Sandpiper / Avocet
Evaluation Kit
User Guide

5V / 3.3V
12 Channel
GPS Receivers

June 2000

axiom NAVIGATION INC.

Contents

Preface

This User Guide explains how to set up Axiom Navigation's GPS receiver Evaluation Kit and how to use accompanying PC software to operate and evaluate the receiver, and collect, display and analyze data. Additional documentation is supplied with this guide to complete the information set. See chapter one for details.

Intended Audience

This User Guide will aid system integrators in the evaluation of Axiom's GPS receiver. This guide assumes the user has basic PC computer skills and is familiar with Windows environments.

If you have any questions about installing or using this Evaluation Kit, please contact Axiom Navigation at:

Tel: 714-780-5900 (7 AM to 6 PM Pacific Time)

Fax: 714-780-0078

email: support@axiomnav.com

Chapter 1   About the Evaluation Kit

Thank you for your interest in Axiom Navigation products. The purpose of this Evaluation Kit is to help one evaluate the performance of Axiom GPS receivers. Axiom receivers feature the excellent acquisition and tracking performance inherent with the SiRF chipset. Value added features make Axiom receivers among the most sought after commercial GPS receivers available today.

Introduction

With one exception, Sandpiper and Avocet GPS receivers are functionally identical. Only their operating voltages set them apart. Avocet operates at 3.3 VDC, and Sandpiper operates across a voltage range of 3.3 to 5.5 VDC. Previous versions of Sandpiper only operated at 5.0 VDC. In April 2000 the Generation D version of Sandpiper was released. This latest version handles the wide voltage range. For the purpose of this document Sandpiper will be described unless otherwise noted.

Sandpiper is a single board, 12 channel GPS receiver engine intended as a component for an Original Equipment Manufacturer (OEM) product. The receiver, shown in Figures 1.1 and 1.2, continuously tracks all satellites in view, thus providing accurate satellite positioning data.

——————————— *NOTE* ———————————
For an overview of the Global Positioning System (GPS), please see Axiom's web site at www.axiomnav.com/tutorials.asp.

Sandpiper takes advantage of SiRF Technology's unbeatable SiRFStar™ architecture. SiRFStar™ technology offers features unique to the commercial GPS market as well as critical to land–based vehicle and personal navigation and tracking. Axiom invites you to see for yourself the excellence you have at your fingertips.

Product Overview

Figures 1.1 and 1.2 show the GPS receiver you will be evaluating.
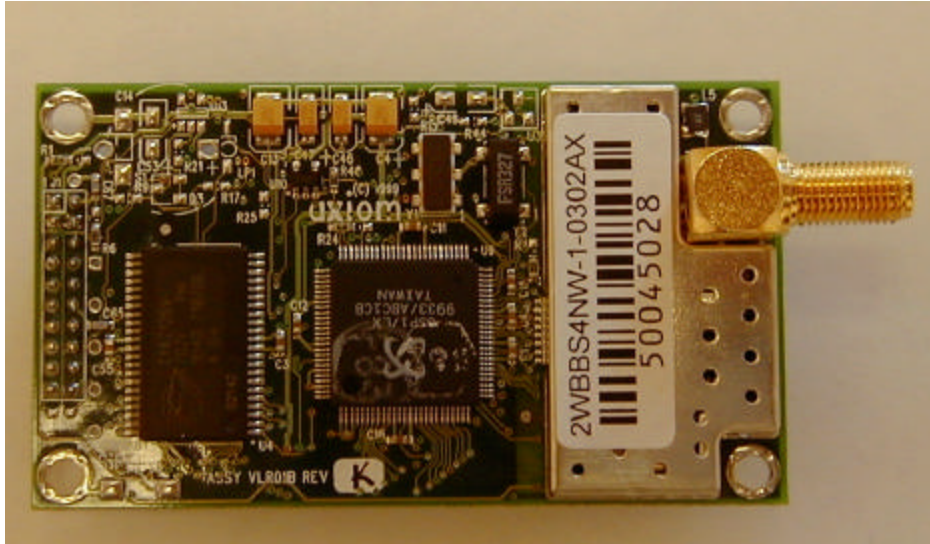
Figure 1.1   Sandpiper/Avocet GPS Receiver Top Side
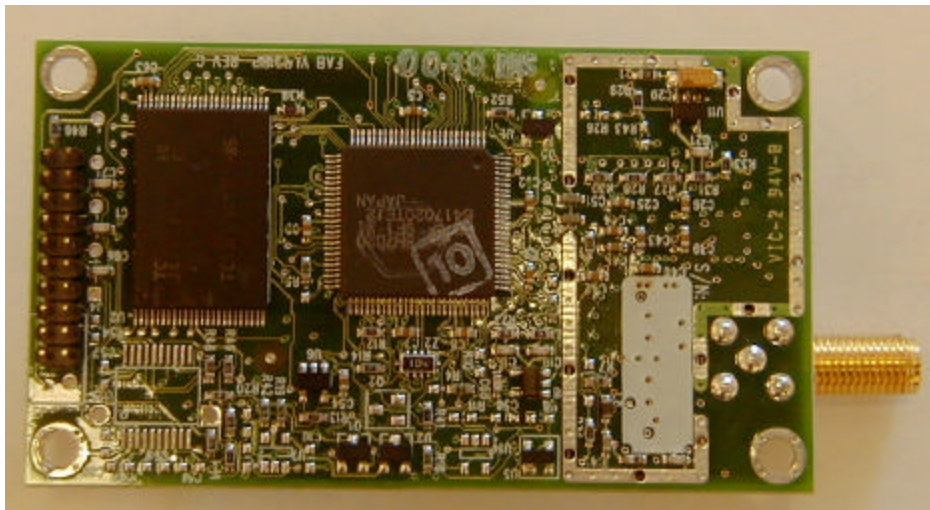
Figure 1.2   Sandpiper/Avocet GPS Receiver Bottom Side

Key features

- **SnapLockÔ**   This high–speed signal acquisition technology renews satellite positioning within a tenth of a second after emerging from a blocked region. This is critical for re-establishing position accuracy, because automobiles quickly pass through intersections in an "urban canyon."

- **SingleSatÔ**   This positioning technology permits a SiRF-enabled GPS system to provide positioning information during intervals when only one satellite is "visible."

- **Multipath Rejection**   The dual multipath mitigation technology effectively eliminates data derived from signals that have taken an indirect path (e.g. signals reflected off of nearby and distant objects).

- **FoliageLockÔ**   This signal tracking technology enables SiRF-enabled GPS products to operate even in areas of dense foliage.

Kit Contents

This Evaluation Kit, shown in Figure 1.3, contains the following:

- **Evaluation Unit**   Avocet GPS receiver, Receiver Interface Board (RIB), and metal housing.

- **Antenna**   Active patch GPS antenna; 5 meter RG-174 coaxial cable; magnet mount; SMA male connector.

- **Wall Power Supply**   Wall transformer with 2.1 mm female, center positive plug (120 VAC input, 9 VDC @ 500 mA output).

- **Auto Power Supply**   Automotive cigarette lighter power adapter with 2.1 mm female, center positive plug (12 VDC input, 12 VDC output). ***Not included with Timing Receiver Evaluation Kit.***

- **Serial Cable**   Six feet, RS-232 with DB-9 ends.

- **CD–ROM**   Conductor and other evaluation programs, and other GPS receiver documentation.

▪ **User Guide**		This manual, *Sandpiper/Avocet Evaluation Kit User Guide,* also found on the CD–ROM.

If any of these items are missing, please contact Axiom Navigation as noted in the preface.

Figure 1.3   Sandpiper/Avocet Evaluation Kit

CD–ROM Contents

Several other programs and documents, as well as this document, are on the supplied CD–ROM, as described below. Some or all of the programs and documentation will aid your evaluation of the GPS receiver.

Documentation

▪ **GPS Message Set**		The file is named **GPS Message Set Specification V22**. It describes in detail the three message sets available

with the Evaluation Unit—SiRF binary, NMEA, and Axiom User1.

▪	**Conductor User Guide**	The file is named **Conductor User Guide**. It describes the Conductor PC program that aids your evaluation.
▪	**Interface Document**	The file is named **Sandpiper Eval Kit 2WBBS4NW-1-0302AX**. This describes the interface to the receiver board, itself. This, ultimately, is of importance to know how to integrate the receiver into a system.
▪	**White Papers**	Several White Papers and Application Notes are provided from SiRF and Axiom. These address topics on the receiver performance and capabilities, and on setup issues, such as active versus passive antenna power. The GPS user equipment and signal specifications are also included here.
▪	**GPS System**	Two GPS system documents are provided. The Interface Control Document (ICD-GPS-200) describes the GPS signal transmitted from the satellites. The WGS-84 document describes the global datum used to specify a location relative to the center of the earth.

