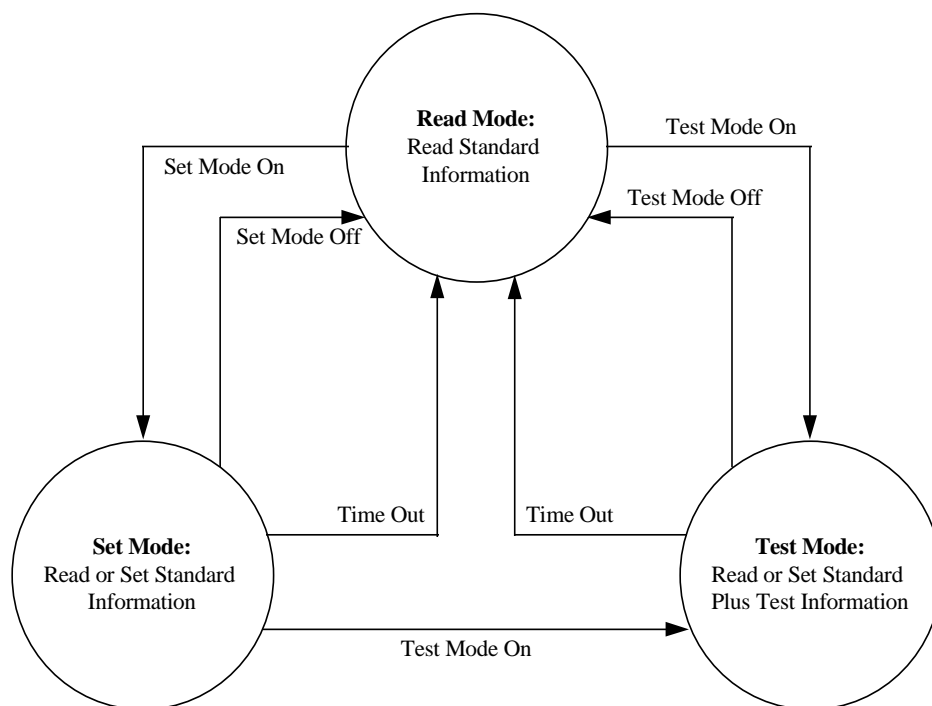
Figure 4-1 Command Structure

COMMAND	DESCRIPTION	MODE	SECTION
ACD	Antenna Cable Delay	READ/SET	4.3.1
ATx	Alarm Time Out	READ/SET	4.3.2
BA	Battery Status	READ	4.3.3
BS	Baud Select	READ/SET	4.3.4
CA	Clear Alarms	SET	4.3.5
CONF, DC	Display Configuration	READ	4.3.6
DAL	Display Alarm Log	READ	4.3.7
DATE, D	Date	READ/SET	4.3.8
DFM	Display Frequency Measurement	READ	4.3.9
DOL	Display Oscillator Log	READ/TEST	4.3.10
DH	Display Tracking Histogram	READ/TEST	4.3.11
EO	Event Output	READ/SET	4.3.12
GSS, DSS, SS	GPS Signal Status	READ	4.3.13
H, Help, ?	Help	READ	4.3.14
LOC	Location	READ/SET	4.3.15
SC	Signature Control	SET	4.3.16
SM	Set Mode	---	4.3.17
STAT, DS	Display Status Information	READ	4.3.18
TIME, T	Time	READ/SET	4.3.19
TM	Test Mode	---	4.3.20
TZO	Time Zone	READ/SET	4.3.21
U2G	UTC to GPS Time Offset	READ	4.3.22
VER	Version	READ	4.3.23
1FO	Frequency Offset	READ/SET	4.3.24
1PO	One PPS Offset	READ/SET	4.3.25

Table 4-1 Alphabetical List of RS-232 Commands

4.3 RS-232 Command Descriptions

In the following command descriptions, characters in ***Bold Italics*** are keys typed by the user. Terminate all command lines with the enter key. The enter key is represented by ***<ent>.*** The responses from the Master Oscillator are in *Italics*. A new line is represented by the carriage return symbol *<cr>*.

Configure the terminal for ANSI, 9600 baud and xon/xoff flow control. The character structure is ASCII, 1 start, 8 data, 1 stop and no parity.

NOTE: All log entries are recorded in UTC time, unless the TZO command is used to set a local time zone.

4.3.1 Antenna Cable Delay

The command, **ACD**, reads or sets the antenna cable delay value expressed in microseconds. The on-time point is offset by the delay value entered to compensate for antenna cable and in-line amplifier delays. The expected cable and amplifier delays are typically negligible. The **ACD** command is intended for advanced user setup. The advanced user can calculate the delay based on the cable manufacturer's specifications.

    Range: 0.000 to 999.999 microseconds
    Default Value: 0.000 microseconds
    Resolution: 1 nanosecond

To read the antenna cable delay, issue the **ACD** command as shown below:

    Type: **ACD <ent>**
    Response: *ANT CABLE DELAY = XXXXXX.XXX MICROSECONDS*
    Where: *XXXXXX.XXX* = 000000.000 to 000999.999 microseconds.

To enter a cable delay, place the clock in *Set Mode* operation, issue the **ACD** command as follows:

    Type: **ACD XXXXXX.XXX** <ent>
    Where: **XXXXXX.XXX** = 000000.000 to 000999.999 microseconds.

NOTE: It is not necessary to fill every digit space when entering a delay value. The delay value can range from 1 to 9 digits long.

The clock then responds with the antenna cable delay value entered. For example, the calculated cable delay for 100 feet of LMR-400 cable is 119 nanoseconds. Follow the example below to compensate the on-time point by the antenna cable delay.

    Type: **SM ON <ent>**
    Response: SET MODE ON
    Type: **ACD 0.119<ent>**
    Response: ANT CABLE DELAY = 000000.119 MICROSECONDS

Cable delay can be calculated using the formula:

$$D = \frac{L \times C}{V}$$

Where: D = Cable delay in nanoseconds.
         L = Cable length in feet.
         C = Constant derived from velocity of light; 1.016.
         V = Nominal velocity of propagation expressed as a decimal, ex. 85% = .85
             Value is provided by cable manufacturer.

4.3.2 Alarm Timeouts

The command **ATx** reads or sets the time out period allotted for tracking alarms AT1, AT2 and AT3. The default time out periods are **AT1 = 1 minute, AT2 = 2 1/2 hours**, and **AT3 = 30 days**.

When the receiver is unable to track at least four qualified satellites a count down timer is started. If the receiver is unable to reacquire qualified satellites within the assigned time out periods the expired time out alarm is asserted.   An AT1 alarm is classified as a Minor alarm. AT2 and AT3 are Major alarms.

To read the current time out values issue the **ATx** command as follows:

> Type: **ATx <ent>**
> **Where x = 1, 2, 3.**
> Example Response:
> *ALARM TIMEOUT x = DDD HH:MM:SS*
> *Where x = 1, 2, 3*
> *DDD = Days 000 … 999*
> *HH = Hours 00 … 23*
> *: = Colon Separator*
> *MM = Minutes 00 … 59*
> *SS = Seconds 00 …59*

To change the alarm time out periods, place the unit in set mode and issue the **ATx** command as shown below:

> Type: **ATx DDD HH:MM:SS**
> Response: *ALARM TIMEOUT x = DDD HH: MM:SS*

4.3.3 Battery Status (Option 02 only)

The **Battery Status** command, **BA**, displays the status of the battery on units that are equipped with internal battery backup. It will indicate one of three conditions. **READY** indicates the battery is good and fully charged, **CHARGING** indicates the battery is OK, but is not yet fully charged, and **REPLACE** indicates the battery has failed a test and should be replaced. The replace battery condition is a minor alarm. This information is also provided in the Display Status command and is displayed using the front panel LED on units with internal battery backup installed. To read the battery status, issue the BA command as follows:

> Type: **BA*<ent>***

> Response:

>> *BATTERY STATUS= READY*

>> -OR-

>> *BATTERY STATUS = CHARGING*

>> -OR-

>> *BATTERY STATUS= REPLACE*

4.3.4 Baud Select

The **Baud Select** command, **BS**, is used to read or set Data Sync Timing Output #2 to $33 \, ^1/_3$ or $26 \, ^2/_3$ Hz output. The default is $33 \, ^1/_3$. Issue this command as follows:

> Type: **BS<ent>**

> Response:

> BAUD GENERATOR SETTING= 33 1/3 OR 26 2/3

To set the baud, place the unit in set mode and issue the BS command as follows:

> Type: **BS 33** or **BS 26 <ent>**

> Response:

> BS 26 WILL SET BAUD GENERATOR 2 TO OUTPUT 26 2/3 HZ
> BS 33 WILL SET BAUD GENERATOR 2 TO OUTPUT 33 1/3 HZ

4.3.5 Clear Alarm

The **Clear Alarm** command, **CA**, resets the Major and Minor Alarm relays even though the fault conditions are still present. If a new alarm condition arises the appropriate alarm relay will be reasserted. The front panel alarm lamps are not reset by this command. The indicator alarm lamps remain on until the fault condition is corrected.

When a **CA** command is issued the unit responds with a change in status report. This report time stamps when the relays were reset and lists the active alarms.

To reset the alarm relays, place the unit in Set Mode and issue the **CA** command as follows:

> Type: **CA<ent>**
> Response:
>
> TIME= 13:44:06 DATE= 2000-03-24 STATUS CHANGE <TEMP= +36.0>
> COOLING FAN= OFF
> ALARM RELAYS: MAJOR= OFF MINOR= OFF
> ACTIVE ALARMS: MAJOR
> FREQUENCY

The **CA BAT** command is used to reset just the Replace Battery lamp and the Minor Alarm relay. This command should be used only to reset the alarms after replacing a failed battery. Resetting the alarms without battery replacement will temporarily clear the alarm. The alarm may reassert when performing the daily battery test at midnight.

When a CA BAT command is issued, the unit responds with a change in status report. This report time stamps when the Replace Battery Alarm was reset.

To clear the Replace Battery Alarm, place the unit in Set Mode and issue the **CA BAT** command as follows:

> TYPE: **CA BAT<ent>**

Example Response:

> TIME= 12:34:14 DATE= 2000-03-24 STATUS CHANGE <TEMP= +36.0>
> COOLING FAN= OFF
> ALARM RELAYS: MAJOR= OFF MINOR= OFF
> ACTIVE ALARMS: NONE

4.3.6   Configuration

The **Configuration** command, **CONF**, provides a listing of all user selectable parameters and their current values. The RS-485 address and baud rate selection is made using the rear panel set up switches. All other parameters are configured using RS-232 or RS-485 command sets.

To retrieve configuration information issue the **CONF** command as shown below:

> Type: **CONF<ent>**
>
> -OR-
>
> **DC<ent>**
>
> Response:
>
> *TIME ZONE= +00:00*
> *1PPS OFFSET= 000000.000 MICROSECONDS*
> *ANT CABLE DELAY= 000000.000 MICROSECONDS*
> *10 MHZ OFFSET= NONE*
> *SIGNATURE CONTROL= OFF*
> *EVENT OUTPUT= ON*
> *RS-485 ADDRESS= 00 BAUD RATE= 9600*
> *ALARM TIME OUT 1= 000 00:01:00*
> *ALARM TIME OUT 2= 000 02:30:00*
> *ALARM TIME OUT 3= 030 00:00:00*

4.3.7 Display Alarm Log

An alarm log entry is made each time there is a change in the alarm relay status. The alarm log can be viewed by using the *Display Alarm Log* command *DAL*. The log contains a time and date stamp of when the alarm status change occurred, alarm relay status and active alarms.

To retrieve the alarm log issue the *DAL* command as shown below:

> Type: **DAL**<ent>

> Example Response:

> *TIME= 12:57:53 DATE= 2000-03-24 STATUS CHANGE <TEMP= +43.0>*
> *COOLING FAN= OFF*
> *ALARM RELAYS: MAJOR= OFF MINOR= ON*
> *ACTIVE ALARMS: MINOR*
> *ANTENNA PROBLEM*
>   *TIME= 12:58:54 DATE= 2000-03-24 STATUS CHANGE <TEMP= +43.5>*
> *COOLING FAN= OFF*
> *ALARM RELAYS: MAJOR= OFF MINOR= ON*
> *ACTIVE ALARMS: MINOR*
> *TRACKING ALARM 1*
> *ANTENNA PROBLEM*
>   *TIME= 13:00:39 DATE= 2000-03-24 STATUS CHANGE <TEMP= +43.5>*
> *COOLING FAN= OFF*
> *ALARM RELAYS: MAJOR= OFF MINOR= OFF*
> ACTIVE ALARMS: NONE

4.3.8 Date

The **DATE** command reads or sets the date of the Master Oscillator. To retrieve the current UTC date, issue the **DATE** command as shown below:

> Type: **DATE <ent>**
>
> *-OR-*
>
> **D<ent>**
>
> Response: *DATE* *=*   *YYYY - MM - DD*
> Where: *YYYY* *=*   Year value, 2005, 2006, etc.
>   *MM* *=*   Month value, 01 to 12, 01= January, 04= April
>   *DD*   *=*   Day of the month, 01 to 31
>   *-*   *=*   Hyphen

To set the date, place the clock in *Set Mode*, then issue the **DATE** command as follows:
> Type: **DATE YYYY-MM-DD <ent>**
> Where: **YYYY-MM-DD** **=** As defined above.

The clock responds with the date message reflecting the date entered.

NOTE: The date cannot be set on receivers tracking GPS satellites. The set date is overwritten with the received date information.

Example: Set the date for May 9, 2005.

> Type: **SM ON <ent>**
> Response: *SET MODE ON*
> Type: **DATE 2005-05-09 <ent>**
> Response: *DATE =2005-05-09*

4.3.9 Display Frequency Measurements

The average 24-hour frequency accuracy can be displayed using the DFM command. The frequency accuracy is determined by subtracting the accumulated phase drift measured at midnight from the previous midnight value. To display the last frequency measurement, issue the DFM command as shown below:

       Type: **DFM <ent>**
       Response: DFM
                     DRIFT = 0003 ns = 3.5E-14 2000-03-24

Adding the "ALL" parameter to the DFM command displays up to 5 days of accuracy measurement:

       Type: **DFM ALL <ent>**

       Response:
              DRIFT = 0024 ns = 2.7E-13 2000-03-22
              DRIFT = 0060 ns = 6.9E-13 2000-03-23
              DRIFT = 0003 ns = 3.5E-14 2000-03-24

If the phase lock process was interrupted, the message "NOT AVAILABLE" will appear in the response.

4.3.10 Display Oscillator Log

The Oscillator Log is a compilation of the last 25 log entries made, or approximately one hour's worth of data. In Test Mode the number of entries is expanded to 1,278, or approximately 3.5 days worth of data. Due to the large number of entries, this command is available with a page parameter *[P].* This allows the log to be output one page at a time with an option to continue or exit after each page.

The Oscillator log can be used to determine overall receiver and oscillator performance. There are 14 different log entries, which may be included in the current oscillator log response. These are listed below:

1. Frequency Measurement: occurs every 1000 seconds and reports frequency error.

2. Automatic Frequency adjustment: when 3 of last 4 frequency measurements agree to within 6 parts in 10^{-10} an adjustment is made. These adjustments only occur during the frequency lock process NOT during phase lock.

3. Manual DAC adjustment: occurs when the Test Mode command DA is used to alter the DAC setting.

4. Reset: occurs when the Test Mode reset command is used to reset the GPS receiver, gates, RAM contents, etc.

5. Start-up: occurs at power on.

6. First satellite found: occurs when the unit detects a satellite for the first time since power on. This entry does not happen after a loss of satellites.

