ATS-6501 Tflex
GPS Time & Frequency Standard

Users Guide

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Revision History

Revision	Dated	Revision description
D1	DEC 2010	Added Contact information and revision history

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1 General Information

1.1 Introduction

The ATS-6501 Tflex is a state-of-the-art GPS Disciplined time and frequency reference. It utilizes an internal rubidium (Rb) atomic clock and low noise synthesizer (LNS) in conjunction with GPS measurements to provide outputs that are characterized by the short-term stability of the atomic clock and the long-term stability of the GPS constellation. Additionally, it provides the user with the capability to enhance the frequency stability and holdover performance of the unit by using an external cesium (Cs) clock as the reference. This provides a scalable architecture that allows users to fulfill a wide range of current and future requirements with a single unit. The ATS-6501 is suitable for a variety of precise time and frequency applications.

The 1 Pulse per Second (PPS) accuracy and frequency stability of the ATS-6501 is further enhanced by using a dual-frequency (L1/L2) GPS receiver. The dual-frequency receiver applies corrections to the GPS timing signals that remove a significant portion of the errors due to ionospheric delay. The measurements can also be made available to users for the purpose of modeling the total electron content (TEC) of the ionosphere.

In applications where reliability is a must the ATS-6501 is capable of operating from an AC (100 – 240VAC, 50-60 Hz) or DC Power (48 VDC) source and comes with two fully redundant power supplies. The unit is capable of operating from a single supply in the event one of the two power supplies fails.

A 4372A module can be ordered and installed in an ATS 6501 for supplying fiber signals to an ATS 6511. The fiber connection includes all timing signals to provide the same capability and performance of the ATS 6501 in the ATS 6511. A 4340 distribution amplifier can be connected to a 4372A output to provide up to 8 more outputs to ATS 6511s. The 4372A module includes input capability to monitor the status of each ATS 6511 connected either directly to the 4372A module or through a 4340 distribution amplifier.

1.2 Ordering Information

ATS 6501A (Tflex): Standard dual frequency GPS time and frequency standard. Dual AC input supplies included. Requires external frequency reference or internal Rubidium reference and includes two 1 PPS/DC IRIG, one 10 MHz, and one AM IRIG output module. A dual frequency GPS antenna included with unit

Option D (DC Power Input): Provides DC input (48 VDC) capability instead of AC for one of the supplies. The second power supply is still AC.

Option D2 (Dual DC Power Input): Provides dual DC input (48 VDC) capability instead of AC.

Option F (Front Panel Memory Card): Provides access to the unit's non-volatile memory via the front panel. This option allows users to perform a complete software upgrade in the field without returning the unit to Symmetricom. Additionally, the unit can be declassified by simply removing the flash card from the system.

Option R (Internal Rb Reference): Integrates an internal Rubidium (Rb) frequency reference as part of the unit. This allows the unit to operate without using an external frequency reference as well as steer the internal reference based upon the clock offset and GPS measurements.

Output Cards: The ATS-6501 has five output cards available:

1. 4395A-10 Four 10Mhz Outputs
2. 4395A-5 Four 5Mhz Outputs
3. 4394A Programmable PPS and DC IRIG Module. Users can define the signal types and operating parameters. Default set up is two 1PPS Outputs and two DC IRIG Outputs(Default = B000)
4. 4387A Four Modulated IRIG Outputs (Default = B120) or NASA36
5. 4372A Four output single mode fiber optic module for supplying signals to a 4340 or ATS 6511

OP001 USB Console Cable: Allows users to connect to the system Command Port via a serial cable.

OP002 USB External Reference Communication Cable: Provides a serial communications port to an external frequency reference (i.e. 5071A).

4340AS-8S: 1 U fiber expansion chassis with single mode input and 8 single mode outputs

Notes:

1. The correct Symmetricom part number is constructed by appending the desired options to the base model in alphabetical order. None of the options are mutually exclusive so users can select as many options as desired.

   Example Part Number: ATS-6501-DFR
   Description: Tflex with 1 AC input and 1 DC input option, front panel memory option, and internal rubidium clock reference option.

2. Antenna cables sold separately.

3. All units include an antenna, network time protocol (NTP), RS232 control of an external 10 MHz source via USB, Ethernet control, and data logging capabilities.

4. Contact Symmetricom (www.symmetricom.com) for current pricing and availability.

5. OP001 and OP002 are DTE; this may require the use of a null modem serial cable.

2 Installation

The ATS-6501 provides a number of features which may require additional setup and this section provides a guideline for the basic setup. After completing this section, the ATS-6501 will produce timing outputs to the coarse calibration accuracies specified in Appendix A. The ATS-6501 is designed to be quickly and easily integrated with other system components. Just a few steps are required in setting up the system so that it will begin producing accurate timing outputs. In order to set the system up, users will need to power up the system and set up communications in order to have access to the system command port.

2.1 Powering on the ATS-6501

Apply power to the system by supplying input power to at least one of the two power supplies. When power is applied to the ATS-6501 the front panel will go through a self test and then the ATS-6501 will begin booting up.

Note: If power is applied to both power supplies the Status Indicator on the front panel of both power supplies should be green. If power is applied to only one of the two supplies the power supply without input power should have a red Status Indicator the units Alarm Indicator should be red.

Note: The ATS-6501 front panel Power-On Self Test (POST) will occur even if the front panel software flash is removed.

A. The Date/Time display will sequentially test each segment on each individual position within the display.
B. One at a time, each position of the display will display the number 8 starting from the far left and working to the right.
C. Each LED below the Date/Time Display (Alarm, Oscillator Locked, GPS Tracking, NTP Locked, & Outputs Enabled) will be turned on one at a time starting from the left to right. As each LED is tested it will be green, then red, and then turn off with the exception of the GPS Tracking indicator, this indicator will turn red, then green, then off.
D. The Date/Time display will then display "-9876543210" on the front panel.
E. Lastly the Date/Time display will have a "-" in the center of each position in the display.
F. When the unit starts the application, the Oscillator Lock, GPS Tracking, and NTP Locked indicators will turn red momentarily the go out.
G. While the ATS-6501 is booting up and waiting for the internal oscillator to lock the LED indicators on the front panel below the Date/Time display should be off and the bars in the display after the POST will move to the top, then center, then bottom and then go out. This display will repeat as long as the unit is not tracking GPS.

Caution: The default antenna supply voltage is **ZERO**. If the antenna requires power to operate the system will stay in this mode until the antenna is properly configured. This prevents the system from potentially damaging any antennas until the antenna supply voltage is set properly.

As the ATS-6501 warms up, the Oscillator Lock indicator should come on within 5 minutes after the system is turned on. The Alarm light may turn on momentarily after the

Oscillator Lock light comes on. This is normal and does not indicate there is a problem with the unit.

2.2 Communicating with the ATS-6501

Operators are capable of communicating with the system through a LAN connection or via one of the USB Ports when using OP001 USB to Serial cable to access the command port.

2.2.1 DHCP

The ATS-6501 runs DHCP by default and will therefore automatically be assigned an IP address if it is connected to a network with a DHCP server. The ATS-6501 will display the current IP address assigned to the unit in the Date/Time display after pressing and releasing the Display pushbutton on the front panel. Users can use this IP Address to access the systems command port.

Note: If the LAN Cable is not connected to the unit an IP Address is not assigned and the front panel display button will not display an IP address. Once the LAN cable is connected to the unit it will automatically attempt to obtain an IP address from a DHCP Server. If this does not work you may need to power cycle the unit.

2.2.2 Static IP Addresses

If you require a Static IP Address there are two options to set the network information in the system.

2.2.2.1 Network

If the network has a DCHP Server you can obtain the IP Address (*ip addr*) by pressing and releasing the Display pushbutton on the front panel. Telnet into the system using "telnet *ip addr* 1700". Once the "ATS-6501>" prompt is displayed run the *network_config* command to manually configure the IP address for the unit. See Section (2.2.3).

.2.2.2.2 Console Cable

This feature allows local users to set the unit up without having to access the system via the network. Connect a terminal to one of the USB ports on the rear panel using the USB to Serial conversion cable (OP001). Changes can be made using any terminal program (e.g., HyperTerm, TeraTerm) from the serial port of a computer/terminal. The communication settings are 115200 Baud, No Parity, 8 Data Bits, and 1 Stop Bit. Once connectivity is established the user will see the ATS-6501> command prompt. Execute the *network_config* command to set the IP Address, Netmask, Broadcast IP, and/or Default Gateway for the system if you are using a static IP Address. See Section (2.2.3).

Note: Make sure the USB-to-Serial Converter (OP001) is installed in one of the two USB ports when the system is powered on. If not, power the system down, plug the cable in and re-apply power. The USB/Serial Cables are programmed to provide users access to the command port (OP001) or to communicate with a 5071A Cesium Clock(OP002). These cables are **NOT** interchangeable.

Caution: By default pressing and holding the Display pushbutton on the front panel for ~10 seconds will reset the IP address to the default of 192.168.0.1. The default IP address will display on the front panel after it is set. If the button is held down too long and the IP Address is set to the default by mistake, power-cycle the unit to restore the proper network settings. This front panel IP reset feature can be disabled using the *frontpanel_button* command. Users are cautioned that the reset feature is ON by default and must be turned off if this is not the desired behavior.

2.2.3 Setting a Static IP Address

Use the following steps to set the IP Address on the ATS-6501.

A. Telnet into the system *telnet ip addr 1700* and the ATS-6501> prompt should appear.

B. Use the *network_config* command and options to set the system to the desired network settings.

network_config --mode <DHCP|static> --ip <ip addr> --mask <mask> --broadcast <broadcast> --gateway <gateway>]

[Example]
network_config --mode static --ip 192.168.1.50 --mask 255.255.255.0 --broadcast 192.168.1.255 --gateway 192.168.1.1

C. These network settings will take effect immediately. Users should see the following:

<working> ..... Once timed out, the connection will drop.

D. Users connected via the network will need to reconnect to the system using the newly assigned static IP Address. These settings are stored on the system automatically and the system will start up with these settings each time it is rebooted or power cycled.

E. Users can also view the current network settings using the *network* command. This will display the current settings.

```
ATS-6501>network

  [broadcast] 192.168.1.255
  [default_gateway] 192.168.1.1
  [ip] 192.168.1.50
  [mode] static
  [netmask] 255.255.255.0
```

2.2.4 USB Ports

The USB ports on the rear panel allow:

- Users to access the command port (OP001). See section 2.2.2.2. Users can set the IP Address on the box following the instructions on section 2.2.3.B-C. The system will automatically connect to the command port and provide the ATS->6501 command prompt.
- The ATS-6501 to communicate with a 5071A Cesium Clock (OP002). See section 2.7.

2.3 Antenna Installation

Installing the antenna properly requires careful planning. The antenna location itself must be selected based solely on the ability to reliably receive the GPS Signal. This may be one of the primary factors in selecting the installation location of this unit depending on the length of the antenna cable.

Note: The antenna cable should have less than 10 dB of loss at 1.5 GHz. If this is not possible due to the cable type or length of cable then additional in-line amplifiers will be need to be installed or you will need a cable type with less loss.

The antenna included with the ATS-6501 has a mounting screw on the bottom. The screw allows the antenna to be easily and securely mounted on a 5/8" coarsely threaded rod. Threaded rods are available at most hardware stores and will need to be mounted securely to the side of a building or other stationary object. Once the rod is properly secured it will provide a stable mount for the antenna.

2.3.1 Antenna Location

This unit is typically mounted in a standard 19" equipment rack but the unit may also be operated from a bench top. No matter which location is chosen, the installation location should be selected keeping in mind that access to a suitable antenna location will be necessary for proper operation.

A. Placement of the GPS antenna is extremely important. It should be placed so that it has clear view of as much sky as possible. Any obstructions such as antennas, large metal objects, or buildings will limit the performance of the ATS-6501. The GPS antenna should have an unobstructed line of sight to the sky.

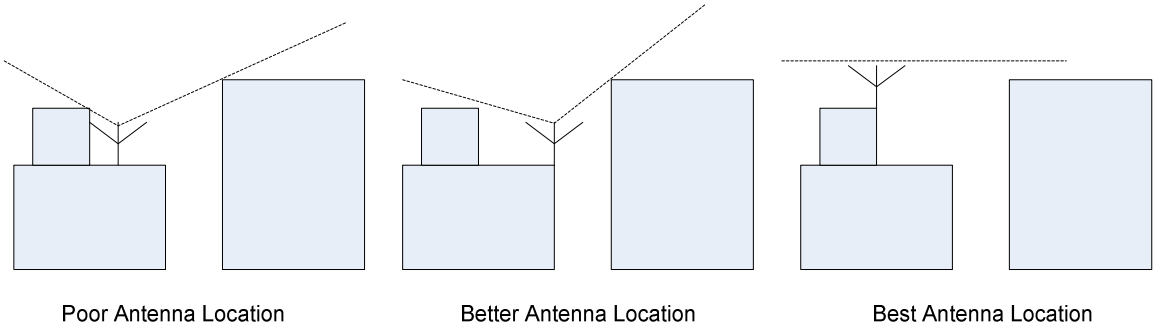

Figure 1 Antenna Location.

B. In selecting a location for the antenna, its proximity to the ATS-6501 should also be considered. Ideally, the antenna will be close enough to the ATS-6501 so that there will be a minimal loss through the antenna cable.

WARNING: An outside antenna system should not be located in the vicinity of overhead power lines or other electric light or power circuits, or where it can fall into such power lines or circuits. When installing an outside antenna system, extreme care

should be taken to keep from touching such power lines or circuits as contact with them might be fatal.

C. Once a suitable antenna location has been identified, it is necessary to ensure that the GPS signal that reaches the ATS-6501 is of suitable quality. The unit requires a minimum of 15dB gain from the antenna gain combined with the amount of loss in the antenna cable. The antenna included with the ATS-6501 has 25dB of gain so the total cable losses in the system must not exceed 10 dB at 1.5 GHz.

Note: If you are using a different antenna please ensure the antenna gain combined with the cable loss will provide sufficient signal strength for the ATS-6501.

D. If the location of the antenna dictates that a longer cable must be used then a line amplifier will need to be inserted into the signal path or you will need to run an antenna cable with less loss. A line amplifier is a device used to amplify the GPS signal to overcome the losses resulting from longer cable runs. In selecting a line amplifier it is necessary to make sure that it provides an adequate amount of gain and that it operates from 1200MHz to 1600MHz.

E. The amount of gain required from a line amplifier can be calculated by knowing the total loss of the antenna cables being used. The signal loss due to a cable varies depending upon the frequency of the signal. For the purposes of GPS antennas the cable loss should be calculated at 1500MHz. The manufacturer of the cable being used should be able to provide an estimate of the cable loss at 1500MHz. Once the cable loss is known it can be inserted into Equation 2-1 to calculate the required gain of the line amplifier

$$MIN\_Gain(dB) = \frac{Cable\_Loss(dB/100\,ft) * Cable\_Length(ft)}{100} - 12 \quad \text{Eq. 2-1.}$$

F. The *MIN_Gain* value in Equation 2-1 serves as the minimum gain required from the line amplifier being used. It is possible to use amplifiers with a slightly higher gain than the minimum value but it will not improve the performance of the system. Using amplifiers with significantly higher gain values can also cause degradation of the GPS signal because it overdrives the input of the GPS receiver.

G. Placement of the line amplifier is also a concern in a properly designed system. Placing the amplifier too far from the antenna may cause unexpected degradation in the GPS signal and the performance will remain poor. The best place for the amplifier is typically half way between the antenna and ATS-6501. This allows the line amplifier to benefit from any surge protection that may be installed near the antenna but is still close enough to the antenna so as not to degrade the signal significantly. Figure 2-2 shows the block diagram of a typical installation that requires a longer antenna cable. Another consideration when installing the line amplifier is how it will receive power. Some amplifiers are powered using a DC bias on the antenna cable and others are power from AC adapters directly. Please contact Symmetricom if you require assistance in selecting the right amplifier for your application.

H. The antenna mount should be secured to a stable structure such as a building, antenna mast, or other suitable mounting platform.

I. The Antenna is designed to withstand rain, snow, and dust. When selecting the mounting location for the antenna try to find a location that will not become buried in snow and/or covered by foliage. Keep the top surface of the antenna clean and brush off any ice and snow, to ensure your antenna performs optimally. In addition, ensure the connector remains clean and dry.

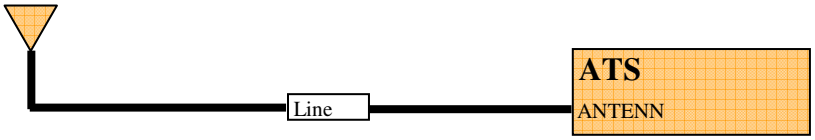

Figure 2Antenna Cable

2.3.2 Setting the Antenna Voltage

The ATS-6501 is capable of providing antenna power (0, 5, 12VDC) by DC biasing the antenna cable but this can cause damage to an antenna if the wrong voltage is applied. Prior to connecting an antenna to the unit, ensure the antenna voltage is set properly. The ATS-6501 is shipped from the factory with the default antenna voltage of 0 volts. If this is not the desired configuration then follow the steps below to set the proper antenna voltage.

A. Telnet into the system *telnet ip addr 1700* or connect via the USB Command Port and the ATS-6501> prompt should appear.

B. At the ATS-6501> prompt, type *settings gps* and press enter, this will display the user configurable GPS settings for the unit to see verify the current voltage being supplied to the antenna

```
ATS-6501>settings gps

  [antenna_delay] 0.000000000000000e+00
  [antenna_voltage] 0.000000000000000e+00
  [datum] wgs84
  [mask_angle] 1.000000000000000e+01
  [positioning]
    [auto_hours] 1.200000000000000e+01
    [manual_position]
      [altitude] 1.592729000000000e+03
      [latitude] 4.001941422777778e+01
      [longitude] -1.052390962444445e+02
    [mode] dynamic
```

C. To change the value, type *antenna_voltage* and the desired value (0, 5, or 12) and press enter. The system should respond with "OK".

```
ATS-6501>antenna_voltage 12
OK
```

Note: If you enter an incorrect value you will get the following message:

```
ATS-6501>antenna_voltage 3
```

```
Usage: 0, 5, or 12
```

D. You can verify the setting is correct by typing *settings gps:antenna_voltage* and pressing enter, this will display the updated user configurable settings.

```
0 VDC     [antenna_voltage] 0.0000000000000000e+00
5 VDC     [antenna_voltage] 5.0000000000000000e+00
12VDC     [antenna_voltage] 1.2000000000000000e+01
```

The antenna voltage setting can also be verified using a voltmeter. To verify the antenna voltage, apply the probes to the ANTENNA connector on the rear panel. The center conductor should be at a higher potential than the ATS-6501 chassis. This voltage reading indicates the voltage being provided to the antenna. If no voltage is present then the antenna is not being powered by the ATS-6501.

E. If this setting is correct type *save* to save the current user default configuration on the system to ensure the system provides the proper antenna voltage after a reboot or power cycle.

2.3.3 Outdoor Antenna Grounding

If an outside antenna is connected to the ATS-6501, be sure the antenna is grounded so as to provide some protection against voltage surges and built-up static charges. Article 810 of the National Electrical Code, ANSI/NFPA 70 provides information with regard to proper grounding of the mast and supporting structure, grounding of the lead-in wire to an antenna discharge unit, size of grounding connectors, location of antenna discharge unit, connection to grounding electrodes, and requirements for the grounding electrode.

2.3.4 Antenna Mask Angle

Adjustment of the antenna mask angle may be necessary for installations with severe multi-path problems. The mask angle of the antenna refers to the elevation angle above the horizon at which all satellites above it are tracked. It may be possible to track satellites below the mask angle but the data is intentionally omitted because it is unreliable. Installations with severe multi-path problems may find that they get better timing performance out of the ATS-6501 when using a higher mask angle. To set the mask angle access the system via the command port and use the *mask_angle* command to set the desired mask angle for the receiver. Mask angle value is in degrees.

```
ATS-6501>mask_angle 10
OK
```

You can verify the current value of the mask angle by sending the *settings gps:mask_angle* command.

```
ATS-6501>settings gps:mask_angle
1.0000000000000000e+01
```

If this setting is correct type *save* to save the current user default configuration on the system to ensure the system uses the proper mask angle after a reboot or power cycle.

2.3.5 Positioning Modes

The ATS-6501 offers three different modes for determining the antenna position and determining receiver operation, dynamic, auto, and manual.

2.3.5.1 Dynamic Position Mode

The Dynamic mode is typically used for systems located on mobile platforms.

Note: The system default mode is dynamic. Users at static locations should change this to auto or manual based on the information provided below.

2.3.5.2 Auto Position Mode

The Auto mode is recommended for static locations where the antenna location has not been surveyed. When using the Auto mode the ATS-6501 will automatically determine the location of its antenna. It does this by averaging its calculated position solutions over a period specified by the *auto_hours* parameter. The factory default for the position period is 12 hours. It is recommended that the auto positioning period should be set to at least 4 hours. Once the position_period expires the ATS-6501 will enter the fixed position mode *(status gps:position:fixed)*. Fixing the antenna position reduces the noise of the GPS measurements and increases the frequency stability of the timing outputs.

To set the positioning mode to auto use the *position_mode* command on the command port.

```
ATS-6501>position_mode auto
OK
```

To set the positioning period, use the *position_period* command. If not specified the value will be in hours. Users can set this value to minutes using *m* after the value.

```
ATS-6501>position_period 12
OK
```

Select the proper datum (WGS84 (default) or NAD83) using the *datum* command.

```
ATS-6501>datum wgs84
OK
```

To verify these use the *settings gps* command to check the current settings.

```
ATS-6501>settings gps

  [antenna_delay] 0.000000000000000e+00
  [antenna_voltage] 0.000000000000000e+00
  [datum] wgs84
  [mask_angle] 1.000000000000000e+01
  [positioning]
    [auto_hours] 1.200000000000000e+01
    [manual_position]
      [altitude] 1.592729000000000e+03
      [latitude] 4.001941422777778e+01
      [longitude] -1.052390962444445e+02
```

[mode] auto

If these settings are correct type *save* to save the current user default configuration on the system to ensure the system uses the positioning mode and period after a reboot or power cycle.

Note: If the unit is rebooted, power cycled, or the application is restarted with the positioning mode set to auto, the system will go through the process of determining its antenna position based on the position period (*auto_hours*). Once that period expires the system will again set itself fixed and use the new determined solution as the correct position. It will do this each time this occurs. The [ptd] or UTC offset value reported by the system will be noisier during the auto position period and will become significantly quieter when the antenna position is fixed.