Programs

▪	**Conductor**	The Conductor PC program aids your evaluation. It will communicate with the receiver in all three message protocols. It also allows for data logging to the PC and a user–friendly view of receiver performance.
▪	**DataLogger**	The DataLogger PC program aids your evaluation with the User1 data logging, providing a simple, direct interface outside of Conductor. ***Not included with Timing Receiver Evaluation Kit.***
▪	**SiRFdemo**	The SiRFdemo PC program is part of a toolkit provided by SiRF. It requires running the receiver in the SiRF binary or NMEA protocols. It allows one to

further evaluate performance. See the SiRF Toolkit chapter for details.

- **CalcPSR**

  The CalcPSR PC program is part of a toolkit provided by SiRF. It requires running the receiver in the SiRF binary protocol. It allows one to post–process logged data in order to calculate satellite pseudo–ranges. See the SiRF Toolkit chapter for details.

- **Other**

  Several other SiRF programs are provided in order to evaluate performance. See the SiRF Toolkit chapter for details.

- **Reprogramming**

  The Ax_Prog PC program allows one to reprogram the receiver. This simple interface sends an S-record file to the receiver to replace the existing firmware. This program would normally only be used if a special request change was made for a customer.

Hardware

The Evaluation Unit—the blue and gray box—consists of a compact, sturdy metal housing with a GPS receiver and Receiver Interface Board (RIB). The unit has the following interfaces:

Table 1.1   Evaluation Unit Interfaces

Description	Function
Port A - GPS	DB–9, RS-232 input/output for data and commands in the selected message set. Also used to reprogram the GPS board.
Port B - DGPS	DB–9, RS-232 input for differential GPS corrections, RTCM SC-104 format.
DC Power Jack	Accepts +7 to +25 VDC 2.1 mm male, center positive plug.
Antenna Connector	SMA female, 1575.42 MHz GPS active antenna input. Sandpiper supplies +5VDC on center pin. Avocet supplies +3VDC on center pin.
Reset Button	A momentary push of this button forces a soft reset.
Push-to-Fix Button	A momentary push of this button initiates a Push-to-Fix sequence.
Power-on LED	Green, constant on indicates the board is receiving power through the jack.
Data Transmission LED	Yellow, blinking indicates the board is transmitting data out Port A.
1PPS	BNC female, *optional (upon request)* one-pulse-per-second output.

Figure 1.4 shows the Sandpiper/Avocet Evaluation Unit.

Figure 1.4   Sandpiper/Avocet Evaluation Unit

Receiver Interface Board

Figures 1.5 and 1.6 show the Receiver Interface Board (RIB). There are some items of interest on the RIB for those wishing to evaluate the receiver more extensively. Chapter 5 also covers how the RIB can be used to evaluate Data Logging and discretes or General Purpose I/O.

Figure 1.5   Receiver Interface Board Top Side
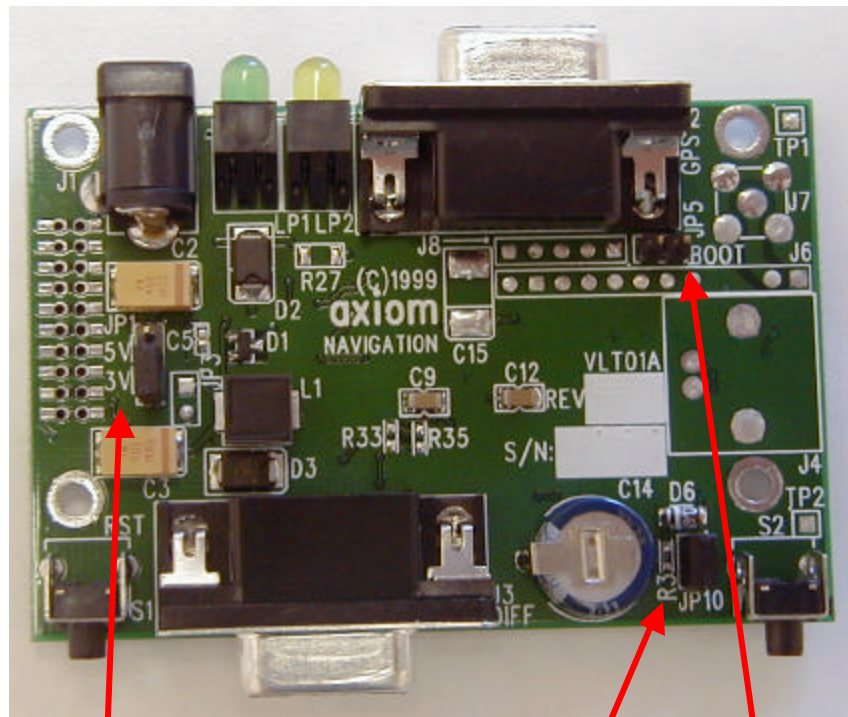
Jumper JP1 controls the voltage
going to the receiver. Across pins
2 and 3 (as shown) it provides
3.3 VDC to the receiver. Across
pins 1 and 2 it provides 5.0 VDC
to the receiver.

Jumper JP5 is used to force
the receiver into BOOT mode.
This is used to reprogram the
receiver. It is also possible to
reprogram without using JP5.

Jumper JP10 supplies battery backup power
to the receiver when power is off. Capacitor
C14 (Supercap) will provide 7 hours of backup
power for SRAM and the RTC.

Figure 1.6   Receiver Interface Board Bottom Side
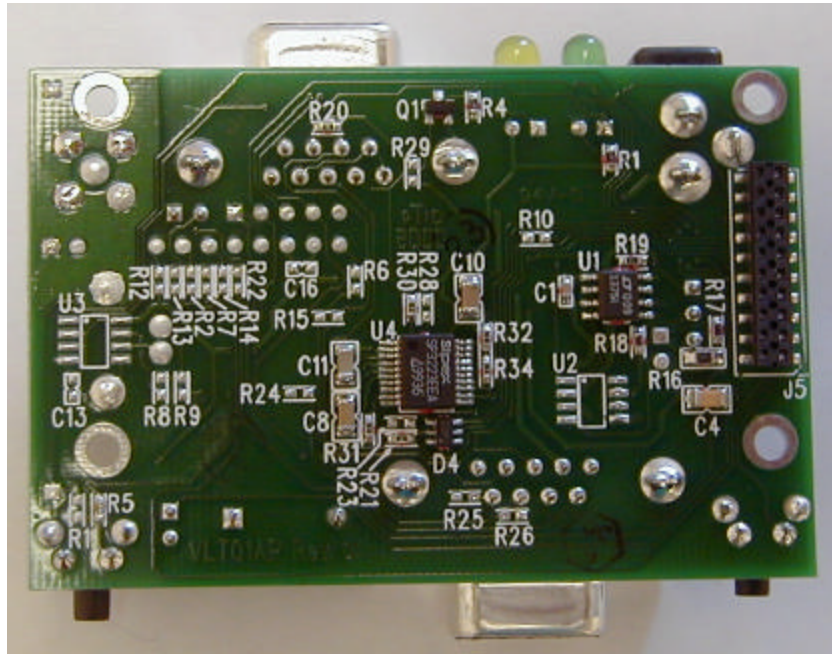
Unit Disassembly

Once you have evaluated the receiver to your satisfaction while it is in the Evaluation Unit, you may want to remove the receiver for integration into your product. The RIB/Receiver assembly can be removed from the housing as follows:

1. Remove the four screws near the housing bottom.
2. Remove the four hex nuts from the DB–9 connectors.
3. Remove the gray bottom from the top housing.
4. Slightly bend the sides of the housing enough to push the switches side up and clear of the mount holes.
5. The assembly will now slide out from the other side.

To separate the receiver from the RIB unsnap the antenna connector side first. The plastic standoffs are designed to lock onto the RIB, but allow the receiver to snap out. The data connector end will snap out more easily once the antenna end is unsnapped.

The Evaluation Unit can be reassembled by reversing the above steps.

Firmware

The standard Evaluation Unit comes programmed with the latest generic firmware available from Axiom. Under certain conditions, Axiom may agree to make custom builds per customer request. The generic firmware includes three message sets, of which the user may select one at any time. See the Conductor User Guide and GPS Message Set documents for details.

- **SiRF Binary**   This is SiRF's proprietary message set. It is also the most feature rich for evaluating the receiver's tracking and navigation performance.

- **NMEA**   This is the standard message set that virtually all commercial receivers output. Most off-the-shelf applications requiring a GPS receiver will accept NMEA format.

- **Axiom User1**   User1 is Axiom's proprietary message set. It is primarily used in any of several variants within Axiom's Fleet Management Systems (FMS). User1 is needed to evaluate the data logging capability of Axiom's receivers.

All aspects of GPS data (position, velocity, time, SV tracking, etc.) can be monitored and logged on a PC under various test scenarios during the evaluation. Conductor software allows analysis of the collected data in order to verify performance metrics such as accuracy, road test position, satellite tracking, time to first fix, etc. All processed data is in ASCII format and can be ported to popular spreadsheets (such as Microsoft Excel) for creating plots and statistics.