7. 3D-Fix: This occurs when the GPS receiver has a 3D-Fix for a period of 1 minute. When the unit is powered on this message coincides with the turning on of the Tracking GPS light. Throughout operation if the unit loses a 3D-Fix and regains it for 60 consecutive seconds this entry will occur again. Also, in the phase process the unit is in position hold, if the receiver drops to less than 4 qualified satellites it is considered to have lost a 3D-Fix. A log entry will occur when the receiver tracks 4 qualified satellites for 60 consecutive seconds. Once an initial 3D-Fix is acquired these log entries are inconsequential unless all satellites are lost. If a lot of 3D-Fix entries are in the log there is a reception problem.

8. Battery Check: occurs at 00:00:00 every day or when initiated by the Test Mode command TB.

9. Phase Calibration: occurs at initial entrance to the phase process and every 15 hours after.

10. Tight Phase Lock: occurs shortly after Phase Calibration.

11. Phase Center adjust: occurs every 5 hours after Phase Calibration.

12. 24 hour phase measurement: occurs at 00:00:00 every day while in Phase Lock.

13. Phase adjustment:
    - Occur every 6 minutes for OCXO units. (Model 8194B and 8195B)
    - Occur every 20 minutes for Rubidium units. (Model 8197B)

14. Free Run Test: this is a factory test procedure to verify the stability of the oscillator.

15. Rubidium Lock Status: Provides timestamp to any changes in the Rubidium lock status. Not applicable to the Model 8194B and 8195B.

16. Exit From Phase Lock: provides the reason the unit exited from the phase lock process. The possible causes are tracking 0 satellites, CPU alarm, Frequency Error $>1.0 \times 10^{-9}$ or Frequency Offset selected.

To retrieve the ***Oscillator Log*** issue the ***DOL*** command as shown below:

        Type: ***DOL<ent>***

                    or

            DOL P <ent> Paged Output

      Response:

> *SPECTRACOM CORPORATION GPS DISCIPLINED OSCILLATOR*
> *SOFTWARE VERSION 2.14 DATE: JULY 20, 2004 08:21:19*
> *UNIT STARTED 12:47:07 2004-07-26*
> *BAUD GENERATOR 1 = VERSION 2.02*
> *BAUD GENERATOR 2 = VERSION 2.02*
> *BAUD GENERATOR 3 = VERSION 2.02*
> *GPS RECEIVER = 12 CHANNEL M12 VERSION 2*
> *TIME= 11:34:43 DATE= 2004-03-24 PHASE ADJUSTMENT*
> *AVG LEN= 0168 TOTAL= 0001653A*
> *DAC= B201(69%) TEMPERATURE= +37.5*
> *PHASE ERROR= +129.55 nSEC*
> *TIME= 11:36:07 DATE= 2004-03-24 D/A= B201(69%) FREQ ERROR= +1.00E-10*
> *LONG GATE 10MHZ OFFSET= NONE   INTERNAL TEMP= +37.5*
> *FREQ CNT= 10,000,000,001*
> *TIME= 11:40:43 DATE= 2004-03-24 PHASE ADJUSTMENT*
> *AVG LEN= 0168 TOTAL= 00012001*
> *DAC= B1FE(69%) TEMPERATURE= +37.5*
> *PHASE ERROR= +104.44 nSEC*
> *MORE<ANY> QUIT<ESC>*

When in Test Mode, the oscillator log can be sorted for a specific log entry type. Each log entry type is assigned a number, 1 through 16, as shown in the above description. Logs may also be viewed from a specified time and date parameter. The ***DOL*** response may be sorted using the command structure shown below:

      Type: **DOL P TYPE YYYY-MM-DDD HH:MM:SS <ent>**

      Where:

P	=	Paged parameter
Type	=	Log entry type, 1 through 16.
YYYY-MM-DD	=	Start date of sort
HH:MM:SS	=	Start time of sort

4.3.11 Display Tracking Histogram

The ***Display Histogram*** command, ***DH***, provides the tracking histogram. The histogram records the number of satellites tracked each second. At the end of every hour a log entry is created and the counters start again. In *Read Mode* the command responds with the last four entries of the histogram and current histogram in process. While in *Test Mode*, this command responds with the entire histogram log, which provides tracking data collected over the past six days. The page parameter, ***P***, causes the histogram to display one page at a time. In paged mode the user may quit or continue the display after each page is displayed. The tracking histogram is useful in verifying receiver and antenna performance.

> Type: **DH <ent>**
>   **- OR -**
>   **DH P <ent> (paged output)**

The tracking histogram is output in the following format:

```
TIME= HH:MM:SS DATE= YYYY-MM-DD
  0= XXXXX  1= XXXXX   2= XXXXX   3= XXXXX 4= XXXXX
  5= XXXXX  6= XXXXX   7= XXXXX   8= XXXXX 9= XXXXX
 10= XXXXX 11= XXXXX 12= XXXXX  Q= QQQQQ
```

> Where:
> HH:MM:SS   =   UTC time log was created.
> YYYY-MM-DD =   Date log was created.
>   XXXXX   =   Number of seconds the receiver tracked the listed
>   quantity of satellites since the beginning of the hour, 0...3600.
> QQQQQ   =   Number of seconds since the beginning of the hour the GPS signal was qualified, 0…3600.

Example: To view the satellite tracking histogram type the following:

> Type**: DH <ent>**

> Response:

```
TIME= 12:00:00 DATE= 2004-03-24
  0= 00000   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= 03600

TIME= 13:00:00 DATE= 2004-03-24
  0= 00000   1= 00000   2= 00000  3= 00000  4= 00000
  5= 00000   6= 00016   7= 01004  8= 02580  9= 00000
 10= 00000  11= 00000  12= 00000  Q= 03600
```

```
TIME= 14:00:00 DATE= 2004-03-24
  0= 00000   1= 00000   2= 00000  3= 00000  4= 00000
  5= 00000   6= 00000   7= 00067  8= 03430  9= 00103
10= 00000  11= 00000  12= 00000  Q= 03600

TIME= 15:00:00 DATE= 2004-03-24
  0= 00000   1= 00000   2= 00000  3= 00000  4= 00000
  5= 00000   6= 00000   7= 00000  8= 02678  9= 00580
10= 00342  11= 00000  12= 00000  Q= 03600

TIME= 15:01:59  DATE= 2004-03-24
  0= 00000   1= 00000   2= 00000  3= 00000  4= 00000
  5= 00000   6= 00000   7= 00000  8= 00000  9= 00027
10= 00091  11= 00000  12= 00000  Q= 00118

END OF LOG
        END OF LOG
```

4.3.12 Event Output

The Master Oscillator maintains logs on alarm conditions, satellite tracking, oscillator performance and corrections. Entries made to these logs are automatically output to the RS-232 port as they are being generated. The *Event Output* command, *EO*, can enable or disable the automatic output of these entries. **The factory default is disabled**.

To view the Event Output configuration issue the *EO* command as follows:

> Type: *EO<ent>*
> Response: *EVENT OUTPUT ENABLED*
> *- OR -*
> *EVENT OUTPUT DISABLED*

To enable or disable the *Event Output* feature, place the unit in Set Mode and issue the following command:

> Type: *EO ON<ent>*
> Response: *EVENT OUTPUT ENABLED*
> *- OR -*
> Type: *EO OFF<ent>*
> Response: *EVENT OUTPUT DISABLED*

4.3.13 GPS Signal Status

The **GPS Signal Status** command**, GSS**, lists the parameters used in qualifying the received GPS signal. This command is useful in verifying proper antenna placement and receiver performance in an installation.

The **GSS** response provides overall tracking and mode status, as well as a table containing individual satellite date.

Issue the **GPS Signal Status** command as shown below:

        Type: **GSS<ent>**

            -OR-

            DSS<ent>

            -OR-

            SS<ent>

An example response is shown below:

```
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

        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
        11    00    00    000    0000
        12    00    00    000    0000
```

The overall tracking and mode status is presented in the format shown below:

```
TRACKING N SATELLITES
GPS STATE = SSSSS  DOP=##.#
QUALITY = QQQQQ
```

Where:

N	=	Number of satellites currently tracking, 0…8.
SSSSS	=	Fix Mode, 2-D fix, 3-D fix, Pos-Hold, Other
##.#	=	Dilution of Precision, 00.0…99.9. This value indicates the degree of uncertainty in a position fix. When in Position Hold Mode, this value shall be 00.0. In all other Fix Modes, the lower the DOP value, except 00.0, the lower the degree of uncertainty.
QQQQQ	=	Results of GPS qualification, Passed, Failed.

The received quality of the GPS signal is continuously monitored. The criteria used in qualifying the GPS signal is listed below:

- Dilution of Precision, $0 \leq DOP < 10$
- Vehicle Identification Number, VID>1
- Channel Tracking Mode, MODE=08
- Relative Signal Strength, STREN>40
- Position Fix Bit Set, BIT7=1

The GPS signal is qualified whenever four or more satellites meet the above criteria for one minute.

Information on each satellite the receiver is currently tracking is presented in table form. The table columns are described below:

CHAN = Channel Number of the GPS receiver, 01...08
VID =   Vehicle (satellite) Identification Number, 01...37
MODE = Channel Tracking Mode, 01...08.

Where: 00 - Code Search   05 - Message Sync Detect
            01 - Code Acquire   06 - Satellite Time Avail
            02 - AGC Set   07 - Ephemeris Acquire
            03 - Freq Acquire   08 - Avail for Position
            04 - Bit Sync Detect

STREN = Signal strength value relative to SNR, 00...55. The higher the number, the greater the received signal. The minimum acceptable level is 40.
STAT =   Channel status flag. Convert the hexadecimal code word to binary to find the status flags set.

(MSB) Bit 15: Reserved
Bit 14: Reserved
Bit 13: Reserved
Bit 12: Reserved
Bit 11: Used for Time
Bit 10: Differential Corrections Available
Bit 9: Invalid date
Bit 8: Parity Error
Bit 7: Used for Position Fix
Bit 6: Satellite Momentum Alert Flag
Bit 5: Satellite Anti-Spoof Flag Set
Bit 4: Satellite Reported Unhealthy
Bit 3-0: Satellite Accuracy as follows
      (per para 20.3.3.3.1.3 ICG-GPS-200)

0000	(0)	0.00	<URA<=2.40
0001	(1)	2.40	<URA<=3.40
0010	(2)	3.40	<URA<=4.85
0011	(3)	4.85	<URA<=6.85
0100	(4)	6.85	<URA<=9.65
0101	(5)	9.65	<URA<=13.65
0110	(6)	13.65	<URA<=24.00
0111	(7)	24.00	<URA<=48.00
1000	(8)	48.00	<URA<=96.00
1001	(9)	96.00	<URA<=192.00
1010	(10)	192.00	<URA<=384.00
1011	(11)	384.00	<URA<=768.00
1100	(12)	768.00	<URA<=1536.00
1101	(13)	1536.00	<URA<=3072.00
1110	(14)	3072.00	<URA<=6144.00
1111	(15)	6144.00	<URA*

* No accuracy prediction is available

Example:
      HEX code words 08A0 translates to the
      following flags set.
      Bit 11:   Used for Time
      Bit 7:   Used for Position Fix
      Bit 5:   Satellite Anti-Spoof Flag Set

4.3.14 Help

Help provides a list of commonly used commands and command parameters. ***Help*** is available by using the following commands:

Type: **HELP <ent>**
                          - OR -
           ? <ent>
                          - OR -
           H <ent>

Response:

SPECTRACOM CORPORATION GPS DISCIPLINED OSCILLATOR
COMMAND LIST FOLLOWS (SET MODE MUST BE ON TO CHANGE PARAMETERS)
CONF= DISPLAY THE CONFIGURATION <DC>
DAL [P]= DISPLAY ALARM LOG <DP>
DOL [P]= DISPLAY THE PERFORMANCE LOG, DFM= DAILY FREQUENCY MEASUREMENT
DH [P]= DISPLAY THE HISTOGRAM LOG
STAT= DISPLAY STATUS INFORMATION <DS>
GSS= GPS SIGNAL STATUS <DSS> <SS>
DATE [YYYY-MM-DD]= CURRENT DATE <D>
TIME [HH:MM:SS]= CURRENT TIME <T>, U2G= UTC TO GPS OFFSET
TZO [+/-HH:MM]= READ OR SET THE TIME ZONE
LOC [D DD MM SS.sss D DDD MM SS.sss]= CURRENT LOCATION
1PO [XXXXXX.XXX]= 1PPS OFFSET
ACD [XXX.XXX]= ANTENNA CABLE DELAY
1FO [SCn so|TV sc]= 10MHZ OFFSET
ATx [DDD HH:MM:SS]= ALARM TIME OUTS x= 1,2 OR 3
SC [ON|OFF]= SIGNATURE CONTROL
CTC [1-4|TABLE] [CODE]= CTCSS SETUP
BS [26|33] = BAUD SELECTION
CA= CLEAR ALARMS
EO [ON|OFF]= EVENT OUTPUT
SM [ON|OFF]= SET MODE
VER= SOFTWARE VERSION NUMBERS
FOR FURTHER INFORMATION PLEASE CONSULT YOUR MANUAL

4.3.15 Location

The command, *LOC*, is for reading or setting the current location of the receiver. This command displays the current latitude and longitude calculated by the GPS receiver. During initial installation it may speed up the time to first fix if the user inputs an approximate position using this command. The GPS receiver constantly calculates its position based on the satellites it is receiving. Once the unit has acquired its first fix, entering a new position using this command has no effect. Also, after initial installation the receiver will keep its current position in Non-Volatile RAM so that on subsequent power cycles the unit will reach first fix much faster than at initial installation.

To view the current receiver location, issue the *LOC* command as shown below:

> Type: **LOC <ent>**
> Response: CURRENT LOCATION:LATITUDE = N 43 07 00.407 LONGITUDE = W 077 29 13.442

To enter a new location place the clock in *Set Mode* and issue the *LOC* command as follows:

> Type: *LOC [N:S] [DD MM SS.SSS][E:W] [DDD MM SS.SSS] <ent>*

> Where: ***N***   =   North Latitude
> ***S***   =   South Latitude
> ***DD MM SS.SSS***   =   Latitude Degrees:Minutes:Seconds
> ***E***   =   East Longitude
> ***W***   =   West Longitude
> *DD MM SS.SSS*   =   Longitude Degrees:Minutes:Seconds

4.3.16 Signature Control

The command **SC** reads or selects the Signature Control feature. Signature Control removes the front and rear panel 10 MHz outputs whenever a Major Alarm is asserted. The Master Oscillator is factory shipped with Signature Control off.

To read the Signature Control configuration issue the **SC** command as follows:

Type:	**SC <ent>**
Response:	*SIGNATURE CONTROL ON*
	- OR -
	SIGNATURE CONTROL OFF

To configure Signature Control place the unit in Set Mode and issue the **SC** command as shown below:

Type:	**SC ON <ent>**
Response:	*SIGNATURE CONTROL ON*
	- OR -
Type:	**SC OFF <ent>**
Response:	*SIGNATURE CONTROL OFF*

4.3.17 Set Mode

This command is used to read or enter *Set Mode* operation. As a safeguard, the unit must be placed into *Set Mode* whenever operational parameters are entered. The units "times out" of Set Mode and returns to Read Mode operation if no commands are issued for 15 minutes. To read the *Set Mode* status (ON or OFF), issue the **SM** command as shown below:

Type: **SM <ent>**
Response:
      SET MODE ON
        - OR -
      SET MODE OFF

To place the unit into Set Mode:
Type: **SM ON <ent>**
Response: SET MODE ON

To return the unit to Read Mode:
Type: **SM OFF <ent>**
Response: SET MODE OFF

4.3.18 Status Information

The **STAT** command provides the current operational status of the Master Oscillator. The Status Log includes a time and date stamp, oscillator status, GPS tracking status, position, battery status, temperature, cooling fan operation, and alarm status.