In addition to automatically determining its antenna location, the ATS 6501 generates a RINEX (Receiver INdependent EXchange) format observation file. This file format is a standard used by the GPS community and provides all the necessary GPS measurements for determining the antenna location. The file can be retrieved from the system by using ftp (login: ftp, password: ftp) to log in and retrieve the file. Once logged in the file will be in the "rinex" subdirectory and will have a ".[yy]o" extension where [yy] represents the last two digits of the current year. Many online processing centers are available (e.g., http://www.ngs.noaa.gov/OPUS, http://sopac.ucsd.edu/cgi-bin/SCOUT.cgi) and will process the observation file free of charge. Doing this improves the position estimate of the antenna and is recommended for precise time recovery. After this is complete it is possible to set the position mode to manual using the coordinates provided by these services.

Note: The receiver has a countdown timer to show the amount of time left (*position_period*) while in the auto positioning mode. Once this timer counts to zero the RINEX file will be generated, the receivers position (*status gps:position:fixed*) will be true and the [time_remaining] field will show 0 seconds.

```
ATS-6501>status gps:auto_positioning
  [time_remaining] 10 hours, 53 minutes

ATS-6501>status gps:position
  [alt] 5.158040000000000e+01
  [fixed] false
  [lat] 3.846640074968000e+01
  [lon] -7.744043070197000e+01
```

2.3.5.3 Manual Position Mode

If the location of the antenna is known then the Manual mode should be used. This mode uses the information provided by the datum, latitude, longitude, and altitude parameters to fix the antenna position at startup.

Note: This bypasses the auto positioning period and does not generate a RINEX observation file. This mode of operation is recommended ONLY if the antenna position is known.

To manually set the antenna position, use the following steps:

Select the proper datum (WGS84 (default) or NAD83) using the *datum* command.

```
ATS-6501>datum wgs84
```

Set the latitude for the antenna using the *latitude* command.

```
ATS-6501>latitude 38.46627893094
or
ATS-6501>latitude 38.46627893094N
```

Note: Default is [N]orth. If you are in the southern hemisphere make sure there is an [S]outh after the latitude or a (-) before the latitude.

```
ATS-6501>latitude -38.46627893094
or
ATS-6501>latitude 38.46627893094S
```

Set the longitude for the antenna using the *longitude* command.

```
ATS-6501>longitude 77.44086542274004
or
ATS6501>longitude 77.44086542274004E
```

Note: Default is [E]ast. If you are in the Western hemisphere make sure there is an [W]est after the latitude or a (-) before the latitude.

```
ATS-6501>longitude -77.44086542274004
or
ATS-6501>longitude 77.44086542274004W
```

Set the altitude for the antenna using the *"altitude"* command. Default value is ellipsoid height meters. Users can specify the height in feet by using *F* after the value.

```
ATS-6501>altitude 51.573999999999998
or
ATS-6501>altitude 169.206037003 F
```

Verify the current settings are correct using the *settings gps* command or narrow it down further with the *settings gps:positioning:manual_position* and *settings gps:datum* commands.

```
ATS-6501>settings gps:positioning:manual_position

  [altitude] 5.1573999999999998e+01
  [latitude] 3.8466278930940000e+01
  [longitude] -7.7440865422740004e+01

ATS-6501>settings gps:datum
wgs84
```

If these settings are correct type *save* to save the current position on the system to ensure the system uses the manual positioning mode after a reboot or power cycle.

2.4 ATS-6501 Installation

The ATS-6501 is ready for installation into a standard 19" (48.3 cm) rack using either slides or shelves and will take up 1U of rack space. The C-300-S Series rack slides from General Devices or equivalent slides are recommended.

CAUTION: Use the screws provided with the unit to mount the rails to the side of the chassis. If longer screws are used, you could damage the power supplies or prevent them from being removed from the chassis.

2.4.1 Power Supplies

The ATS-6501 operates with two power supplies capable of operating on different power sources. The 4385A (AC Power Supply) and 4386A (DC Power Supply) are available. The ATS-6501 is capable of operating on one power supply in the event the other fails or its input source fails. Power Supply #1 is on the left and Power Supply #2 is on the right. See Appendix A for the specifications on the Power Supplies.

2.4.2 Output Cards

The ATS-6501 has the capability using six output cards in each unit. The cards slots are identified by number so the operator is capable of determining the slot of the card in the show command and identifying the cards physical location in the chassis. The view below is from the rear of the unit from left to right.

Slot 1	Slot 3	Slot 5
Slot 2	Slot 4	Slot 6

Figure 3 Rear Panel Output Card Locations

This ATS-6501 will operate with four different types of output cards. The output cards can be operated in any of the six slots. The unit will automatically detect and configure the system based on the cards installed. The cards are also hot swappable. Each output card has four output connectors with the output number identified as shown below in Figure 2-4. See Appendix A for the specifications of each output module.

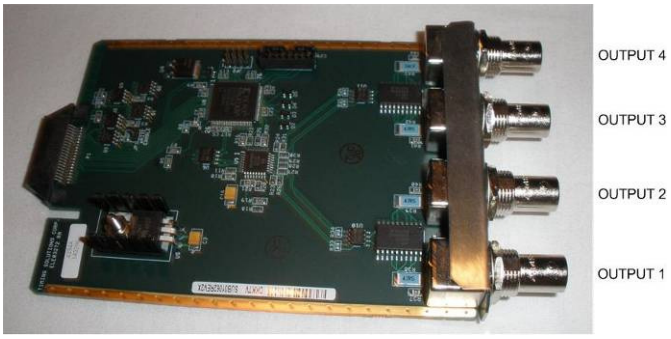

Figure 4 Output Modules

2.4.2.1 4394A (PPS/DC IRIG)

The factory default for this module provides two 1PPS outputs and two DC IRIG (B000) Outputs. Outputs 1 and 2 are 1PPS and Outputs 3 and 4 are DC IRIG.

The output types are user selectable/programmable. Users can change the signal types (PPS/DC IRIG), the PPS signal parameters, and the IRIG signal types on individual output ports.

- **PPS:** Valid PPS settings are 1, 10, 100, 1K, 10K, 100K, and 1M PPS. To set the PPS signal parameters use the *pps* command:

```
ATS-6501> pps [slot#] [port#] [pulse period] [pulse width]
```

The following example sets the PPS on Slot 1, Port 2 to 1MPPS and the pulse width to 500nsec (1/2 the duty cycle).

```
ATS-6501>pps 1 2 1e-6 5e-7
```

The following rules apply:

1. *Pulse_width* must be a multiple of 10 us, at least 10 us wide, and at most half the duty cycle of the *pulse_period*.
2. For PPS rates where half the duty cycle is less than 10 us, the *pulse_width* must be exactly one-half the *pulse_period*. (See example)

The system will generate an error message if the values are not correct.

To verify the settings use the *settings hardware:slots:N* command (where N=Slot #) to obtain the current settings for a particular card.

```
ATS-6501> settings hardware:slots:1
    [tsc4373]
      [ports]
        [1]
          [pps_period] 1
          [pps_width] 1.000000000000000e-04
          [type] pps
        [2]
          [pps_period] 1.000000000000000e-06
          [pps_width] 5.000000000000000e-07
          [type] pps
        [3]
          [format] B
          [signal_word] 0
          [type] irig
        [4]
          [format] B
          [signal_word] 0
          [type] irig
```

- **IRIG:** Valid DC IRIG Codes are A(000,003,007), B(000,003,007), D002, E002, G002, and H002. Default is B000. To set the IRIG Code for the individual ports use the *irig* command:

```
ATS-6501> irig [slot#] [port#] [Code A-H] [Code Format <NNN>]
```

The following example sets the IRIG for Slot 1, Port 3 to A 003.

```
ATS-6501>pps 1 3 A 003
```

The system will generate an error message if the operator attempts to enter an unsupported or invalid code.

To verify the settings use the *settings hardware:slots:N* command (where N=Slot #) to obtain the current settings for a particular card.

```
ATS-6501> settings hardware:slots:1
    [tsc4373]
      [ports]
        [1]
          [pps_period] 1
          [pps_width] 1.000000000000000e-04
          [type] pps
        [2]
          [pps_period] 1.000000000000000e-06
          [pps_width] 5.000000000000000e-07
          [type] pps
        [3]
          [format] A
          [signal_word] 3
          [type] irig
        [4]
          [format] B
          [signal_word] 0
          [type] irig
```

Note: The system will drop the leading Zeros in the signal_word.

To verify the card is working properly use the *status hardware:slots:N* command (where N=Slot #) to obtain the current settings for a particular card.

```
ATS-6501>status hardware:slots:1
   [ports]
     [1]
       [status] good
     [2]
       [status] good
     [3]
       [status] good
     [4]
       [status] good
   [power] enabled
   [type] 4394A
```

2.4.2.2 4395A-10 (10MHz) / 4395A-5 (5MHz)

No programming is required for these modules. These modules will also work in any of the 6 output card slots.

2.4.2.3 4387A (Modulated IRIG/NASA36)

This module provides four Amplitude Modulated (AM) IRIG Outputs or the NASA36 Serial Time Code. Valid AM IRIG Codes are A(130, 133, 137), B(120, 123, 127), E(111, 112, 121), G(141, 142, 147), and H(111, 112, 121, 122, 127). Default is B120.

- **IRIG:** To set the IRIG Code for the individual ports use the *irig* command:

```
ATS-6501> irig [slot#] [port#] [Code A-H] [Code Format <NNN>]
```

The following example sets the IRIG Code for Slot 5, Port 3 to G 141.

```
ATS-6501>irig 5 3 G 141
```

The system will generate an error message if the operator attempts to enter an unsupported or invalid code.

To verify the settings use the *settings hardware:slots:N* command (where N=Slot #) to obtain the current settings for a particular card.

```
ATS-6501> settings hardware:slots:5
    [tsc4387]
      [ports]
        [1]
          [format] B
          [signal_word] 120
          [type] irig
        [2]
          [format] B
          [signal_word] 120
          [type] irig
        [3]
          [format] G
          [signal_word] 141
          [type] irig
        [4]
          [format] B
          [signal_word] 120
          [type] irig
```

- **NASA36:** To set the NASA 36 Code for the individual ports use the *nasa36* command:

```
ATS-6501> nasa36 [slot#] [port#]
```

The following example sets the Time Code for Slot 5, Port 3 to NASA 36.

```
ATS-6501>nasa36 5 3
```

The system will generate an error message if the operator attempts to enter an unsupported or invalid code.

To verify the settings use the *settings hardware:slots:N* command (where N=Slot #) to obtain the current settings for a particular card.

```
ATS-6501> settings hardware:slots:5
    [tsc4387]
      [ports]
        [1]
          [format] B
          [signal_word] 120
          [type] irig
        [2]
          [format] B
          [signal_word] 120
          [type] irig
        [3]
          [format] G
          [signal_word] 141
          [type] nasa36
        [4]
          [format] B
          [signal_word] 120
          [type] irig
```

2.4.2.4 4372A Fiber output module

No programming is required for this module. This module will work in any of the 6 output card slots.

To verify the card is working properly use the *status hardware:outputs:slots:N* command (where N=Slot #) to obtain the current settings for a particular card.

```
ATS-6501>status hardware:outputs:slots:5
   [ports]
     [1]
       [status] good
     [2]
       [status] good
     [3]
       [status] good
     [4]
       [status] good
   [power] enabled
   [type] 4372A
```

2.4 Antenna Delay Calibration

Utilizing the ATS-6501 as a precise time recovery system requires a complete calibration of the ATS-6501 and distribution system. Cables and distribution equipment external to the ATS-6501 affect the calibration of the overall system and will result in an offset from UTC(USNO). This section assumes the on-time-point (OTP) of the system is the rear panel outputs on the ATS-6501. This may not be the desired location for the OTP; users should refer to section 2.5 for information on changing the location of the OTP for the system.

For applications requiring the highest level of accuracy, the ATS-6501 should be calibrated at Symmetricom. This process involves installing the user's antenna and antenna cable at the factory and comparing the PPS outputs to a system which has a known offset to UTC(USNO). Once the calibration is complete, the antenna delay value is provided to the customer when the unit is delivered to the user. The PPS outputs will be accurate to the precise calibration levels specified in Appendix A as long as the user installs the antenna at a surveyed location. If a surveyed antenna location is not available, the ATS-6501 can be used to survey the location. See Section 2.3.5 on determining the antenna position.

A coarse calibration of the ATS-6501 is accomplished by accounting for the individual system delays and combining them to determine the overall delay of the system. This method is generally less accurate because the individual delays in the system are estimated and may not be entirely accurate. Equation 2-2 gives the general formula for performing a coarse calibration of the ATS-6501.

$$\text{ATS\_6501}\_Delay(\text{sec}onds) = \frac{Length\_of\_Antenna\_Cable(meters)}{Signal\_Velocity(meters/\text{sec}ond)} - 48.5E-9$$

Eq. 2-2

The *Signal_Velocity* refers to the velocity of the GPS signal as it travels through the antenna cable. This information can be obtained from the manufacturer of the cable. It is typically specified as a percentage of the speed of light and it is up to the user to calculate the actual *Signal_Velocity*. Calculation of the *Signal_Velocity* is shown in Equation 2-3. It is calculated using the speed of light and the *Velocity_of_Propagation* given by the cable manufacturer. If the *Velocity_of_Propagation* is not available or the accuracy of the PPS signal is not important to the application then 0.85 may be used as a typical value.

$$Signal\_Velocity(meters/\text{sec}ond) = 299792458 * Velocity\_of\_Propagation \qquad \text{Eq. 2-3}$$

Once the ATS_6501 delay has been calculated, it must be entered into the system using the *antenna_delay* command. The example below is using a delay value of 118.5nsec. Once the antenna delay value has been properly set use the *save* command to save the current delay to ensure the system uses the correct delay value after a reboot or power cycle. Users can verify the value was set properly by using the *settings gps:antenna_delay* command and reviewing the settings.

Note: The new delay value will take effect immediately and could cause an alarm if the delay value forces the UTC(UNSO) offset to be larger than 100ns. The system will steer the internal clock to remove the antenna delay, if the alarm light came on it will go out once the UTC Value is within 100nSec. The ATS-6501 outputs will now be accurate to the coarse calibration accuracy specified in Appendix A.

```
ATS-6501>antenna_delay 1.185E-7
OK

ATS-6501>settings gps:antenna_delay
  [antenna_delay] 1.185000000000000e-07
```

2.5 On Time Point (OTP)

The OTP of a system is defined as the point at which the timing signals coincide with UTC(USNO). Typical systems use distribution amplifiers and cabling to distribute timing signals from a single source to multiple users. This distribution network will delay the timing signals and affect their accuracy. For this reason it is important to select an appropriate OTP so that the desired timing signals are accurate when they reach the user.

Section 2.5 calibrates the ATS-6501 assuming that the OTP of the system is the rear panel of the ATS-6501. This is not generally a convenient location for the OTP of the system because there will be a delay associated with the distribution of the signals to the user. Figure 2-5 illustrates how to move the OTP of the system from the rear panel of the ATS-6501 to the user inputs. In moving the OTP of the system it is imperative that the distribution delays from the ATS-6501 to each of the users is equal. This will ensure that all users receive accurate timing signals.

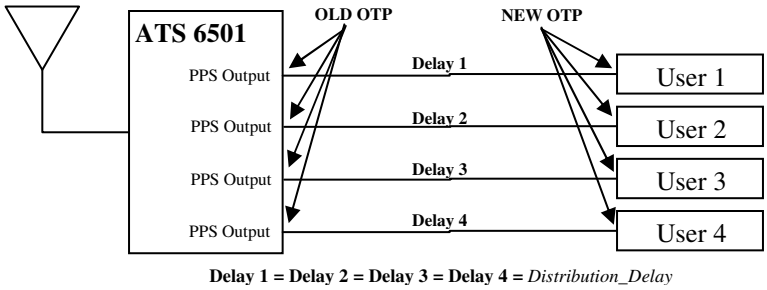

Figure 5 Timing System Diagram

Once the delay of the distribution network is known the OTP of the system can be shifted from the output of the ATS-6501 to the input of user equipment. Equation 2-4 is used to calculate the *antenna_delay* value that should be entered into the system to adjust the OTP. The *Distribution_Delay* is the measured delay of the timing distribution network as shown in Figure 3-2. The *ATS_6501_Delay* is the delay calculated in Equation 2-2 or the calibrated delay given by Symmetricom.

$$\text{ANTENNA\_DELAY} = \text{ATS6501\_}\textit{Delay}(\text{seconds}) + \textit{Distribution\_Delay}(\text{seconds}) \qquad \text{Eq. 2-4}$$

2.7 Using an External Frequency Reference:

Users may decide to provide an EXTERNAL frequency reference to the ATS-6501. The external frequency reference may be monitored by the ATS-6501 via RS232 through either of the USB Connectors on the rear of the unit (OP001). The Symmetricom 5071A is the only model currently supported; users should contact Symmetricom about the possibility of utilizing other clocks. The 5071A communications settings must be set to 9600 Baud, No Parity, 8 Data Bits, and 1 Stop Bit (9600,N,8,1) and a null modem cable will be required.

WARNING: Prior to setting the reference to external ensure the 10MHz signal from the reference is connected to the 10MHz IN connector on the rear of the ATS-6501. If not, the ATS-6501 outputs will not be within their specifications and it could take up to several hours for the system to begin providing the output within their specifications.

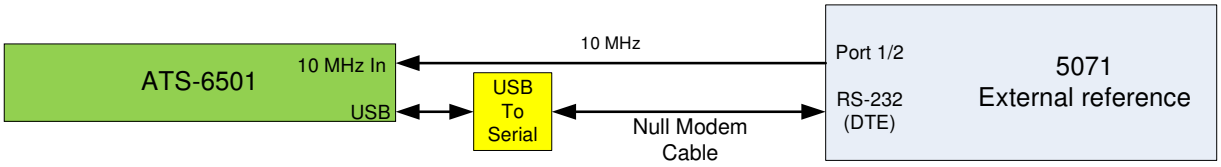

Figure 6 External Frequency Reference

Current status can be determined using the *status oscillator:external* command.

```
ATS-6501>>status oscillator:external
```

[external] signal missing	10MHz reference signal is not present. Do NOT select the reference type as External.
[external] cannot communicate	10MHz reference signal is present but the system is unable to communicate with the 5071A
[external] locked	10MHz reference signal is present and the system is able to communicate with the 5071A
[external] unknown	10MHz reference signal is present. The system will not attempt to communicate with the external reference.

Note: Make sure the USB-to-Serial Converter is installed on one of the two USB ports when the system is powered on. If not, power the system down, plug the cable in and re-apply power. The USB/Serial Cables are programmed to communicate with an external reference or to provide users access to the command port. These cables are **NOT** interchangeable.

To set the type of reference use the *reference_type* command. If users are operating with a Symmetricom 5071A and they will set the system up so the ATS-6501 is communicating with the 5071A select *hp5071A*, if not select *cesium*.

```
ATS-6501>reference_type hp5071a
OK
```

Note: If the system is unable to communicate with the external reference and the *reference_type* is hp5071A the Alarm light will come on and the Osc Lock light will go out and remain this way after you switch to the external reference. Make sure you select the proper *reference_type* before switching to external.

To set the reference to external use the *reference* command via the command port.

```
ATS-6501>reference external
OK
```

Note: The Alarm light will come on and the Osc Lock light will go out for a few seconds when you switch references. The system should clear all alarm indications within a few seconds.

To verify the settings use the *settings reference* command to check the current settings.

```
ATS-6501>settings reference

  [external]
```

```
[type] hp5071a
[source] external
```

If these settings are correct type *save* to save the proper reference and reference type in the default user configuration file on the system to ensure the system starts up properly after a reboot or power cycle.

2.8 Saving User Configuration Files

The ATS-6501 provides the flexibility of operating using different user configurations. Users are able to save these configurations for system settings and ftp | real-time data logging and recall them when needed via the command port.

2.8.1 User Configuration Files

The ATS-6501 will boot up with the **FACTORY** configuration settings automatically and will continue to use these settings until any changes to the configuration are made **and** saved as the user default settings (*default*). To save the user *default* file, simply type *save* and press enter. This will save the updated configuration and the ATS-6501 will boot up using the settings in the user *default* file. To see if the user settings have been saved use the *list* command to obtain a list of the possible configuration files. If there are no user configuration files available the system will report *no files*.

```
ATS-6501>list              ATS-6501>list
default          or        no files
```

Note: The user *default* file is used at start up if it is present otherwise the unit will start up with the factory *default* file. Users are encouraged to set **AND** save their default system settings based on their application so the system will start up properly after a reboot or power cycle.

Users can create other configuration files. Simply make the desired changes to the system configuration, type *save* and a filename to identify the configuration and press enter. The system will save this configuration containing the new settings. To use this configuration after the system has been rebooted use the *list* command to bring up a list of the possible configuration files and use the *load* command to have the system load and start running with the desired configuration settings. Use the *settings* command to ensure the system is using the desired settings based on the newly loaded configuration file.

```
ATS-6501>save example
OK
ATS-6501>list
example
default

ATS-6501>load example
OK
```

Note: The system will recognize case sensitive alphanumeric characters, -, ‘ ‘, and _. If any other characters are used the system will inform the user that the filename is not valid and will not save the settings.

```
ATS-6501>save te%^$st
```

```
Illegal filename
```

Users can also remove any configuration files that are no longer needed on the system. Use the *list* command to bring up a list of the available configuration files and use the *delete <filename>* command to remove the desired file. Users must provide the filename of the file to be removed from the system, if not the system will provide an error message reminding the user to identify the file to be removed.

```
ATS-6501>delete example
OK

ATS-6501>delete
Error: <filename>
```

Caution: Users can delete the *default* file. If this is done and a new user default configuration is not saved, the system will use the factory defaults when rebooted or power cycled.

2.8.2 FTP and Real-Time (rt) Configuration Files

The ATS-6501 will boot up with the **FACTORY** ftp | rt settings automatically and will continue to use these settings until any changes to the logging configurations are made **and** saved as the user default ftp | rt settings (*default*). This will save the updated logging configuration and the ATS-6501 will use these settings each time the system is rebooted/restarted. To save the default file simply type *save_logs ftp* or *save_logs rt*. To see if the user settings have been saved use the *list_logs ftp* or *list_logs rt* command to obtain a list of the possible configuration files. If there are no user configuration files available the system will report *no files.*

```
ATS-6501>list_logs ftp          ATS-6501>list_logs rt
default                         default
```

or if there are no user files,

```
ATS-6501>list_logs ftp
no files
```

Note: The ftp | rt user *default* files are used at start up if they are available otherwise the system will use the factory default settings. To modify the ftp or real-time logging behavior, make the changes needed based on your application and type *save_logs ftp* or *save_logs rt.* Users are encouraged to set the user default ftp |rt settings based on their application so the system will properly configure the logging after a reboot or power cycle.