Version Numbering

Two distinct version numbers define the firmware on an Axiom receiver. One is the SiRF baseline version number. Axiom's receiver firmware is built from an underlying core of navigation and tracking modules supplied by SiRF. That core has a version number referred to as the SiRF baseline.

Example SiRF baseline version number: **1.3.2Dkit344**

The Axiom version number, alone, will determine the baseline from which it was built. The Axiom version number consists of six characters. The first two characters are digits representing the

major release number. The next two characters are digits representing the minor release number. The last two characters are alphabetic representing a customer code.

Example Axiom version number: **0302AX**

This example represents major release 03, minor release 02, and customer code AX, for Axiom.

Chapter 2   Getting Started

This chapter describes the PC requirements and step-by-step instructions to install the Conductor program using Windows 95, 98, 2000 or NT. It also explains how to connect the Evaluation Unit to your PC.

Installing the Evaluation Unit

Follow these steps for a successful and effective evaluation of Axiom's GPS receiver:

1) Plan the entire evaluation.

The most important step in your evaluation is to plan where and how you will do it. Antenna location is critical to the performance of any GPS receiver. Satellite signals are extremely weak and easily blocked or attenuated by structures, and even trees. Foil-backed building insulation or metal-film windows will block GPS signals.

Bodies of water, other structures, and things like ventilation equipment on rooftops can all cause reflections of GPS signals, which result in multipath–induced errors. While SiRF provides excellent signal acquisition performance under foliage, and multipath mitigation techniques, the receiver is still not completely immune to either effect.

For initial receiver checkout, use an antenna location with as full of a view of the sky as possible. You will want to evaluate the receiver under ideal conditions first to help you gauge its performance under more rigorous conditions later.

You will also want to subject any competing receivers to side-by-side testing with Axiom's, especially under the rigorous conditions. That is where Axiom's receivers show a wide difference in performance over the competition. In a situation where you cannot do side-by-side comparisons, you can nearly achieve the same result by running a subsequent test at the exact same time 12 or 24 hours later. That is when the satellites will be in the same geometry again.

2) Read the included documentation.

At the very least, scan over everything so you will know where to look if you have a question or problem with the receiver or

Conductor program. Print a hard copy of every document from the PC. Conductor was designed to simplify your evaluation of the receiver. Like any sophisticated program, however, you need to spend some time learning how to use it correctly. One can certainly get by just fine without looking at the Conductor documentation, but chances are that a more thorough evaluation could be achieved by looking at the User Guide.

3) Install the antenna.

Screw the SMA connector from the supplied active GPS antenna onto the Evaluation Unit. The antenna itself should be located where a clear view of the sky is available. However, to verify that the Evaluation Unit is working properly and the software is installed correctly, you do not need to connect the antenna.

If no GPS signals are present, within about a minute, the receiver will go into an intensive slow search mode in an attempt to locate GPS satellites. Communication with Conductor is less obvious when the receiver is in slow search.

WARNING

If you wish to use a different antenna than supplied with the evaluation kit, be aware that some passive antennas have their signal connected to their ground plane. Plugging this type of passive antenna into the Evaluation Unit will damage it.

4) Install Conductor.

See the Conductor 3 User Guide (included on the supplied CD) for details on installation and operation of Conductor.

5) Connect to a PC.

Connect one end of the serial cable to an available communications port (COM port) on your PC and the other end of the serial cable to the data output on the Evaluation Unit, labeled PORT A - GPS.

When Conductor first starts up, it will automatically select an open COM port. If your PC has both a serial mouse and a modem, it is likely that there will not be any available COM ports. In this case, it would be easiest to switch to a PS/2 mouse in order to free up a COM port.

6) Power Up the Unit.

Connect the cable on the transformer power supply to the Evaluation Unit and plug the transformer power supply into a power source. If you wish to use another power supply besides the one provided with the Evaluation Kit, it must output +7 to +25 VDC regulated @ 500 mA with a 2.1 mm, center positive, DC jack.

One of the LED lights on the input side of the Evaluation Unit will show a steady green light when the unit is receiving power. The other light flashes yellow when data is being sent from the unit out through the serial port.

7) Optional.

If you wish to use DGPS corrections, use a serial cable to carry the DGPS corrections to the port labeled PORT B - DGPS.

If you have requested an Evaluation Unit with 1PPS output, plug a cable with a BNC (male) connector into the 1PPS output port and connect the other end to your test equipment.

System Requirements

These are the system requirements for running the Conductor program:

- Microsoft Windows 95, 98, 2000 or NT operating system

- 1 available communications (COM) port

- 6 MB free hard disk space

- 16 MB RAM

- Pentium processor or equivalent

- 800 x 600 256 color display minimum,
  1024 x 768, 16-bit color recommended

——— *NOTE* ———
For optimum display, set your display settings to Small Fonts.

Chapter 3　　Evaluation Kit Specification

Interface Board Specification

Physical

Dimensions	76.2 x 50.8 x 15.8 mm (3.0 x 2.4 x 0.63 in)
Weight	36.85 g (1.3 oz) without BNC

Electrical

Operating Voltage	7.0 to 25.0VDC
Power Consumption	20 mA maximum

Environmental

Operating Temperatures	-40° to $+85^{\circ}$ C
Storage Temperatures	-55° to $+125^{\circ}$ C
Operating Humidity	5% to 95% R.H., Non-condensing, @ $+60^{\circ}$ C
Shock	20 g (11 ms sawtooth)
Vibration	4 g

Connectors

COM ports	D-Sub, 9 pin
Power	Barrel plug, Tip positive, 5.5 mm outer diameter, 2.1 mm inner diameter
1 PPS	Female BNC (optional)

Options

1 PPS	RS–485 / 422 compliant, requires BNC connector
Battery backup	Remove jumper JP10 to remove the battery (super cap) backup power
Programming	Jumper JP5 forces BOOT mode for reprogramming the receiver

Power selection	Jumper JP1 selects 3.3 or 5.0VDC power source (Avocet or Sandpiper)

Miscellaneous

Ports	Two RS–232C Port A (J2) – GPS commands & data Port B (J3) – DGPS input
LEDs	Steady Green LED while powered Flashing Yellow LED while transmitting out Port A
Discrete I/O	4 general purpose I/O accessible from unpopulated connector J8 (GPIO1 on pin 1, … GPIO4 on pin 4)
Reset switch	Soft resets the receiver (S1)
PTF switch	Generates a Push-to-Fix signal (S2)
Super Cap	7 hour RTC & SRAM backup power

Power

A female 2.1 mm x 5.5 mm barrel plug jack on the Evaluation Unit connects external power from the included AC wall adapter, or the vehicle power adapter. The center conductor is positive and the outer conductor is circuit ground. Connecting directly to a power source greater than +25 VDC can result in permanent damage to the Evaluation Unit.

―――――――――――――*WARNING*―――――――――――――
The Evaluation Unit does not have built in reverse voltage protection. If you use a power adapter other than the one supplied, check all cables before connecting the unit.

1 PPS Signal

The one–pulse–per–second (1 PPS) output is an optional feature. If requested, an Evaluation Unit with a female BNC connector will be provided. The BNC connector is used to monitor the TTL–level 1 PPS signal from the GPS receiver. This signal is buffered by an RS485/422 compatible differential driver. It can drive loads as low as 27 ohms with a differential output voltage of at least 1.5 V.

The 1 PPS is a 100 ms pulse. The rising edge of the pulse marks the 1 PPS event. The pulse is aligned to GPS time.

Avocet GPS Receiver Specification

General

Standard Log Capacity   5000 position and
event records in
non-volatile memory (4Mbit flash)

Optional Log Capacity   25000 records (8Mbit flash)
65000 records (16Mbit flash)
145000 records (32Mbit flash)

Discretes   4 Programmable as Input
or Output (5, if 1PPS not used)

Architecture

Channels   12 simultaneous, all–in–view

Frequency   L1 1575.42 MHz

Tracking   C/A code & carrier

Flash ROM   256 k x 16

Static RAM   64 k x 16

Processor Speed   Hitachi SH1 at 12.288 MHz

Dynamics

Altitude   −1000 m to 18,000 m

Velocity   500 meters per second

Acceleration   4 g

Jerk   5 meters/second3

Acquisition

Cold Start   < 50 seconds (average)

Warm Start   < 40 seconds (current position,
time, and almanac)

Hot Start   < 8 seconds (current position, time,
almanac, and ephemeris)

SnapStart   2 seconds

Reacquisition   100 milliseconds

Accuracy

Position (SA off)	< 25 meter SEP (SA off)
DGPS	1 to 5 meters
Timing, 1PPS (SA off)	< 75 ns, dynamic (SA off)
Receiver Sensitivity	–143.5dB-Hz

Physical

Dimensions	41.91 x 71.88 x 8.76 mm (1.65 x 2.83 x 0.35 in)
Weight	19.84 g (0.7 oz)

Electrical

Operating Voltage	3.3 ±0.33 VDC, 50 mVp-p (max)
Power Consumption Continuous On	150 mA
Antenna bias	20 mA (max.)
TricklePower Correlator portion Sleep Mode	Down to 3 mA 40 mA 10 uA (RTC & SRAM)

Environmental

Operating Temperatures	–40º to +85º C
Storage Temperatures	–55º to +125º C
Operating Humidity	5% to 95% R.H., Non-condensing, @ +60º C
Shock	20 g (11 ms sawtooth)
Vibration	4 g

Connectors

RF	SMA right-angle, bulkhead
I/O	20 pin header with 2 mm centers (standard)

Messages

Formats	NMEA 0183, SiRF binary, Axiom User 1, RTCM SC-104
Baud Rates	2400, 4800, 9600, 19200, 38400

Update Rate	Once per second
NMEA Message Rates (per message type)	Never, once or every 1 to 255 seconds

Datums

Standard	WGS–84
User Definable	1
User Selectable	219; Visit Axiom's web Site for datum details.