To retrieve operational status information issue the **STAT** command as follows:

> Type: **STAT <ent>**
>   *-OR-*
>   **DS <ent>**
> Response:
>   TIME= 14:54:18 DATE= 2000-03-24
>   OSCILLATOR STATUS= LOCKED
>   GPS SIGNAL= QUALIFIED
>   BATTERY STATUS= READY
>   INTERNAL TEMP= +37.5 DEGREES C   COOLING FAN= OFF
>   ALARM RELAYS: MAJOR= OFF   MINOR= OFF
>   ACTIVE ALARMS: NONE

4.3.19 Time

The command, **TIME**, reads or sets the time of the Master Oscillator.

To retrieve the current UTC time (or local time, if TZO has been entered), issue the **TIME** command as shown below:

> Type: **TIME <ent>**
>
> **-OR-**
>
> **T<ent>**
>
> Response:
> **TIME =**   **HH:MM:SS**
> Where: HH   =   UTC hours 00...23
>   MM   =   Minutes 00...59
>   SS   =   Seconds 00...60

To set the time, place the clock in *Set Mode* and issue the **TIME** command as follows:

> Type: **TIME HH:MM:SS <ent>**
> Where: **HH:MM:SS** = As defined above.

The clock responds with a time message reflecting the time entered.

NOTE: Receivers tracking GPS satellites cannot be set using this command. The received time data overwrites the set time.

Example:
Manually set the TIME 13:45:00.
Type: **SM ON <ent>**
Response: SET MODE ON
Type: **TIME 13:45:00 <ent>**
Response: TIME = 13:45:00

4.3.20 Test Mode

This command is used to read or enter *Test Mode* operation. *Test Mode* commands are used in factory testing and field troubleshooting. The unit "times out" of *Test Mode* and returns to *Read Mode* operation if no commands are issued for 15 minutes. Major and Minor alarms are asserted whenever the clock is in *Test Mode*.

To read the *Test Mode* status (ON or OFF), issue the **TM** command as shown below:
Type: **TM <ent>**
Response: TEST MODE ON
                    - OR -
                 TEST MODE OFF

To place the clock into *Test Mode* operation, issue the **TM** command as follows:
Type: **TM ON <ent>**
Response:

NOTE: Placing the unit in Test Mode asserts both the Major and Minor alarms. If the unit is installed in a redundant system the Major Alarm may cause the system to switch-over to Backup.

TIME= 14:57:54 DATE= 2000-03-24 STATUS CHANGE <TEMP= +37.5>
COOLING FAN= OFF
ALARM RELAYS: MAJOR= ON MINOR= ON
ACTIVE ALARMS: MAJOR
IN TEST MODE
   - OR -
TEST MODE= ON

4.3.21 Time Zone Offset

The **TZO** command reads or sets a Time Zone Offset value from UTC. This command allows all time stamps provided by the Master Oscillator to reflect local time.

NOTE: Daylight saving time corrections are not automatically performed. DST/STD time change requires changing the Time Zone Offset value. The factory default value is +00:00 offset from UTC.

Table 4-2 lists the North American Time Zone offset values for periods of Standard time and Daylight Saving time.

TIME ZONE	STANDARD TIME (October -April)	DAYLIGHT SAVING TIME (April - October)
Atlantic	-04:00	-03:00
Eastern	-05:00	-04:00
Central	-06:00	-05:00
Mountain	-07:00	-06:00
Pacific	-08:00	-07:00

Table 4-2 Common Offset Values

To read the current **Time Zone Offset** value, issue the **TZO** command as shown below:

        Type: **TZO<ent>**
    Response: T*ime Zone = SHH:MM*
       Where: *S = + or - offset from UTC*
                 HH = Hours 00 to 23
                 := Colon separator
                 MM = Minutes 00 to 59

A Time Zone Offset may be entered by placing the unit in set mode and issuing the TZO command as follows:

        Type: **TZO ±HH:MM<ent>**
       Where: ±HH:MM = As described above

A response reflecting the selected offset value is output.

4.3.22 UTC To GPS Time

The **U2G** command displays the offset in seconds between UTC and GPS times. This offset is due to leap seconds that have occurred since the GPS system was launched.

To view the UTC to GPS offset, issue the **U2G** command as shown below:

Type: **U2G <ent>**
Response: *UTC TO GPS OFFSET= +013 SECONDS*

4.3.23 Version

The **VER** command provides the software version levels of the main and baud generator programs. Included in the response message is the time and date the unit was turned on and GPS receiver type. To retrieve version information, issue the **VER** command as shown below:

Type: **VER <ent>**
Response:

SPECTRACOM CORPORATION GPS DISCIPLINED OSCILLATOR
SOFTWARE VERSION 3.01 DATE: OCTOBER 21, 2004 11:51:47
UNIT STARTED 12:47:07 2004-11-21
BAUD GENERATOR 1 = VERSION 2.02
BAUD GENERATOR 2 = VERSION 2.02
BAUD GENERATOR 3 = VERSION 2.02
GPS RECEIVER = 12 CHANNEL M12 VERSION 2

4.3.24 Frequency Offset

The **1FO** command allows the user to read or set the 10 MHz offset. The simulcast offsets are divided into two groups; Simulcast 1 (SC1) and Simulcast 2 (SC2). Simulcast 1 has offset steps sized for UHF as listed in Table 1-3. Simulcast 2 has offset steps sized for VHF Hi as listed in Table 1-4. Within each group exist four positive offset steps and the complimentary negative offset steps. The default offset value is **none**.

Offset Name	Offset Δf_s	Output Frequency	Offset @ 450 MHz
SC1 + 1	+1.1E-9	10,000,000.011 Hz	+0.5 Hz
SC1 + 2	+2.2E-9	10,000,000.022 Hz	+1.0 Hz
SC1 + 3	+3.3E-9	10,000,000.033 Hz	+1.5 Hz
SC1 + 4	+4.4E-9	10,000,000.044 Hz	+2.0 Hz
SC1 - 1	-1.1E-9	9,999,999.989 Hz	-0.5 Hz
SC1 - 2	-2.2E-9	9,999,999.978 Hz	-1.0 Hz
SC1 - 3	-3.3E-9	9,999,999.967 Hz	-1.5 Hz
SC1 - 4	-4.4E-9	9,999,999.956 Hz	-2.0 Hz

Table 4-3 UHF Simulcast Offsets SC1

Offset Name	Offset Δf_s	Output Frequency	Offset @ 150 MHz
SC2 + 1	+2.0E-8	10,000,000.200 Hz	+3.0 Hz
SC2 + 2	+3.4E-8	10,000,000.340 Hz	+5.0 Hz
SC2 + 3	+4.7E-8	10,000,000.470 Hz	+7.0 Hz
SC2 + 4	+6.0E-8	10,000,000.600 Hz	+9.0 Hz
SC2 - 1	-2.0E-8	9,999,999.800 Hz	-3.0 Hz
SC2 - 2	-3.4E-8	9,999,999.660 Hz	-5.0 Hz
SC2 - 3	-4.7E-8	9,999,999.530 Hz	-7.0 Hz
SC2 - 4	-6.0E-8	9,999,999.400 Hz	-9.0 Hz

Table 4-4 VHF HI Simulcast Offsets SC2

The frequency offset at the carrier frequency is determined by the formula:

$$\Delta f_C = F_C \times \Delta f_S$$

Where: Δf_C = carrier offset

F_C = carrier frequency

Δf_S = offset of 10 MHz standard (from the tables)

To read the 10 MHz offset value issue the *1FO* command as shown below:

Type: **1FO <ent>**
Response: 10MHZ OFFSET = NONE

To select a 10 MHz simulcast offset, place the unit in Set mode and issue the 1FO command as follows:

Type: **1FO SCn so<ent>**
Where: n = Simulcast Offset Group: 1 or 2.
s = Sign, positive or negative: + or -.
o = Offset #: 1,2,3 or 4.

To remove a 10 MHz simulcast offset and return the unit to no offset operation, place the unit in Set mode and issue the 1FO command as follows:

Type: **1FO 0<ent>**

Examples:

Configure the Master Oscillator 10 MHz outputs for a VHF 150 MHz simulcast offset of –7 Hz. From Table 4-4 this offset value is equivalent to SC2 –3.

To enter in the 10 MHz offset value place the unit in Set Mode to allow configuration changes then issue the 1FO command as shown below:

Type: ***SM ON <ent>***
Response: *SET MODE ON*
Type: ***1FO SC2 -3 <ent>***

Response:
        The unit responds with a message stating that Phase Lock
        Process has been halted and a frequency offset has been specified.

4.3.25 1PPS Offset

The relative phase of the recovered GPS 1PPS output can be offset using the **1PO** command. The offset range is 0 - 1 second in .001 microsecond steps. In addition, the Data Clock and Data Sync output signals that are leading edge synchronized to the GPS 1PPS will follow the offset value. The Data Clock 1PPS and 9.6 kHz outputs are leading edge synchronized. The Data Sync leading edge synchronized outputs are $17\ ^2/_3$ Hz and $33\ ^1/_3$ Hz or CTCSS outputs #1 and #2 if Option 14 is present.

To read the 1PPS offset value issue the **1PO** command as shown below:

      Type: **1PO <ent>**
      Response: *1PPS Offset = 000000.000 Microseconds*

To select a 1PPS offset, place the unit in Set mode and issue the **1PO** command as follows:

      Type: **1PO XXXXXX.XXX <ent>**
      Where: *XXXXXX.XXX = 000000.000 TO 999999.999 microseconds*

NOTE: It is not necessary to fill every digit space when entering an offset value. The offset value can range from 1 to 8 digits long with up to 3 decimal places of precision. The maximum offset value is 999999.999 microseconds.

4.4 RS-485 Command Structure

The commands described here must conform to a specific command protocol. The protocol is shown in Table 4-5.

FIELD	SIZE	DESCRIPTION
Start Word	2 Bytes	Unique characters <#> <$> used to synchronize with data stream
Source Address	1 Byte	0-31= unit address 32-254= reserved 255= broadcast
Destination Address	1 Byte	0-31= unit address 32-254=reserved 255= broadcast
Message Length	2 Bytes	Variable length from 1 to 502 bytes
Message	1 to 502 Bytes	4 character commands plus parameters
Check Word	2 Bytes	Running sum including all bytes after the start word through the last message byte.
Stop Word	2 Bytes	Unique characters (<cr><lf>) used to synchronize with data stream

Table 4-5 RS-485 Command Protocol

All inputs via the RS-485 port must follow this format, or they will be ignored. The descriptions that follow are for the Message field of the commands. When the first character of a command is 'w' this indicates the controller is writing information to the unit. If the first character is 'r' the controller is reading information. The RS-485 Com port operates at 9600 baud, character structure is 1 start, 8 data, 1 stop, and no parity.

4.5 RS-485 Command Descriptions

Table 4-6 provides an alphabetical listing of the **RS-485 Command** set.

	DESCRIPTION	READ	WRITE	SECTION
acd	Antenna Cable Delay	√	√	4.5.1
aeh	Alarm Event History	√		4.5.2
ast	Alarm Status Display	√		4.5.3
at1	Alarm Time Out 1	√	√	4.5.4
at2	Alarm Time Out 2	√	√	4.5.4
at3	Alarm Time Out 3	√	√	4.5.4
cah	Clear Alarm History		√	4.5.5
gcs	GPS Signal Strength	√		4.5.6
loc	Full location	√	√	4.5.7
rrsn	Signal Selection	√		4.5.8
sts	Short Status Display	√		4.5.9
tad	Time and Date	√		4.5.10
tzo	Time Zone		√	4.5.11
who	Vendor, Version	√		4.5.12
1fo	Ten MHz Offset	√	√	4.5.13
1po	One PPS Offset	√	√	4.5.14

Table 4-6 Alphabetical List of RS-485 Commands

4.5.1 Antenna Cable Delay

This command is to read or set the antenna cable delay. Although this value is generally negligible, the 1PPS timing can be affected by the antenna cable delay. The default is 0. The maximum delay value is 000999.999 microseconds.

wacdXXXXXX.XXX
Where XXXXXX.XXX is a number in microseconds.
wacdXXXXXX.XXX
racd
racdXXXXXX.XXX

Cable delay can be calculated using the formula:

$$D = \frac{L \times C}{V}$$

Where:
- D = Cable delay in nanoseconds.
- L = Cable length in feet.
- C = Constant derived from velocity of light; 1.016.
- V = Nominal velocity of propagation expressed as a decimal, i.e. 66% = .66
  Value is provided by cable manufacturer.

4.5.2 Alarm Event History

This command is to read **Alarm Events**. The unit will respond with the most recent alarm event not yet returned by this command. When all events have been read, the most recent event is returned with the valid entry indicator set to 'n' (event already read).

raeh
raeh VHHMMSSsHHMMDDMMYYYYtNTFOCsssAOGBNL where V = y or n indicating if this entry is a valid entry, HHMMSS= time of event, sHHMM= time zone offset of the unit, DDMMYYY= date of event, t(y/n) = 10 MHz out of specification (AT3), N(y/n) = 9.6 kHz out of spec (AT2), T(y/n)= in test mode, F(y/n)= in Free Run, O(y/n)= Oscillator Failure (Frequency Alarm), C(y/n)= CPU alarm, sss= three major alarm spares, A(y/n)= Adjust Oscillator, O(y/n)= Output fault, G(y/n)= GPS out of spec (AT1), B(y/n)= replace battery, N(y/n)= antenna problem, L(y/n)= low GPS quality.

4.5.3 Alarm Status

This command read **Alarm Status**. This is a short command designed to let the controller know if there are any alarms present.

rast
rastC where C = y or n indicating if there are alarm conditions present.

4.5.4 Alarm Timeouts

This command is to read or set the three **Alarm Time outs** individually. Each time-out controls the status of an alarm relay. If the GPS receiver stops tracking satellites the timers start counting down. If the timer reaches 0 before the receiver begins to track satellites again, the alarm relay is activated. In addition, if Alarm Time out 1 occurs, this is a minor alarm. Alarm Time out 2 and Alarm Time out 3 are Major alarms. Defaults are: AT1 = 1 minute, AT2 = 2½ hours, AT3 = 30 days.

watXDDDHHMMSS where X = 1,2, or 3 indicating which time out.
watXDDDHHMMSS
ratX
ratXDDDHHMMSS

4.5.5 Clear Alarm History

This command is to **Clear the Alarm History**. This command accompanies the **raeh** command and is used to "erase" the alarm history. After this is issued, subsequent use of the **raeh** command will respond with the valid entry character set to 'n', until a new alarm event occurs.

wcah
wcah

4.5.6 GPS Signal Status

The GPS Signal Status Command, *rgcs*, lists the parameters used in qualifying the received GPS signal. This command can be used to verify proper antenna placement and receiver performance. The total message length is 118 bytes.

rgcsQSDD.DIISSSCCCCIISSSCCCCIISSSCCCCIISSSCCCCIISSSCCCCIISSSCCCCI
ISSSCCCCIISSSCCCCIISSSCCCCIISSSCCCCIISSSCCCCIISSSCCCC

Where:
Q	= qualified (y/n)
S	= Receiver status(2 – 2D fix; 3 – 3D fix; a – Acquired; o – others)
DD.D	= Dilution of position, Indicates the degree of uncertainty in a position fix. In Position Hold Mode, DOP=
II	= Satellite ID number
SSS	= Signal strength value relative to SNR, 000…055. The higher the number, the greater the received signal. The minimum acceptable signal level is 40.
CCCC	= Channel status, flag, 0000 to ffff.