Users can create other logging configuration files. Simply make the desired changes to the logging configuration, type *save_logs ftp* or *save_logs rt* and a filename to identify the configuration and press enter. The system will save this configuration containing the new settings. To use this configuration after the system has been rebooted use the *list_logs ftp* or *list_logs rt* command to bring up a list of the possible configuration files and use the *load_logs ftp* or *load_logs rt* command to have the system load and start running with the desired configuration settings. Use the *settings* command to ensure the system is using the desired settings based on the newly loaded logging configuration file.

```
ATS-6501>save_logs ftp example
OK
```

```
ATS-6501>list_logs ftp
example
default

ATS-6501>load_logs ftp example
OK
```

Note: The system will recognize case sensitive alphanumeric characters, -, ‘ ‘, and _. If any other characters are used the system will inform the user that the filename is not valid and will not save the settings.

```
ATS-6501>save_logs rt te%^$st
Illegal filename
```

The log files contain a header at the start of each line proceeded by a # indicating the data type for that line of data. If the user is logging multiple data types it allows them to sort out the data fields.

FTP:

```
#RANGEA,COM1_5,0,58.5,FINE,1518,243060.000,00a00008,5103,3311;20,21  …
#RXHWLEVELSA,COM1_5,0,58.5,FINE,1518,243060.000,00a00008,  …
#WAAS9A,COM1_5,0,54.5,SATTIME,1518,243239.000,00a00008  …
```

Real-Time:

```
$GPGGA,200240.00,3827.9772032,N,07726.4522017,W,9,08,1.5,51.663,M,,,03,0138*14
$GPGGA,200241.00,3827.9771961,N,07726.4521871,W,9,08,1.5,51.692,M,,,03,0138*1C
$GPGGA,200242.00,3827.9771900,N,07726.4521733,W,9,08,1.5,51.703,M,,,04,0138*1F
```

Users can also remove any logging configuration files that are no longer needed on the system. Use the *list_log ftp|rt* command to bring up a list of the available configuration files and use the *delete_logs ftp|rt <filename>* command to remove the desired file. Users must provide the filename of the file to be removed from the system, if not the system will provide an error message reminding the user to identify the file to be removed.

```
ATS-6501>delete_logs ftp example
OK

ATS-6501>delete_logs ftp
Error: ftp|rt <filename>
```

Caution: Users can delete the *default* file(s). If this is done and a new user default logging configuration is not saved, the system will use the factory defaults when rebooted or power cycled.

Use the *settings gps_logging:ftp* or *gps_logging:rt* command to ensure the system is using the desired settings based on the newly loaded configuration file. Use the *save* command to save the current system settings and this will also save the log settings and the system will use these settings after a power cycle or reboot.

3 Operations

Two distinct tasks are performed by the ATS-6501 1) collection of GPS measurement data 2) the generation of timing signals. These two tasks are entirely separate except for the fact that they must share CPU time and data from the GPS receiver. Because the generation of timing signals requires that events (e.g., clock steering) occur at very specific times, operational precedence is always given to timing tasks. As a result, any operations concerning the collection and storage of GPS data are postponed until all timing operations have been completed.

3.1 Front Panel

The ATS-6501 has several front panel indicators to provide the operator with the overall status of the unit and will provide a visual alarm indication if a problem with the hardware or the unit detects a condition that would cause the output signals to be outside of their timing specifications. More detailed status information can be retrieved using the *status* command on the Command Port.

Figure 7 ATS 6501 Front Panel

3.1.1 Power Supply Indicators

Each power supply has a front panel indicator that provides the operator an instant visual indication of the supply status. Power Supply #1 is on the left, power supply #2 is on the right as viewed from the front.

Indicator	Status
Off	No power is being provided to the ATS-6501.
Green	Power supply is good and is supplying power.
Red	ATS-6501 has power and the module has failed, is not seated properly, or is unplugged from the power source.

Table 3-1 Power Supply Indicator Status

3.1.2 Alarm Indicator

The Alarm LED will turn red when the unit is not producing timing within their specifications or the system has suffered a major hardware failure.

Indicator	Status
Off	Unit has no current alarms.
Green	This indicator should only turn green during the front panel POST.
Red	Either power supply is missing/has failed or is without input power. Any output module(s) is reporting a failure GPS not tracking for more than 6 hours GPS receiver hardware error Reference clock wander exceeded 100ns from UTC

	The outputs are not locked to the reference Over temperature (internal temperature is greater than 65 C) The internal rubidium clock is unlocked. If set up for an External Reference: • System is unable to communicate with the 5071A if set up to operate with that reference_type. • 10MHz input from the external reference is not detected

Table 3-2 Alarm Indicator

3.1.3 Oscillator Locked (Osc Lock) Indicator

The Oscillator Locked indicator on the ATS 6501 indicates the current status of the internal or external references. During system start up this light can take up to 10 minutes before it comes on.

Indicator	Status
Off	Internal Reference: • The Internal rubidium reports that it is not functioning properly • The OCXO cannot be steered. External Reference: • System is unable to communicate with the 5071A if set up to operate with that reference_type. • 10MHz input from the external reference is missing
Green	Internal: The rubidium reports that it is functioning properly and the OCXO is being steered. External: ATS-6501 is able to communicate with the external reference (if 5071A) and the 10MHz signal from the reference is available on the 10Mhz In connector.
Red	POST only.

Table 3-3 Oscillator Locked Indicator

3.1.4 GPS Tracking Indicator

The TRACKING GPS light indicates whether the unit is collecting data from enough GPS satellites to calculate a position and time solution. If the light is green then the GPS data is being used in steering the frequency reference. If it is not lit and GPS was previously available then the reference is being steered to the unit's best estimate of UTC(USNO). This light should be green during normal operations but may have occasional outages depending on the location of the GPS antenna and quality of the installation. These outages do not significantly degrade the timing performance of the system unless they occur for extended periods of time. If this light remains off for more than six hours then the ALARM light will illuminate to indicate a possible error. This light will turn RED if the operator manually enters a position and makes an error such that the GPS receiver is unable to use the data.

Indicator	Status
Off	GPS receiver is not tracking at least four GPS satellites Position coordinates were entered incorrectly (Manual Mode). External Reference: This indicator will go out when the 10Mhz is lost and will come back on after the 10Mhz has been restored.

Green	The GPS receiver is in fine time mode (< 50 ns)
Red	POST Only.

Table 3-4 GPS Tracking Indicator

3.1.4 NTP Locked Indicator

A Network Time Protocol (NTP) server is provided for the dissemination of time to other devices on the network. When this indicator is green the system has accurately set it's time, the internal NTP Server is operating, and the ATS-6501 is capable of accurately synchronizing any of the nodes on your network that are pointing to this device as the NTP Server. If the indicator is off, the NTP Server is not meeting specifications.

Indicator	Status
Off	NTP server is not providing time that meets specification.
Green	NTP server is providing time that meets specification.
Red	POST only.

Table 3-5 NTP Locked Indicator

3.1.5. Outputs Enabled Indicator

This indicator provides the operator a visual indication regarding the output modules installed in the rear card slots on the unit. No user set up is required and the system will automatically configure the internal monitoring based on the card installed in each slot. To determine which module(s) is causing the alarm use the *status health:output_modules* command.

Indicator	Status
Off	Outputs not yet enabled
Green	Outputs are enabled and reporting their status is good.
Red	POST Only

Table 3-6 Outputs Enabled Indicator

3.1.6. Fans

Each fan is monitored by the ATS-6501. Any issues with the fans will be reported as an issue under the [health] status for the fans. Fan #1 is on the left and fan #2 is on the right. To check the status of the fans use the following commands on the command port.

```
ATS 6501>status fan

  [1] true                          true indicates the fan is working
  [2] true                          false indicates the fan is off

ATS 6501>status health:fan

  [1]
    [active] false
    [occurrences] 0
  [2]
    [active] false
    [occurrences] 0
```

The active line will display false when the fans are functioning normally and true for one or both fans if they are not. If a fan is having issues you will see the number of occurrences increment up from 0 as each event occurs.

3.1.7. Flash Card

This card contains the operating software for the system.

3.1.8. Display Button

When pressed, this button will display the ATS-6501's current IP Address if the address has been set through DHCP or statically. If the system is set up to use DHCP and it was unable to obtain an IP Address the system will set the IP Address to 0.0.0.0 and will not display an IP Address when this button is pressed.

The second feature of this button is enabled by default. If this button is pressed for 10 seconds it will set the IP Address on the system to 192.168.0.1. This is a temporary setting and it will not survive a system reboot or power cycle. This feature can be disabled using the *frontpanel_button* command and setting the value to 0. Once set the value can be confirmed using the *settings hardware* command. Make sure to *save* the system settings.

```
ATS-6501>frontpanel_button 0
OK

ATS-6501>settings hardware
  [enable_fp_button] false
```

3.2 Rear Panel

All hardware interfaces and connectors are located on the rear panel of the ATS-6501. The system can provide six types of timing signals: 1 PPS, 10 MHz, 5MHz, DC IRIG, AM IRIG, and NASA36 depending on which output modules are installed and the system configuration settings. Each output module has four BNC(F) connectors. These outputs can be used to directly feed other instruments or feed a distribution system that provides any number of user outputs. The on-time-point (OTP) of the system is typically at the output of the BNC connectors (Section 2.5) but it can be adjusted to be any point in an integrated system by accounting for distribution delays and adjusting the antenna delay value (Section 2.6).

Figure 8 ATS 6501 Rear Panel

The only inputs required for operation of the ATS-6501 are at least one power source and the GPS Antenna. GPS is the source of time (UTC) for the unit and the ATS-6501 will not start up without it. Once at least four satellites have been acquired the unit will continue to output timing signals even when the GPS antenna is removed. However, the accuracy of these outputs will degrade over time.

Connection to a local area network (LAN) is supported by the ATS-6501. This allows users to access the unit remotely and also provides error monitoring capabilities. In addition, the ATS-6501 can serve as the source of network time for other systems on the network if using network time protocol (NTP). The USB ports can be used in conjunction with a USB-to-Serial conversion cable to allow users access to the command port via a local terminal and/or allows the system to communicate with an external reference (5071A). The GPS Antenna connector is used to connect the GPS Antenna to the system. The 10MHz IN connector is used to provide the 10MHz signal input from an external frequency reference. See Figure 9.

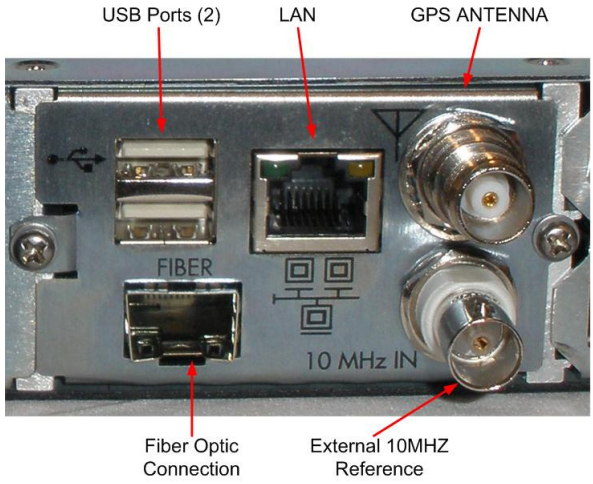

Figure 9 Rear Panel Connections

Note: The Fiber Optic Connection is not currently enabled and is available for expanding the system's capabilities in the future.

3.3 Software

3.3.1 Current Version

ATS-6501: Users can obtain the current software version via the command port using the *status tflex:ver* command.

```
ATS-6501>status tflex:ver
tflex-3-3-5
```

CAUTION: Do **NOT** remove the software flash while the unit is on, it may cause an unrecoverable error on the flash rendering the system inoperative.

GPS Receiver: Users can obtain the current GPS firmware version by sending the *status gps:model* command.

```
ATS 6501>status gps:model

  [hw_version] OEMV3G-4.00-X2T
  [name] L12LV
  [serial_number] DAB08190113
```

[sw_version] 3.400

3.3.2 Software Updates

Upgrading the software can be accomplished via two methods.

3.3.2.1 Flash Card Replacement

This requires removing the currently installed flash disk and installing a new one which has the updated software. Power the system down, press and release the SD card located in the SD Card slot on the front panel. Remove the current flash disk and replace it with the new flash. Once the new flash is securely installed restore power to the unit. The system network and user configuration settings are **NOT** saved and the system will need to be set up.

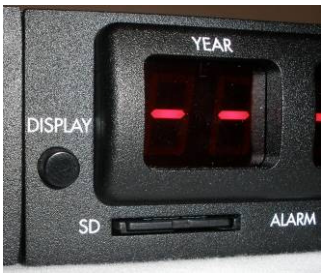

Figure 10 Flash Card

3.3.2.2 Remote Software Update

The ATS-6501 software can be updated remotely over the network. Users can download the new software image onto the flash and run the *software_update* command to load the new software onto the flash. Once the software has successfully been updated the system will automatically reboot. The system network and user configuration files will be saved and reloaded onto the new software image and do not require any additional steps. To update the system with the new software:

1. FTP into the system and log in (username: ftp, password: ftp).

2. Switch to binary transfer mode if needed, upload (put) the .iso file, and quit ftp.

```
localhost> ftp 192.168.1.254
Connected to 192.168.1.254.
220 tflex FTP server (Version 6.00LS) ready.
Name (192.168.1.254:localhost): ftp
331 Guest login ok, send your email address as password.
Password:
230 Guest login ok, access restrictions apply.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> binary                          Use this command to switch to binary if needed.
200 Type set to I.
ftp> put tflex.tflex-3-3-5.iso
local: tflex.tflex-3-3-5.iso remote: tflex.tflex-3-3-5.iso
229 Entering Extended Passive Mode (|||53133|)
150 Opening BINARY mode data connection for 'tflex.tflex-3-3-5.iso'.
100% |*****************************************************************************|  9644 KB  397.51
KB/s    00:00 ETA
```

```
226 Transfer complete (unique file name:tflex.tflex-3-3-5.iso).
10856448 bytes sent in 35.75Seconds 303.68Kbytes/sec.

ftp> quit
221 Goodbye.
```

3. Use the *software_update /<filename>* command to update the software. When the application launches, users should see the following information on the console as the updater application run through the routine to update the system software.

```
ATS-6501>software_update /tflex-3-3-5.iso
common_updater.sh: Creating filesystem on /dev/mmcsd0s2a ..... ..... ..... ..... .... done.
common_updater.sh: Creating filesystem on /dev/mmcsd0s2e ..... ..... . done.
common_updater.sh: Storing files tar: Removing leading '/' from member names
. done.
common_updater.sh: Unpacking files ..... ..... ..... ..... ..... ..... ..... ..... ..... ... done.
common_updater.sh: Unpacking files . done.
```

4. Once the update is complete the system will automatically reboot. Local users will see the front panel display lock up for ~2 minutes. After this the system will begin launching the application and local users will see the typical boot process where the bars repeatedly start off at the top, move to the middle, then bottom, then go out. The application start up will take ~2 minutes. Once the oscillator lock light is on it should take about 1 minute to begin tracking GPS and the front panel clock to come back. It will take an additional 1.5 to 2 minutes for NTP to lock and for the outputs to be enabled.

Note: Users can obtain the new software image from Symmetricom ftp://ftp.timing.com/pub/ATS-6501. If the software update is not applied and the unit is rebooted or power cycled users will need to upload the .iso file again in order to update the system software.

3.3.3 GPS Firmware Updates

Updating the firmware on the GPS receiver requires that the GPS receiver be removed from the system, updated, and reinstalled. The GPS Firmware version can be checked using the *status gps:model* command.

```
ATS-6501>status gps:model

 [hw_version] OEMV3G-4.00-X2T
 [name] L12LV
 [serial_number] DAB08400075
 [sw_version] 3.400
```

3.3.4 Declassifying the System

Some users may require that the ATS-6501 be declassified before shipping the system to a new location. Doing this involves removing all non-volatile memory from the unit. Power the system down and press lightly on the SD Card in the slot on the front panel. This will release the SD Card. Simply remove the flash disk from the front panel. The flash disk must be destroyed per the user's standard security procedures. A new flash disk can be obtained from Symmetricom.

3.4 User Interfaces

Software interfaces on the ATS-6501 are limited in their ability to provide users with real-time control. Adjusting some system parameters during operation of the ATS-6501 can seriously impact the timing performance of the unit and therefore the ability to adjust these parameters is limited by the software. Once properly installed, the ATS-6501 serves as a stand-alone device which requires little to no interaction. Remote error monitoring capabilities are provided as a means to ensure that the unit is powered and operating properly.

3.4.1 Operating System

The ATS-6501 operates a TSC modified version of FreeBSD. FreeBSD is a Berkeley derivative of the UNIX operating system and largely equivalent to other UNIX operating systems.

3.4.2 Telnet

One advantage of accessing the ATS-6501 via telnet is that multiple telnet sessions may be active at once. It is recommended that users connect directly to the desired port based on the function(s) they are going to perform.

- 1135 Real Time Logging
- 1700 Command
- 1800 Diagnostics
- 1900 Status

3.4.3.1 Real Time Data Port (1135)

Certain applications require that GPS data be retrieved in a timely manner. For this purpose, Port 1135 may be configured to provide real-time data output. Users can specify which logs are output and users may request any of the ASCII logs specified in the user manual for the Novatel OEMV receiver (http://www.novatel.com/support/docupdates.htm#oemv).

3.4.3.2 Command Port (1700)

System commands can be issued to the ATS 6501 via the command port. These commands provide a limited set of operations to be used for remote control of the system. Typically, a remote monitoring station may record an error that indicates user intervention is required. The remote monitoring station would then be able to access the command port via the Ethernet and issue the commands required for recovering from the error. The following list provides a short description of each command.

Note: All commands are in lowercase and the commands **are** case sensitive.

Command	Description
altitude	Set Antenna altitude Default units = [m]meters, optional [ft] feet
antenna_delay	Sets GPS antenna delay in seconds.
antenna_voltage	Set GPS antenna voltage (0,5,12)
clear_alarms	Clears latched alarm events.
config	Shows unit configuration parameters
datum	Set GPS datum, Default = wgs84, option nad83
delete	Deletes specified user system configuration files.

Command	Description
delete_logs (ftp|rt)	Deletes specified user ftp|rt logging configuration files.
diag	Adjust diagnostic logging levels.
diag_port	Switch to the diagnostic port (1800).
fix_position	Sets a static location based on current GPS determined position location or it allows the operator to enter the latitude, longitude, and altitude. [current] or [<latitude> <longitude> <altitude>]. Default = Current.
frontpanel_button	Enables(1) or disables (0) the front panel button from resetting the units IP address if held in for ~10Seconds.
help, h or ? <command>	Display help for a command or list all commands. Proper format is to proceed the command with help, h, or ? help <command>
irig	Allows the operator to set the IRIG codes on the 4394A (DC IRIG) and 4387A (AM IRIG) Cards.
latitude	Sets latitude, Default [N], option [S] or [-].
list	List available user configuration files available on disk. If there are no files listed the ATS-6501 is using the factory default settings.
list_logs (ftp|rt).	Lists the user gps logging settings for the ftp or real-time (rt) configuration files. If there are no files listed the ATS-6501 is using the factory default settings.
load	Restore system configuration settings from a file on the disk
load_logs (ftp|rt).	Restore the ftp or rt user logging configuration settings from file(s) on the disk
log (ftp|rt) [type].	Add a GPS log. User must specify if the log is for ftp or real time (rt) logs, and the log type desired from the Novatel receiver.
log_compression	Enable or disable GZIP compression for the ftp log files. 0=Off 1=On
log_enable (ftp|rt)	Enable or disable GPS logging, Specify ftp or real time (rt) then off|on. 0=Off, 1=On
log_filename	Set name pattern of log files log_filename <user|timestamp> Timestamp – files are named based on the date/time they were created with an optional suffix. User – Users supplies file prefix name, Unique ID, and suffix for the filename.
log_interval	Sets the GPS logging interval for ftp files, in minutes log_interval <interval in minutes> [1-1400]
log_number	Sets the maximum number of GPS ftp log files. log_files <number>
longitude	Set longitude. longitude <degrees> [E](default) or [W]
mask_angle	Set mask angle. mask_angle <degrees>
nasa36	Allows the operator to enable the Nasa36 time code on the selected 4387A (AM IRIG) card port.
network	Show network interface configuration
network_config	Set up network settings. [--mode DHCP|static] [--ip <ip>] [--mask <netmask>] [--broadcast <broadcast>] [--gateway <gateway>]
position_mode	Set GPS position mode. position_mode [auto|manual|dynamic]
position_period	Set GPS auto-positioning period. position_period <period> [h]ours(default) or [m]inutes.
pps	Allows the operator to set the PPS parameters on the 4394A Card.
prompt	Allows the operator to change the command prompt for the current session or make the changes part of the system default settings.

Command	Description
quit	Closes the command connection and terminates the telnet connection.
reboot	Reboots the ATS 6501.
reference	Indicates which frequency reference to use (internal | external)
reference_type	Indicates which frequency reference is providing the external reference input (cesium|hp5071a)
restart	Restarts the application without rebooting the system
save	Save current configuration settings to disk. save <filename>. Default = <default>
save_logs (ftp|rt).	Save GPS logging settings to disk. logs_save (rt|ftp) <filename>. Default = <default>.
settings	Shows the current user control/configuration settings.
show	Shows the current system factory (config), user configuration (settings), network (network), and system status (status) values. This command is the equivalent of sending these 4 commands at the same time.
software_update	Execute the software update routine.
status	Shows the values of all runtime status variables
status_port	Switch to the status port (1900)
syslog	Dump system log. syslog error|info|debug.
unlog (ftp | rt) [type]	Clear specified GPS logs. unlog (rt|ftp) [type] Default = all logs.