Options

Super Cap	7 hour RTC & SRAM backup power
RS–232	2 transmit, 2 receive
TricklePower	Power saving modes
Larger Flash ROM	512 k x 16 (8 Mbit) 1024 k x 16 (16 Mbit) 2048 k x 16 (32 Mbit)
Larger SRAM	128 k x 16

Miscellaneous

Discrete I/O	5 general purpose, TTL levels
DGPS	Yes, on port B
On board LNA	14 dB gain

Serial Ports

The serial ports consist of Port A, used for navigation messages and control, and Port B, used for RTCM differential GPS correction input. Port A is located on the same side as the LED lights. Port B is located on the same side as the two buttons. Connection to either port is accomplished via the included serial cable, which is configured to connect directly to a serial port.

Following is the pin assignments for these ports. Both ports use a female DB–9 connector wired as a NULL modem for direct connection to a serial port. Signal names are the standard RS–232 names for each pin.

Table 3.1   Port A – Pin Descriptions

Pin #	Name	Description
1	DCD	Connected to pins 4 and 6
2	Rx data	Transmit data from GPS receiver Port A
3	Tx data	Receive data to GPS receiver Port A
4	DTR	Connected to pins 1 and 6
5	GND	Connected to signal ground
6	DSR	Connected to pins 1 and 4
7	RTS	Connected to pin 8
8	CTS	Connected to pin 7
9	RI	Not connected

Table 3.2   Port B – Pin Descriptions

Pin #	Name	Description
1	DCD	Connected to pins 4 and 6
2	Rx data	Transmit data from GPS receiver Port B
3	Tx data	Receive data to GPS receiver Port B
4	DTR	Connected to pins 1 and 6
5	GND	Connected to signal ground
6	DSR	Connected to pins 1 and 4
7	RTS	Connected to pin 8
8	CTS	Connected to pin 7
9	RI	Not connected

Antenna Specification

The included GPS patch antenna is cabled to the receiver through a female SMA connector. The part number for the antenna is VLA01B–3A. See the full antenna specification on the CD–ROM for a list of options.

GENERAL

ENVIRONMENTAL
    Operating Temperature   –30°C to +90°C

    Storage Temperature   –40°C to +100°C

    Relative Humidity   20% to 95% (non–condensing)

ELECTRICAL
    Input Voltage   3.0VDC, $\pm$0.5V

    Power Consumption   30 mA maximum

RF Connector	SMA,
Cable	RG–174, 5 meters, black

MECHANICAL

Mounting	Magnetic
Waterproof	Yes
Shock	50g, vertical axis, 30g, all axis
Vibration	3.0g, Log Sweep, 10 – 200 Hz, 15min
Magnet pulling force	30NT
Weight	130 grams maximum
Dimensions	40 mm x 45 mm x 15 mm thick

ANTENNA

Frequency Range	1,575.42 $\pm$ 10 MHz
Gain (on 65mm square plane)	+1 dBi at 90° elevation, –4dBi min at 20° elevation
Polarization	Right Hand Circular Polarization
Axial Ratio	3 dBi – on 65mm square ground plane.

PERFORMANCE (antenna, LNA, cable loss included)

Frequency Range	1,575.42 $\pm$ 10 MHz
Gain	20 dBi min. on 65mm square ground plane
Noise Figure	1.6 dB maximum at +23°C 2.1 dB maximum at +90°C
Out-of-Band Rejection	–25 dBc @ $\pm$100 MHz from 1,575 MHz
Output Impedance	50 ohms
Output VSWR	2.0:1 maximum

Chapter 4   Sandpiper / Avocet Functionality

Hardware Functional Description

Overview and Walk–through

Figure 2 shows a functional block diagram of the receiver. The module is divided into these sections:

- **RF Section**   Receives the GPS satellite signals from the antenna, down-converts them, and passes them to the digital section.

- **Digital Section**   Process those inputs into raw I/O measurements.

- **Flash Firmware**   Uses raw I/O measurements to compute a position and velocity solution using a general purpose CPU and then output them over the serial port.

- **Digital Interface**   Provides the power serial connection and communication to the outside world.

The module is designed around the two SiRFstarI/LX chips — the GSP1/LX and GRF1/LX. The GSP1/LX is the digital signal processor and the chief component in the digital section. The GRF1/LX is the Radio Frequency (RF) front–end converter, and the chief component in the RF section.
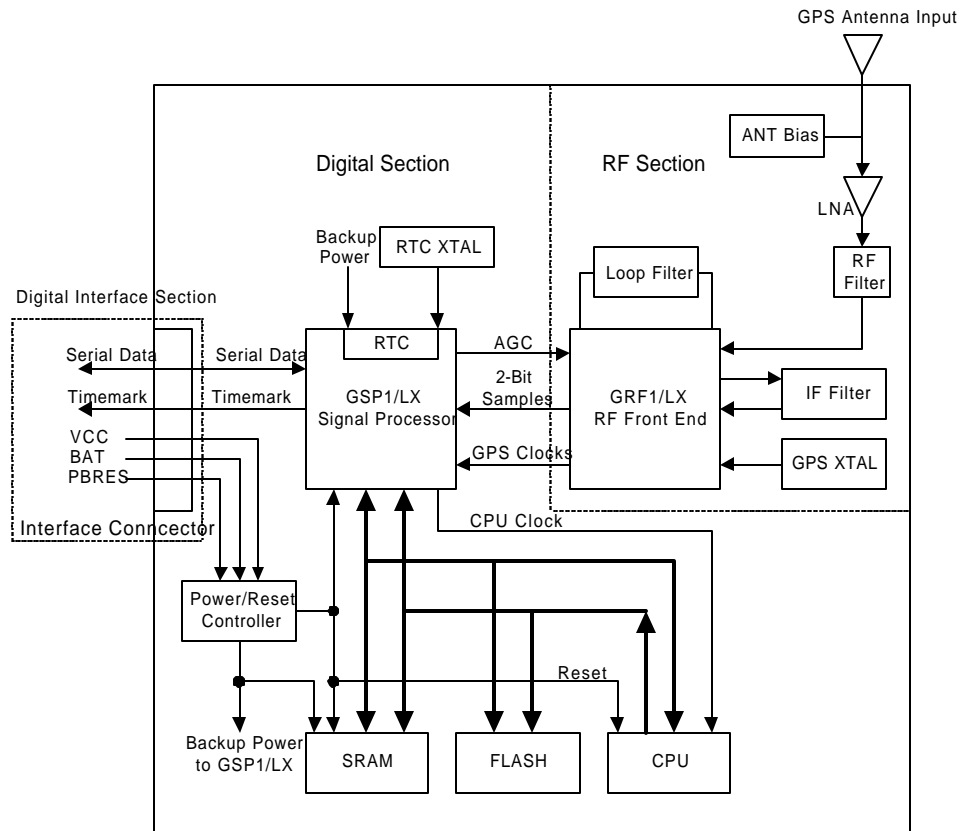
Figure 4.1   GPS Module Functional Block Diagram

RF Section Functional Description

The RF section amplifies the very weak (–l30dBm nominal) GPS signals, filters it, and then down–converts it to an Intermediate Frequency (IF) where it is processed digitally. The SiRFstarl/LX architecture relies on the high level of integration in the GRF1/LX to significantly reduce part count and circuit complexity to accomplish this.