Convert the hexadecimal code word to binary to find the status flags set.
(MSB) Bit 15: Reserved
Bit 14: Reserved
Bit 13: Reserved
Bit 12: Reserved
Bit 11: Used for Time
Bit 10: Differential Corrections Available
Bit 9:   Invalid date
Bit 8:   Parity Error
Bit 7:   Used for Position Fix
Bit 6:   Satellite Momentum Alert Flag
Bit 5:   Satellite Anti-Spoof Flag Set
Bit 4:   Satellite Reported Unhealthy
Bit 3-0: Satellite Accuracy as follows
(per para 20.3.3.3.1.3 ICG-GPS-200)

0000	(0)	0.00	<URA<=2.40
0001	(1)	2.40	<URA<=3.40
0010	(2)	3.40	<URA<=4.85
0011	(3)	4.85	<URA<=6.85
0100	(4)	6.85	<URA<=9.65
0101	(5)	9.65	<URA<=13.65
0110	(6)	13.65	<URA<=24.00
0111	(7)	24.00	<URA<=48.00
1000	(8)	48.00	<URA<=96.00
1001	(9)	96.00	<URA<=192.00
1010	(10)	192.00	<URA<=384.00
1011	(11)	384.00	<URA<=768.00
1100	(12)	768.00	<URA<=1536.00
1101	(13)	1536.00	<URA<=3072.00
1110	(14)	3072.00	<URA<=6144.00
1111	(15)	6144.00	<URA*

* No accuracy prediction is available

Example: HEX code word 08A0 translates to the following flags set:
Bit 11:   Used for Time
Bit 7:   Used for Position Fix
Bit 5:   Satellite Anti-Spoof Flag Set

Q =   Qualified GPS: YES=Y, NO=N.

The received quality of the GPS signal is continuously monitored. The criteria used in qualifying the GPS signal is listed below:

- Dilution of Precision, 0 ≤DOP<10
- Vehicle Identification Number, VID>1
- Channel Tracking Mode, MODE=08
- Relative Signal Strength, STREN>40
- Position Fix Bit Set, BIT7=1

The GPS signal is qualified whenever four (4) or more satellites meet the above criteria for one (1) minute.

4.5.7 Location

This command is to read or set the *Location*. The GPS receiver will automatically find its correct position, but the time to first fix can be shortened by entering an approximate position. The GPS receiver constantly calculates its position based on the satellites it is receiving. Once the unit has acquired its first fix, entering a new position using this command has no effect. Also, after initial installation the receiver will keep its current position in Non-Volatile RAM so that on subsequent power cycles the unit will reach first fix much faster than at initial installation.

wlocLDDMMSSMMMLDDDMMSSMMM
wlocLDDMMSSMMMLDDDMMSSMMM

Where L= latitude direction N or S, DD= degrees 00 to 90, MM= minutes, SS= seconds, MMM= milliseconds, L= longitude direction E or W, DDD= degrees 000 to 180, MM= minutes, SS= seconds, MMM= milliseconds.

rloc
rlocLDDMMSSMMMLDDDMMSSMMMHHHHHP
First 21 characters same as wloc, plus HHHHHP where HHHHH= height in meters, and P= Y or N for position Hold yes or no.

4.5.8 Signal Selection

This command reads the MUX timing outputs available on the rear panel.

Rrsn
rrsn # where # =   1 for 1.544 MHz outputs.
                              2 for 2.048 MHz outputs.
                              3 for a 1.544 MHz and a 2.048 MHz output.
                              0 for all other configurations.

4.5.9 Short Status

This command gives a **Short Status** string.   The controller can read this status information for alarm conditions.   This command would generally be issued after the controller has polled the unit using the Alarm Status command.

rsts
rstsSDDDHHMMSSDDDHHMMSSDDDHHMMSSSDD.D32TFFCsssAO1BNL where S = number of satellites (If tracking satellite is greater than 8, it will be truncated to 8), DDD= days remaining T1, HHMMSS= time remaining T1, DDD= days remaining T3, HHMMSS= time remaining T3, DDD= days remaining T2, HHMMSS= time remaining T2, SDD.D= internal temperature, 3=y or n for T3 timed out, 2(y/n)= T2 timed out, T(y/n)= test mode, F(y/n)= free run, F(y/n)= Frequency alarm (oscillator failure), C(y/n)= cpu alarm, sss = three major alarm spares, A(y/n)= oscillator adjust, O(y/n)= output fault, 1(y/n)=T1 time out, B(y/n)= replace battery, N(y/n)= antenna problem, L(y/n)= low GPS quality.

4.5.10 Time And Date

This command is to read the **Date and Time**.   The leading character of the RS-485 protocol message is the "on-time" point.

rtad
rtadHHMMSSsHHMMDDMMYYYY where HH = hours 00 to 23, MM = minutes, SS = seconds, s = sign of Time Zone offset, HHMM = hours and minutes of Time Zone offset, DD = days, MM = months, and YYYY = year.

4.5.11 Time Zone Offset

This command allows the user to set the unit's clock to local time. All time stamps will reflect the time zone offset. The default setting is 0000, which is UTC time.

wtzoSHHMM
wtzoSHHMM where S= + or -, and HH = 00 to 23, and MM=00 to 59

NOTE: The GPS time system does not correct for Daylight Savings Time. If the user wishes to have the time reflect DST they will need to change the time zone offset twice per year. Table 4-7 lists the North American Time Zone offset values for periods of Standard time and Daylight Saving time.

TIME ZONE	STANDARD TIME (October -April)	DAYLIGHT SAVING TIME (April - October)
Atlantic	-0400	-0300
Eastern	-0500	-0400
Central	-0600	-0500
Mountain	-0700	-0600
Pacific	-0800	-0700

Table 4-7 Common Offset Values

4.5.12 Who – Model Identification

This command is to inform the controller of the vendor and software version.

rwho
rwhoSPECTRACOMMODEL8195BVX.XX   If it is a 8195B unit
Or
rwhoSPECTRACOMMODEL8197BVX.XX   If it is a 8197B unit
Where X.XX is software version

4.5.13 10MHz Offset

This command allows the user to read or set the *10MHz Offset*.

The default is no offset selected. Table 4-8 and 4-9 lists the 10 MHz offset selections available when using the RS-485 COMM port.   The same offset values are available through the RS-232 COMM port command *1FO*.

W1foSX where S = + or – and X = 1 to 4 for the UHF frequency offsets
W1foSX
W2foSX where S = + or – and X = 1 to 4 for the VHD frequency offsets
w2foSX
R1FO
r1foSX or r2foSX depending on which offset is currently being applied.

If **no frequency offset** is being applied, *r1fo+0* will be returned.

If a frequency offset other than the ones in the UHF and VHF tables below is applied, **r1foEE** will be returned.

Offset Name	Offset Δf_s	Output Frequency	Offset @ 450 MHz
1fo+1	+1.1E-9	10,000,000.011 Hz	+0.5 Hz
1fo+2	+2.2E-9	10,000,000.022 Hz	+1.0 Hz
1fo+3	+3.3E-9	10,000,000.033 Hz	+1.5 Hz
1fo+4	+4.4E-9	10,000,000.044 Hz	+2.0 Hz
1fo-1	-1.1E-9	9,999,999.989 Hz	-0.5 Hz
1fo-2	-2.2E-9	9,999,999.978 Hz	-1.0 Hz
1fo-3	-3.3E-9	9,999,999.967 Hz	-1.5 Hz
1fo-4	-4.4E-9	9,999,999.956 Hz	-2.0 Hz

Table 4-8 UHF Simulcast Offsets

Offset Name	Offset Δf_s	Output Frequency	Offset @ 150 MHz
2fo+1	+2.0E-8	10,000,000.200 Hz	+3.0 Hz
2fo+2	+3.4E-8	10,000,000.340 Hz	+5.0 Hz
2fo+3	+4.7E-8	10,000,000.470 Hz	+7.0 Hz
2fo+4	+6.0E-8	10,000,000.600 Hz	+9.0 Hz
2fo-1	-2.0E-8	9,999,999.800 Hz	-3.0 Hz
2fo-2	-3.4E-8	9,999,999.660 Hz	-5.0 Hz
2fo-3	-4.7E-8	9,999,999.530 Hz	-7.0 Hz
2fo-4	-6.0E-8	9,999,999.400 Hz	-9.0 Hz

Table 4-9 VHF Simulcast Offsets

4.5.14 1PPS Offset

The relative phase of the recovered GPS 1PPS output can be offset using the **w1po(write 1po)** and **r1po(read 1po)** command. The offset range is 0 - 1 second in 0.1 microsecond steps. In addition, the Data Clock and Data Sync output signals that are leading edge synchronized to the GPS 1PPS will follow the offset value. The Data Clock 1PPS and 9.6 kHz outputs are leading edge synchronized. The Data Sync leading edge synchronized outputs are 17 $^2/_3$ Hz and 33 $^1/_3$ Hz or CTCSS outputs #1 and #2 if Option 14 is present.

The 10MHz outputs are not affected by this offset. The default offset value is 0.

w1poXXXXXX.X where XXXXXX.X is a number in microseconds.
w1poXXXXXX.X
r1po
r1poXXXXXX.X

5 Options And Accessories

5.1 Introduction

This section describes the following options and accessories that are available for the Master Oscillator.

- Internal Battery Backup – Option 02
- Internal Distribution Amplifier – Option 03
  - Distribution Accessories:
    - Model 8140T Line Taps
    - Model 8140TA Line Extender Amplifier
    - Model 8140VT VersaTap™ Frequency Synthesizer
    - Model 8140MT MultiTap™
- 12.8–MHz Outputs – Option 06
- 5–MHz Outputs – Option 07
- Slides for Rack Mount – Option 11 (refer to section 5.7.6 for more information)
- CTCSS outputs one and two – Option 14
  - CTCSS Accessories:
    - Model 1118 Tone Generator
- 1PPS on the third and fourth rear panel frequency outputs – Option 16
- CTCSS outputs three and four – Option 17
- DS1 Framed All Ones – SP294
- E1 Framed All Ones – SP295

Power options are described in Section 3.3.10 of this manual.

The input power options are:

Option 52	±12 VDC input.
Option 53	±24 VDC input.
Option 54	±48 VDC input.

5.2 Option 02 - Internal Battery Backup

Option 02 provides the Master Oscillator with an internal battery backup power source. This option is not available on the Model 8197B product line. The battery powers the 10 MHz OCXO and GPS receiver module whenever AC power fails or is turned off. The primary benefit of the battery option is that the Data Clock and Data Sync timing outputs are available within 90 seconds of power-on. This is possible because the GPS receiver continues to track satellites and maintaining power to the OCXO eliminates warm up and retrace issues when AC power is restored. The battery pack typically provides 18 hours of backup operation.

The battery is continuously float-charged whenever AC power is present. Maximum recharge period is 20 hours. The battery is tested daily to verify battery operation. At midnight "receiver time" the microprocessor enables the battery pack to power the oscillator and GPS receiver for approximately four minutes. The battery test is

transparent to unit operation. If the battery falls below the minimum voltage set point, the test is discontinued and the Replace Battery alarm is asserted. Refer to Section 6, Service Information, for battery replacement instructions.

A battery disconnect switch is provided on the rear panel to prevent battery discharge when shipping or storing the unit. To disconnect the battery, first remove the unit from AC power and then depress the recessed switch labeled BATT DISC.

NOTE: Failing to disable a battery prior to shipment or storage may result in reduced capacity and shortened battery life.

5.2.1 Frequency Lock Recovery

The battery backup powers only the 10 MHz OCXO and GPS receiver board during AC power failures. Outputs are not provided under backup operation. A Frequency Alarm is asserted when AC power is restored. Battery backup shortens the recovery period to 2 hours when AC power returns by eliminating oscillator warm up and GPS reacquisition delay. Without backup power, a 3 to 4 hour recovery period is required.

The Battery Backup option permits even faster recovery when the following conditions are met:
- The unit achieved Oscillator Lock before losing AC power.
- The power outage was less than 2 hours.
- The internal ambient temperature did not change by more than 10° C.

When AC power is restored the Frequency and AT alarms are turned off after one minute. If the unit does not have any 10MHz frequency offsets entered, it will begin the phase locking process. The Oscillator Lock lamp will turn on in approximately one hour.

If the unit is configured with 10 MHz frequency offsets it does not require phase locking. Therefore the Oscillator Lock lamp is turned on immediately.

5.2.2 Battery Lamps

Units equipped with Option 02 include front panel indicators to communicate battery status.

***Ready Lamp*:** This green lamp is on when the battery is OK and fully charged. This lamp is off while the battery is being tested.

***Charging Lamp*:** This yellow lamp is on when the battery is charging. This lamp is off while the battery is being tested.

***Replace Lamp*:** This red lamp turns on and a Minor Alarm asserted when the battery has remained in charge mode for two days or has failed the daily test. The battery must be replaced, refer to the Service Information section of this manual. This is the only latched alarm in the unit. This light can be cleared after changing the battery by issuing

the **CA BAT** command or if the battery test on the second midnight after replacement is successful.

5.2.3 Clear Battery Alarm

The **Clear Battery Alarm** command*, CA BAT,* resets the Replace Battery lamp and the Minor Alarm relay. This command should be used only to reset the alarms after replacing a failed battery. Resetting the alarms without battery replacement will temporarily clear the alarm. The alarm may reassert when performing the daily battery test at midnight. When a **CA BAT** command is issued, the unit responds with a change in status report. This report time stamps when the Replace Battery Alarm was reset.

To clear the Replace Battery Alarm, place the unit in Set Mode and issue the **CA BAT** command as follows:

> Type: **CA BAT<ent>**
> Response:
> > TIME= 12:34:14 DATE= 2000-03-24 STATUS CHANGE <TEMP= +36.0>
> > COOLING FAN= OFF
> > ALARM RELAYS: MAJOR= OFF MINOR= OFF
> > ACTIVE ALARMS: NONE

5.2.4 Option 02 Specifications

Battery:	12V, 7 A/H, sealed lead acid.
Backup Operation:	12 hours minimum, 18 hours typical.
Recovery Time:	Power outage <2 hours and <10° C change with 3-D fix, Frequency Alarm clears in 1 minute, Oscillator Lock within 1 hour. Recovery time for all other conditions is 2 hours.
Recharge Rate:	20 hours maximum from a complete discharge.
Charge Current:	500 milliamps maximum, 10 milliamps float-charge.
Battery Life:	4 years typical.

5.3 Option 03 Built-in Distribution Amplifier

Option 03 allows counters and synthesizers throughout a facility to use the GPS disciplined 10 MHz outputs from a Master Oscillator as a common time base. Allowing equipment to share an accurate common time base eliminates the need to buy expensive, high stability time bases for each instrument or remove them from service for periodic calibration.

Units equipped with Option 03 may drive up to 25 remote stations. Multiple outputs are provided on the rear panel so that signals may be sent in several different directions. A Line Tap at each remote station receives DC power and the 10 MHz from the main coaxial trunk line cable. The signal is buffered then divided to the frequency needed at that station. After filtering, the signal is available at the Line Tap output. New stations are easily added to the system by inserting additional Line Taps.

5.3.1 System Components

A frequency distribution system may use Model 8140T Line Taps, Model 8140VT VersaTaps, Model 8140TA Line Extender Amplifiers or Model 8140MT MultiTaps. The following paragraphs describe each of these units. Contact Spectracom Sales Department at 585-321-5800, for additional information on these products.

5.3.1.1   Model 8140T Line Taps.

These devices, powered by DC on the coaxial cable, are attached to the coaxial distribution network and provide an output frequency of 1 MHz, 5 MHz, or 10 MHz.

Input: Buffered high input impedance causes negligible mismatch on main trunk line distribution cable. Accepts signal levels provided by the base station equipped with Option 03.