Table 3-7 System Command List

Access to the ATS6501 command port is available via telnet (Port 1700) and through the USB Ports located on the back of the unit via the OP001 Console Cable. The ATS-6501 is a DTE device utilizing the RS232 communication protocol. Settings for the port are: 115,200 baud, 8 data bits, 1 stop bit, no parity, and no flow control. It is sometimes necessary to access the system via the USB port because the ATS-6501 may not be accessible via the network until the IP Address has been set.

3.4.3.3 Diagnostic Port (1800)

The ATS-6501 provides an IP port to aid in diagnosing system errors. Each of the subsystems within the ATS-6501 provides diagnostic output that can aid in identifying system errors. It is typically not necessary for users to access the diagnostic port because all system errors are reported on the front panel (Alarm Light), in the alarms list (*status alarm*) and/or can be recovered using the *syslog* command.

Diagnostic messages are only displayed on the diagnostic port. If users wish to save the messages provided by the diagnostic port then the output of this port must be saved to a file. It is recommended that diagnostic messages be saved only to remote systems and not locally on the ATS-6501. Storing files locally may cause the file system to exceed its storage capacity and the ATS-6501 will no longer operate.

The options for the diagnostic outputs include error, info, or debug messages from the GPS receiver, kas2, and the clocks. To determine the current settings telnet into the command port and use the *settings diaglog* command.

```
ATS-6501>settings diaglog
    [clock] info
    [gps] info
```

```
[kas2] info
```

To change the settings use the *diag* command then specify which subsystem you would like to change (gps, kas2, clock), then specify which message types (error, info, or debug) you would like to see for that subsystem. Example – if you want to look at the debug messages for the GPS use the *diag gps debug* command. You can verify this by using the *settings diaglog* command.

```
ATS-6501>diag gps debug
OK

ATS-6501>settings diaglog

    [clock] info
    [gps] debug
    [kas2] info
```

Users can modify these settings as needed and are able to save these settings to the default start up if desired by typing *save*. These settings can also be saved to a different configuration file if desired by typing *save* and providing a configuration filename.

3.4.3.4 Status Port (1900)

This port provides users with real time system status updates. As the fields that are displayed using the config, settings, status, and network commands are updated internally they are forwarded to this port in real time. Users wanting to display system parameters, measurements, and/or alarms in real time are able to use the data provided by the status port to update their displays in real time. See Appendix C for an example of the data provided by the status port.

3.4.4 File Transfer Protocol (FTP)

Allows users to:

- Obtain the FTP log files and the RINEX files. The gps log files are available in the ftp user's home directory and the rinex files are available in the rinex subdirectory. Users can get to these files using the change directory command (*cd rinex*).
- Upload a new software version (.iso) and use the *software_update* command to update the system software.

The ftp user (username: ftp, password: ftp) has read and write access to these GPS log files and software update images. The ftp user cannot delete the files in the rinex subdirectory.

3.4.4 Network Time Protocol (NTP)

Network Time Protocol (NTP) is provided for the dissemination of time to other devices on the network. The NTP structure classifies devices based upon levels referred to as stratums. Stratum-1 indicates a clock that is obtaining time from a reference clock. The ATS-6501 NTP server is a stratum 1 server. To check the status of the internal NTP Server telnet into port 1700 and use the *status ntp* command. locked = true indicates the system is providing accurate time, false indicates it is not. The source should indicate that it is using the internal reference clock (REFCLK(25,0)).

```
ATS-6501>status ntp
  [locked] true
  [source] REFCLK(25,0)
```

3.5 Status Command

The ATS-6501 provides overall system status, health, and measurement results via the *status* command available on the command port (1700). For more detailed information and a description of the fields refer to Appendix B.

Status provides a sequence of field names to distinguish various devices and information from one another. Each information field has a unique ID. Users can display the entire set of data fields using the *status* command. It is possible to further refine the data requested by adding additional information fields to the command line. For example, if the user simply wanted to get the information on this system type *status tflex.*

```
ATS-6501>status tflex

  [network]
    [MAC] 00:30:96:00:00:98
    [broadcast] 192.168.1.255
    [ip] 192.168.1.253
    [netmask] 255.255.255.0
  [serial_number] SP00235
  [start] 2009-06-04-22:46
  [uptime] 15 hours, 29 minutes, 44 seconds
  [ver] tflex-3-2-4
```

Users can further refine the requested data fields by adding the desired information line to the field to look for specific data. If the user wanted to look for the system uptime, the user would simply add a ":" then the sub-category under Tflex. Additional subcategories can be added to the command line, separated with the ":".

```
ATS 6501>status tflex:uptime
15 hours, 29 minutes, 55 seconds

ATS 6501>status health:fan:1

  [active] false
  [occurrences] 0
```

3.6 Data Logging

Certain applications require that GPS data be retrieved in a timely manner. There are two available options for this purpose.

- FTP Data Logging
- Real Time Data

3.6.1 FTP Data Logging

Data can be recorded and stored on the ATS-6501 and can be retrieved via a FTP client (username: ftp, password: ftp). The logs that are stored are determined by the user and can be one

of any of the ASCII logs specified in the Novatel OEMV user manual. To set up data logging users will need to follow the steps outlined below to set up the type of data to be logged, log file intervals, maximum number of log files to store, set up the filename schema, set the file compression on or off, and then turn the logging on. Users can also verify the data logging configuration settings.

The OEMV user manual is at: (http://www.novatel.com/support/docupdates.htm#oemv)

A. Access the system via the command port.

B. Use the *log ftp <novalog>* command to set up they data type to be sent over the data port. The *novalog* text on the command line specifies which data type to forward over this port. Some examples are provided below.

```
ATS-6501> log ftp timea ontime 1

        ionutca  onchanged          // log IONO & UTC data
        rawalma onchanged           // log almanac on startup
        rangea  ontime 60           // L1/L2 observations @ 60 seconds
```

C. Set the interval for the log file to the desired value using the *log_interval* command. Log interval value is in minutes and can be between 1 and 30 minutes. Default is 15 minutes.

```
ATS-6501>log_interval 15
OK
```

D. Set the maximum number of log files for the system to hold in memory using the *log_number* command. If the logs in the storage directory exceed the maximum number of logs then the oldest log will be deleted to ensure that there is room for new logs. Default is 100 log files.

```
ATS-6501>log_number 4
OK
```

Note: Your data retrieval setup will need to take these values into account. The maximum time the logs will be available on the system is the log_interval * log_files, in the examples above that is 60 minutes. If you are not retrieving the files frequently enough you will lose data.

E. Use the *log_filename (user|timestamp)* to set up the file naming scheme. Default is *timestamp*.

   a. When using the **user** file naming scheme you will also need to provide the file prefix, the number of digits you would like to use as the unique file identifier, and the suffix for the file.

```
ATS-6501>log_filename user Test 4 dat
OK
```

   File will be stored as: Test####dat, where the # is a sequence of 4 numbers and characters to uniquely identify the file name.

Note: When the file are stored using the "user" option, the filename will not end with a *.gz* extension even if the compression is turned on.

b. When using the **timestamp** file naming scheme the files are written out at the log_interval setting and time stamped starting with the last two digits of the year, two digit month, two digit day, two digit hour, and two digit minute when the log was opened. Example (File 0810021530) log was opened 2 Oct 2008 at 15:30 (UTC). This command will also accept an optional suffix to append to the filename (i.e. .nov = 0810021530.nov).

```
ATS-6501>log_filename timestamp <suffix>
OK
```

Warning: If the ATS-6501 is currently logging data and you change the file naming convention you may wipe out any saved files stored in memory. Ensure these files are downloaded prior to making any changes to prevent a possible loss of data.

F. If file compression is desired use the *log_compression* command and turn the compression on (1) or off (0). Default is on (1)

```
ATS-6501>log_compression 0                (Compression=Off)
OK
```

Note: When using compression in conjunction with the timestamp filename option the file will end with the *.gz* file extension. User defined filenames will not append the *.gz* extension. Users will need to keep this in mind when they attempt to open these files.

G. You can verify the data logging settings using the *settings gps_logging:ftp* command.

```
ATS-6501>settings gps_logging:ftp

  [compression] false
  [enable] false
  [file_count] 4
  [filename]
    [digits] 4
    [prefix] test
    [suffix] dat
    [type] user
  [interval] 15
  [log_selection]
        [bestposa] ontime 7200
        [ionutca] ontime 7200
        [rangea] ontime 60
        [rawalma] onchanged
        [rawephema] onchanged
        [rxhwlevelsa] ontime 60
        [waas9a] onchanged
```

H. If needed, turn the ftp logging on using the *log_enable* command.

```
log_enable ftp 1
```

Once the data logging is enabled the settings gps_logging:ftp:enable value will = true.

Users can make changes to the desired information that is being logged by using the log command to add logs as described above or delete a desired log using the *unlog* command. To delete the desired data type use the *unlog ftp [datatype]* command to remove the desired data from the list. Users can remove all of the log files simply using the *unlog ftp all* command.

```
ATS-6501>unlog ftp waas9a
OK

ATS-6501>settings gps_logging:ftp

  [compression] true
  [enable] true
  [file_count] 100
  [filename]
    [digits] 3
    [prefix] user
    [suffix] nov
    [type] timestamp
  [interval] 15
  [log_selection]
    [bestposa] ontime 7200
    [ionutca] ontime 7200
    [rangea] ontime 60
    [rawalma] onchanged
    [rawephema] onchanged
    [rxhwlevelsa] ontime 60
```

Once the desired changes are made save the set up using the *save_logs ftp* command.

```
ATS 6501>save_logs ftp
OK
```

Note: If you do not save the setup the system will come back up with the factory defaults when the system is rebooted and any changes that were made will not be retained. Users can also save these settings to a different configuration file if desired by adding the filename to the *save_logs ftp* command.

3.6.2 Real Time Data Logging

For this purpose, Port 1135 may be configured to provide real-time data output. Which logs are output will be specific to the application but users may request any of the ASCII logs specified in the user manual for the Novatel OEMV receiver http://www.novatel.com/support/docupdates.htm#oemv

To set up the real time data logging users will need to follow the steps outlined below to set up the type of data to be logged and then turn the logging on. Users can also verify the data logging configuration settings.

A. Telnet into the command port (1700).

B. Use the *log rt <novalog>* command to set up they data type to be sent over the data port. The *novalog* text on the command line specifies which data type to forward over this port. Some examples are provided below.

```
log rt timea ontime 1

    ionutca  onchanged          // log IONO & UTC data
    rawalma onchanged           // log almanac on startup
    rangea  ontime 60           // L1/L2 observations @ 60 seconds
    ionutca  ontime 7200        // log IONO & UTC data every 2 hours
    rawephema  onchanged        // log broadcast ephemerides
    waas9a  onchanged           // log WAAS data
```

C. If needed, turn the real time logging on using the *log_enable rt* command.

```
log_enable rt 1
```

D. You can verify the real time log settings using the *settings gps_logging:rt* command.

```
ATS 6501>settings gps_logging:rt

[enable] true
[log_selection]
   [timea] ontime 1
    [waas9a] onchanged
```

E. The data requested will now be available on port 1135.

Users can make changes to the desired information that is being logged by using the log command to add logs as described above or delete a desired log using the *unlog* command. To delete the desired data type use the *unlog rt [datatype]* command to remove the desired data from the list. Users can remove all of the log files simply using the *unlog rt all* command.

```
ATS-6501>unlog rt waas9a
OK

ATS 6501>settings gps_logging:rt

[enable] true
[log_selection]
   [timea] ontime 1
```

Once the desired changes are made save the set up using the *save_logs rt* command.

```
ATS 6501>save_logs rt
OK
```

Note: If you do not save the setup the system will come back up with the factory defaults when the system is rebooted and any changes that were made will not be retained. Users can also save these settings to a different configuration file if desired by adding the filename to the *save_logs rt* command.

3.7 WAAS Satellites

The ATS-6501 is capable of tracking up to two of the Wide Area Augmentation Systems (WAAS) satellites. These satellites broadcast GPS signals with information that is useful in improving the accuracy of GPS. The ATS-6501 automatically determines which of up to two nearest satellites to track based on the current antenna position.

```
# WAAS Satellite Tracking Configuration
#
# Name      PRN     Longitude(Deg E)     Doppler     Window
AORE        120        -15.5                0          50
AORW        122        -142                 0          50
POR         134        178                  0          50
IOR         131        65.5                 0          50
IORW        126        25                   0          50
PANAMSAT    135        -133                 0          50
TELESAT     138        -107.3               0          50
ARTEMIS     124        21.5                 0          50
```

3.8. System Verification

After the system installation and setup are complete, users can verify the system is operating properly by looking at several of the system operating parameters to verify the values are correct. If there are no red LEDs lit on the front panel, the system is operating correctly. Details of the system operation can be observed using the following steps:

A. Access the command port.

B. Type *status* and press enter. This command displays numerous fields that indicate system status.

C. There should be no active alarms on the system.

```
ATS 6501>status
[alarm] no alarm
```

D. Both fans should be operating properly

```
[fan]
  [1] true
  [2] true
```

E. The GPS Receiver should be tracking at least 4 satellites, the signal description should be good and the system should show it is locked onto L1 and L2 ([freq] dual) and the receiver should be reporting an accurate position.

```
[gps]
  [auto_positioning]                    This only applies when the position_mode=auto
    [time_remaining] 8 hours, 26 seconds
  [mode]
    [desc] tracking
    [value] 4
  [model]
    [hw_version] OEMV3G-4.00-X2T
```

```
  [name] L12LV
  [serial_number] DAB08190172
  [sw_version] 3.400
[position]
  [alt] 4.999890000000000e+01
  [fixed] false                    Auto position mode - position_period has not expired
  [lat] 3.846628110427000e+01
  [lon] -7.744086206042000e+01
[satellite]
  [number] 7
  [signal]
    [avg] 4.531842422485352e+01
    [desc] Good
    [enum] 2
    [freq] dual
    [max] 4.987799835205078e+01
    [min] 3.897399902343750e+01
```

1. Look at the [satellite] [signal] [desc] field to get an idea on signal quality:
   a. Good: Indicates that the signals being received from the GPS satellites are at an appropriate level.
   b. Fair: The signal level is either too high or too low. GPS is being received and the system will function but the levels are not optimal. An in-line amplifier may be required if the cable loss is too great.
   c. Poor: Signal quality is very bad. System will perform very sporadically. An in-line amplifier may be required if the cable loss is too great.

2. The [satellite] [number] field should be at least 4. If the value is 0 then no satellites are being tracked. Wait ten minutes after the Oscillator Lock light is Green to give the system a chance to acquire satellites. If the value is still 0 ten minutes after the Oscillator Lock light turned green then there is likely a problem with the antenna setup.

   If you are using the manual position mode and the system is reporting satellites but the GPS Tracking indicator is off the position entered is incorrect. Verify the position was entered correctly. If this problem persists, switch the system to the **auto** mode *(position_mode auto*) and allow the system to resurvey the antenna position.

3. The [gps] [satellite] [signal] [freq] field indicates whether single frequency or dual frequency measurements are being received from the receiver. If only single frequency measurements are being received then check the antenna and make sure that it is the Novatel (L1/L2) antenna included with the unit. If you are not using the supplied antenna the system may be connected to a single frequency (L1) antenna.

F. Verify the system hardware is operating properly by ensuring the system is displaying the proper serial number, the outputs are enabled, the power supply status is good and it displays the correct model #. The slots fields should show which cards are installed in each slot (or empty if no card is present), the port status for all four outputs are good (=1) and power is enabled.

```
[mainboard]
  [EUID] 00:30:96:02:00:00:00:f6
```

```
  [serialnum] SP00253
  [type] 4370A-140
[outputs]
  [enabled] true
  [numslots] 6
[power]
  [numsupplies] 2
  [supplies]
    [1]
      [status] good
      [type] 4385A
    [2]
      [status] good
      [type] 4385A
[slots]
  [1]
    [ports]
      [1]
        [status] good
      [2]
        [status] good
      [3]
        [status] good
      [4]
        [status] good
    [power] enabled
    [type] 4394A
  [2]
    [type] empty
  [3-6]
```

Note: Slots [3-6] will display information as shown for slots 1 & 2 based on which slots have cards in them and what type of cards are installed. If a card is not installed the type will be **empty**.

G. The power supply status should show both power supplies operating normally.

```
[power]
  [numsupplies] 2
  [supplies]
    [1]
      [status] good
      [type] 4385A
    [2]
      [status] good
      [type] 4385A
```

H. Each of the conditions monitored by the system health functions should report false and have zero active errors.

```
[health]
  [clock_freq_step]
    [active] false
    [occurrences] 0
  [clock_phase_step]
    [active] false
    [occurrences] 0
```

```
[clock_steer]
  [active] false
  [occurrences] 0
[clock_wander]
  [active] false
  [occurrences] 0
[fan]
  [1]
    [active] false
    [occurrences] 0
  [2]
    [active] false
    [occurrences] 0
[gps_error]
  [active] false
  [cleared]
    [what]
    [when] 1998-01-01-00:03:51.102
  [occurrences] 1
  [set]
    [what] Gps internal error
    [when] 1998-01-01-00:03:48.283
[gps_tracking]
  [active] false
  [occurrences] 0
[leapseconds]
  [internal_error]
    [active] false
    [occurrences] 0
  [unknown]
    [active] false
    [occurrences] 0
```

Note: The GPS Errors recorded when the unit starts up may be reported, if so, they will always have a date of 1 Jan 1998.

I. Each [output modules] [1-6] should have zero active errors and the [outputs disabled] and [outputs unlocked] active blocks should be zero. The [power supply] [0-1] active blocks should also be zero.

```
[output_modules]
  [1]
    [active] false
    [occurrences] 0
  [2]
    [active] false
    [occurrences] 0
  [3]
    [active] false
    [occurrences] 0
  [4]
    [active] false
    [occurrences] 0
  [5]
    [active] false
    [occurrences] 0
  [6]
    [active] false
```

```
    [occurrences] 0
  [outputs_disabled]
    [active] false
    [occurrences] 0
  [outputs_unlocked]
    [active] false
    [occurrences] 0
  [over_temperature]
    [active] false
    [occurrences] 0
  [power_supply]
    [1]
      [active] false
      [occurrences] 0
    [2]
      [active] false
      [occurrences] 0
```

J. The [ref_unlocked] fields are reporting the clock status and system performance information. The reference should be locked ([ref_unlocked] [active] = false).

```
[ref_unlocked]
  [active] false
  [occurrences] 0
```

K. Once the system obtains a sufficient amount of clock data the kas2 values will be available.

```
[kas2]
  [antenna_delay] -1.878000000000000e-08
  [frequency] -5.116576335241098e+01
  [frequency_aging] -1.726953124522067e-06
  [phase_error] 6.369868716533948e-09
  [ptd] 5.814561427000000e-09
  [steer] -5.411878228187561e-11
```

L. The system should show that NTP is locked (true) and that the system is using the internal clock (REFCLK(25,0)

```
[ntp]
  [locked] true
  [source] REFCLK(25,0)
```

M. The system will also show if the external & internal clocks have been detected, the outputs should be enabled and the system will provide the internal operating temperature. If an external 10MHz signal is not being provided, the *oscillator:external* field will display *signal missing*

```
[oscillator]
  [external] unknown (reference_type=Cesium)
  [internal] locked
  [lns] locked
  [locked] true
[outputs] enabled
[temperature] 27
```

N. The last set of data [tflex] will display the system network information, serial number, the startup time (when NTP Locked), the uptime since the last power cycle, the software version running on the system, and the time the *status* command was executed.

```
[network]
  [MAC] 00:30:96:00:00:98
  [broadcast] 192.168.1.255
  [ip] 192.168.1.253
  [netmask] 255.255.255.0
[serial_number] SP00235
[start] 2009-06-04-22:46
[uptime] 15 hours, 29 minutes, 44 seconds
[ver] tflex-3-3-5
```

O. Send the *settings* command and verify the user defined set up parameters are correct.

```
ATS-6501>settings

[command_port]
  [prompt]
    [enable] true
    [text] ATS-6501>
[diaglog]
  [clock] info
  [gps] info
  [kas2] info
[gps]
  [antenna_delay] 0.000000000000000e+00
  [antenna_voltage] 0.000000000000000e+00
  [datum] wgs84
  [mask_angle] 1.000000000000000e+01
  [positioning]
    [auto_hours] 1.200000000000000e+01
    [manual_position]
      [altitude] 1.592729000000000e+03
      [latitude] 4.001941422777778e+01
      [longitude] -1.052390962444445e+02
    [mode] auto
[gps_logging]
  [ftp]
    [compression] true
    [enable] true
    [file_count] 100
    [filename]
      [digits] 3
      [prefix] user
      [suffix] nov
      [type] timestamp
    [interval] 15
    [log_selection]
      [bestposa] ontime 7200
      [ionutca] ontime 7200
      [rangea] ontime 60
      [rawalma] onchanged
      [rawephema] onchanged
      [rxhwlevelsa] ontime 60
      [waas9a] onchanged
  [rt]
```

```
    [enable] true
    [log_selection]
      [gpggartk] ontime 1
[hardware]
  [enable_fp_button] true
  [slots]
    [1]
      [tsc4373]
        [ports]
          [1]
            [pps_period] 1
            [pps_width] 1.000000000000000e-04
            [type] pps
          [2]
            [pps_period] 1
            [pps_width] 1.000000000000000e-04
            [type] pps
          [3]
            [format] B
            [signal_word] 0
            [type] irig
          [4]
            [format] B
            [signal_word] 0
            [type] irig
    [2]
      [tsc4373]
        [ports]
          [1]
            [pps_period] 1
            [pps_width] 1.000000000000000e-04
            [type] pps
          [2]
            [pps_period] 1
            [pps_width] 1.000000000000000e-04
            [type] pps
          [3]
            [format] B
            [signal_word] 0
            [type] irig
          [4]
            [format] B
            [signal_word] 0
            [type] irig
    [3]
      [tsc4395]
        [ports]
          [1]
            [enabled] true
          [2]
            [enabled] true
          [3]
            [enabled] true
          [4]
            [enabled] true
    [5]
      [tsc4387]
        [ports]
          [1]
```

```
        [format] B
        [signal_word] 120
        [type] irig
      [2]
        [format] B
        [signal_word] 120
        [type] irig
      [3]
        [format] B
        [signal_word] 120
        [type] irig
      [4]
        [format] B
        [signal_word] 120
        [type] irig
  [reference]
    [external]
      [type] hp5071a
    [source] internal
```

P. At this point if there are no alarms the ATS-6501 is functioning properly. Network connectivity should be checked to ensure that data is being transmitted properly.