This section describes the functional blocks of the RF section as shown in Figure 3, starting with the antenna.
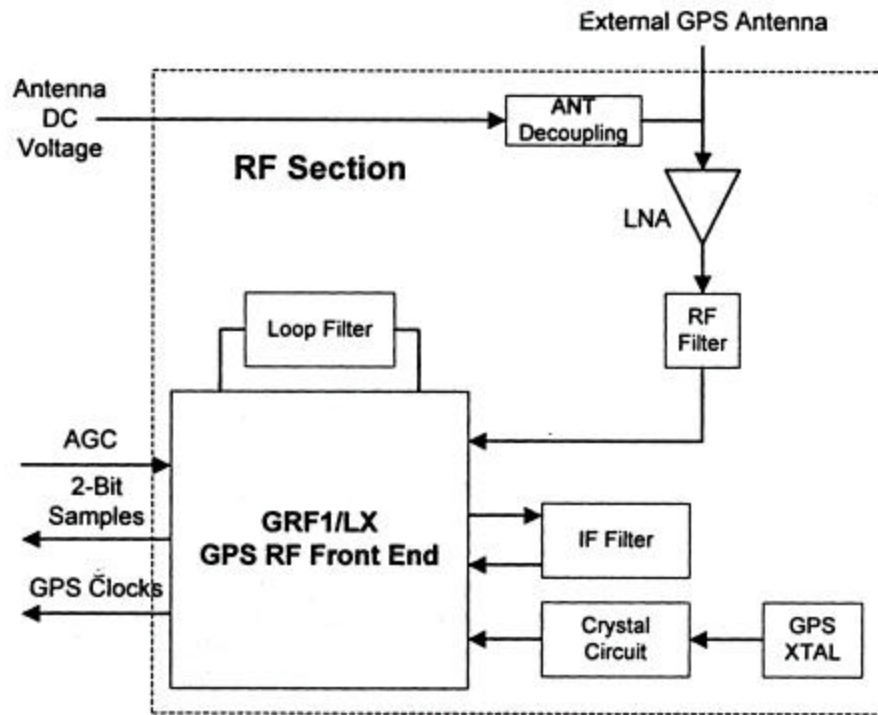
Figure 4.2   RF Functional Block Diagram

Antenna Input

>The receiver works with either a passive (non–powered) antenna, or an active (powered) antenna with up to +35dB of gain.

Antenna Decoupling

>If you are using an active antenna, you must load the Antenna Decoupling circuit to provide 5V or 3.3V to the LNA in the antenna. If you are using a passive antenna, you do not need to load this circuit.

LNA

>The front-end Low Noise Amplifier (LNA) provides approximately 14dB of gain, and sets the overall signal-to-noise ratio for the receiver.

RF Filter

> The RF bandpass filter is a 2-pole ceramic filter that provides protection from out-of-band signals prior to the amplifier.

GRF1/LX

> Internally the GRF1/LX converts the incoming 1575.42MHz (L1) signal to a 47.7MHz Intermediate Frequency (IF) which is fed to the external IF filter. After filtering, the signal is returned to the GRF1/LX internal IF strip.
>
> The IF strip implements a digitally controlled amplifier that is software adjustable (via an AGC word from the GSPI/LX) so that the signal remains below saturation. The IF signal is fed to two high-speed threshold detectors to implement a 2-bit analog-to-digital convert. These outputs are the SIGN and MAG bits fed to the GSP1/LX DSP chip (These are labeled as the 2-bit samples between the GRF1/LX and GSP1/LX in Figure 3). In addition, the GRF1/LX synthesizes the clock outputs to the GSP1/LX.

IF Filter

> The IF filter is a 2-pole, lumped-element bandpass filter, implemented differentially to reject common mode noise. Its center frequency is 47.7 MHz and its bandwidth is typically between 6 and 10MHZ. This filter further helps prevent spurious signals from interfering with GPS signal processing.

Crystal Circuit

> The GRF1/LX uses a single external crystal (24.5535MHz) as a part of a reference oscillator. It is used for three purposes:
>
> 1. To phase–lock the internal mixer local oscillator (1527.68MHz).
> 2. To generate the ADC (Analog to Digital Converter) sample clock at 38.19MHz.
> 3. To generate the overall GPS system clock of 49.107MHz.

Table 4.1   Crystal Specification

Description	Description
Center Frequency	24.5535 MHz (fundamental)
Frequency Tolerance	± 25 ppm @ 25° C
Frequency Stability	± 15 ppm (over operating temperature range)
Operating Temperature	–40° C to +85° C
Drive Level	0.1 mW maximum
Series Resistance	30 ohms maximum
Crystal Aging (short term)	< ± 1.0 ppm maximum per year
Crystal Aging (long term)	< ± 5.0 ppm maximum per 10 years
Load Capacitance	32 pF
Frequency Perturbations	< ± 0.5 ppm from the crystal's AT cut curve
Allen Variance	± 0.001 ppm per second, maximum
G Sensitivity	± 0.003 ppm maximum per G

Loop Filter

The loop filter integrates the charge-pump output to provide a clean, stable control input to the on-chip VCO. Overall, the loop bandwidth is set to about 500KHz.

DC Regulator

The DC regulator provides the supply voltage required for the operation of GRF1/LX. In addition to that it reduces the noise injected to the RF circuit.

Digital Section Functional Description

The purpose of the digital section is to process the 2-bit sample signals from the RF section into a navigation solution for output to the Digital Interface connector. The GSPI/LX combines dedicated GPS hardware and general purpose interface logic to simplify the digital section. Figure 4 shows these functional blocks.
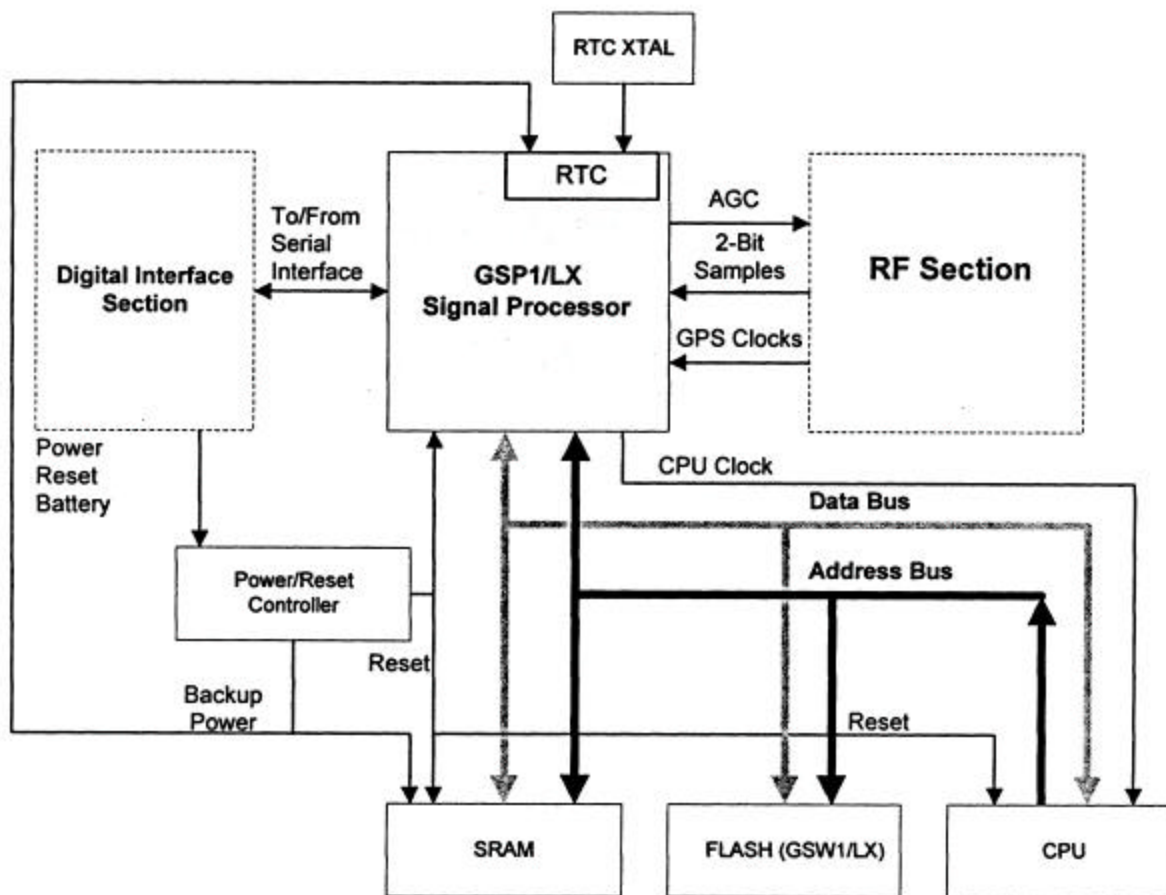
Figure 4.3   Digital Section Block Diagram

Referring to Figure 4, this section describes the purpose of each part, moving counter–clockwise from the GSP1/LX.

- **GSP1/LX**
- **Power/Reset Controller**
- **SRAM**
- **Flash memory (firmware)**
- **CPU**

GSP1/LX Digital Signal Processor

The GSP1/LX functions as an ASIC DSP (Digital Signal Processor) for GPS signals. It converts the 2-bit samples into software-accessible registers containing I (in-phase) and Q (quadrature) values for up to 12 independent satellite channels.