- **Output Level:** 600 mV rms sinewave into 50 ohms.
- **Output Frequencies:** 10, 5.0, or 1.0 MHz. Specify frequency for each Line Tap ordered.
- **Harmonic Distortion of Output:** -40 dB.
- **Cross talk (Isolation):** *80 dB minimum.*
- **Output Phase Noise:** Typically less than -130 dB/Hz 1 kHz from carrier for 10 MHz input to base station amplifier.
- **Line Tap Size:** 5.25 L x 2.63 W x 1.71 H inches. (133 L x 67 W x 43 H mm). Mounting hole pattern: 4.75 x 1.75 inches (121 x 44 mm).

5.3.1.2   Model 8140VT VersaTap Frequency Synthesizer

The VersaTap is a single-frequency synthesizer whose output is factory-set to any frequency between 1 kHz and 16 MHz in 1 kHz increments and up to 20 MHz in 2 kHz increments. Some special frequencies can be furnished, such as the 3.5795454...MHz TV color sub-carrier. Exact frequencies must be specified at time of order.

- **Input:** Buffered high impedance input. Accepts 10.0 MHz with signal level between 100 millivolts and 5.5 V p-p on a DC voltage of 7 to 12 VDC. The DC current requirement is 110 milliamps at +12 VDC.

- **Output A:** A sine wave of 600 mV rms at the specified frequency into a 50-ohm load for frequencies greater than 60 kHz. A TTL output for frequencies below 60 kHz with a source impedance of 50 ohms (SN74S140) driver.

- **Output B:** A TTL output at the specified frequency with a source impedance of 50 ohms (SN75S140 driver). If the internal jumper, W6, is moved to location W5, Output B is HIGH when the VersaTap™ is phase locked to the incoming reference and LOW when it is unlocked.

- **Lock LED:** The LED will light when the VersaTap™ is locked to the incoming reference. The LED will blink if the DC input is low, which may cause the VersaTap™ to malfunction. The LED will be unlit when the VersaTap™ is not locked to the incoming reference.

- **VersaTap™ Size:** 8.3 L x 4.2 W x 1.7 H inches. (211 L x 107 W x 43 H mm). Mounting hole pattern 8.88 x 2.75 inches (225.4 x 69.9 mm).

5.3.1.3   Model 8140TA Line Extender Amplifier

The Line Extender Amplifier must be used to boost the output signal when the coaxial distribution network is more than 1500 feet (457 m) long. The Line Extender will drive an additional 1500-feet (457 m) of RG58 coaxial cable with Model 8140 Line Taps installed along its length.

Two DC-isolated 50-ohm terminators must be used: one at the input tee connector of the Line Extender Amplifier and one at the far end of the cable connected to the output of the Line Extender Amplifier.
See the "Typical Interconnection Diagram" at the end of this section for an approved method of interconnection.

5.3.1.4   Model 8140MT MultiTap

The Spectracom Model 8140MT MultiTap is a programmable frequency divider/buffer. Three outputs can be configured to the same frequency or set independently. When used as part of your Spectracom Distribution System it decreases the cost per output and allows future modifications as requirements change.

- **Frequency Outputs:** Three square wave outputs per MultiTap. 1.5V p-p into 50 ohms. Once a group is chosen, any divisor in a group may be individually selected.

Output divisors:

Group A	B	C	D
1	1	5	5
2	2	10	10
10	20	50	100
50	100	250	500
250	500	1250	2500

For a 10 MHz input, the available outputs in MHz are:

Group A	B	C	D
10.0	10.0	2.0	2.0
5.0	5.0	1.0	1.0
1.0	0.5	0.2	0.1
0.2	0.1	0.04	0.02
0.04	0.02	0.008	0.004

- **Power Requirements:** When driven by a Distribution Amplifier, the DC load equals three Line Taps. Option 40, which is required for stand-alone operation, reduces the distribution load to one Line Tap equivalent, and is required whenever output frequencies are below 100 kHz. Maximum current is less than 150 mA.

- **MultiTap size:**   5.25L x 2.63W x 1.71H inches.
  (133L x 67W x 43H mm)
  Mounting hole pattern 4.75 x 1.75 inches. (121 x 44 mm)

5.3.2 Design of Distribution Networks

This section provides guidelines for using the Option 03 distribution outputs. In planning a system installation follow the guidelines listed below:

1. A maximum of 25 Line Tap loads may be driven from one base station. More than 25 loads are not permitted due to power supply limitations and impedance matching. Table 5-1, LINE TAP LOADS, lists the equivalent number of loads and current each distribution device consumes. The receiver may provide up to 1.2 Amps total to the distribution network.

DEVICE	LOADS	CURRENT (mA)
8140T All Versions	1	45
8140TA	1	45
8140VT Standard	3	150
8140VT w/Opt 45	5	250
8140VT w/Opt 48	4	200
8140VT w/Opt 62	4	200
8140MT	3	150

Table 5-1 Line Tap Loads

If more than 25 Line Tap loads are required you may:

Add a Model 8140 Frequency Distribution Amplifier. The Model 8140 contains an internal power supply and will feed an additional 25 Line Tap loads. A Line Tap is required (typically 10 MHz) to provide the input frequency source to the Model 8140. This "Daisy Chaining" may be continued indefinitely.

2. Voltage drops and signal attenuation limit the longest trunk line using RG-58 cable to1500 feet (457 m).

Figure 5-1, LINE TAP NUMBER AND DISTANCE CHART, is used to calculate the number of Line Tap loads that may be used at various distances from the base station.

For example, if 25 Line Taps are used, their average distance from the amplifier is limited to 750 feet (228 m), using RG-58. Up to 12 Line Taps may be placed at 1500 feet (457 m) on any one trunk line.

If longer runs are required, you may:

   A. Locate the unit in the geographical center of the installation, running distribution lines in both directions and achieving a coverage of 3000 linear feet (914 m).
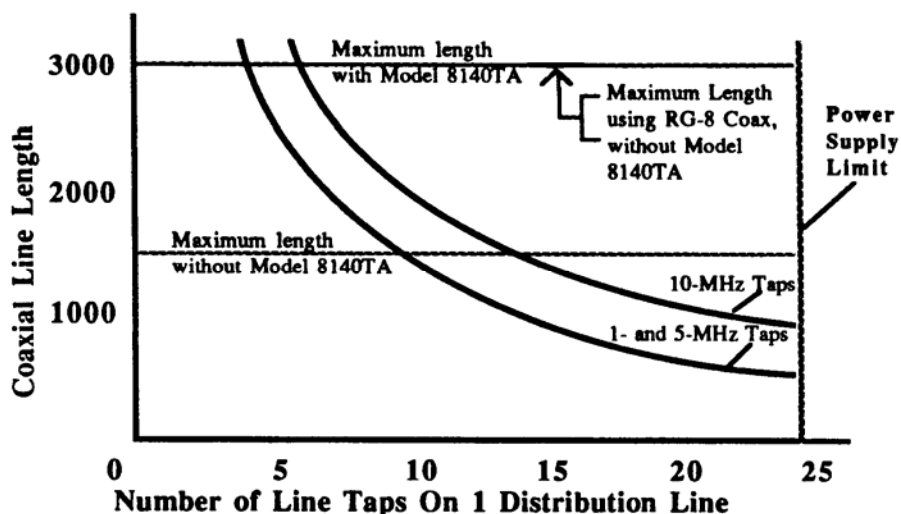
Figure 5-1 Line Tap Number and Distance Chart

B. Use a Model 8140TA Line Extender Amplifier at 1500 feet, allowing a further 1500-foot (457 m) extension of the distribution line. The Model 8140TA counts as one Line Tap towards the total number allowed. Use a DC-isolated 50-ohm terminator, part number 004490, at the input tee connector and at the end of the extended line section as shown in the "Typical Interconnection Diagram", Figure 5-2.

C. Use a Model 8140 Frequency Distribution Amplifier.

3. Each distribution line must be continuous from the base station to the DC isolated 50-ohm load that must be used at the far end. Line taps are inserted along the distribution line by using the supplied input tee connector. No branching or "Y" configurations may be used as this causes impedance mismatch on the line. Anything other than a 50-ohm line impedance may cause reflections, which can cancel the output waveform at the receiver triggering an output fault alarm. Refer to the Figure 5-2, TYPICAL INTERCONNECTION DIAGRAM, for an approved method of interconnection.

4. Four DC-isolated 50-ohm loads are furnished with each unit equipped with Option 03. They may be found in the ancillary kit that is packed with each unit when it leaves the factory. If any of these loads are lost, replacements may be purchased from Spectracom. The part number to order is 8140-0000-1000. Terminators may be placed on any unused distribution output connector to prevent loss.

5. Wherever practical, permanently mount the Line Taps to a lab bench or wall nearby. This avoids their loss or misplacement and discourages people from disconnecting them, thus cutting off the signal to stations further down the line.

6. NEVER DIRECTLY CONNECT A DISTRIBUTION LINE TO AN INSTRUMENT; always use a Line Tap, Multitap or VersaTap. Direct connection may damage the instrument or cause an impedance mismatch on the distribution line.
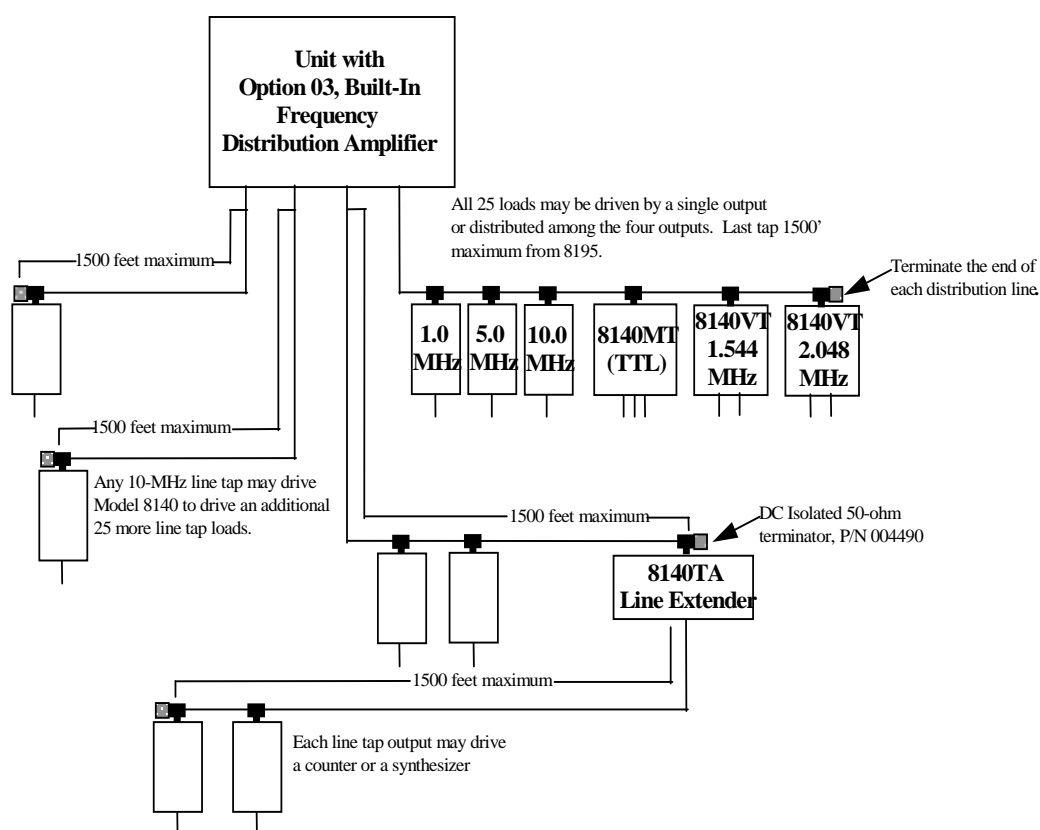
Figure 5-2 Typical Interconnection Diagram

5.4 OPTION 06 – 12.8 MHZ outputs

Option 06 changes the front and rear panel 10.0 MHz outputs to 12.8 MHz. These outputs provide a 750 mV rms sine wave into 50 ohms. Harmonic suppression is better than -30 dBc. The 12.8 MHz is synthesized from the GPS disciplined 10MHz oscillator using a phase lock loop.

NOTE: This option reconfigures the phase lock loop used to synthesize the 2048kHz output. The frequency found on the 2048kHz connector changes to 1600 kHz. This change also affects the 64 kHz output found on the DB15 Data Sync connector. This output is changed from 64 kHz to 50 kHz.

5.5 OPTION 07 – 5 MHZ outputs

Option 07 changes the front and rear panel from 10MHz outputs to 5 MHz. These outputs provide a 750 mV rms sine wave into 50 ohms. Harmonic suppression is better than -30 dBc.

5.6 OPTION 11 – Rack Mount Slides

Option 11 allows the Master Oscillator to be mounted in a 19-inch rack with slide-out capabilities. Table 5-2 lists the hardware supplied with Option 11. Verify that these items have been received. Much of the hardware supplied with this option will not be used.

QUANTITY	DESCRIPTION
1	Right hand slide assembly
1	Left hand slide assembly
2	Adjustable rear support bracket
1	Hardware Pack containing nut plates, small rear support brackets, and assorted hardware
1	Hardware pack containing PEM nuts and #10-32 x 1/2 truss head screws
1	Hardware pack containing #10 KEP nuts and #10-32 x 3/8 pan head screws.

Table 5-2 Option 11 Checklist

Install Option 11 as illustrated in Figure 5-3 and as described below:

1. Remove the chassis section from the right hand slide rail assembly. The right hand assembly is designated with the letters *RH* after the manufacturer's date code label.

   Attach the chassis section to the unit using #10-32 screws. The locking tab must be towards the rear of the unit.

2. Repeat Step 1 for the left chassis section.

3. Mount the right and left stationary sections into the rack using the appropriate rear support brackets, nut plates and required hardware.

4. Insert the receiver into the rack assembly. Secure the unit to the rack using the front panel mounting holes.

   NOTE: Insert the intermediate section into the stationary section prior to rack installation.
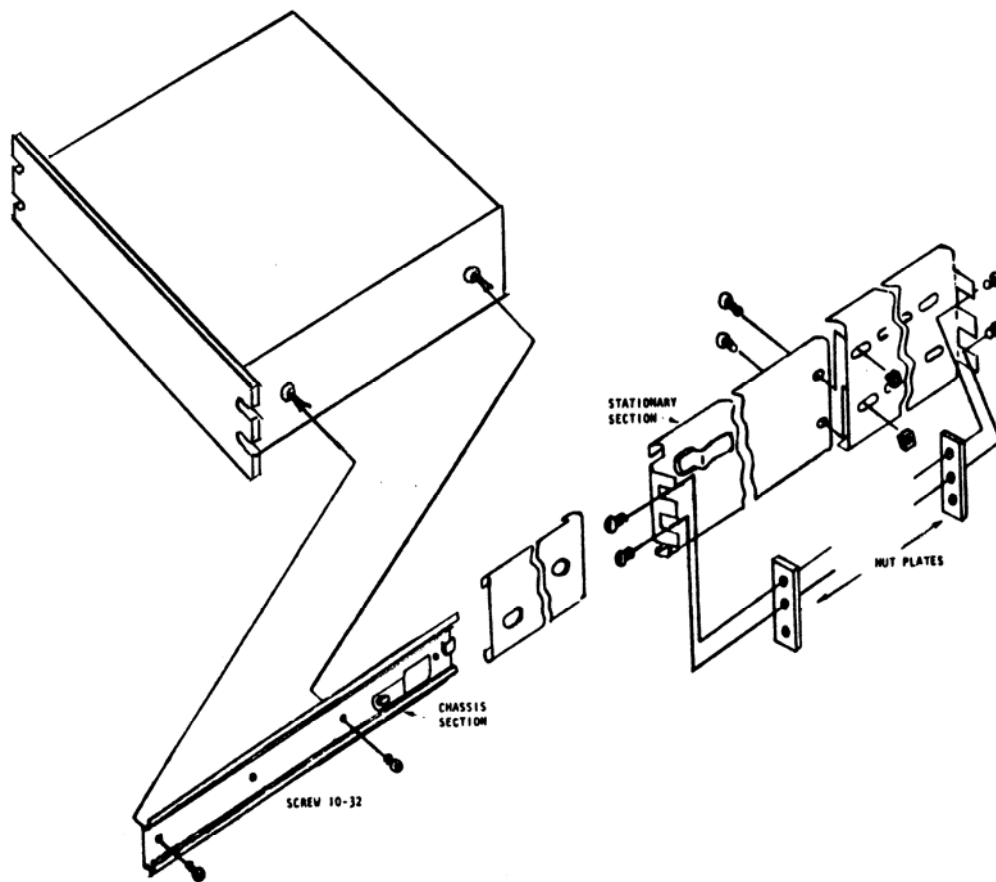
Figure 5-3 Slides Assembly

5.7 OPTION 14 - CTCSS Outputs One and Two

Option 14 provides the Master Oscillator with two selectable Continuous Tone Coded Squelch System (CTCSS) outputs. The available CTCSS frequencies range from 67.0 to 254 Hz. The rear panel Data Sync connector provides the CTCSS frequencies in RS-485 levels. These outputs are typically used with the Spectracom Model 1118 CTCSS Filter Board. The Model 1118 converts the applied RS-485 signal to a sine wave and features adjustable signal level and PTT delay with output inhibit capability. Refer to section 5.7.6 for more information on the Model 1118 CTCSS.