Q. Log files will be available to the FTP user after the specified log period has expired. If in the auto positioning mode the rinex file will be available after the auto_positioning period has expired.

R. If operations are normal and the setup is proper type *save* at the command prompt to save the system default settings or *save filename* to save the settings to a different configuration file. Use the *save_logs ftp* and *save_logs rt* commands to save the ftp or real time logging default settings or add a filename to these commands to save the settings to a different configuration file.

Note: If you do not save the user *default* settings the system will come up with the *factory default* values the next time the system reboots.

4 Theory of Operations

Two distinct tasks are performed by the ATS-6501: collection of GPS measurement data and the generation of timing signals. The two tasks are entirely separate except for the fact that they must share CPU time and data from the GPS receiver. Because the generation of timing signals requires that events (e.g., clock steering) occur at very specific times, operational precedence is always given to timing tasks. As a result, any operations concerning the collection and storage of GPS data are postponed until all timing operations have been completed.

4.1 Generation of Timing Signals

A rubidium standard serves as the short term and holdover with no GPS frequency reference for the ATS-6501. The frequency of the Rubidium is measured and the low noise OCXO is steered to be on frequency. The frequency adjustments made to the OCXO allow it to be aligned with UTC(USNO) which is the source of GPS time and is used as a long term frequency reference. In doing this, the ATS-6501 exhibits the short-term frequency stability characteristics of the Rubidium while exhibiting the long-term characteristics of GPS. The OCXO provides low phase noise performance for the 10 MHz outputs.

The 10MHz output provided by the OCXO serves as the time base for the ATS-6501. All timing signals (e.g., 1 PPS, IRIG-B, 10 MHz) are derived from this reference and thus exhibit the same frequency and phase characteristics. The 100 MHz TCXO which is the clock for the main FPGA is divided by 10 and phase locked to the OCXO 10 MHz output. The rear panel 10 MHz plug in card has a D/A converter which is used along with a sine look up table to provide a 10 MHz signal from the 100 MHz internal clock. This D/A output is then filtered and distributed to the four outputs of the plug in card. The FPGA which is clocked by the 100 MHz TCXO provides 1 PPS and serial time codes which are used by the 1 PPS/DC IRIG and AM IRIG cards to produce 1 PPS and IRIG time codes.

The GPS receiver locks its internal reference to the 10MHz signal provided by the OCXO frequency reference. A 1 PPS signal is then generated by the receiver which has a fixed phase relationship to the frequency reference. Measurements of this PPS are made to determine its offset to UTC(USNO) and this information is passed to the CPU via a serial port. These measurements are used in generating a timescale that estimates the clock offset from UTC(USNO). The CPU slowly adjusts the frequency of the OCXO to align the PPS to be coincident with UTC(USNO), Depending on the type of frequency reference, this adjustment period varies from a day (rubidium) to several months (external cesium), although rough alignment to within 10ns occurs on the order of a few hours in either case.Commands are sent by the CPU to the Low Noise Synthesizer clock to adjust the analog control voltage to the OCXO as a means of affecting this steering.

The PPS signal from the GPS receiver is used in aligning both the IRIG-B signal and the CPU clock to UTC(USNO). At startup this PPS is used to align the internally generated 1 PPS and IRIG-B signal with the correct 10 MHz clock cycle. From that point on the 1 PPS and IRIG-B signals are kept on time by using the OCXO 10MHz signal as its reference. The 1 PPS signal from the GPS receiver generates an interrupt to the ARM 9 processor which serves as an indicator of the top-of-second. This is used by the CPU along with messages received from the GPS receiver to set the CPU time to UTC(USNO). In doing this, the CPU can serve as a stratum-1 network time protocol (NTP) server and provide time to other computers and systems on the network.

The fiber optic outputs from the 4372A module, when plugged into an ATS 6501, contain a proprietary bit stream with 1 PPS marker and time code information. The ATS 6511A decodes this bit stream, extracts the time code, and steers its internal OCXO to the frequency and phase if the fiber signal. Outputs from the ATS 6501 are the same as those in the ATS 6501, with the additional feature that the 4399A L-Band card may be installed in it. The ATS 6511A provides complete status information in the return fiber to the 4372A module. A 4340A fiber optic distribution chassis may be connected to the output of the 4372A module to provide up to 8 outputs which can be connected to ATS 6511s. All status from the ATS 6511s connected to the 4340 will be consolidated and sent to the upstream 4372A for display in the ATS 6501 Telnet command responses.

4.2 Log Collection

GPS measurement data is available to users in a variety of log formats. The ATS-6501 uses a Novatel OEMV (dual-frequency and WAAS capable) as its GPS receiver and thus any logs generated by the receiver are available to users. For a complete description of logs and their formats refer to the OEMV manual at http://www.novatel.com/support/docupdates.htm#oemv.

Logs on the ATS-6501 are handled in two ways. They are either stored in volatile memory for retrieval by FTP or they are output to the Ethernet port in real-time. Logs stored in volatile memory are referred to as ionospheric logs and may be compressed to increase the capacity of the storage area. A total of 16 MB is dedicated to the storage of ionospheric logs and as storage capacity is approached older logs will be deleted to make room for newer logs. Real-time logs are logs requested by the user for output to the Ethernet port on the rear panel of the ATS-6501. They are provided to the user in a timely manner but are not stored on the system.

All logs must be enabled at startup through the use of configuration files. Ionospheric logs are specified in the ftp configuration file and real-time logs are specified in the real-time configuration file. Ionospheric logs are always generated by the ATS-6501 but the Ethernet port (1135) must be configured at startup in order to receive the desired real-time logs.

4.3 Startup Sequence

A very specific sequence exists for starting each of the internal devices within the ATS-6501. This sequence exists to ensure that the unit generates the appropriate timing outputs and that they are all in sync with each other. Startup time of the ATS-6501 varies from 5 to 45 minutes depending upon how long the unit has been powered off but the timing outputs are not enabled until 1 PPS and 10 MHz are accurate.

The 10MHz frequency reference measurements are made on either the internal Rb oscillator or an external Cs source. In either case the ATS-6501 waits for the frequency reference to indicate that it has warmed up and is providing a stable signal. The internal Rb is generally warm and operational within 10 minutes but external references may take longer. Once the frequency reference is operational, the front panel indicator “OSC LOCK” will illuminate green. This indicates that the frequency reference is the ATS-6501 is locked to the frequency reference and the startup operations will continue.

Once the frequency is locked, the GPS receiver is restarted using the 10 MHz signal as its reference. The receiver will begin generating the 1 PPS outputs but they will not be aligned to UTC(USNO). A search algorithm is used by the GPS receiver which attempts to acquire and track the signal received from GPS satellites. This process usually takes 5 to 10 minutes but may take as long as 30 minutes depending upon how long the ATS-6501 has been powered off. After four satellites are being tracked by the GPS receiver, the PPS output is adjusted so that it is

aligned with UTC(USNO). The green "TRACKING GPS" light on the front panel will also illuminate to indicate to the user that the system is currently tracking the GPS signal.

To serve as a Stratum-1 network time protocol (NTP) server requires that the system's CPU clock be aligned with UTC(USNO). The process of locking the CPU clock to UTC(USNO) requires setting the system time to UTC(USNO) and using the PPS received from the GPS receiver to continuously steer the CPU clock. If the unit has been powered off for a long period of time the CPU time may be multiple seconds off. In these cases, a coarse adjustment of system time is performed and then the startup sequence is restarted. This process should only happen once and only in cases where the system has been powered off.

The Time Code generator uses 10 MHz, 1 PPS, and system time to generate the IRIG/NASA36 signals. As a result, it is the final step in the startup procedure. The Time Code generator uses the 10MHz as its frequency reference and the PPS to indicate the start of the second. These two signals serve as the time base for the Time Codes. System time is sent by the CPU to the Time Code generator to indicate what time is associated with the received PPS signal. This information is then used to produce the user/factory defined time codes.

5 Maintenance

The recommended maintenance schedule for the ATS-6501 is outlined in Table 5-1. Although this schedule is sufficient for most applications, it may be necessary to increase the number of scheduled maintenance events for extremely dusty or dirty environments. Contact Symmetricom if there are questions about the scheduled maintenance cycle.

A minimal amount of maintenance is required for the ATS-6501. It is designed to operate continuously over long periods of time with little to no interaction. The primary factor in maintaining a working unit is to verify that it remains dust free and the antenna and antenna cable are in good condition. The following maintenance schedule is applicable.

Interval	Maintenance Required
Monthly	None
Semi-Annual	None
Annual	1. Fan Filter[1] 2. Antenna inspection 3. Internal inspection[2]

Table 5-1. Maintenance Schedule

5.1 Internal Inspection

The internal inspection of the ATS-6501 is necessary to ensure that all components are relatively free of dust and particles that may cause electronic components to fail. The following instructions outline the required steps in performing an internal inspection of the ATS-6501.

1. Shut the system down.
2. Remove the top of the ATS-6501.
3. Visually inspect the various components and make sure that an excessive amount of dust is not present. Excessive dust can be removed by using compressed air or vacuum cleaner to clean the electrical components of any accumulated dust.
4. Use a vacuum cleaner to clean the fan filter of any accumulated dust.
5. Re-install the cover on the ATS-6501.
6. Restart the system.

5.2 Antenna and Antenna Cable Inspection

The Antenna and antenna cables are a common source of failure because they are exposed to harsh environmental elements. The following process outlines the steps required in performing an inspection of the antenna and antenna cable.

1. Follow the antenna cable from the rear of the ATS-6501 to the antenna. Look for any severe bends in the cable or damage to the shielding of the cable.
2. Remove any severe bends in the cable and replace any cables that have damaged shielding.
3. Examine the portions of the cables that are exposed to the elements. Look for signs of excessive weathering such as a deterioration of the outermost insulator. Replace any cables that appear severely weathered.

[1] In extreme operating environments it may be necessary to clean the fan filter more frequently.
[2] Internal inspections are only required if the fan filter is extremely dirty.

4. Inspect the antenna. Clean any buildup of dirt or other contaminants from the surface of the antenna. These contaminants may degrade the strength of the GPS signal. If the antenna has been damaged by the weather, replace it.
5. Verify that the antenna is still securely mounted.

5.3 Fan Filter

The fan filters helps protect the system from accumulating dust inside the unit as well and allows the fans to provide the proper level of cooling for the internal components. It is important to keep this filter clean to allow the proper level of air flow to prevent the system from overheating. To clean the filter:

1. Remove the fan assembly from the front by loosening the two captive screws.
2. Remove the filter from the fan assembly.
3. Use a vacuum cleaner to clean the fan filter of any accumulated dust.
4. Re-install the filter and assembly into the chassis. Take care to feed the cable into the chassis while inserting the fan assembly.

6. Troubleshooting

The following section provides some basic troubleshooting information to assist users in case they suspect there is an issue with the system.

6.1 Front Panel Indications

You can use the front panel indicators to assess the status and operation of the unit. Under normal operating conditions the user should see:

- Green Status Indicator on both power supplies
- The front panel clock should display the last two digits of the year, the correct Julian Date (see appendix D.) and the correct time (UTC). The time should also increment each second.
- The Alarm Light is Off
- The OSC Lock, GPS Tracking, NTP Locked, and Outputs Enabled lights are green.

6.2 Alarm Light

The alarm light will turn red when the unit has detected a hardware failure or an event has occurred that may cause the timing signals output by the unit to be outside of their specifications.

- Either power supply missing/failed or without AC/DC input power.
- Any output module reporting a failure or is not locked to the reference
- GPS has not been not tracking for at least 6 hours or there is a hardware error
- Reference clock wander has exceeded 100ns from UTC
- The Rubidium is unlocked.
- Over temperature (65 C)
- External Reference
    - System is unable to communicate with the external reference source
    - 10MHz input from the external reference is missing

If the alarm light is on users can determine the exact cause of the alarm by accessing the command port and typing the *status alarm* command and obtain a list of the current alarms.

If the alarm light was on and is currently off, users can connect to the command port and type the command *syslog error* to obtain the list of errors from the error log file maintained by the system.

6.2.1 Power Supplies

The system has two power supplies and is capable of operating from either supply in the event one of them fails. If one of the status indicators on the power supply front panel is red there is a problem with that supply. The front panel alarm light should also be on. Power supply #1 is on the left and Power Supply #2 is on the right. The possible problems are listed below:

- Power Supply has failed
- Internal Fuse is open
- Power Supply is unplugged, make sure the power supply is plugged in

- Power Source has failed, check to ensure the power source is available and connected to the rear panel of the unit.

Users can also check the current system using the *status alarm* and the *status health:power_supply* commands to check the system status.

```
ATS-6501>status alarm
power_supply:2 -- AC/DC supply missing, or hardware error

ATS 6501>status health:power_supply

  [1]
    [active] false
    [occurrences] 0
  [2]
    [active] true
    [occurrences] 1
    [set]
      [what] AC/DC supply missing, or hardware error
      [when] 2008-10-06-16:12:51.346
```

If the fault condition has cleared, users are able to check the events in the system using the *status health:power_supply* commands to check on events that occurred earlier.

```
ATS 6501>status health:power_supply

  [1]
    [active] false
    [occurrences] 0
  [2]
    [active] false
    [cleared]
      [what] No errors
      [when] 2008-10-06-16:14:38.874
    [occurrences] 1
    [set]
      [what] AC/DC supply missing, or hardware error
      [when] 2008-10-06-16:12:51.346
```

6.2.2 Outputs Enabled

This indicator will turn off if the ATS-6501 detects a hardware fault with one or more of the output modules. Verify the output modules are locked to reference and the outputs are enabled using the *status health:outputs_disabled* and *status health:outputs_ulocked* commands and verify both active and occurrences = 0.

```
ATS-6501>status health:outputs_disabled

  [active] false
  [occurrences] 0

ATS-6501>show health:outputs_unlocked

  [active] false
  [occurrences] 0
```

Users can determine which output module(s) has failed:

- Based on which systems the ATS-6501 is driving are no longer operating properly
- By unplugging the output modules, one at a time, to see which output module was at fault.
  Note: If this does not work there may be more than one output module that failed. Pull them all and reinsert them one at time to see which one(s) cause a FAULT.
- By using the *status health:output_modules* command and/or the *syslog error* command and checking both the active = true and/or occurrences is greater than 0.

```
ATS 6501>status health:output_modules

[1]
  [active] true
  [occurrences] 1
[2]
  [active] false
  [occurrences] 0
[3]
  [active] false
  [occurrences] 0
[4]
  [active] false
  [occurrences] 0
[5]
  [active] false
  [occurrences] 0
[6]
  [active] false
  [occurrences] 0
```

6.2.3 GPS Performance

There are several factors that could impact the performance of the GPS receiver.

6.2.3.1 Poor GPS Receiver Performance

There are several issues that can cause poor performance with the GPS receiver. This may be reflected in the signal quality parameter or the fact the ATS 6501 GPS Tracking indicator goes out periodically. Use the *status gps* command to look at the current system status.

```
ATS 6501>status gps

[mode]
  [desc] tracking
  [value] 4
[model]
  [hw_version] OEMV3G-4.00-X2T
  [name] L12LV
  [serial_number] DAB08400198
  [sw_version] 3.400
[position]
  [alt] 5.050310000000000e+01
  [fixed] true
  [lat] 3.846628161218000e+01
  [lon] -7.744086549511999e+01
[satellite]
```

```
[number] 8
[signal]
  [avg] 4.723037719726562e+01
  [desc] Good
  [enum] 2
  [freq] dual
  [max] 4.942499923706055e+01
  [min] 4.031800079345703e+01
```

- Poor antenna location.
  - Make sure that there are no obstructions between the GPS antenna and the sky. If you are inside a building, surrounded by tall buildings, or in a tunnel the GPS antenna will not have a clear view of the sky.
  - The GPS receiver requires signals from at least four satellites, even partial obstructions can prevent your GPS receiver from functioning properly.
- Ensure the mask angle is not set too low or too high.
  - If set too low the receiver might not be able to track the satellites because of obstructions
  - If set too high, the receiver will not be able to use all of the available satellites to determine a fix and determine the correct time.
  - Ensure the mask angle is correct using the *settings gps:mask_angle* command. Default = 10 degrees.

```
ATS 6501>settings gps:mask_angle
1.0000000000000000e+01
```

- Ensure you are using the correct positioning datum.
  - Default is WGS84.
  - System is capable of using the NAD-83 datum.
  - Ensure any manually entered position is using the correct datum using the *settings gps:datum* command

```
ATS-6501>settings gps:datum
wgs84
```

6.2.3.2 GPS Not Tracking

This indictor will go out if the ATS-6501 is not tracking at least 4 GPS Satellites. The indicator will also go out if the manually entered position is incorrect. If the position error is large enough the indicator will turn red and the GPS receiver is unable to track properly depending on how large the position error is. If the system is not tracking GPS for 6 or more hours, the Alarm indicator will turn red. Users can look at the GPS performance and look at the number of events and the last time GPS was not tracking properly using the *status gps* command

```
ATS6501>status gps

  [mode]
    [desc] not tracking
    [value] 3
  [model]
    [hw_version] OEMV3G-4.00-X2T
    [name] L12LV
    [serial_number] DAB08190113
    [sw_version] 3.400
```

```
[position]
  [alt] 1.8410799999999998e+01
  [fixed] true
  [lat] 3.8466365580420003e+01
  [lon] -7.7440877483110000e+01
  [mode]
    [enum] 0
[satellite]
  [number] 0
  [signal]
    [avg] 0.0000000000000000e+00
    [desc] Poor
    [enum] 0
    [freq] single
    [max] 0.0000000000000000e+00
    [min] 0.0000000000000000e+00
```

Note: If the system is reporting it is *not tracking* yet it shows it is tracking 4 or more satellites the manually entered position may be incorrect. Verify the position settings and correct any errors. If the position is not known or the error will not clear change the *position_mode* to auto and resurvey the antenna position. This should clear the GPS Tracking Error. Users can obtain the position information after the auto_hours (*position_period*) has expired by processing the RINEX file.

Possible causes are:

- Poor antenna location (See 6.3.1)
- Mask Angle set improperly (See 6.3.1)
- Antenna Cable Failure
    - Failed lightning protection device. If a lightning protection device has been installed in the RF & DC path ensure the device has not failed and is not open (no continuity).
    - Bad Cable. The cable may have failed due to exposure to the weather, kinking, or bending. Inspect the antenna cable and correct any issues and replace any cables that appear to be weathered.
    - Improper Antenna Cable. The cable may be either too long or the improper type. Symmetricom recommends using low loss coaxial cables for the GPS antenna cable. Cable losses cannot exceed 10dB when using the antenna supplied with the ATS-6501.
- Antenna Failure
    - Loss of Power. Antenna requires 5-18Vdc to operate properly. Disconnect the cable from the antenna and measure the DC voltage between the center pin (+) and shield (-) to ensure the antenna operating voltage is present. If not, check the cable continuity and DC Power Source.

      Note: The DC Power source may be a BIAS Tee or the ATS-6501. Ensure the antenna voltage is available from the proper source.

    - Failed Antenna. If the DC Power source is available and at the proper level and the antenna cable continuity is good, replace the antenna.
- User entered an invalid position

- GPS Tracking indicator is RED or OFF. Enter the correct position for the antenna. Use the *status health:gps_error* command to look at the status of the GPS hardware.

6.2.4 Internal Clocks

If you suspect there may be an issue with the internal clocks use the *status health* and *status oscillator* commands to look at the status of the internal clocks.

Note: The example below has been edited to show the relevant fields in the system health status for the clocks.

```
ATS-6501>status health

  [clock_freq_step]
    [active] false
    [occurrences] 0
  [clock_phase_step]
    [active] false
    [occurrences] 0
  [clock_steer]
    [active] false
    [occurrences] 0
  [clock_wander]
    [active] false
    [occurrences] 0

ATS-6501>status oscillator

  [external] locked
  [internal] locked
  [lns] locked
  [locked] true
```

Users can also check the status of the time scale to ensure the UTC offset value [ptd] is under +/- 100nSec from UTC and the clock is being steered

```
ATS-6501>status kas2
  [antenna_delay] -1.878000000000000e-08
  [frequency] -5.116576335241098e+01
  [frequency_aging] -1.726953124522067e-06
  [phase_error] 6.369868716533948e-09
   [ptd] -2.7412538500000002e-09
   [steer] -3.2777525484561920e-11
```

6.2.5 External Reference

If you suspect there may be issues with the external reference use the *status health* and *status oscillator* commands to look at the status of the external reference and internal clocks.

Note: The example below has been edited to show the relevant fields in the system health status for the clocks.

```
ATS-6501>status health
```

```
[clock_freq_step]
  [active] false
  [occurrences] 0
[clock_phase_step]
  [active] false
  [occurrences] 0
[clock_steer]
  [active] false
  [occurrences] 0
[clock_wander]
  [active] false
  [occurrences] 0
```

```
ATS-6501>status oscillator

  [external] locked
  [internal] locked
  [lns] locked
  [locked] true
```

Users can also check the status of the time scale to ensure the UTC offset value [ptd] is under +/- 100nSec from UTC and the clock is being steered

```
ATS 6501>status kas2
  [antenna_delay] -1.878000000000000e-08
  [frequency] -5.116576335241098e+01
  [frequency_aging] -1.726953124522067e-06
  [phase_error] 6.369868716533948e-09
  [ptd] -2.7412538500000002e-09
  [steer] -3.2777525484561920e-11
```

If there is an issue with the 10MHz Input it will show in the *status oscillator* command. The front panel Alarm light will be RED and the Oscillator Lock light will be OFF.

```
ATS-6501>status oscillator

  [external] signal missing
  [internal] locked
  [lns] locked
  [locked] false
```

When the 10Mhz signal is restored the Alarm light will remain on, the Oscillator lock light will remain out and the GPS Tracking indicator will go out for ~30 seconds. Once the GPS Tracking indicator is lit the system will report the ptd values.

Warning: The PTD Values will not be within specifications possibly for several hours, the system will report this error and the Alarm light will remain lit as long as the signals provided by the ATS-6501 are outside of their specifications.

If the ATS-6501 is unable to communicate with the external reference the operator will get an indication of the error. The front panel Alarm light will be RED and the Oscillator Lock light will be OFF.

```
ATS-6501>status alarm
```

```
  [external] ref_unlocked – cannot communicate with device

ATS-6501>status oscillator

  [external] cannot communicate
  [internal] locked
  [lns] locked
  [locked] false

ATS-6501>status health:ref_unlocked

    [ref_unlocked]
      [active] true
      [cleared]
        [what] reference is locked
        [when] 1998-01-01-00:02:32.634
      [occurrences] 2
      [set]
        [what] cannot communicate with device
        [when] 2009-01-27-16:22:02.591
```

Once communications are restored the system will clear the alarm indications and resume normal operations.