The GSP1/LX registers are memory mapped so the external CPU can easily access them over the address and data bus.

Real Time Clock

The GSP1/LX includes a Real Time Clock (RTC) that provides the current time of day to the firmware at power-on. It counts seconds, minutes, hours, day of the month, month, day of the week, and year with leap year compensation. This time is used by the receiver to initialize the satellite search algorithm for hot and warm starts. The clock uses a standard external crystal of 32,768Hz.

The GSP1/LX also has two full-duplex built-in serial ports. Port A is for navigation information, command, and control. Port B is for differential corrections.

Power/Reset Controller Block

The Power/Reset Controller Block has three parts:

1. Battery backup
2. SRAM data retention
3. Reset

SRAM Data Retention circuits ensure that switchover from primary power to battery power occurs smoothly and without causing a false write to the RAM, and to ensure minimal power drain from the battery. Figure 5 is a block diagram of the data retention circuit.

The data retention circuit delivers power to both the RTC and SRAM whenever the unit is powered up, or when the backup battery (VBAT) is connected to pin 3 of connector JI.
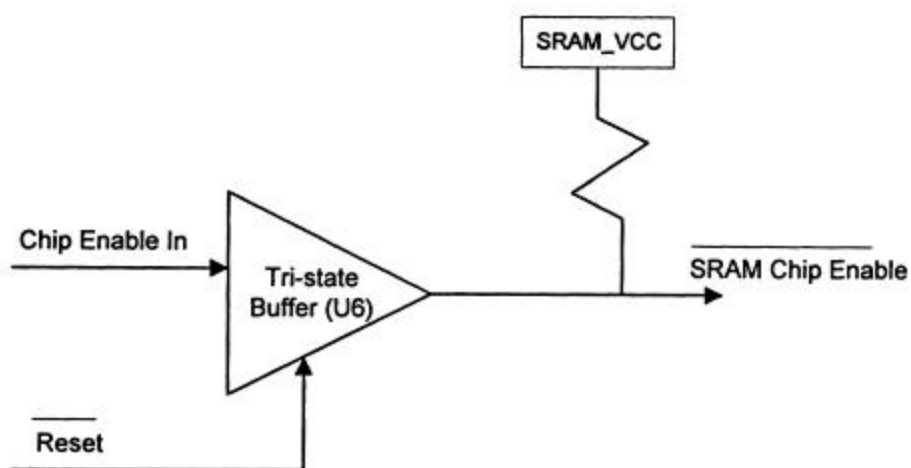
Figure 4.4.   SRAM Data retention

In this circuit, the high-speed tri-state buffer disables undesired accesses to the static RAM while unit power is turned off. To prevent access to the RAM during reset and during the transition between reset condition and power off and vice versa, the buffer must be fast and the output of the tri-state control has to be high when disabling accesses to the RAM.

To protect against inadvertent writes, the buffer isolates the chip-select input of the RAM from outside circuits and keeps it inactive during battery-powered operation. This is also important because static RAMs that provide a low voltage/ultra-low power standby mode require that the chip-enable input be at VCC during battery back-up.

The receiver uses an external tri–state buffer in series with the chip-enable signal as shown in Figure 5. The chip enable is gated off during power–down mode and pulled up to the battery voltage so no low–impedance path exists for current to flow from the battery.

Reset Controller

The reset portion of the Power/Reset Controller circuit provides the reset signal to the entire digital section to assure proper start-up at power-on. The device asserts a reset signal whenever the VCC supply voltage falls below a preset threshold, keeping, it asserted for approximately 200ms after VCC rises above the rest threshold.

It has an active-low reset output, which is guaranteed to be in the correct state for VCC down to IV. The reset comparator inside the controller ignores fast transient operation on VCC.

The reset is connected directly to the CPU and through a series resistor to GSP1/LX reset input to allow the CPU to reset GSP1/LX with its CPU output to support TricklePower mode.

Static RAM

The static RAM is a 1 Mbit part in a 64K by 16 organization. It provides all of the variable and stack memory required for the firmware. The CPU provides the chip-select signal for the two clock accesses for use with 100ns parts or 70ns depending on the CPU clock frequency.

Flash EPROM

The Flash EPROM is a 4 Mbit part in 256K by 16 organization. It contains the firmware. 8 Mbit, 16 Mbit, and 32 Mbit flash are also available for quantity orders.

CPU

The CPU is a Hitachi SH-1 HD6477021. The CPU clock comes from the GSP1/LX, unless it is a TricklePower capable board. For TricklePower boards the clock comes from a crystal outside of the GSP1.

Firmware Functional Description

The firmware is a tasking based architecture driven by a 1 ms interrupt generated the GSP1/LX.

Task Levels and Priority

Although the firmware does not run under a real–time operating system, it uses the 1 ms interrupt to create three levels of tasks:

1. Background Task
2. Tracking Tasks
3. Navigation Task

Background Task

A continuous loop that runs all non–real–time critical tasks.

Tracking Tasks

Interrupts may be generated by the 1 ms timer, UARTs, or channel integration done interrupt. The 1 ms timer drives a priority queue based schedule system, which allocates processor time based on task priority. The same IRQ line is used for all GSP1/LX interrupts. After an interrupt occurs, the ISR code reads interrupt status registers from the GSP1/LX to determine the source of the interrupt and perform service. The Channel Integration done interrupt processing is somewhat more complicated than a simple UART service because it attempts to decrease peak throughput needs by delaying processing of the data into a task outside of the ISR. Triggered by the channel integration done interrupt, the tracking tasks read the incoming I/Q data from the GSP1/LX. It schedules a task to complete the processing of the data, which will be completed later but before the next channel integration period is complete to close the tracking loops for up to 12 independent channels.

Navigation Task

Every second, at the conclusion of the 1000th 1 ms tracking interrupt, the navigation task is started with higher priority that the background task but lower that the tracking task. This task takes the measurements from the tracker and runs them through the Kalman filter to produce a position and velocity solution.

The navigation task also contains the receiver manager, which is responsible for assigning satellites to channels for the tracker. At

the completion of the navigation solution, the user interface code runs, which creates the serial output messages.

Data Formats

The module outputs data to the main serial port (TXA and RXA) in one of three formats:

1. SIRF binary
2. NMEA
3. Axiom User1

The default is SIRF Binary at 19200 baud. The format and baud rate are controllable using serial commands. For detailed information about data formats and serial port control, refer to the **GPS Message Set Specification**.

Digital Interface Functional Description

Your primary interface to the receiver is through the Digital Interface connector. The connector appearing on the left side of Figure 6 shows the functional blocks.
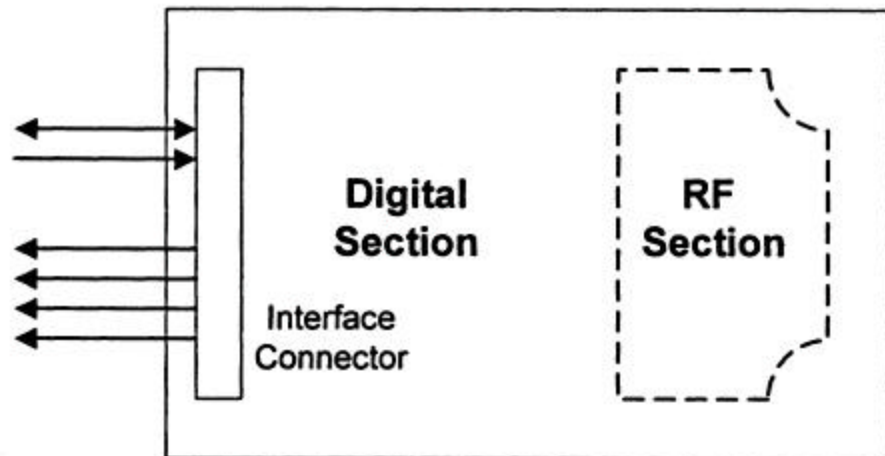

Figure 4.5   Digital Interface Section Block Diagram

TIMEMARK

This pin provides a one–pulse–per–second (1PPS) output from the receiver which is synchronized to within 1 microsecond of GPS time. The output is a CMOS level signal with the rising edge marking the seconds interval. The signal is nominally low with a short positive pulse.

Battery (VBAT)

This is the battery backup supply that powers the SRAM and RTC when main power is off. This input can range between +2V and (VCC) and requires a current capability of at least 60 uA. Typical receiver consumption is 10 uA.

Without an external battery or supercap, the receiver will execute a cold start (an initial fix time of approximately 48 seconds). A supercap or battery backup allows for a faster start–up of typically 8 seconds for a hot start, or 38 seconds for a warm start.

Table 4.2   Battery Voltage Swing

GPS Receiver	VCC	Minimum	Maximum
Sandpiper	+5.0 VDC	2.0	4.5
Avocet	+3.3 VDC	2.0	4.5

To maximize battery life, the battery voltage should not exceed the supply voltage (VCC).