5.7.1 Data Sync Timing Outputs

Option 14 replaces the Data Sync 33-1/3 Hz and the 17-2/3 Hz outputs with CTCSS #1 and CTCSS #2 outputs. The Data Sync connector is a DB15 female numbered as shown in Figure 5-4. Option 14 Data Sync pin assignments are listed in Table 5-3.
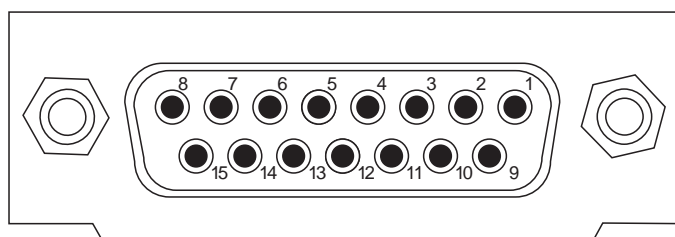
Figure 5-4 Data Sync Connector

PIN	SIGNAL	DESCRIPTION
1	+ 64 kHz*	RS-485 B Terminal
2	-64 kHz*	RS-485 A Terminal
3	+18 kHz	RS-485 B Terminal
4	-18 kHz	RS-485 A Terminal
5	**+ CTCSS #2**	RS-485 B Terminal
6	**- CTCSS #2**	RS-485 A Terminal
7	**+ CTCSS #1**	RS-485 B Terminal
8	**- CTCSS #1**	RS-485 A Terminal
9	Ground	Cable Shield
10	Major - C	Common Contact
11	Major - NO	Normally Open
12	Major - NC	Normally Closed
13, 14, 15	Ground	Cable Shield

Table 5-3 Option 14 Data Sync Pin Assignments

The 64kHz and 18kHz Data Sync outputs are derived from the 10MHz GPS disciplined oscillator. *The 64kHz signal is changed to 50kHz on units equipped with Option 06, 12.8 MHz outputs.

The CTCSS #1 and CTCSS #2 outputs are derived from the 10MHz GPS disciplined oscillator and are triggered by the GPS 1PPS output. Using the 1PPS offset command, 1PO, these outputs can be offset from 0 to 1 second in 0.001 microsecond steps. Refer to Section 4 for additional information on the 1PO command. The leading edges of the CTCSS #1and CTCSS #2 outputs are synchronized within ± 2.0 microseconds (± 0.25°) of the Data Clock 1PPS output.

CTCSS #1 and CTCSS #2 can be configured to provide any frequency listed in Table 5-4. The default CTCSS frequency is 67.00 Hz. Refer to section 5.7.6 for information on configuring the CTCSS outputs.

CTCSS FREQUENCIES (Hz)					
67.00	69.33	72.00	74.33	77.00	79.66
82.66	85.33	88.66	91.66	94.66	97.33
100.00	103.66	107.33	111.00	114.66	118.66
123.00	127.33	131.66	136.66	141.33	146.33
151.33	156.66	162.33	168.00	173.66	180.00
186.33	192.66	203.66	206.66	210.66	218.00
225.66	229.00	233.66	241.66	250.33	254.00

Table 5-4 CTCSS #1 and CTCSS #2 Frequency List

5.7.2   Data Sync Alarm Contacts

Major Alarm relay contacts are found on Pins 10, 11 and 12 of the Data Sync connector. A Major Alarm is asserted whenever any of the following alarm conditions exist: Frequency, Tracking Alarm 2, Tracking Alarm 3, CPU or the unit is placed in Test Mode.

During normal operation the Major Alarm relay is energized. The energized relay causes continuity between the common contact, Pin 10 and the normally open contact, Pin 11.

A Major Alarm or power failure de-activates the relay causing continuity between common, Pin 10 and normally closed, Pin 12. The relay remains in alarm condition until the fault is corrected or reset by the clear alarm, CA, command.

5.7.3 RS-485 Timing Signals

The Data Sync timing signals are output in RS-485 levels. RS-485 is a balanced differential transmission requiring twisted pair cable. Cable lengths up to 4000 feet are possible when using cables specifically designed for RS-485 applications, like Belden 9844 or equivalent. These cables have a braided shield, nominal impedance of 120 ohms, and a capacitance of 12 to 15 Pico farads per foot. Refer to Figure 5-5 for a schematic representation of an RS-485 line driver. Relative to RS-485 specifications the A Terminal (-) is negative with respect to the B Terminal (+) for a Binary 1. The A Terminal (-) is positive to the B Terminal for a Binary 0.
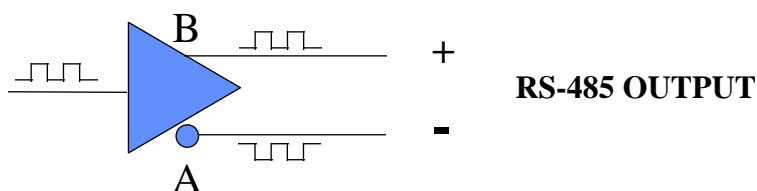
Figure 5-5 Data Sync Drivers

5.7.4 RS-232 CTCSS Configuration

The CTCSS outputs are configured using the front panel RS-232 COM port. The **C**TCSS **T**one **C**ontrol command, CTC, is used to read or set the configuration or provide a listing of all CTCSS frequencies available.

In the following command descriptions, characters in ***Bold Italics*** are keys typed by the user. Terminate all command lines with the enter key. The enter key is represented by ***<ent>***. The responses from the unit are shown in *Italics*. Configure the terminal for ANSI, 9600 baud, and xon/xoff flow control. The character structure is ASCII, 1 start, 8 data, 1 stop and no parity.

To retrieve the current CTCSS output configuration, issue the ***CTC*** command as shown below:

> Type: ***CTC <ent>***
> Response:
> *CTCSS GENERATOR SETTINGS*
> *1= XZ (67.00Hz) 2= XZ (67.00Hz) 3= NOT PRESENT 4= NOT PRESENT*

To configure the CTCSS outputs, the unit must first be placed in *Set Mode*. Issue the ***CTC*** command followed by the CTCSS generator number and corresponding time code. The ***CTC*** command structure is shown below:

> Type: **CTC # xx <ent>**
> Where: # =   CTCSS generator number, 1 or 2 (Option 17 adds 3 and 4)
>   xx =   Two digit code corresponding to a CTCSS tone frequency. Refer to Table 5-5 for code listings.

XZ (67.00Hz)	WZ (69.33Hz)	XA (72.00Hz)
WA (74.33Hz)	XB (77.00Hz)	WB (79.66Hz)
YZ (82.66Hz)	YA (85.33Hz)	YB (88.66Hz)
ZZ (91.66Hz)	ZA (94.66Hz)	ZB (97.33Hz)
1Z (100.00Hz)	1A (103.66Hz)	1B (107.33Hz)
2Z (111.00Hz)	2A (114.66Hz)	2B (118.66Hz)
3Z (123.00Hz)	3A (127.33Hz)	3B (131.66Hz)
4Z (136.66Hz)	4A (141.33Hz)	4B (146.33Hz)
5Z (151.33Hz)	5A (156.66Hz)	5B (162.33Hz)
6Z (168.00Hz)	6A (173.66Hz)	6B (180.00Hz)
7Z (186.33Hz)	7A (192.66Hz)	M1 (203.66Hz)
8Z (206.66Hz)	M2 (210.66Hz)	M3 (218.00Hz)
M4 (225.66Hz)	9Z (229.00Hz)	M5 (233.66Hz)
M6 (241.66Hz)	M7 (250.33Hz)	0Z (254.00Hz)

Table 5-5 CTCSS Tones List – CTCSS #1 & #2

Example: Configure CTCSS #1 to provide a 74.33 Hz tone.

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

Type: ***CTC 1 WA <ent>***
Response:
      CTCSS GENERATOR SETTINGS
      1= WA (74.33Hz) 2= XZ (67.00Hz) 3= NOT PRESENT   4= NOT PRESENT

Configure the remaining CTCSS generator as required.

To view the entire CTCSS code table, issue the ***CTC*** command as shown below:
Type: ***CTC TABLE <ent>***
Response:
      CTCSS TABLE:
      XZ (67.00Hz)   WZ (69.33Hz)   XA (72.00Hz)
      WA (74.33Hz)   XB (77.00Hz)   WB (79.66Hz)
      YZ (82.66Hz)   YA (85.33Hz)   YB (88.66Hz)
      ZZ (91.66Hz)   ZA (94.66Hz)   ZB (97.33Hz)
      1Z (100.00Hz)   1A (103.66Hz)   1B (107.33Hz)
      2Z (111.00Hz)   2A (114.66Hz)   2B (118.66Hz)
      3Z (123.00Hz)   3A (127.33Hz)   3B (131.66Hz)
      4Z (136.66Hz)   4A (141.33Hz)   4B (146.33Hz)
      5Z (151.33Hz)   5A (156.66Hz)   5B (162.33Hz)
      6Z (168.00Hz)   6A (173.66Hz)   6B (180.00Hz)
      7Z (186.33Hz)   7A (192.66Hz)   M1 (203.66Hz)
      8Z (206.66Hz)   M2 (210.66Hz)   M3 (218.00Hz)
      M4 (225.66Hz)   9Z (229.00Hz)   M5 (233.66Hz)
      M6 (241.66Hz)   M7 (250.33Hz)   0Z (254.00Hz)

5.7.5 RS-485 CTCSS Configuration

This RS485 command is used to change the settings of the CTCSS generators installed in the unit. There may be one or two generator chips installed in the unit, resulting in 2 or 4 CTCSS frequencies output.
The format for the command is:

wctcC1C2C3C4
plus the normal header and footer.

C1, C2, C3, and C4 are the two-letter CTCSS code that has been selected to be output. The following is a table of all the codes and their subsequent frequencies. (Note: the output frequencies are not the exact CTCSS frequencies). The two-letter code MUST be in Capital Letters.

If a CTCSS generator is not installed in the 8195A/8197 the command is simply ignored. If only one generator is installed only the codes for that generator are used, the other codes should be set to 00 (zero zero).

Also, the second CTCSS generator (C3 and C4) can only output frequencies that are integers – 67.00, 72.00 are valid, 69.33 is not.

Examples:
Set CTCSS #1 to 69.33, #2 to 180.00, #3 & #4 are not installed.
wctcWZ6B0000

Set CTCSS #1 to 136.66, #2 to 127.33, #3 to 100.00, and #4 to 254.00.
wctc4Z3A1Z0Z

5.7.6 Model 1118 CTCSS

The Model 1118 CTCSS Tone Generator is used in conjunction with the Model 8195B or 8197B Ageless Oscillator to generate precision synchronized CTCSS tones. The master oscillator must be equipped with the appropriate Option 14 or Option 17 output. There are two versions of the 1118: the 1118-2, a version with an enclosure; and the 1118-1, a rail mount version. This manual lists the pins and connectors for the 1118-2 first, then the pins and connections for the 1118-1 in brackets [ ].

The Spectracom CTCSS Tone Generator offers the following features:

- Accuracy: Continuous self-calibrated to GPS provides $\pm1.0 \times 10^{-11}$ frequency accuracy.
- PTT input and an adjustable delayed PTT output.
- TIA compliant CTCSS reverse burst.
- Inhibit input that disables CTCSS tone generation.

5.7.6.1   STANDARD CTCSS FREQUENCY OUTPUT (CONTINUOUS TONE CONTROLLED SQUELCH SYSTEM)

Signal: 67-254Hz sinewave derived from GPS disciplined oscillator with configurable 180-degree inverted "reverse burst" tone during delayed PTT output.   See table 1-1 for tone frequencies and H1 jumper position.

Connector: 12 pin pluggable header J4 pins 6 and 7 [or 6 Pin Header J6 pin 1, and 3 Pin Header J5 pin 1].

Signal Level: Adjustable with a potentiometer from 0.0 to 4.0 volts P-P (1.4 Vrms) into 600 ohms.

Source Impedance: 33 ohms

Harmonics: 25dB below the CTCSS fundamental minimum

Spurious: 25dB below the CTCSS fundamental minimum

PTT Operation: CTCSS tones are gated by PTT with a configurable PTT hold or millisecond reverse burst.

Code	Tone Freq.	Actual Tone Freq.	H1 Pos	Code	Tone Freq.	Actual Tone Freq.	H1 Pos	Code	Tone Freq.	Actual Tone Freq.	H1 Pos
XZ	67.0	67.000	B	1B	107.2	107.333	B	6A	173.8	174.000	A
WZ	69.3	69.333	B	2Z	110.9	111.000	B	6B	179.9	180.000	A
XA	71.9	72.000	B	2A	114.8	115.000	B	7Z	186.2	186.333	A
WA	74.4	74.333	B	2B	118.8	119.000	B	7A	192.8	193.000	A
XB	77.0	77.000	B	3Z	123.0	123.000	B	M1	203.5	203.666	A
WB	79.7	79.666	B	3A	127.3	127.333	B	8Z	206.5	206.666	A
YZ	82.5	82.666	B	3B	131.8	132.000	B	M2	210.7	210.666	A
YA	85.4	85.333	B	4Z	136.5	136.666	B	M3	218.1	218.333	A
YB	88.5	88.666	B	4A	141.3	141.333	B	M4	225.7	225.666	A
ZZ	91.5	91.666	B	4B	146.2	146.333	B	9Z	229.1	229.000	A
ZA	94.8	95.000	B	5Z	151.4	151.333	A	M5	233.6	233.666	A
ZB	97.4	97.333	B	5A	156.7	156.666	A	M6	241.8	242.000	A
1Z	100.0	100.000	B	5B	162.2	162.333	A	M7	250.3	250.333	A
1A	103.5	103.666	B	6Z	167.9	168.000	A	0Z	254.1	254.000	A

Table 5-6 CTCSS Standard Frequency Chart

5.7.6.2   Delayed PTT Output

Signal: Digital

Connector: 12 Pin Pluggable Header J4 Pin 9 [or 6 Pin Header J6 Pin 6,]

Signal Level: Output structure is a Solid State Switch consisting of two MOSFETS (AC and DC operation) that present a high resistance when off and less than 0.4 ohms when on.