6.2.6 NTP Server

The NTP locked indicator will be green when the NTP server is capable of providing time within specifications to other systems on the network. When the NTP Server is operating outside of its specification the indicator will be out. To look at the current status of the internal NTP Server use the *status ntp* command. If the NTP Server is operating properly the user will see the following:

```
ATS 6501>status ntp
  [locked] true
  [source] REFCLK(25,0)
```

6.2.7. PTD Value is Noisy

The PTD (UTC Offset) value will be much noisier when the ATS-6501 is in the dynamic mode and during the positioning period while in the AUTO mode.

- Static position users should use the AUTO mode when the antenna position is unknown. After the auto_hours has expired, the antenna position will be determined by the receiver and the ATS-6501 will switch to the fixed position mode. Once this happens, the PTD value will be significantly quieter.
- If the antenna position is known, users should put the system in Manual positioning mode and enter the latitude, longitude, and altitude of the antenna.
- Poor antenna location and/or multipath issues can cause instabilities, relocate the antenna to a more suitable location.

```
ATS-6501>settings gps

  [antenna_delay] 0.000000000000000e+00
  [antenna_voltage] 0.000000000000000e+00
  [datum] wgs84
```

```
[mask_angle] 1.000000000000000e+01
[positioning]
  [auto_hours] 1.200000000000000e+01
  [manual_position]
    [altitude] 1.592729000000000e+03
    [latitude] 4.001941422777778e+01
    [longitude] -1.052390962444445e+02
  [mode] auto
```

6.2.8 Over Temperature and Fans

The ATS 6501 monitors the internal temperature will trigger an alarm to be displayed on the front panel and the *status alarm* list when the internal temperature reaches or exceeds 65ºC. To check the current temperature on the system use the *status temperature* command.

```
ATS-6501>status temperature
31
```

Users can look to see if the unit had any temperature issues by using the *status health:over_temperature* command

```
ATS-6501>status health:over_temperature

  [active] false
  [occurrences] 0
```

The ATS-6501 monitors the fans on the front panel to ensure they are operating, to check the current status of the fans use the *status fan* command. Both fans should show a status of 1 indicating it is operating normally.

```
ATS-6501>status fan

  [1] true
  [2] true
```

Users can look to see if the unit had any issues with either of the fans by using the *status health:fan* command

```
ATS 6501>status health:fan
  [1]
    [active] false
    [occurrences] 0
  [2]
    [active] false
    [occurrences] 0
```

Note: If the unit is reporting an over temperature condition and the fans are not reporting an error, ensure the ambient temperature is less than 50 C and the fan filters are clean.

6.2.9 PPS Outputs

The ATS-6501 is capable of providing different PPS outputs on each port of the 4394A card. By default ports #1 and #2 are set to 1PPS with a 100us wide pulse. Users can modify these settings. Users are cautioned to ensure they connect the correct cables to the correct output ports to avoid any problems.

To verify the settings use the *settings hardware:slots:N* command (where N=Card Slot #) to verify the system settings.

```
ATS-6501> settings hardware:slots:1

  [tsc4373]
    [ports]
      [1]
        [pps_period] 1
        [pps_width] 1.000000000000000e-04
        [type] pps
      [2]
        [pps_period] 1
        [pps_width] 1.000000000000000e-04
        [type] pps
      [3]
        [format] B
        [signal_word] 0
        [type] irig
      [4]
        [format] B
        [signal_word] 0
        [type] irig
```

To check the status of the output card use the *status hardware:slots:N* command (where N=Card Slot #) to verify the card status.

```
  [ports]
    [1]
      [status] good
    [2]
      [status] good
    [3]
      [status] good
    [4]
      [status] good
  [power] enabled
  [type] 4394A
```

6.2.10 IRIG Outputs

The ATS-6501 is capable of providing different DC IRIG outputs on each port of the 4394A card and AM IRIG outputs on the 4387A card. By default ports #3 and #4 on the 4394A card are set to B000. The 4387A outputs are set to B120 by default. Users can modify these settings. Users are cautioned to ensure they connect the correct cables to the correct output ports to avoid any problems.

To verify the settings use the *settings hardware:slots:N* command (where N=Card Slot #) to verify the system settings.

```
ATS-6501> settings hardware:slots:1

  [tsc4373]
    [ports]
      [1]
        [pps_period] 1
```

```
      [pps_width] 1.000000000000000e-04
      [type] pps
    [2]
      [pps_period] 1
      [pps_width] 1.000000000000000e-04
      [type] pps
    [3]
      [format] B
      [signal_word] 0
      [type] irig
    [4]
      [format] B
      [signal_word] 0
      [type] irig
```

To check the status of the output card use the *status hardware:slots:N* command (where N=Card Slot #) to verify the card status.

```
[ports]
  [1]
    [status] good
  [2]
    [status] good
  [3]
    [status] good
  [4]
    [status] good
[power] enabled
[type] 4387A
```

6.2.11 NASA36 Outputs

The ATS-6501 is capable of providing NASA 36 Time Code outputs on each port of the 4387A AM IRIG card. The 4387A outputs are set to IRIG B120 by default. Users can modify these settings. Users are cautioned to ensure they connect the correct cables to the correct output ports to avoid any problems.

To verify the settings use the *settings hardware:slots:N* command (where N=Card Slot #) to verify the system settings.

```
ATS-6501>>settings hardware:slots:5

[tsc4387]
  [ports]
    [1]
      [format] B
      [signal_word] 120
      [type] irig
    [2]
      [format] B
      [signal_word] 120
      [type] irig
    [3]
      [format] B
      [signal_word] 120
      [type] nasa36
    [4]
```

```
    [format] B
    [signal_word] 120
    [type] irig
```

To check the status of the output card use the *status hardware:slots:N* command (where N=Card Slot # of the 4387A) to verify the card status.

```
ATS-6501> settings hardware:slots:5

  [ports]
    [1]
      [status] good
    [2]
      [status] good
    [3]
      [status] good
    [4]
      [status] good
  [power] enabled
  [type] 4387A
```

6.3 Communication Problems

This section describes some of the errors associated with communications problems and some potential sources of those issues.

6.3.1 LAN

- LAN Connector unplugged.
- DHCP
  - When the system is operating press the "Display" button on the front panel. If the IP Address is set it should switch to those displays and give the local operator the IP Address. If not, the IP Address was not set it will not display the IP Address and the unit will assign an IP Address of 0.0.0.0. Plug the LAN Connector into the rear of the unit and if a DHCP server is available, the unit should obtain an IP Address.
  - Power cycle the unit.
- Static
  - Verify the static IP address Netmask, Broadcast IP, and Gateway were set properly using the *network* command.
  - If incorrect, Use the *network_config* command to set the correct Mode, IP address, netmask, broadcast, and gateway.

6.3.2 Console (Command Port)

- USB to Serial adapter the improper type (OP 001)
- Improper baud rate set on terminal serial port
  - 115200,N,8,1, no flow control.
- Incorrect serial cable type (requires Null Modem cable.)

6.3.3 External Reference

- USB to Serial adapter the improper type (OP002)

- Improper baud rate set on external reference serial port
  - 9600,N,8,1, no flow control.
- Incorrect serial cable type (requires Null Modem cable.)

Note: Communications are only used when the external frequency reference is a 5071A. If you are using a different cesium clock use the *reference_type cesium* command to set the proper reference clock type.

6.4 Syslog Error Command

All system error messages can be listed using the *syslog error* command on the command port. The following information is typically contained in this log during startup. The date/time will be set to Jan 1 00:00:00 when the system is first powered on or rebooted since the time is not set until the GPS receiver is tracking.

```
ATS-6501>syslog error
Jan  1 00:01:27 tflex newsyslog[374]: logfile first created
Jan  1 00:02:47 tflex tflex[496]: No matching processes were found
Jan  1 00:02:49 tflex [495]: .356 0x34f000 [Control] Loaded settings at <empty address>
Jan  1 00:02:49 tflex [495]: .578 0x34f000 [Control] Loaded settings at <empty address>
Jan  1 00:02:52 tflex [495]: .667 0x392700 [Alarm] gps_error asserted: Gps internal error
Jan  1 00:02:52 tflex [495]: .886 0x392700 [Alarm] ref_unlocked cleared:
Jan  1 00:02:52 tflex [495]: .898 0x392700 [Alarm] outputs_unlocked cleared:
Jan  1 00:02:52 tflex [495]: .910 0x392700 [Alarm] over_temperature cleared: Temperature is normal
Jan  1 00:02:52 tflex [495]: .923 0x392700 [Alarm] fan:1 cleared: Fan is running
Jan  1 00:02:52 tflex [495]: .936 0x392700 [Alarm] fan:2 cleared: Fan is running
Jan  1 00:02:52 tflex [495]: .947 0x392700 [Alarm] outputs_disabled cleared: Outputs are enabled
Jan  1 00:02:52 tflex [495]: .960 0x392700 [Alarm] output_modules:1 cleared:
Jan  1 00:02:52 tflex [495]: .972 0x392700 [Alarm] output_modules:2 cleared:
Jan  1 00:02:52 tflex [495]: .985 0x392700 [Alarm] output_modules:3 cleared:
Jan  1 00:02:52 tflex [495]: .996 0x392700 [Alarm] output_modules:4 cleared:
Jan  1 00:02:53 tflex [495]: .010 0x392700 [Alarm] output_modules:5 cleared:
Jan  1 00:02:53 tflex [495]: .029 0x392700 [Alarm] output_modules:6 cleared:
Jan  1 00:02:53 tflex [495]: .043 0x392700 [Alarm] power_supply:1 cleared:
Jan  1 00:02:53 tflex [495]: .056 0x392700 [Alarm] power_supply:2 cleared:
Jan  1 00:02:53 tflex [495]: .068 0x392700 [Alarm] output_modules:1 cleared: No errors
Jan  1 00:02:53 tflex [495]: .085 0x392700 [Alarm] output_modules:2 cleared: No errors
Jan  1 00:02:53 tflex [495]: .097 0x392700 [Alarm] output_modules:3 cleared: No errors
Jan  1 00:02:53 tflex [495]: .109 0x392700 [Alarm] output_modules:4 cleared: No errors
Jan  1 00:02:53 tflex [495]: .120 0x392700 [Alarm] output_modules:5 cleared: No errors
Jan  1 00:02:53 tflex [495]: .132 0x392700 [Alarm] output_modules:6 cleared: No errors
Jan  1 00:02:53 tflex [495]: .146 0x392700 [Alarm] ref_unlocked asserted: LNS is unlocked
Jan  1 00:02:53 tflex [495]: .164 0x392700 [Alarm] power_supply:1 cleared: No errors
Jan  1 00:02:53 tflex [495]: .175 0x392700 [Alarm] power_supply:2 cleared: No errors
Jan  1 00:02:53 tflex [495]: .186 0x392700 [Alarm] ref_unlocked cleared: reference is locked
Jan  1 00:02:53 tflex [495]: .199 0x392700 [Alarm] clock_wander cleared:
Jan  1 00:02:54 tflex [495]: .445 0x392700 [Alarm] gps_error cleared:
Jan  1 00:02:57 tflex tflex[496]: /usr/bin/ntpq: read: Connection refused
Jan  1 00:03:18 tflex last message repeated 5 times
Jan 26 22:18:35 tflex [495]: .925 0x392700 [Alarm] clock_wander asserted: Clock wander exceeded 100.000000ns
Jan 26 22:18:48 tflex [495]: .144 0x392700 [Alarm] clock_wander cleared: Clock wander is less than 100.000000ns
```

Error Logs: After startup the system tracks all alarm conditions (asserted) and when those alarms cleared (cleared) as they occurred in chronological order.

```
Jan 26  18:59:06 tflex [13549]: .470 0x345b00 [Alarm] clock_wander asserted: Clock wander exceeded 100.000000ns
Jan 26  19:00:40 tflex [13549]: .575 0x345b00 [Alarm] clock_wander cleared: Clock wander is less than 100.000000ns
```

Appendix A System Specifications

Environmental

Operating Temperature	0° - 50° C, 95% Humidity, non-condensing
Storage Temperature	-20° - 70°, 95% Humidity, non-condensing

Physical

Size	17”W x 19”D x 1.75”H.
Weight	20 Lbs (9.1kg) - two power supplies & 4 plug-in modules.

10 MHz Input -

Quantity	1
Connector Type	BNC (F)
Input Power	+10 dbm - +17 dbm
Input Impedance	50 Ω

Timing Performance

UTC(USNO) Offset (w/ GPS)	
- Precise Calibration	15 ns RMS
- Coarse Calibration	100 ns RMS
Allan Deviation (Locked to GPS)	1s <5E-12 10s <5E-12 100s <5E-12
Frequency Accuracy	1e-11 @ one day
Holdover Accuracy, 10Mhz Output	5E-11/month

Ethernet Interface

Quantity	1
Connector	RJ-45
Protocol	TCP/IP
Speed	10/100 Base-T
Network Time Protocol (NTP) Server	
- Stratum	Level 0/Level 1 when locked to GPS
- Client Support	~100 client request per second
File Transfer Protocol	
- Logging Files	User:ftp, Password: ftp
- Software Update	User: ftp, Password: ftp
Ports	
- Command Port	1700
- Debug Port	1800

- Status Port	1900
- Real-Time Data	1135

USB Command Port Cable (OP001)

Connector	DB9 (M)
Communications Parameters	115200,N,8,1
Type	DTE

USB External Reference Port Cable (OP002)

Connector	DB9 (M)
Communications Parameters	9600,N,8,1
Type	DTE

GPS Receiver

Antenna Connector	TNC(F)
Output Voltage	0, 5, or 12VDC - (User Selectable), Default = 0
Input Frequency	L1 (1575 MHz) L2 (1272 MHz)
Antenna Cable	Cable loss not to exceed 10dB.

PPS / DC IRIG Module (4394A)

Characteristic	Description
Number of outputs	Four
Output connectors	BNC(F)
Impedance	50 Ω
Signals	PPS (2) DC IRIG (2)
PPS	
- Intervals	Default – 1PPS, Valid PPS values are 1M, 100K, 10K, 1K, 100, 10,& 1
- Levels	1V RMS into 50 Ω
- Pulse Width	Default - ~100us +/-10us. Pulse width is variable in integer counts of 100MHz clock period.
- Rise Time	< 15ns
- Jitter	<200ps
- Skew	<+/-2ns
DC IRIG	Default - B000
- Types	A000, A003, A007, B000, B003, B007, D002, E002, G002, H002
- Levels	>2.4V = High, <.8V = Low

10 MHz Module (4395A-10)

This module provides four 10 MHz outputs. The module also monitors each output for levels below approximately 10 dBm, after which an alarm is raised.

Characteristic	Description
Number of outputs	Four
Output connectors	BNC(F)
Impedance	50 Ω
Amplitude	+13dbm +/- 2dBm
Signal	Sine Wave
Harmonic	< -40dbc
Phase Noise	1 Hz -100dbc/Hz 10 Hz -125dbc/Hz 100Hz -132dbc/Hz 1KHz -138dbc/Hz 10KHz -141dbc/Hz 100Khz -141dbc/Hz

5 MHz Module (4395A-5)

This module provides four 5 MHz outputs. The module also monitors each output for levels below approximately 10 dBm, after which an alarm is raised.

Characteristic	Description
Number of outputs	Four
Output connectors	BNC(F)
Impedance	50 Ω
Amplitude	+13dbm +/- 2dBm
Signal	Sine Wave
Harmonic	< -40dbc
Phase Noise	1 Hz -100dbc/Hz 10 Hz -125dbc/Hz 100Hz -132dbc/Hz 1KHz -138dbc/Hz 10KHz -141dbc/Hz 100Khz -141dbc/Hz

Amplitude Modulated (AM) IRIG Module (4387A)

Characteristic	Description
Number of outputs	Four
Output connectors	BNC(F)
Impedance	50 Ω
Amplitude into 50 Ω	3 Vpp
Modulation Ratio	10:3
IRIG types	Default - B120
Supported Types	A130, A133, A137, B120, B123, B127, E 111, E112, E121, E122, E127, G141, G142, G147, H111, H112, H121, H122, H127 or NASA36

Fiber Optic Output Module (4372A)

Characteristic	Description
Number of outputs	Four
Output connectors	LC – Duplex in SFP pluggable modules. These modules can be individually changed to different mode transceivers. Outputs contain time code, 1 PPS and frequency for ATS 6511 Inputs are not required and contain status information from the ATS 6511 connected directly to the output, or from multiple ATS 6511s connected to a 4340A connected to this output

AC Power Supply (4385A)
100–240 V AC, 50-60 Hz, ~.75A
Power Mains Fuse AC Input: Two 250 V~1 A T (Time delay) 5 x 20 mm

DC Power Supply (4886A)
–48 VDC (SELV type), Power Inlet Type, DC input Mates with 3 pin Amp Part#: 1-350346-0 connector with female sockets Amp Part# 925661-1

Power Supply Cord Set, DC input Minimum 1.5 mm² (14 AWG) with a 15A fuse or circuit breaker. A 20A circuit breaker may be used if the external wiring is jacketed 14 AWG, with maximum length of 20 feet.

DC Input: Two 250 V~1.6 A T (Time delay) 5 x 20 mm

Power Consumption: 52W (fully loaded chassis).

Appendix B Status Command Fields

This section provides information on the results from the status command

ATS-6501>status

```
[alarm] no alarm                                  Current alarm list
[fan]                                             Fan Status
  [1] true                                              true = Running
  [2] true                                              false = Off
[gps]                                             GPS Status
  [auto_positioning]                                    Auto Position Status
    [time_remaining] 7 hours, 39 minutes            Time left to determine position
  [mode]
    [desc] tracking                                     Not Tracking/Tracking
    [value] 4                                           Diagnostic value
  [model]                                           GPS Receiver Information
    [hw_version] OEMV3G-4.00-X2T                        Model #
    [name] L12LV                                        Receiver frequencies
    [serial_number] DAB08190113                         Serial #
    [sw_version] 3.400                              Firmware Version
  [position]                                        Current Position
    [alt] 4.8305500000000002e+01                        Ellipsoid Height
    [fixed] false                                   Auto position information.
    [lat] 3.8466278665490002e+01                        Latitude
    [lon] -7.7440859995379995e+01                       Longitude
    [mode]
      [enum] 0                                      Diagnostic value.
  [satellite]                                       Satellite Information
    [number] 7                                      Number of satellites tracked
    [signal]
      [avg] 4.5854572296142578e+01                  Average signal strength
      [desc] Good                                   Signal Quality
      [enum] 2                                      Diagnostic value.
      [freq] dual                                   Tracking L1 only (Single) or L1/L2
      [max] 4.9664001464843750e+01                  Maximum signal strength
      [min] 3.7810001373291016e+01                  Minimum signal strength
[hardware]                                          Hardware Status
  [mainboard]                                       System Mainboard
    [EUID] 00:30:96:02:00:00:00:f6                      Electronic Unit ID
    [serialnum] SP00253                                 Serial Number
    [type] 4370A-140                                    Mainboard Rev.
  [outputs]                                         System Outputs
    [enabled] true                                      True =On, False = Off
    [numslots] 6                                        Number of board slots (6)
  [power]                                           Power Supply Info
    [numsupplies] 2                                     Number of supplies (2)
    [supplies]                                          Supply Info
      [1]                                               Supply #1
        [status] good                                   Current Status (Good/Bad)
        [type] 4385A                                    Model #
```

```
      [2]                                   Same as Supply #1
        [status] good
        [type] 4385A
    [slots]                                 Output Cards
      [1]                                   Slot #1
        [ports]                                     Port Status
          [1]                                       Port #1
            [status] good                           Good/Bad.
          [2]                                       Same for Ports 2-4
            [status] good
          [3]
            [status] good
          [4]
            [status] good
        [power] enabled                             Enabled or disabled.
        [type] 4394A                                Model # or empty if not installed

      [2-5]                                         Same for slots 2-5

      [6]                                   Example if any slot is empty.
        [type] empty
  [health]                                  System Health
    [clock_freq_step]                               Frequency Steps
      [active] false                                        Event currently active = true
      [occurrences] 0                                       Number of events
    [clock_phase_step]                      Phase steps
      [active] false                                        Event currently active = true
      [occurrences] 0                                       Number of events
    [clock_steer]                           Clock Steer command failures
      [active] false                                        Event currently active = true
      [occurrences] 0                                       Number of events
    [clock_wander]                                  Clock Wander
      [active] false                                        Event currently active = true
      [occurrences] 0                                       Number of events
    [fan]                                   Fan Failures
      [1]                                           Left Fan
        [active] false                                      Event currently active = true
        [occurrences] 0                             Number of events
      [2]                                           Right Fan
        [active] false                                      Event currently active = true
        [occurrences] 0                             Number of events
    [gps_error]                                     GPS Receiver Errors
      [active] false                                        Event currently active = true
      [occurrences] 0                                       Number of events
    [gps_tracking]                                  GPS Tracking
      [active] false                                        true = Not tracking
      [occurrences] 0                                       # of not tracking events
    [leapseconds]                           Leap Seconds
      [internal_error]                              Issue w/the # of leapseconds
        [active] false                              false = no issues
        [occurrences] 0                             # of events
      [unknown]                                     # of leapseconds is unknown
        [active] false                              false = no issues
```

```
      [occurrences] 0
  [output_modules]
    [1]
      [active] false
      [occurrences] 0
    [2]
      [active] false
      [occurrences] 0
    [3]
      [active] false
      [occurrences] 0
    [4]
      [active] false
      [occurrences] 0
    [5]
      [active] false
      [occurrences] 0
    [6]
      [active] false
      [occurrences] 0
  [outputs_disabled]
    [active] false
    [occurrences] 0
  [outputs_unlocked]
    [active] false
    [occurrences] 0
  [over_temperature]
    [active] false
    [occurrences] 0
  [power_supply]
    [1]
      [active] false
      [occurrences] 0
    [2]
      [active] false
      [occurrences] 0
  [ref_unlocked]
    [active] false
    [cleared]
      [what] Rb and LNS are locked
      [when] 1998-01-01-00:02:42.563
    [occurrences] 1
    [set]
      [what] LNS is unlocked
      [when] 1998-01-01-00:02:42.528
[kas2]
  [antenna_delay] -1.878000000000000e-08
  [frequency] -5.116576335241098e+01
  [frequency_aging] -1.726953124522067e-06
  [phase_error] 6.369868716533948e-09
  [ptd] 1.1450885630000001e-09
  [steer] -2.7197785675525666e-11
[ntp]
```

```
      # of events
Output Modules
      Slot #1
            true = Active alarm
            Number of events
      Slot #2
            The remaining slots are the
            same as slot #1.
      Slot #3

      Slot #4

      Slot #5

      Slot #6


      Outputs Disabled
            true = Active alarm
            Number of events
      Outputs unlocked
            true = Active alarm
            Number of events
      Over Temp
            Temperature > 65C
            # of over temp events
      Power Supply Status
      Left Power Supply
            true = Active alarm
      Number of events
      Right Power Supply
            true = Active alarm
      Number of events
      Reference unlocked alarm*
            true = Active alarm
            Status (set(1)/cleared(0))
      Description of last event
      Date/Time of the event
            Number of Events
            Shows last active alarm
            Description of the alarm
      Date/Time the alarm occurred
      Timescale Information
            Time augmented GPS Function
            Frequency offset of the clock
            Clock Aging
            Phase error of the clock
            UTC Offset (OTP)
            Current steering value
NTP Server Status
```

[locked] true	false = Unlocked
[source] REFCLK(25,0)	REFCLK = Internal Clock
[oscillator]	Oscillator Status
[external] locked	10Mhz Ref Status
[internal] locked	Internal RB Locked to reference.
[lns] locked	Low Noise Synth(Unlocked/Locked)
[locked] true	System Locked (true/false)
[outputs] enabled	Outputs (Enabled/Disabled)
[temperature] 31	System Temperature (C)
[tflex]	Unit Information
[network]	Current Network Settings
[MAC] 00:30:96:00:00:98	Unit MAC Address
[broadcast] 192.168.1.255	Current Broadcast Address
[ip] 192.168.1.253	Current IP Address
[netmask] 255.255.255.0	Current Netmask
[serial_number] SP00220	Serial Number
[start] 2008-10-02-17:49	Date/Time of last restart
[uptime] 2 hours, 2 minutes, 54 seconds	Total time systems been up
[ver] 3.2.5	Software version
[time] 2008-10-02-19:52:03	Time show data requested

System Errors: Alarms and events on the ATS-6501 are available via the *status* command. As the events occur the system will *set* the alarm and time. Once the condition clears the system will indicate the condition *cleared*, what the condition was, when it cleared and increment the occurrence counter.

```
[clock_wander]
  [active] false
  [cleared]
    [what] Clock wander is less than 100.000000ns
    [when] 2009-01-26-22:18:48.141
  [occurrences] 1
  [set]
    [what] Clock wander exceeded 100.000000ns
    [when] 2009-01-26-22:18:35.922
```

Appendix C Status Port (1900) Example

The data in this first section (boot+) is provided each time the user connects to the status port. It allows users to obtain all of the system **settings/config/status/network** parameters each time they connect to the status port. Once this data is sent the only data forwarded from this port is the data that has changed since the system has been running. This data will be preceded by the date and time of the event as this information is updated. It is important to recognize these parameters are also reflected in the results from the status command.