Table 4.3   *Supercap Discharge Time*

GPS Receiver	Discharge Time
Sandpiper	24 hours
Avocet	7 hours

With a supercap installed, and after at least ten minutes of continuous operation, data retention (initialization parameters and time) will be maintained for the capacitor discharge time.

————————— *NOTE* —————————
Although counter–intuitive at first glance, the supercap on the lower power Avocet has a shorter discharge time, because it is charged to a lower voltage level in the first place.

Chapter 5　　　User1 Protocol — Data Logging

This chapter describes the PC program provided by Axiom for evaluating the data logging capability inherent with Axiom's User1 protocol. See the **GPS Message Set Specification V22** document for details on the User1 message set.

Data Logger Program

For data logging evaluation, you should not use the Conductor program to retrieve data. While some data retrieval functionality was built into Conductor, not all required features are available. Use the Data Logger program.

Data Logger is rather simple and self–explanatory. The main screen is shown in Figure 5.1. The unit has four possible commands:

- Get Record Count
- Clear History
- Set Log Settings
- Get History Records

Data Logger only runs the User1 protocol. You can select the COM port number and baud rate, however, 19200 baud is the standard output rate (unless it was changed via command to the receiver).

Figure 5.1　Data Logger — Main Screen

Get Record Count

Selecting this command button sends a **RL** command to the receiver. The receiver responds with a **LS** message. Data Logger then displays the number of position/event records stored in the receiver's flash ROM.

Clear History

Selecting this command button sends a **CH** command to the receiver. The receiver responds with a **FO** message. The receiver then erases those flash sectors that are allocated to data logging. One the erase is complete the receiver performs a soft reset.

The number of sectors erased depends on the flash size. The smallest, and standard sized flash, is 4M bits. That size has two flash sectors, or 128 k bytes allocated for data logging. Depending on the flash size ordered, up to 3712 k bytes may be allocated for data logging. The evaluation kit contains the standard, smallest flash size.

Each time the sectors are erased the receiver performs a soft reset (effectively, a power cycle). This is needed to recover from the length of time it takes to erase a sector. While a sector is erased all interrupts must be disabled. The sector erase takes long enough that the satellite tracking loops are affected. The soft reset provides for a fast and simple way to return to the state just prior to the erase. Typically, it takes about 3 seconds to transition from a soft reset back into generating a navigation solution.

Set Log Settings

Selecting this command button brings up the Log Settings window, as shown in Figure 5.2. After entering the desired log settings, select the **OK** command button. This sends a **HI** command to the receiver. The receiver responds with a **FO** message. The receiver will immediately begin logging records based on the log settings commanded to it. A subsequent log settings command overrides the previous settings.

The four logging parameters described below may be used in any combination, such as time–based in conjunction with speed–based logging.

Max Time between records is the number of seconds from the last log time after which the receiver must log again. If there is no previously logged record, then the first position fix obtained when the receiver started navigating is used. The minimum time is two

seconds. The maximum time is approximately 18 hours. Uncheck the box to disable time–based logging.

Max Distance between records is the number of meters from the last log position after which the receiver must log again. If there is no previously logged record, then the first position fix obtained when the receiver started navigating is used. A direct distance from the last log record is used, not cumulative distance since the last log. So if you log every mile, you could drive unlimited miles within a mile radius of the last log position, without generating a new log entry.

The maximum selectable distance is approximately 40 miles. The minimum is 10 meters. Uncheck the box to disable distance–based logging.

Log when Speed exceeds will log whenever the receiver's speed crosses this speed threshold (in miles per hour). Hysteresis is built into the speed algorithm to prevent excessive log entries when the receiver is moving around the threshold. The hysteresis value works out to about a 3 MPH buffer zone at a speed of 70 MPH. Uncheck the box to disable speed–based logging.

Log Stops that are this long is the number of seconds being stopped after which the receiver must log. This logging parameter is particularly useful for fleet vehicles that make service stops throughout the day. Rather than logging a large number of distance or time–based records, often a service stop or unauthorized stop is of most interest to the user. One should choose a number of seconds that exceeds the typical times spent at a stop light or in stop–and–go traffic. The start of the stop and the end of the stop are each logged as individual records. The stopped bit is set only for the beginning of the stop. The end of the stop is indicated by the stopped bit being clear. Uncheck the box to disable stop–based logging.

For example, if most traffic light stops are under 3 minutes, then a setting of 3 minutes makes sense to log service stops and unauthorized stops, but not traffic light stops. The stopped bit is set only if the stopped duration log setting is used. Otherwise the receiver does not care about a stop, it is simply a velocity of zero.

Stop–based logging generates a log after the receiver has remained stopped for the specified length of time. The log entry represents the state (time, position, etc) from when the stop begins, not from when the duration threshold is met.

Combination Settings

Any of the logging parameters may be used in various combinations. Keep in mind that the last logged record is always used for time and distance logs. For example, if you want to log every 1 minute and every 1 mile, and you were traveling at 120 miles per hour (2 miles per minute), you would only generate distance-based logs because you would never get beyond 30 seconds since the last log. This is by design to help reduce the log size. Multiple records just seconds or meters apart from each other are generally of no value to most operations.

Figure 5.2   Data Logger — Log Settings Screen

Get History Records

Selecting this command button opens a new window to select where the download file should be created. After the download file name and folder are selected the program sends a **RP** command to the receiver. The receiver responds with a set of **SF** messages, one for each log record.

——————————— *NOTE* ———————————
After downloading records you should close the Data Logger program before you open the download file. Otherwise the records may not be accessible.

History Records File

Following is an example download file from the Data Logging program. Eleven fields are recorded as follows:

- **Time of Observation**   This is the time and date associated with the rest of the record. Time is relative to UTC (roughly Greenwich Mean Time). For example, Pacific Standard Time is eight hours behind UTC.

- **Latitude**   This is the latitude, in degrees and fractional degrees, of the receiver when the record was logged.

- **Longitude**   This is the longitude, in degrees and fractional degrees, of the receiver when the record was logged.

- **Alt**   This is the altitude, in meters above the WGS–84 elipsoid (roughly mean sea level), of the receiver when the record was logged.

- **Speed**   This is the speed, in meters per second, of the receiver when the record was logged.

- **Stop**   This is **Yes** at the start of a stop interval (as specified by the **Log Stops that are this long** logging parameter).

- **Nav**   This is **Yes** if the receiver was navigating when the record was logged. This would be **No** only if a discrete input changed.

- **D1**   This is the value of discrete input 1 in the receiver when the record was logged. **On** means it was left floating or set high. **Off** means it was shorted to ground.

- **D2**   This is the value of discrete input 2 in the receiver when the record was logged.

- **D3**   This is the value of discrete input 3 in the receiver when the record was logged.

- **D4**   This is the value of discrete input 4 in the receiver when the record was logged.

The first row of the download file always shows the field names. In the below example, two minutes of static logging is shown. The log parameters were set up for time–based logging every five seconds.

Time of Observation	Latitude	Longitude	Alt	Speed	Stop	Nav	D1	D2	D3	D4
21-Jul-2000 21:16:01	33.825452	-117.916232	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:06	33.825452	-117.916233	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:11	33.825451	-117.916233	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:16	33.825451	-117.916233	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:21	33.825450	-117.916233	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:26	33.825450	-117.916233	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:31	33.825449	-117.916232	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:36	33.825449	-117.916231	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:41	33.825448	-117.916229	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:46	33.825446	-117.916227	36.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:51	33.825445	-117.916225	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:16:56	33.825444	-117.916224	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:01	33.825442	-117.916222	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:06	33.825441	-117.916221	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:11	33.825441	-117.916219	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:16	33.825440	-117.916218	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:21	33.825439	-117.916217	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:26	33.825438	-117.916217	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:31	33.825438	-117.916217	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:36	33.825437	-117.916216	36.00	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:41	33.825437	-117.916215	35.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:46	33.825437	-117.916214	35.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:51	33.825437	-117.916214	35.50	0.00	No	Yes	On	On	Off	On
21-Jul-2000 21:17:56	33.825437	-117.916214	35.50	0.00	No	Yes	On	On	Off	On

Discrete Inputs

Discrete inputs to the receiver are pulled high internally. Contact closure to ground will set the logged value for that discrete to Off. Discrete number 3 is always Off because it is reserved for another purpose in this build. The Evaluation Kit does not take advantage of that potential functionality, but the discrete remains reserved for that purpose.

For logging purposes, the other three discretes are set up as inputs. In a delivered custom build the discretes may be configured as input or output. A fifth discrete is also available (in a custom build), at the expense of not having a 1 PPS output.

In the User1 data logging protocol a record is logged anytime one of the discretes change value (high–to–low, or low–to–high). See the next section for more details on this.