Pulse Width: Follows PTT Input plus an adjustable delay (100 – 500 milliseconds), factory set to 150 milliseconds.

Delay Control: The trailing edge of the PTT output is delayed 100 – 500 milliseconds from the trailing edge of the PTT input, factory set to 150 milliseconds.

Delayed PTT Operation: CTCSS tones are gated by PTT; the PTT input active immediately causes the PTT Output to go active. PTT inactive will cause the PTT output to go inactive after the PTT delay. The delay is factory set to 150 milliseconds.

5.7.6.3   PTT Input

Signal: Digital CMOS levels

Connector: 12 Pin Pluggable Header J4 Pin 5 [or 6 Pin Header J2 Pin 5].

Signal Level: CMOS 0.5-4.5 volts or contact closure to ground, minimum sink current = 0.01 amps. Turn on current equals 10 ma and turn off current equals 1ua. Turn on voltage equals 0.8 volts and turn off voltage equals 4.5 volts

Impedance: 2700 ohms

Polarity: H3 position A for PTT on with closed circuit
                               H3 position B for PTT on with open circuit

5.7.6.4   Synchronized CTCSS Digital Inputs

There are four possible CTCSS inputs labeled CTCSS #1, CTCSS #2, CTCSS #3 and CTCSS #4. The different CTCSS frequencies are set on the 8195B or the 8197B driving the CTCSS filter board assembly. They are input to the CTCSS filter assembly on connector J1 or J3. J2 is a loop thru connector for connecting more CTCSS filter boards to the same 8195B or 8197B output. If the loop thru connector is used the termination should be set on the last CTCSS filter board in the string. The CTCSS inputs are individually selected and terminated with jumpers. Use either jumper pair H6 and H7 for CTCSS #1, H8 and H9 for CTCSS #2, H10 and H11 for CTCSS #3, or H12 and H13 for CTCSS #4 to select one of the CTCSS inputs.

Signal:	RS-485
Connector:	DB15 male connector J1 pins 7 and 8 for CTCSS #1, pins 5 and 6 for CTCSS #2, or DB9 connector J3 pins 3 and 8 for CTCSS #3, pins 1 and 6 for CTCSS #4.
Impedance:	120 ohms or high impedance. A jumper can individually terminate each CTCSS input: jumper H14 for CTCSS #1, jumper H15 for CTCSS #2, jumper H16 for CTCSS #3 or jumper H17 for CTCSS #4.

5.7.6.5   18 kHz Clock input (CTCSS #1 and 2)

Signal:	RS-485
Connector:	DB15 male connector J1 Pins 3 and 4
Impedance:	120 ohms or high impedance selected by jumper H19.

5.7.6.6   18 kHz Clock input (CTCSS #3 and 4)

Signal:	RS-485
Connector:	DB9 male connector J3 Pins 2 and 7
Impedance:	120 ohms or high impedance selected by jumper H18.

5.7.6.7   Input Power

DC Input: 7 to 20 VDC, 1 W

Connector: 12 Pin Pluggable Header J4 pins 3 and 2 [or 6 Pin Header
                                   J6 pins 3 and 4]

Polarity: Positive on J4 pin 3 [or J6 pin 4]

5.8 OPTION 16 – 1PPS Rear Panel Frequency Outputs

Normally, the four BNC Frequency Output connectors on the rear panel of the unit provide a 10MHz signal. With Option 16, the third and fourth outputs of this set are changed to provide a 1PPS signal instead. The settings and specification of the 1PPS outputs on the rear panel is identical to the one that is currently being provided on the front panel. The specifications are as follows:

Signal: 1PPS derived from the 10 MHz GPS disciplined oscillator.

Connector: BNC female, rear panel.

Signal Level: TTL compatible into loads >100 ohms.

Pulse Width: 200 milliseconds.

Accuracy: Positive edge within ±500 nanoseconds of UTC when in Position Hold Mode and NO DELAY selected.

Delay Control: The 1PPS output can be delayed 0 - 1 second in 0.001 microsecond (1 nanosecond) steps. The delay value is entered via the RS-232 or RS-485 communication ports.

5.9 OPTION 17 – CTCSS Outputs Three and Four

Option 17 expands on Option 14 by replacing the 9.6 kHz and the 1 PPS outputs on the Data Clock connector with CTCSS #3 and CTCSS #4 outputs. The Data Clock connector is a DB9 female numbered as shown in Figure 5-6. Option 17 Data Sync pin assignments are listed in Table 5-6. CTCSS #3 and CTCSS #4 are limited to whole frequencies (e.g. 67.00 Hz, but not 69.33 Hz). See section 5.7 for further details on the CTCSS output and refer to tables 5-7 and 5-8.
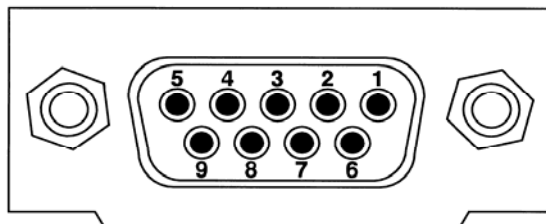

Figure 5-6 Data Clock Connector

PIN	SIGNAL	NOTES
1	**+ CTCSS #3**	RS-485 B TERMINAL
2	+18 KHZ	RS-485 B TERMINAL
3	**+ CTCSS #4**	RS-485 B TERMINAL
4	MAJOR ALARM	GROUND = NORMAL
5	GROUND	CABLE SHIELD
6	**- CTCSS #3**	RS-485 A TERMINAL
7	-18 KHZ	RS-485 A TERMINAL
8	**- CTCSS #4**	RS-485 A TERMINAL
9	GROUND	CABLE SHIELD

Table 5-7 Option 17 Data Sync Pin Assignments

XZ (67.00Hz)
1Z (100.00Hz)
2Z (111.00Hz)
3Z (123.00Hz)
6Z (168.00Hz)
XB (77.00Hz)
Z (229.00Hz)
XA (72.00Hz)
6B (180.00Hz)
M3 (218.00Hz)
0Z (254.00Hz)

Table 5-8 CTCSS Tones List – CTCSS #3 & #4

5.10 OPTION SP294 – DS1 Framed All Ones

Special Request Number SP294 provides the Spectracom Models 8195B or 8197B with two DS1 Framed All Ones outputs. The 1544 kHz DS1 clock is derived from the 10 MHz GPS Disciplined Oscillator. Each DS1 output consists of a Tip (T), Ring (R) and Ground (G) connection on the rear panel terminal strip as shown in Figure 5-7.
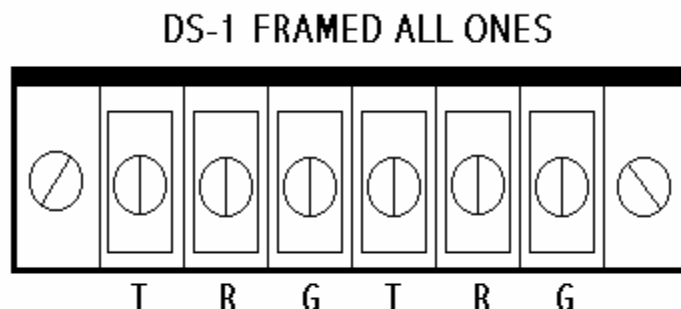

Figure 5-7 DS1 Framed All Ones Connector

The DS1 outputs are available with D4 or ESF Framing. SP294 equipped units are factory configured for D4 Framing. ESF Framing is enabled by moving the internal shorting plug on HDR3 as shown in Figure 5-8. Refer to Figure 5-9 for assistance in locating HDR3.
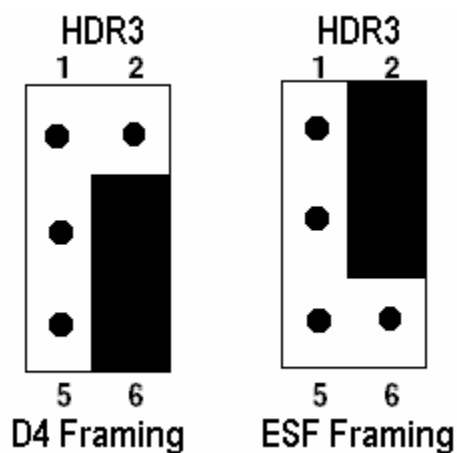

Figure 5-8 Frame Selection Jumper

The outputs may also be programmed to provide an Unframed All Ones (Blue Alarm) or complete removal of signal whenever the 1544 kHz signal is not phase locked to the disciplined 10 MHz oscillator.

The unit is factory configured to provide a Blue Alarm when unlocked. To program the DS1 outputs for complete removal when unlocked, remove the shorting plug found on HDR5. Refer to Figure 5-9 to locate HDR5.

Figure 5-9 Programmable Jumper Locations

SPECIFICATIONS

Signal:	DS1 Framed All Ones
Accuracy:	Model 8195B: 24-hour average accuracy typically ±1 x 10^{-11} Model 8197B: 24-hour average accuracy typically ±1 x 10^{-12}
Framing:	D4 or ESF; Internal jumper selection. Factory configured for D4 framing.
Level:	3.0 Vpk into 100 ohms
Connector:	Terminal Strip

5.11 OPTION SP295 – E1 Framed All Ones

Special Request Number SP295 provides the Spectracom Models 8195B or 8197B with two E1 Framed All Ones outputs. The 2048 kHz E1 clock is derived from the 10 MHz GPS Disciplined Oscillator producing clock accuracies of $\pm1 \times 10^{-11}$ for Model 8195B and $\pm1 \times 10^{-12}$ for Model 8197B receivers. Each E1 output consists of a Tip (T), Ring (R) and Ground (G) connection on the rear panel terminal strip as shown in Figure 5-10.
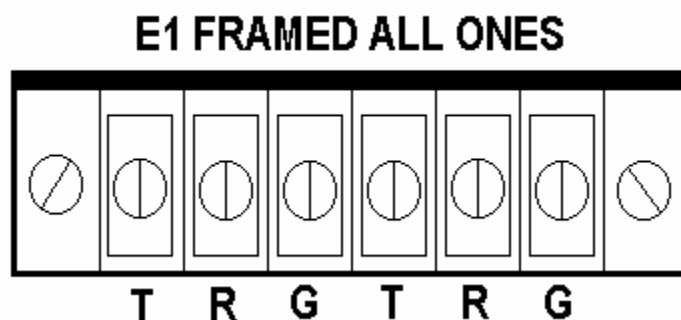
Figure 5-10 E1 Framed All Ones Connector

The E1 outputs are available with CRC4 Multiframe or CAS Multiframe. Both outputs have HDB3 coding. SP295 equipped units are factory configured for CRC4 Multiframe. CAS Multiframe is enabled by moving internal shorting plugs on HDR1 of the Framed All Ones generator board as shown in Figure 5-11. Refer to Figure 5-12 for Assistance in locating HDR1.
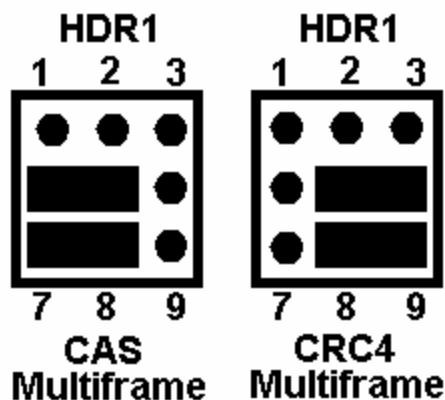
Figure 5-11 Frame Selection Jumpers

The outputs may also be programmed to provide either an Unframed All Ones or complete removal of the signal whenever the 2048 kHz clock reference is not phase locked to the disciplined 10 MHz oscillator. The unit is factory configured to provide an Unframed All Ones when unlocked. To program the E1 outputs for complete removal when unlocked, remove the shorting plug found on HDR5.
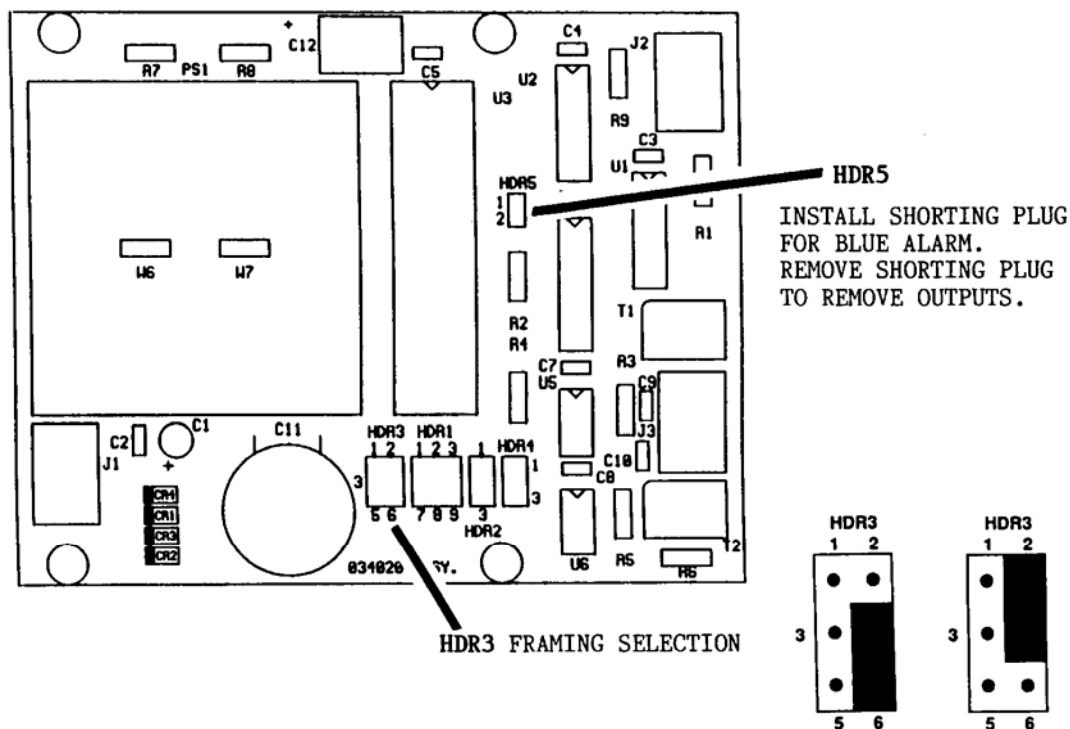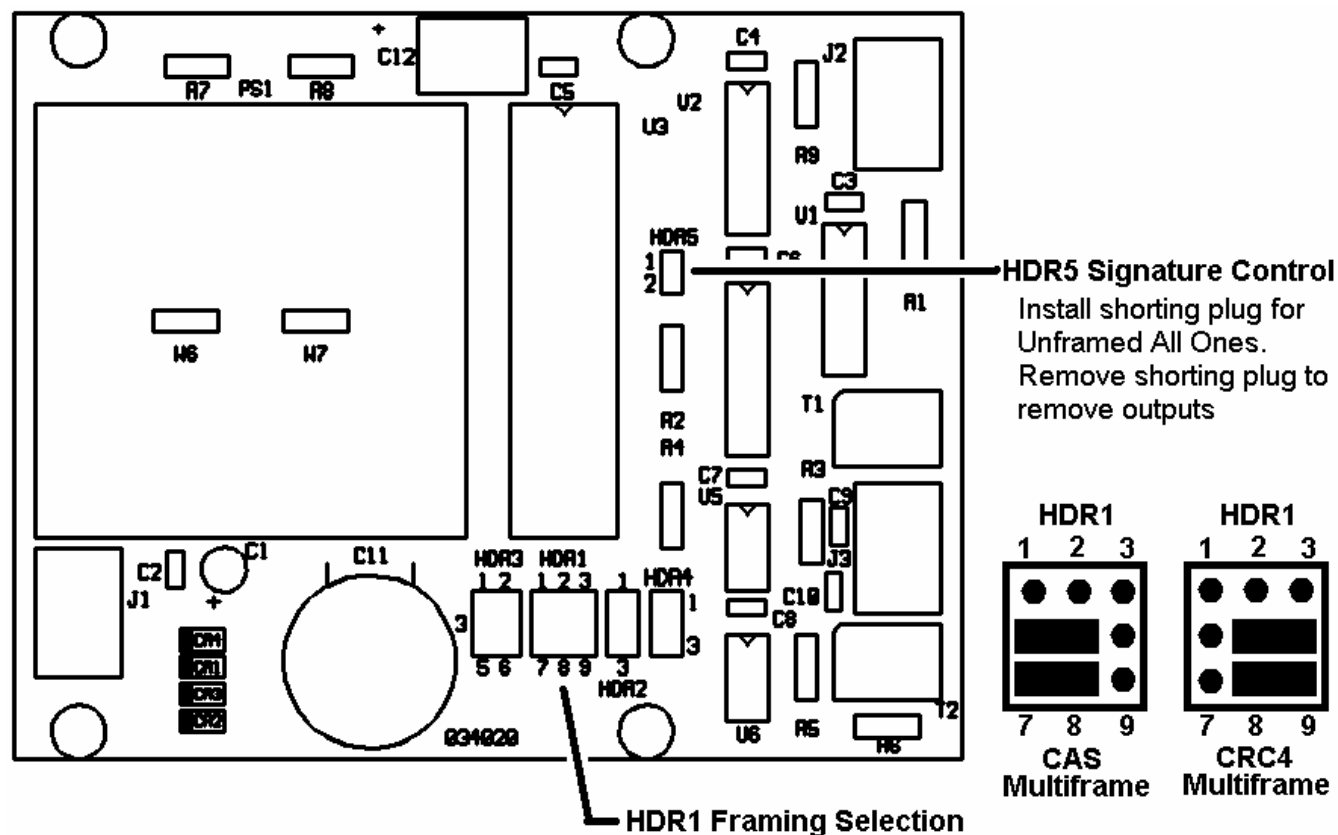
Figure 5-12 Programmable Jumper Locations