Network

boot+883612976 network:broadcast=192.168.0.255
boot+883612976 network:default_gateway=192.168.0.254
boot+883612976 network:ip=192.168.0.1
boot+883612976 network:mode=DHCP
boot+883612976 network:netmask=255.255.255.0

Settings:

boot+883612978 settings:diaglog:clock=info
boot+883612978 settings:diaglog:gps=info
boot+883612978 settings:diaglog:kas2=info
boot+883612978 settings:gps:antenna_delay=0.000000000000000e+00
boot+883612978 settings:gps:antenna_voltage=0.000000000000000e+00
boot+883612978 settings:gps:datum=wgs84
boot+883612978 settings:gps:mask_angle=1.000000000000000e+01
boot+883612978 settings:gps:positioning:auto_hours=1.200000000000000e+01
boot+883612978 settings:gps:positioning:manual_position:altitude=1.592729000000000e+03
boot+883612978 settings:gps:positioning:manual_position:latitude=4.001941422777778e+01
boot+883612978 settings:gps:positioning:manual_position:longitude=-1.052390962444445e+02
2009-02-10-19:06:13.199 settings:gps:positioning:mode=auto
boot+883612978 settings:gps_logging:ftp:compression=1
boot+883612978 settings:gps_logging:ftp:enable=1
boot+883612978 settings:gps_logging:ftp:file_count=100
boot+883612979 settings:gps_logging:ftp:filename:digits=3
boot+883612979 settings:gps_logging:ftp:filename:prefix=user
boot+883612979 settings:gps_logging:ftp:filename:suffix=nov
boot+883612979 settings:gps_logging:ftp:filename:type=timestamp
boot+883612979 settings:gps_logging:ftp:interval=15
boot+883612979 settings:gps_logging:ftp:log_selection:bestposa=ontime 7200
boot+883612979 settings:gps_logging:ftp:log_selection:ionutca=ontime 7200
boot+883612979 settings:gps_logging:ftp:log_selection:rangea=ontime 60
boot+883612979 settings:gps_logging:ftp:log_selection:rawalma=onchanged
boot+883612979 settings:gps_logging:ftp:log_selection:rawephema=onchanged
boot+883612979 settings:gps_logging:ftp:log_selection:rxhwlevelsa=ontime 60
boot+883612979 settings:gps_logging:ftp:log_selection:waas9a=onchanged
boot+883612979 settings:gps_logging:rt:enable=1
boot+883612979 settings:gps_logging:rt:log_selection:gpggartk=ontime 1
boot+883612979 settings:reference:external:type=hp5071a
boot+883612979 settings:reference:source=internal

Status:

2009-02-10-19:06:13.634 status:alarm=no alarm
boot+883612937 status:fan:1=1
boot+883612937 status:fan:2=1
boot+883613027 status:gps:mode:desc=tracking
boot+883613027 status:gps:mode:value=4

```
boot+883612973 status:gps:model:hw_version=OEMV3G-4.00-X2T
boot+883612973 status:gps:model:name=L12LV
boot+883612973 status:gps:model:serial_number=DAB08400198
boot+883612973 status:gps:model:sw_version=3.400
2009-02-10-20:44:25.876 status:gps:position:alt=4.960770000000000e+01
2009-02-10-20:44:25.869 status:gps:position:lat=3.846628273820000e+01
2009-02-10-20:44:25.872 status:gps:position:lon=-7.744087167828999e+01
2009-02-10-19:06:12.967 status:gps:position:mode:enum=0
2009-02-10-19:06:12.963 status:gps:positioning:desc=auto
boot+883612973 status:gps:positioning:period=1.200000000000000e+01
2009-02-10-19:06:12.961 status:gps:positioning:value=0
2009-02-10-20:44:25.878 status:gps:satellite:number=10
2009-02-10-20:44:25.890 status:gps:satellite:signal:avg=4.502349853515625e+01
boot+883613010 status:gps:satellite:signal:desc=Good
boot+883613010 status:gps:satellite:signal:enum=2
boot+883613020 status:gps:satellite:signal:freq=dual
2009-02-10-20:44:25.887 status:gps:satellite:signal:max=5.012699890136719e+01
2009-02-10-20:44:25.883 status:gps:satellite:signal:min=3.602600097656250e+01
boot+883613027 status:gps:tracking:state=tracking
boot+883612936 status:hardware:mainboard:EUID=00:30:96:02:00:00:00:f6
boot+883612936 status:hardware:mainboard:serialnum=SP00253
boot+883612936 status:hardware:mainboard:type=4370A-140
boot+883612936 status:hardware:outputs:enabled=1
boot+883612936 status:hardware:outputs:numslots=6
boot+883612936 status:hardware:power:numsupplies=2
boot+883612960 status:hardware:power:supplies:1:status=good
boot+883612960 status:hardware:power:supplies:1:type=
boot+883612960 status:hardware:power:supplies:2:status=good
boot+883612960 status:hardware:power:supplies:2:type=4385A
2009-02-10-19:06:53.076 status:hardware:slots:1:ports:1:status=1
2009-02-10-19:06:53.079 status:hardware:slots:1:ports:2:status=1
2009-02-10-19:06:53.082 status:hardware:slots:1:ports:3:status=1
2009-02-10-19:06:53.095 status:hardware:slots:1:ports:4:status=1
boot+883612944 status:hardware:slots:1:power=enabled
boot+883612937 status:hardware:slots:1:type=4394A
2009-02-10-19:06:53.146 status:hardware:slots:2:ports:1:status=1
2009-02-10-19:06:53.149 status:hardware:slots:2:ports:2:status=1
2009-02-10-19:06:53.154 status:hardware:slots:2:ports:3:status=1
2009-02-10-19:06:53.201 status:hardware:slots:2:ports:4:status=1
boot+883612951 status:hardware:slots:2:power=enabled
boot+883612944 status:hardware:slots:2:type=4394A
2009-02-10-19:06:56.423 status:hardware:slots:3:ports:1:status=1
2009-02-10-19:06:56.426 status:hardware:slots:3:ports:2:status=1
2009-02-10-19:06:56.429 status:hardware:slots:3:ports:3:status=1
2009-02-10-19:06:56.432 status:hardware:slots:3:ports:4:status=1
2009-02-10-19:06:55.495 status:hardware:slots:3:power=enabled
boot+883612951 status:hardware:slots:3:type=4395A-10
boot+883612951 status:hardware:slots:4:type=empty
2009-02-10-19:06:54.641 status:hardware:slots:5:ports:1:status=1
2009-02-10-19:06:54.644 status:hardware:slots:5:ports:2:status=1
2009-02-10-19:06:54.647 status:hardware:slots:5:ports:3:status=1
2009-02-10-19:06:54.650 status:hardware:slots:5:ports:4:status=1
boot+883612959 status:hardware:slots:5:power=enabled
boot+883612951 status:hardware:slots:5:type=4387A
boot+883612959 status:hardware:slots:6:type=empty
boot+883612979 status:health:clock_freq_step:active=0
boot+883612979 status:health:clock_freq_step:occurrences=0
boot+883612979 status:health:clock_phase_step:active=0
boot+883612979 status:health:clock_phase_step:occurrences=0
```

These fields will update as the GPS Receiver tracks in Auto/Dynamic Mode.

boot+883612979 status:health:clock_steer:active=0
boot+883612979 status:health:clock_steer:occurrences=0
2009-02-10-19:06:13.595 status:health:clock_wander:active=0
2009-02-10-19:06:04.366 status:health:clock_wander:cleared:what=Clock wander is less than 100.00000ns
2009-02-10-19:06:13.593 status:health:clock_wander:cleared:when=2009-02-10-19:06:13.562
2009-02-10-19:06:10.488 status:health:clock_wander:occurrences=2
2009-02-10-19:06:02.202 status:health:clock_wander:set:what=Clock wander exceeded 100.000000ns
2009-02-10-19:06:10.491 status:health:clock_wander:set:when=2009-02-10-19:06:10.461
boot+883612979 status:health:fan:1:active=0
boot+883612979 status:health:fan:1:occurrences=0
boot+883612979 status:health:fan:2:active=0
boot+883612979 status:health:fan:2:occurrences=0
boot+883612980 status:health:gps_error:active=0
boot+883612980 status:health:gps_error:cleared:what=
boot+883612980 status:health:gps_error:cleared:when=1998-01-01-00:03:00.855
boot+883612979 status:health:gps_error:occurrences=1
boot+883612979 status:health:gps_error:set:what=Gps internal error
boot+883612979 status:health:gps_error:set:when=1998-01-01-00:02:59.177
boot+883612979 status:health:gps_tracking:active=0
boot+883612979 status:health:gps_tracking:occurrences=0
boot+883612979 status:health:output_modules:1:active=0
boot+883612979 status:health:output_modules:1:occurrences=0
boot+883612979 status:health:output_modules:2:active=0
boot+883612979 status:health:output_modules:2:occurrences=0
boot+883612979 status:health:output_modules:3:active=0
boot+883612979 status:health:output_modules:3:occurrences=0
boot+883612979 status:health:output_modules:4:active=0
boot+883612979 status:health:output_modules:4:occurrences=0
boot+883612979 status:health:output_modules:5:active=0
boot+883612979 status:health:output_modules:5:occurrences=0
boot+883612979 status:health:output_modules:6:active=0
boot+883612979 status:health:output_modules:6:occurrences=0
boot+883612979 status:health:outputs_disabled:active=0
boot+883612979 status:health:outputs_disabled:occurrences=0
boot+883612979 status:health:outputs_unlocked:active=0
boot+883612979 status:health:outputs_unlocked:occurrences=0
boot+883612979 status:health:over_temperature:active=0
boot+883612979 status:health:over_temperature:occurrences=0
boot+883612979 status:health:power_supply:1:active=0
boot+883612979 status:health:power_supply:1:occurrences=0
boot+883612979 status:health:power_supply:2:active=0
boot+883612979 status:health:power_supply:2:occurrences=0
boot+883612979 status:health:ref_unlocked:active=0
boot+883612979 status:health:ref_unlocked:occurrences=0
2009-02-10-20:44:27.142 status:kas2:ptd=-1.557515731000000e-09
2009-02-10-20:42:59.279 status:kas2:steer=-7.223356515169143e-11
2009-02-10-19:06:51.798 status:ntp:locked=1
2009-02-10-19:05:02.767 status:ntp:source=REFCLK(25,0)
2009-02-10-19:08:53.118 status:oscillator:external=cannot communicate
boot+883612960 status:oscillator:internal=locked
boot+883612960 status:oscillator:lns=locked
boot+883612960 status:oscillator:locked=1
2009-02-10-19:06:52.757 status:outputs=enabled
boot+883612937 status:temperature=27
boot+883612984 status:tflex:network:MAC=00:30:96:00:00:f6
2009-02-10-19:05:36.199 status:tflex:network:broadcast=192.168.1.255
2009-02-10-19:05:36.193 status:tflex:network:ip=192.168.1.253
2009-02-10-19:05:36.195 status:tflex:network:netmask=255.255.255.0
boot+883612937 status:tflex:serial_number=SP00253

boot+883612935 status:tflex:ver=tflex-3-1-0

As events occur and/or the system parameters change, these changes will be updated on the status port.

2009-02-10-20:45:05.971 status:health:power_supply:1:occurrences=1
2009-02-10-20:45:05.982 status:health:power_supply:1:set:when=2009-02-10-20:45:05.915
2009-02-10-20:45:05.992 status:health:power_supply:1:set:what=AC/DC supply missing, or hardware error
2009-02-10-20:45:06.007 status:health:power_supply:1:active=1
2009-02-10-20:45:06.063 status:alarm=power_supply:1 -- AC/DC supply missing, or hardware error
2009-02-10-20:45:10.891 status:hardware:power:supplies:1:status=failing-latched
...
2009-02-10-20:45:13.271 status:health:power_supply:1:cleared:when=2009-02-10-20:45:13.151
2009-02-10-20:45:13.282 status:health:power_supply:1:cleared:what=No errors
2009-02-10-20:45:13.287 status:health:power_supply:1:active=0
2009-02-10-20:45:13.300 status:alarm=no alarm

2009-02-10-20:45:35.718 status:gps:mode:value=3
2009-02-10-20:45:35.721 status:gps:mode:desc=not tracking
2009-02-10-20:45:35.723 status:gps:tracking:state=not tracking
2009-02-10-20:45:35.746 status:gps:satellite:number=0
2009-02-10-20:45:35.750 status:gps:satellite:signal:min=0.000000000000000e+00
2009-02-10-20:45:35.753 status:gps:satellite:signal:max=0.000000000000000e+00
2009-02-10-20:45:35.760 status:gps:satellite:signal:avg=0.000000000000000e+00
2009-02-10-20:45:35.766 status:gps:satellite:signal:freq=single
2009-02-10-20:45:35.768 status:gps:satellite:signal:desc=Poor
2009-02-10-20:45:35.770 status:gps:satellite:signal:enum=0

If GPS is not tracking the ATS-6501 will not report the kas2[ptd] value.

2009-02-10-20:45:55.952 status:gps:satellite:number=5
2009-02-10-20:45:55.958 status:gps:satellite:signal:min=4.702999877929688e+01
2009-02-10-20:45:55.963 status:gps:satellite:signal:max=4.985499954223633e+01
2009-02-10-20:45:55.975 status:gps:satellite:signal:avg=4.883119964599609e+01
2009-02-10-20:45:55.984 status:gps:satellite:signal:desc=Good
2009-02-10-20:45:55.988 status:gps:satellite:signal:enum=2
2009-02-10-20:45:58.007 status:gps:mode:value=4
2009-02-10-20:45:58.009 status:gps:mode:desc=tracking
2009-02-10-20:45:58.015 status:gps:tracking:state=tracking
2009-02-10-20:45:58.192 status:kas2:ptd=-1.021275279700000e-08
2009-02-10-20:45:59.113 status:kas2:ptd=-1.050371841700000e-08
2009-02-10-20:45:59.193 status:time=2009-02-10-20:45:59
2009-02-10-20:45:59.201 status:tflex:uptime=1 hour, 42 minutes, 51 seconds
2009-02-10-20:46:19.280 status:kas2:steer=-7.224287837743760e-11

Appendix D. Detailed Command Information

The commands are listed alphabetically. Each command is listed with an explanation of what it does along with examples. All of the commands are case sensitive. The system will inform the operator that the commands were executed by returning an "OK" or other language denoting the command has been accepted. Operators will be informed if the system cannot recognize the command or syntax that was entered. In such cases where the data value entered is out of range or is incorrect the ATS-6501 will generate an error message and will leave the current operating value for that parameter unchanged and provide the operator with the acceptable range of values.

The system will recognize alphanumeric characters as well as the dash(-), single quotes'', and the underscore'_' when attempting to save user configuration files. Use of any other characters is prohibited and strictly enforced and the user will be informed they attempted to use an illegal filename.

If the system cannot recognize the configuration, status, network or settings parameter the operator is requesting it may return "no info". Make sure the fields were typed correctly for the data you are attempting to retrieve.

Command Arguments:

- < > Any arguments contained are optional and can be left out if desired.
- / is used to separate alternative inputs for a single parameter (e.g., On/Off, 1/0)
- [n] is a number (e.g., 3, 11, 114).
- [nf] is a number which may contain a decimal point (e.g., 5.2 or 12 or 0.4).
- [nt] is a time or a length of time.
- [filename] is the name of a system, ftp, or real-time (rt) configuration file.

Altitude:

Description: Sets the antenna altitude in meters (default) or feet (ft).

Syntax: altitude [nf]

Note: Once this command is executed, the positioning mode will be manual and the longitude and longitude values in the manual gps settings will be in effect.

Command Examples:
ATS-6501>altitude 51.573999999999998
or
ATS-6501>altitude 169.206037003 ft

Query:
ATS-6501>settings gps:positioning:manual_position:altitude
[altitude] 5.1573999999999998e+01

Antenna Delay:

Description: Sets the antenna delay value for calibration and system on-time-point. The system will accept scientific notation values as shown below. The example below has a delay of 96.3nsec

Syntax: antenna_delay [nt]

Command Example:
ATS-6501>antenna_delay 9.63E-8

Query:
ATS-6501>settings gps:antenna_delay
9.630000000000000e-08

Antenna Voltage:

Description: Sets the DC Bias voltage level on the Antenna connector. Default is Zero. The system will give the user an error message with the acceptable values [0,5,12] if the operator attempts to enter an invalid DC voltage.

Syntax: antenna_voltage [n]

Command Example:
ATS-6501>antenna_voltage 12

Query:
ATS-6501>settings gps:antenna_voltage

0.0000000000000000e+00	0V
5.0000000000000000e+00	5VDC
1.2000000000000000e+01	**12VDC**

Clear Alarms

Description: Clears any latched alarm events from the alarm list and front panel. This allows the operator to acknowledge a system alarm and clear it from the status message (*status alarm*) and clear the front panel alarm light. If any additional alarms/events occur the new alarm will be added to the list (*status alarm*) and the front panel alarm light will illuminate. If the condition the *clear_alarms* command was issued for clears and returns, the alarm will be displayed in status alarm and the front panel alarm light will come on.

Syntax: clear_alarms

Command Example:
ATS-6501>clear_alarms
Latched alarms cleared

Config:

Description: Displays the current system configuration settings. These settings are done and the factory and cannot be changed by the user. They are for information only. Short-cut for show config.

Syntax: config

Command Example:
ATS-6501>config

Datum:

Description: Sets the current datum to be used by the system.

Syntax: datum (wgs84 / nad83), default is wgs84.

Command Example:
ATS-6501>datum wgs84

Query:
ATS-6501>settings gps:datum
wgs84

Delete

Description: Deletes the user specified system configuration file. In the example below the user is deleting the "test" configuration. Once complete the ATS-6501 will respond with an "OK". If the file does not exist the system will return with "no such file". The system will not accept files named with illegal characters and if any illegal characters are specified in the filename the system will indicate the user is attempting to delete a file with an "illegal filename".

Syntax: delete [filename]

Command Example:
ATS-6501>delete test

Query:
ATS-6501>list
This command lists all of the current system configuration files saved by the user.

Delete_logs

Description: Deletes the user specified ftp or real-time (rt) gps logging configuration file. In the example below the user is deleting the ftp "test" configuration. Once complete the ATS-6501 will respond with an "OK". If the file does not exist the system will return with "no such file". The system will not accept files named with illegal characters and if any illegal characters are specified in the filename the system will indicate the user is attempting to delete a file with an "illegal filename".

Syntax: delete_logs (ftp / rt) [filename]

Command Example:
ATS-6501>delete_logs ftp test

Query:
ATS-6501>list_logs (ftp / rt)
This command lists all of the current gps logging configuration files saved by the user. The user must specify ftp or rt for the log type.

Diag:

Description: Sets the current diagnostic message type (error/info/debug) for the three internal (clock/gps/kas2) systems monitored by the ATS-6501. This command specifies what message types will be sent to Port 1800. The default message type is info.

Syntax: diag (clock / gps /kas2) (error / info /debug)

Command Example:
ATS-6501>diag gps debug

Query:
ATS-6501>settings diaglog
[clock] info
[gps] debug
[kas2] info

Diag_port:

Description: Switches the current telnet session from the Command Port (1700) to the Diagnostic Port (1800).

Syntax: diag_port

Command Example:
ATS-6501>diag_port

To end this session and return to the command port type *quit* and press enter.