Discrete Checking

Once a second the current position, time, and discretes state is compared against the logging parameters. This means the discretes levels are checked once a second. Logs are not triggered by the change of the discrete itself, but rather by the periodic

check of the discrete against its previous value. Clearly, such a design is intended for discretes that will not change states faster than every second.

Changing Discretes

Besides the J1 connector directly on the GPS receiver, you can also control the discrete lines to the receiver from the RIB (Receiver Interface Board). Connector J8 on the RIB connects to the four standard discretes—GPIO1, GPIO2, GPIO3, and GPIO4. The first pin is square and connects to GPIO1. The rest follow in order. The fifth pin is connected to ground. Figure 5.3 shows the location of J8.
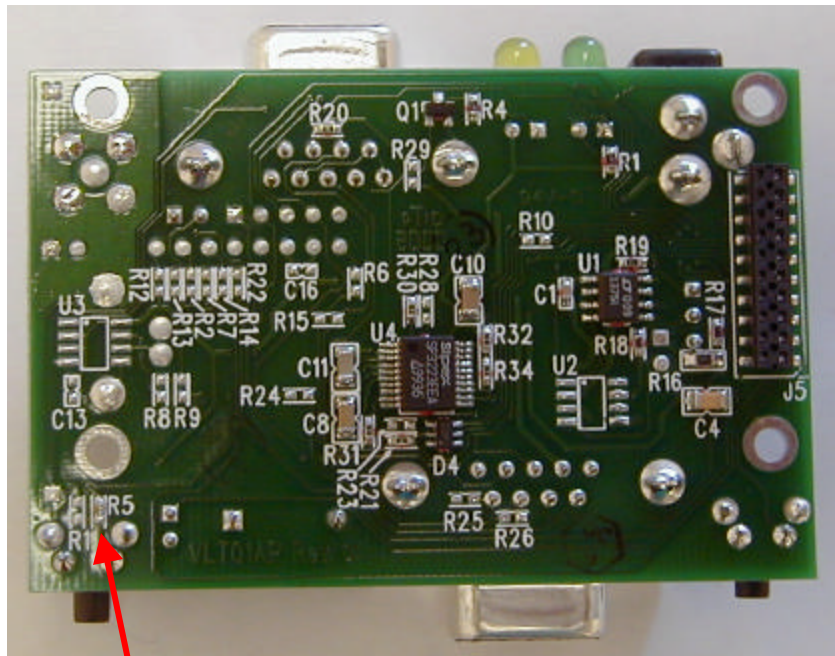
Figure 5.3   Receiver Interface Board Top Side
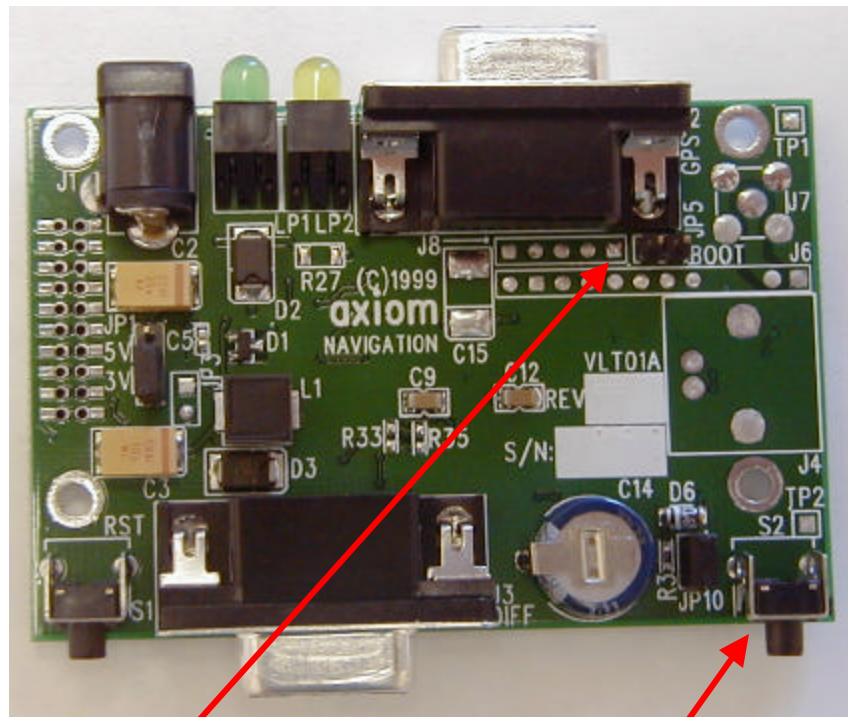
The four discretes, or GPIO can be accessed from J8. Pin 1 (GPIO1) has the pointer to it.

Switch S2 can be configured to be Push–to–Fix or to control GPIO4. See Figure 5.4 for details.

Figure 5.4   Receiver Interface Board Bottom Side

Resistor R5 is a 0 Ohm jumper. In location R5 it enables switch S2 to control the Push–to–Fix power mode feature. If you move the resistor to the R11 pads (immediately left of R5) switch S2 will control GPIO4. Pushing in the switch grounds that discrete (drives it low).

Chapter 6　　Power Moding

This chapter describes those methods available in Axiom receivers to reduce receiver power consumption. Low–power modes are available, as follows:

- **TricklePower**　　　In TricklePower mode, the power to the SiRF chipset is cycled periodically. The CPU also goes into a sleep state, so the receiver is, effectively, only operating a fraction of the time. In a typical scenario the receiver is powered 200 ms, or 20% of every second.

- **Push–to–Fix**　　　In Push–to–Fix mode, the receiver is normally off, but turns on to collect ephemeris and maintain RTC calibration. A user triggered discrete input turns the receiver on just long enough to output a position fix message. The fix message is typically available in one–tenth the time needed for a cold start.

TricklePower

This mode periodically cycles power to the GRF1 chip based on two user specified parameters — OnPeriod and DutyCycle. A third parameter — OffPeriod — is derived from the other two as follows:

$$DutyCycle = OnPeriod / (OnPeriod + OffPeriod)$$

The GRF1 chip powers on for OnPeriod milliseconds, and then virtually powers off for OffPeriod milliseconds. The cycle repeats itself indefinitely. The RTC in the GRF1 actually remains powered (drawing 10 microamps) so that it can generate the interrupt used to turn the receiver back on again.

After the OnPeriod ends the microprocessor remains running just long enough to complete the navigation computations and to output messages. For a detailed discussion on this mode see the SiRF White Papers on the CD–ROM.

Push–to–Fix

In the Push-to-Fix mode, the receiver goes into a very low power mode (drawing 10 microamps) after it has collected ephemeris and determined its position. Periodically it wakes up to refresh its ephemeris and update and output its position. The net power draw is around 4 mA.

Pin 20 is pulled high internally. By grounding that line you cause the receiver to power up, obtain a position, output the position, and then power down again. Typically the receiver will run for anywhere from 10 to 30 seconds, outputting messages at the normal rate. Then the receiver will power down again until the next time the Push–to–Fix line is activated.

Chapter 7   SiRF ToolKit

This chapter describes PC programs provided by SiRF. SiRF uses the toolkit internally for receiver and baseline firmware checkout.

————————*NOTE*————————
Axiom provides this toolkit only to supplement the evaluation. Some documentation, but **no warranty or support** is provided for any elements of the toolkit either by Axiom or SiRF.

For documentation on any of this toolkit, refer to the **SiRF ToolKit.pdf** file in the **SiRF ToolKit** directory on the supplied CD–ROM. SiRF provides the ToolKit document with their version of an Evaluation Kit. SiRF does not produce GPS receivers, except in quantities to support Evaluation Kits. The SiRF ToolKit document should only be used with the associated tools in the ToolKit directory. It does not describe the Evaluation Kit you have purchased from Axiom.

SiRF Demonstration

SiRFdemo is a PC program provided by SiRF. It requires running the receiver in the SiRF binary or NMEA protocols. It allows one to further evaluate performance. For documentation on this program, refer to the SiRF ToolKit.pdf file in the SiRF ToolKit directory on the supplied CD–ROM. Chapters 3 through 8, and portions of chapter 9 describe how to operate the SiRFdemo program. Appendix B also describes some of the files used by SiRFdemo.

Calculate Pseudo–Ranges

CalcPSR is a PC program provided by SiRF. It requires running the receiver in the SiRF binary protocol. It allows one to post–process logged data in order to calculate satellite pseudo–ranges. For documentation on this program, refer to the SiRF ToolKit.pdf file in the SiRF ToolKit directory on the supplied CD–ROM. Portions of chapter 9 describe how to operate the CalcPSR program. Appendix B also describes some of the files used by it. Source files are provided to further aid in one's understanding or for modification of this program.

Other Tools

A variety of other tools (programs) are provided by SiRF. For documentation on this program, refer to the SiRF ToolKit.pdf file in the SiRF ToolKit directory on the supplied CD–ROM. Portions of chapter 9 describe how to operate these programs. Appendix B also describes some of the file formats used by them.