SPECIFICATIONS

Signal: E1 Framed All Ones, HDB3 coded

Framing: CAS or CRC4 Multiframe; internal jumper selection. Factory configured for CRC4.

Accuracy: Model 8195B: 24-hour average accuracy typically ±1 x 10^{-11}
Model 8197B: 24-hour average accuracy typically ±1 x 10^{-12}

Level: 3.0 Vpk into 100-ohms

Connector: Terminal strip

6 Service Information

6.1 Introduction

This section provides information on battery replacement and oscillator adjustment. Refer to Section 2 for troubleshooting GPS reception problems. Please direct all service calls to Spectracom customer service at: **585-321-5800**.

6.2 Battery Replacement

Option 02 provides the unit with an internal battery backup power source. Battery life expectancy is typically four years. The battery is tested daily to verify it is available for backup operation. If the battery fails the daily test, or if it remained in continuous charge mode for 2 days, a Replace Battery alarm is asserted. This condition latches the front panel Replace Battery lamp on and asserts a Minor Alarm. The unit will remain in alarm condition until the battery either again passes the daily test or is replaced.

Replacement batteries can be ordered from Spectracom Sales Department at 585-321-5800. Specify Part Number B00004. Batteries can also be obtained locally. Select a 12 Volt, 7.0 Amp/Hour sealed lead acid battery. Power Sonic part number PS-1270, Panasonic LC-R127R2P and Power Patrol SLA1075 are acceptable replacements. Batteries may also be purchased from DigiKey, a large mail order electronics distributor. Call 1-800 DIGIKEY, specify their part number P078-ND.

A Phillips screwdriver and a PC with terminal emulation software, i.e. HyperTerminal, ProComm Plus, and a straight through (one to one) pinned DB9 RS-232 cable is required. The PC is used to clear the Replace Battery alarm.

Set the terminal emulation program for 9600 baud, 8 data, 1 stop, no parity and XON/XOFF flow control.

6.2.1 Battery Replacement Instructions

Turn off the rear Panel AC power switch.

Remove the top cover. Rack mounted units, unless equipped with Option 11, Rack Mount Slides, must be removed. 12 screws secure the cover.

Disconnect the two-position battery cable from the front panel circuit board. Note the orientation of the connector before removing it.

Remove four screws securing the cover of the battery holder assembly and then remove the battery. Please note that it is a tight fit, carefully work the battery out.

Remove the battery cable from the old battery and connect to the new battery. Make certain the red wire is connected to the positive battery terminal.

Install the replacement battery into the holder and reinstall the holder cover.

Reconnect the two-position plug to the front panel circuit board. Verify the plug is properly mated to the header to maintain the correct polarity.

Reinstall the top cover.

Reapply power to the unit.

NOTE: The Replace Battery lamp will remain on after replacing the battery. The lamp can be reset using the RS-232 command CA BAT, or will self-clear after successfully completing the first battery test (typically 48 hours).

Connect the PC to the front panel RS-232 Com port and issue the command **CA BAT** to reset the latched Replace Battery alarm lamp.

> The Reset Battery Alarm command is a Set Mode command.
> Place the unit in Set Mode by sending the following command:
>
> Type: **SM ON <ent>**
>
> The unit will respond with an acknowledgement that Set Mode is enabled. Issue Battery Reset command as follows:
>
> > Type: **CA BAT <ent>**
>
> The Battery Status lamps shall now indicate that the battery is Charging or is Ready.

This completes the battery replacement procedure. The unit will require a two to three hour period to obtain oscillator lock to the GPS reference.

NOTE: The next two sections only apply to Models 8194B and 8195B that use an OCXO 10 MHz oscillator. It does not apply to the Model 8197B that has a Rubidium oscillator. For Rubidium oscillator adjustment, you will need to send the unit back to Spectracom's technical support department.

6.3 OCXO Oscillator Adjustment (8194B and 8195B ONLY)

Over time the OCXO 10 MHz oscillator may require an adjustment to compensate for crystal aging. The unit warns when this adjustment is needed by asserting an Adjust Oscillator Alarm. This condition activates the Minor Alarm status lamp and relay. An Adjust Oscillator Alarm is asserted when the frequency controlling D/A converter approaches a control range limit. Typically, this alarm provides a two to three month warning before a control range end is reached.

On rare occasions, an oscillator may experience a sudden shift in frequency, causing an Adjust Oscillator and a Frequency Alarm. When this occurs, both Major and Minor alarms are activated. The D/A is set to a control range end unable to correct the oscillator frequency. Frequency error shall exceed 1×10^{-8}

This section describes the oscillator adjustment procedure using a frequency counter and an RS-232 terminal. After completing the adjustment procedure, the alarm lamps and relays are cleared, and the oscillator will reacquire phase lock to the GPS reference.

The frequency counter must have a time base accuracy and measurement resolution of at least 1×10^{-9} (0.01 Hz at 10 MHz).

A PC running terminal emulation software (HyperTerminal, ProComm Plus, etc.) can be used as an RS-232 terminal. Configure the terminal for ANSI emulation, 9600 baud and a character structure of 1 start, 8 data, 1 stop and no parity. Flow control is not required, although xon/xoff is supported.

6.3.1 OCXO Adjustment Procedure (8194B and 8195B ONLY)

Perform the steps listed below to adjust the OCXO 10 MHz oscillator.

NOTE: The oscillator must be powered for at least 1 hour prior to making this adjustment.

1. Remove the top cover. Rack mounted units, unless equipped with Option 11, Rack Mount Slides, must be removed.

2. Connect the terminal to the unit's RS-232 Comm port.

3. Connect the frequency counter to the front panel 10 MHz output.

4. Place the unit in Test Mode by sending the TM command as follows:

    > Type: ***TM ON <ent>***
    > Response:
    > > *TIME= 16:11:43 DATE= 2000-03-27 STATUS CHANGE <TEMP= +37.0>*
    > > *COOLING FAN= OFF*
    > > *ALARM RELAYS: MAJOR= ON MINOR= ON*
    > > *ACTIVE ALARMS: MAJOR*
    > > *IN TEST MODE*
    > > *ADJUST OSCILLATOR*

5. Set the D/A control voltage to its maximum value by sending the SHI command.

    > Type: ***SHI<ent>***
    > Response: *D/A = FFFF (99%)*

6. Remove the seal screw from the 10 MHz OCXO. The oscillator is located near the center of the logic circuit board assembly. The OCXO is approximately 2" square. Insert a flat-bladed tuning tool into the access hole. Adjust the oscillator for a frequency measurement of 10,000,002.50 ±.05 Hz.

    Replace the seal screw and record the upper limit oscillator frequency. F_{HI} =_____Hz.

7. Set the D/A control value to its minimum value by sending the SLO command.
    > Type: ***SLO<ent>***
    > Response: *D/A = 0000 (00%)*

    Record the lower limit oscillator frequency
    F_{LO} =_____Hz.

8.   Subtract the lower limit frequency, F_{LO}, from the upper limit frequency, F_{HI}, to determine the pull range of the oscillator. This difference is entered as the Hertz Range Value.

      F_{HI} - F_{LO} = HR

      Enter the hertz range value by sending the HR command as shown below:
      Type: ***HR XXX.XXX***
      where XXX.XXX =   Hertz Range Value
      Response: *Hertz Range = XXX.XXX D/A = C000*

9.   Return the unit to normal operation by taking it out of Test Mode.
      Type: ***TM OFF<ent>***

The oscillator adjustment procedure is now complete. Replace the top cover and reinstall the unit. The unit will require a two to three hour period to phase lock to the GPS reference.

A. Appendix A – Operation with Low GPS Quality

A.1 Introduction

The Spectracom Master Oscillator is often used to provide a reference to transmitters when precise frequency control is needed. In some installations, the GPS reception has been poor or intermittent, preventing reliable operation of the disciplined oscillator.

One reason for poor reception is harmonics from a local broadcast interfering with the GPS L1 carrier of 1575.42 MHz. Certain television or FM radiobroadcasts, while operating within their frequency allocation, can cause GPS jamming due to harmonics of the carrier. Television interference presents a greater challenge due to higher output power, typically 2-3 MW. Table A-1 lists the potential problem television stations and their respective GPS harmonic.

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

Table A-1 Television Stations with GPS Jamming Potential

FM 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 harmonic.

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

A.2   GPS qualifying algorithm selection

The Spectracom Master Oscillator is equipped with three selectable GPS qualifying algorithms. The factory default algorithm is GPS Qualifying Algorithm GQA1. This algorithm places strict requirements on the received GPS signal. Every second the GPS signal is qualified and receives a pass/fail quality judgment. Under GQA1, reception is of passing quality when the receiver is tracking at least four satellites with signal strengths >40 and a Tracking Mode of 08. This rigid qualifying process is needed to enable the phase locking algorithm. The phase lock algorithm produces accuracies of $\pm 1 \times 10^{-11}$ on the disciplined oscillator outputs.

In applications where GPS reception is marginal or intermittent, an alternate GPS qualifying algorithm may be selected. GPS qualifying algorithms GQA2 and GQA3 permit operation while tracking only a single satellite. These algorithms do not require a minimum signal strength threshold. A satellite is qualified for use whenever its Tracking Mode is set to 08.

The number of satellites tracked and their current Tracking Model value can be seen using the GSS command. Refer to Section 4 of this manual for a complete description of the GSS command.

GPS Qualifying Algorithm GQA3 initially begins similar to GPS Qualifying Algorithm GQA1. A minimum of four satellites with signal strengths greater than 40, Tracking Mode of 08 must be tracked and establish a 3D-fix for 1 minute. At this point, the Tracking GPS lamp will turn on and the qualifying parameters are reduced to tracking one satellite with a Tracking Mode of 08.

GPS Qualifying Algorithm GQA2 does not require an initial 3D-fix or track more than one satellite to operate. Select GPS Qualifying Algorithm GQA2 whenever local interference prevents the receiver from obtaining a 3D-fix. For example, select GQA2 for installations installed in close proximity to TV channels 66 or 23 transmitters.

NOTE: Selecting GPS Qualifying Algorithm GQA2 or GQA3 changes the oscillator-disciplining algorithm from phase locking to frequency locking. This reduces the output accuracy from 1×10^{-11} to 1×10^{-10}. This accuracy is sufficient to meet most transmitter frequency requirements.

A.3 GQA Command

To select the GPS Qualifying Algorithm, a terminal or PC running terminal emulation software (Hyperterminal, Procomm Plus, etc.) will be needed to communicate with the RS-232 Comm port. Configure the terminal for ANSI emulation, 9600 baud, and a data structure of 1 start, 8 data, 1 stop and no parity. Flow control is not required, though xon/xoff is supported.

The GQA selection command is aTest Mode command. Place the unit in Test Mode by sending the following command:

>   Type: **TM ON <ent>**

The unit will respond with an acknowledgement that Test Mode is enabled. To read the current GQA selection, issue the command as shown below:

>   Type: **GQA <ent>**
>   Response: GPS Qualifying Algorithm= 1

To change the GQA algorithm, issue the GQA command as follows:

>   Type: **GQA1 <ent>**
>   or
>   **GQA2 <ent>**

The unit will respond with the selected algorithm.
Turn Test Mode operation off as shown below:

>   Type: **TM OFF <ent>**

The unit shall respond with another Change in Status message.

Allow the receiver two to three hours to frequency lock the oscillator to GPS. When the oscillator is disciplined to GPS, the front panel OSC LOCK lamp turns on and the frequency and major alarms clear. The unit may now be placed in service.

It is recommended to periodically monitor the reception characteristics to guarantee reliable operation. Reception quality can easily be verified using the Display Alarm Log command, DAL. The alarm log records all changes in operational status. Total loss of reception may cause a tracking alarm to actuate. Tracking Alarm 1 is a minor alarm and is asserted whenever the GPS signal is lost for one minute. Tracking Alarm 2 is a major alarm, and is asserted whenever the GPS signal is lost for 2.5 hours. Due to the potentially large number of entries contained in this log, a page parameter "P" can be added to the command. This allows the log to be output a page at a time with an option to continue or exit after each page. To retrieve the alarm log, issue the DAL command as shown below:

Type: **DAL <ent>**
or
DAL P <ent> Paged Output

An example of a Tracking Alarm is shown below:

```
TIME= 18:18:04  DATE= 1999-06-28  STATUS CHANGE <TEMP= +36.5>
COOLING FAN= OFF
ALARM RELAYS:  MAJOR= OFF  MINOR= ON
ACTIVE ALARMS: MINOR
TRACKING ALARM 1
```

Search the Alarm Log for the presence of Tracking Alarms, noting the time and date of these occurrences. An occasional Tracking Alarm 1 is considered acceptable. The presence of Tracking Alarm 2 represents reception problems and is not acceptable.

REVISION HISTORY

Revision Level	Description
B	Corrected several occurrences of 1PPS offset from 0.1 microsecond steps (incorrect) to 0.001 microsecond steps (with the exception of Section 4.5.14, *1PPS Offset*, where 0.1 microsecond steps is correct for w1po(write 1po) and r1po(read 1po). Corrected several instances of 50 nanosecond accuracy to read 500 nanosecond accuracy.
C	Minor administrative corrections.
D	Corrected Table 1-1, Product Comparison Table, to reflect availability of options 52, 53, and 54 in Model 8194B. (ECN 2111)
E	ECN 2223: 8194 Option 02, 52, 53, 54. ECN 2231: E1 output changed to HDB3. ECN 2196: Software version change, baud select command added. Added 26 2/3 Hz output.