Fix Position:

Description: Sets the ATS-6501 position to the current GPS coordinates <current> or to the settings entered by the user [nf]. When entering the position manually users must enter all three values (latitude, longitude, and altitude). The ATS-6501 will respond with "OK" when the settings have been accepted. The command will only accept the values in decimal format and latitudes in the southern hemisphere and longitudes in the western hemisphere must be preceded with a (-) sign.

Syntax: fix_position <current> or [nf (latitude] [nf (longitude)] [nf altitude)]

Note: Once this command is executed, the positioning mode will be manual.

Command Example:
ATS-6501>fix_position 38.466279772 -77.440869253 51.5161

Query:
ATS-6501>settings gps

```
  [antenna_delay] 0.000000000000000e+00
  [antenna_voltage] 0.000000000000000e+00
  [datum] wgs84
  [mask_angle] 1.000000000000000e+01
  [positioning]
    [auto_hours] 1.200000000000000e+01
    [manual_position]
      [altitude] 5.151610000000000e+01
      [latitude] 3.846627977200000e+01
      [longitude] -7.744086925300000e+01
    [mode] manual
```

Front Panel Button

Description: This command turns the IP Reset feature on the front panel display button on (1) or off (0). This feature is enabled by default (1).

Syntax: frontpanel_button (0/1)

Command Example:
ATS-6501>frontpanel_button 0

Query:
ATS-6501>settings hardware
[enable_fp_button] false true=enabled, false=disabled.

Help:

Description: Displays the entire command list or will provide details on the specified command <command>. Acceptable shortcuts are h or a '?'.

Syntax: help <command>

Command Examples:
ATS-6501>help <command>
ATS-6501>h <command>
ATS-6501>? <command>

Irig:

Description: Allows the operator to set the DC and AM IRIG outputs on individual ports. The ATS-6501 will respond with "OK" when the settings have been accepted. The system will generate an error message if the operator attempts to enter an unsupported or invalid IRIG Time Code.

Syntax: irig [slot #] [port#] [Type A-H] [Code <NNN>]

Command Examples:
ATS-6501>irig 5 2 G 141

Query:

```
ATS-6501> settings hardware:slots:5
    [tsc4387]
      [ports]
        [1]
          [format] B
          [signal_word] 120
          [type] irig
        [2]
          [format] B
          [signal_word] 120
          [type] irig
        [3]
          [format] G
          [signal_word] 141
          [type] irig
        [4]
          [format] B
          [signal_word] 120
          [type] irig
```

Latitude:

Description: Sets the ATS-6501 latitude. The ATS-6501 will respond with "OK" when the settings have been accepted. The command will only accept the values in decimal format and latitudes in the southern hemisphere must be preceded with a (-) sign or followed with a [S]. Default is the northern hemisphere.

Syntax: latitude [nf]

Note: Once this command is executed, the positioning mode will be manual and the longitude and altitude values in the manual gps settings will be in effect.

Command Examples:

```
ATS-6501>latitude 38.466279772
ATS-6501>latitude 38.466279772N
ATS-6501>latitude -38.466279772
ATS-6501>latitude 38.466279772S
```

Query:

```
ATS-6501>settings gps:positioning:manual_position
      [altitude] 5.151610000000000e+01
      [latitude] 3.846627977200000e+01
      [longitude] -7.744086925300000e+01
```

List

Description: Lists all of the saved user system configuration files. If there are no saved user configuration files the system will return with "no files".

Syntax: list

Command Example:

ATS-6501>list

Query:
ATS-6501>list
default

List_logs

Description: Lists all of the saved user ftp or real-time (rt) gps logging configuration files. If there are no saved user configuration files the system will return with "no files".

Syntax: List_logs (ftp / rt)

Command Example:
ATS-6501>list_logs (ftp / rt)

Query:
ATS-6501>list_logs ftp
default

Load

Description: Loads the user specified system configuration file. In the example below the user is loading the "test" configuration. Once complete the ATS-6501 will respond with an "OK". If the file does not exist the system will return with an error indicating the file does not exist. The system will not accept files named with illegal characters and if any illegal characters are specified in the filename the system will indicate the user is attempting to load a file with an "illegal filename".

Syntax: load [filename]

Command Example:
ATS-6501>load test

Query:
ATS-6501>list
default
test

Load_logs

Description: Loads the user specified ftp or real-time (rt) gps logging configuration file. In the example below the user is loading the ftp "test" configuration. Once complete the ATS-6501 will respond with an "OK". If the file does not exist the system will return with an error indicating the file does not exist. The system will not accept files named with illegal characters and if any illegal characters are specified in the filename the system will indicate the user is attempting to load a file with an "illegal filename".

Syntax: load_logs (ftp / rt) [filename]

Command Example:

ATS-6501>load_logs ftp test

Query:
ATS-6501>list_logs (ftp / rt)
default
test

Log

Description: Determines which GPS logs are saved in the files (ftp) or available on the real-time (rt) port (1135). Users specify the log type (ftp/ rt) and the Novatel OEMV log command <novalog command>. Users can specify multiple log file types but they must be done on separate command lines.

Syntax: log (ftp / rt) <novalog command>

Command Example:
ATS-6501> log (ftp/rt) ionutca ontime 7200 (ionutca ontime 7200 is the novalog command)

Query:
ATS-6501>settings gps_logging:ftp:log_selection
[ionutca] ontime 7200

Log Compression

Description: User can opt to compress (1) the log ftp log files or leave these files uncompressed (0).

Syntax: log_compression (0/1)

Note: When using the log_filename setting of *timescale* the .gz extension will be appended to the filename. When using the *user* setting the .gz extension will **not** be appended even if the files are compressed.

Command Example:
ATS-6501> log_compression 1

Query:
ATS-6501>settings gps_logging:ftp:compression
true

Log Enable

Description: User can opt to turn the ftp and/or real-time (rt) logs on (1) or off (0).

Syntax: log_enable (ftp/rt) (0/1)

Command Example:
ATS-6501> log_enable rt 1

Query:

```
ATS-6501>settings gps_logging:rt:enable
true
```

Log Filename

Description: User can set up the file naming scheme for the ftp gps log files.

Syntax: log_filename (user / timestamp) <prefix> <id> <suffix>

User: When using the **user** file naming scheme you will also need to provide the file prefix, the number of digits you would like to use as the unique file identifier, and the suffix for the file.

Command Example:
```
ATS-6501>log_filename user Test 4 nov
```

File will be stored as: Test####nov, where the # is a sequence of 4 numbers and characters to uniquely identify the file name.

Timestamp: When using the timestamp file naming scheme the files are written out at the log_interval setting and time stamped starting with the last two digits of the year, two digit month, two digit day, two digit hour, and two digit minute when the log was opened. Example (File 0810021530) log was opened 2 Oct 2008 at 15:30 (UTC). This command will also accept an optional suffix to append to the filename (i.e. .nov = 0810021530.nov).

Note: When using this option the prefix and digits values that apply for the *user* filename settings have no impact on the filenames.

Command Example:
```
ATS-6501>log_filename timestamp <nov>
```

Warning: If the ATS-6501 is currently logging data and you change the file naming convention you will wipe out all of the log files currently saved in memory. Ensure these files are downloaded prior to making any changes to prevent a possible loss of data.

Query:
```
ATS-6501>settings gps_logging:ftp:filename
    [digits] 4
    [prefix] Test
    [suffix] nov
    [type] timestamp
```

Log Interval

Description: Amount of time to record and save the ftp log file information in minutes. Default value is 15 minutes. Log interval can be between 1 and 1440 minutes.

Syntax: log_interval [n]

Note: Changing the interval will not impact the log files already stored on the system.

Command Example:
ATS-6501> log_interval 5

Query:
ATS-6501>settings gps_logging:ftp:interval
5

Log Number

Description: The maximum number of logs to save on the system. Once the number of logs has reached the maximum value the system will delete the oldest log and replace it with the newest log each time a new log file is generated. It will continue to do this as long as the number of log files storage is equal to the log number. Default value is 100 logs minutes.

Syntax: log_number [n]

Note: Changing the number of logs on the system will not impact the log files already stored on the system unless the new value is lower than the number of log files currently in storage. If so, the system will delete as many log files as needed to drop the number of logs to the new value starting with the oldest file and working forward.

Command Example:
ATS-6501> log_number 15

Query:
ATS-6501>settings gps_logging:ftp:file_count
15

Longitude:

Description: Sets the ATS-6501 longitude. The ATS-6501 will respond with "OK" when the settings have been accepted. The command will only accept the values in decimal format and longitudes in the western hemisphere must be preceded with a (-) sign or followed with a [W]. Default is the eastern hemisphere.

Syntax: longitude [nf]

Note: Once this command is executed, the positioning mode will be manual and the latitude and altitude values in the manual gps settings will be in effect.

Command Examples:
ATS-6501>longitude 77.44086542274004
ATS6501>longitude 77.44086542274004E
ATS-6501>longitude -77.44086542274004
ATS-6501>longitude 77.44086542274004W

Query:
ATS-6501>settings gps:positioning:manual_position

[altitude] 5.151610000000000e+01
[latitude] 3.846627977200000e+01
[longitude] -77.44086542274004**e+01**

Mask Angle:

Description: Sets the mask angle for the internal GPS receiver in degrees. System default is 10.

Syntax: mask_angle [n]

Command Example:
ATS-6501>mask_angle 15

Query:
ATS-6501>settings gps:mask_angle
1.000000000000000e+01

Nasa36:

Description: Allows the operator to select the NASA36 on any of the AM IRIG outputs on the 4387A Output card. The ATS-6501 will respond with "OK" when the settings have been accepted. The system will generate an error message if the operator attempts to enter an unsupported or invalid Time Code.

Syntax: nasa36 [slot #] [port#]

Command Examples:
ATS-6501>nasa36 5 2

Query:
ATS-6501> settings hardware:slots:5
[tsc4387]
[ports]
[1]
[format] B
[signal_word] 120
[type] irig
[2]
[format] B
[signal_word] 120
[type] nasa36
[3]
[format] B
[signal_word] 120
[type] irig
[4]
[format] B
[signal_word] 120
[type] irig

Network

Description: Displays the current system network settings as set by the user. Short-cut for show network.

Syntax: network

Note: These settings are not necessarily what the system is currently using unless the system has static IP Address assigned. If the system is using DHCP the current IP settings being used by the system will be displayed using the *status tflex:network* command.

Command Example:
ATS-6501> network

Query:
ATS-6501>network

[broadcast] 192.168.1.255
[default_gateway] 192.168.1.1
[ip] 192.168.1.50
[mode] static
[netmask] 255.255.255.0

If = DHCP – check *status tflex:network* for current settings

Network Configuration

Description: Allows the user to change the mode for setting the IP Address (DHCP / static) and assigning the network settings when using a static IP Address.

Syntax: network_config --mode (DHCP/static) --ip <IP Address> -- mask <netmask> -- broadcast <Broadcast IP> --gateway <Gateway IP>

Command Example:
ATS-6501> network_config --mode static --ip 192.168.1.50 --mask 255.255.255.0 --broadcast 192.168.1.255 --gateway 192.168.1.1

Note: These network settings will take effect immediately. Users should see "<working>" with a series of periods on the screen. Once the new settings take effect the connection will time out and drop. Users will need to reconnect to the system using the newly assigned static IP Address. These settings are also stored on the system automatically and the system will start up with these settings each time it is rebooted or power cycled.

Query:
ATS-6501>network

[broadcast] 192.168.1.255
[default_gateway] 192.168.1.1
[ip] 192.168.1.50
[mode] static
[netmask] 255.255.255.0

Position Mode:

Description: Sets the ATS-6501 positioning mode to the desired value. Default setting is dynamic. Static users should use the auto mode if the antenna position is not known and manual if the position is known.

Syntax: position_mode (dymanic / auto / manual)

Command Example:
ATS-6501>position_mode auto

Query:
ATS-6501>settings gps:positioning:mode
auto

Position Period:

Description: This is the amount of time the system will use to provide the antenna position when the position_mode is auto. Default period is 12 hours. Users can also set the value to minutes using the (m) option. It is recommended this period be for a at least 4 hours.

Syntax: position_period [nt] (m)

Command Example:
ATS-6501>position_period 10

Query:
ATS-6501>settings gps:positioning:auto_hours
10

Note: If the system starts up in auto mode or is switched into the auto mode from dymanic or manual the system will begin averaging over this period to determine the position. While the system is performing this function a countdown timer will show how much time remains before the system determines and fixes its position (status gps:auto_positioning). Once the period expires the antenna position will be fixed (*status gps:position:fixed = true*) and the system will generate a RINEX file in the rinex directory.

PPS:

Description: Allows the operator to set the PPS outputs on individual ports on the 4394A Card. The ATS-6501 will respond with "OK" when the settings have been accepted. The system will generate an error message if the operator attempts to enter an invalid setting.

Syntax: pps [slot #] [port#] [pulse_period] [pulse_width]

Command Examples:
ATS-6501>pps 1 2 1e-6 5e-7

Query:
ATS-6501> settings hardware:slots:1
[tsc4373]
[ports]
[1]

```
    [pps_period] 1
    [pps_width] 1.000000000000000e-04
    [type] pps
  [2]
    [pps_period] 1.000000000000000e-06
    [pps_width] 5.000000000000000e-07
    [type] pps
  [3]
    [format] B
    [signal_word] 0
    [type] irig
  [4]
    [format] B
    [signal_word] 0
    [type] irig
```

Prompt:

Description: Allows the user to change the command prompt text, turn the prompt on (1) or off (0) and can make that change for the current session or the system default.

Syntax: prompt –text(text) –enable(0/1) --default

Command Example:
This command changes it for the current session.

```
ATS-6501>prompt –text Test
Test>           Changes the prompt immediately, only in effect for the current telnet session.

ATS-6501>prompt –enable 0
Prompt is no longer visible.  This change is only in effect for the current telnet session.
```

Command Example:
This command makes it the system default.

```
ATS-6501>prompt –text Test --default
ATS-6501>       Note:  Prompt does not change until the next command port connection is made.
ATS-6501>prompt –enable 0 --default
ATS-6501>               Prompt is still visible, Prompt does not disappear until the next
                        command port connection is made.
```

Query:

```
ATS-6501>settings command_port

  [prompt]
    [enable] true
    [text] Test>
```

Note: Making any changes without the –default option will impact the current session and will not impact the system settings. Using the –default option will change the system settings (*settings command_port*) values and will be used the next time the user makes a command port connection. These settings must also be saved.

Quit:

Description: Terminates the current command port connection

Syntax: quit

Command Example:
ATS-6501>quit

Reboot:

Description: Reboots the ATS-6501.

Syntax: reboot

Command Example:
ATS-6501>reboot

Reference:

Description: Allows the user to set the ATS-6501 to use the internal reference or a user provided external reference. Default is internal.

Syntax: reference (internal / external)

Command Example:
ATS-6501>reference external

Query:
ATS-6501>settings reference:source
external

Warning: Prior to setting the reference to external, make sure the 10MHz signal from the external reference is plugged in to the 10Mhz IN connector on the rear of the ATS-6501.

Reference Type:

Description: Allows the user to set the type of external reference to be used. hp5071a is the default setting. The ATS-6501 is capable of communicating with the Symmetricom 5071A and will check the status of this clock during normal operations to ensure the reference is operating properly. All other external reference types should be set to cesium.

Syntax: reference_type (cesium / hp5071a)

Command Example:
ATS-6501>reference_type hp5071a

Query:
ATS-6501>settings reference:external:type
hp5071a

Restart:

Description: Restarts the ATS-6501 application without rebooting the system.

Syntax: restart

Command Example:
ATS-6501>restart

Save

Description: Saves the user specified system configuration file. The user can save the default system settings by typing save and pressing enter. The users can save other system configurations as desired by adding a filename to the save command. In the example below the user is saving the "test" configuration. Once complete the ATS-6501 will respond with an "OK". The system will not accept files named with illegal characters and if any illegal characters are specified in the filename the system will indicate the user is attempting to load a file with an "illegal filename".

Syntax: save [filename]

Command Example:
ATS-6501>save test

Query:
ATS-6501>list
default
test

Save_logs

Description: Saves the user specified ftp or real-time (rt) GPS logging configuration file. The user can save the default system GPS logging settings by typing save (ftp /rt) and pressing enter. The users can save other system configurations as desired by adding a filename to the save (ftp / rt) command. In the example below the user is saving the ftp "test" configuration. Once complete the ATS-6501 will respond with an "OK". The system will not accept files named with illegal characters and if any illegal characters are specified in the filename the system will indicate the user is attempting to load a file with an "illegal filename".

Syntax: save_logs (ftp / rt) [filename]

Command Example:
ATS-6501>save_logs ftp test

Query:
ATS-6501>list_logs (ftp / rt)
default
test

Settings:

Description: Displays the list of current user settings in effect. Short-cut for show settings.

Syntax: settings

Command Example:
ATS-6501>settings

show:

Description: This command displays all of the current system factory, user, and network settings as well as the current system status. It is the equivalent of sending the config, network, settings, and status commands at the same time.

Syntax: show

Command Example:
ATS-6501>show

Software Update:

Description: Updates the ATS-6501 system software using a previously uploaded iso image file.

Syntax: software_update

Command Example:
ATS-6501>software_update

Note: If the iso image is not on the system the command will attempt to execute, display a line feed and the system will return to the command prompt. If this occurs the iso file must be uploaded to the system before the software can be updated.

Status:

Description: Displays the current system status, health, and alarms. Short-cut for show status.

Syntax: status

Command Example:
ATS-6501>status

Status_port:

Description: Switches the current telnet session from the Command Port (1700) to the Status Port (1900).

Syntax: status_port

Command Example:
ATS-6501>status_port

To end this session and return to the command port type *quit* and press enter.

Syslog:

Description: Displays the current system log file contents for the user specified type.

Syntax: syslog (debug /error / info)

Command Example:
ATS-6501>syslog error

Unlog

Description: Allows the user to remove log files type from the FTP files and real-time data on port 1135. Users specify the log type (ftp/ rt) and the Novatel OEMV [type] to remove. Users can also use the keyword all to remove all user specified log types.

Syntax: unlog (ftp / rt) (log / all)

Command Example:
ATS-6501>unlog ftp waas9a waas9a = [type]

Query:
ATS-6501>settings gps_logging:ftp:log_selection
[bestposa] ontime 7200
[ionutca] ontime 7200
[rangea] ontime 60
[rawalma] onchanged
[rawephema] onchanged
[rxhwlevelsa] ontime 60

Appendix E Julian Date Calendars

JULIAN DATE CALENDER
(PERPETUAL-NON LEAP YEARS)

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	001	032	060	091	121	152	182	213	244	274	305	335
2	002	033	061	092	122	153	183	214	245	275	306	336
3	003	034	062	093	123	154	184	215	246	276	307	337
4	004	035	063	094	124	155	185	216	247	277	308	338
5	005	036	064	095	125	156	186	217	248	278	309	339
6	006	037	065	096	126	157	187	218	249	279	310	340
7	007	038	066	097	127	158	188	219	250	280	311	341
8	008	039	067	098	128	159	189	220	251	281	312	342
9	009	040	068	099	129	160	190	221	252	282	313	343
10	010	041	069	100	130	161	191	222	253	283	314	344
11	011	042	070	101	131	162	192	223	254	284	315	345
12	012	043	071	102	132	163	193	224	255	285	316	346
13	013	044	072	103	133	164	194	225	256	286	317	347
14	014	045	073	104	134	165	195	226	257	287	318	348
15	015	046	074	105	135	166	196	227	258	288	319	349
16	016	047	075	106	136	167	197	228	259	289	320	350
17	017	048	076	107	137	168	198	229	260	290	321	351
18	018	049	077	108	138	169	199	230	261	291	322	352
19	019	050	078	109	139	170	200	231	262	292	323	353
20	020	051	079	110	140	171	201	232	263	293	324	354
21	021	052	080	111	141	172	202	233	264	294	325	355
22	022	053	081	112	142	173	203	234	265	295	326	356
23	023	054	082	113	143	174	204	235	266	296	327	357
24	024	055	083	114	144	175	205	236	267	297	328	358
25	025	056	084	115	145	176	206	237	268	298	329	359
26	026	057	085	116	146	177	207	238	269	299	330	360
27	027	058	086	117	147	178	208	239	270	300	331	361
28	028	059	087	118	148	179	209	240	271	301	332	362
29	029		088	119	149	180	210	241	272	302	333	363
30	030		089	120	150	181	211	242	273	303	334	364
31	031		090		151		212	243		304		365

JULIAN DATE CALENDAR
(FOR LEAP YEARS ONLY)

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	001	032	061	092	122	153	183	214	245	275	306	336
2	002	033	062	093	123	154	184	215	246	276	307	337
3	003	034	063	094	124	155	185	216	247	277	308	338
4	004	035	064	095	125	156	186	217	248	278	309	339
5	005	036	065	096	126	157	187	218	249	279	310	340
6	006	037	066	097	127	158	188	219	250	280	311	341
7	007	038	067	098	128	159	189	220	251	281	312	342
8	008	039	068	099	129	160	190	221	252	282	313	343
9	009	040	069	100	130	161	191	222	253	283	314	344
10	010	041	070	101	131	162	192	223	254	284	315	345
11	011	042	071	102	132	163	193	224	255	285	316	346
12	012	043	072	103	133	164	194	225	256	286	317	347
13	013	044	073	104	134	165	195	226	257	287	318	348
14	014	045	074	105	135	166	196	227	258	288	319	349
15	015	046	075	106	136	167	197	228	259	289	320	350
16	016	047	076	107	137	168	198	229	260	290	321	351
17	017	048	077	108	138	169	199	230	261	291	322	352
18	018	049	078	109	139	170	200	231	262	292	323	353
19	019	050	079	110	140	171	201	232	263	293	324	354
20	020	051	080	111	141	172	202	233	264	294	325	355
21	021	052	081	112	142	173	203	234	265	295	326	356
22	022	053	082	113	143	174	204	235	266	296	327	357
23	023	054	083	114	144	175	205	236	267	297	328	358
24	024	055	084	115	145	176	206	237	268	298	329	359
25	025	056	085	116	146	177	207	238	269	299	330	360
26	026	057	086	117	147	178	208	239	270	300	331	361
27	027	058	087	118	148	179	209	240	271	301	332	362
28	028	059	088	119	149	180	210	241	272	302	333	363
29	029	060	089	120	150	181	211	242	273	303	334	364
30	030		090	121	151	182	212	243	274	304	335	365
31	031		091		152		213	244		305		366