12-Channel GPS Receiver For Space Application

SPACE GPS

User's Guide

Version 1.1

Accord Software & Systems Pvt. Ltd.
37, K.R.Colony, Domlur Layout, Bangalore 560071, **INDIA**
Tel: +91-80-25350105/36/38, Fax: +91-80-25352723
Email: contactus@accord-soft.com, Web: www.accord-soft.com

This document, product and software described herein were developed by Accord Software & Systems Pvt. Ltd., Bangalore.

No part of this document may be reproduced or transmitted in any form for any purpose without the express written permission of Accord.

Copyright © 2009, Accord Software & Systems Pvt. Ltd., All rights reserved.

Print – Feb 2010

Document Number: UG-SPACE GPS -02-02-2010

MSDOS and Windows™ are registered trademarks of Microsoft Corporation.

Table of contents

Quick Start Guide

The 12-Channel GPS receiver, computer, antenna and power supply should be interconnected through appropriate cables. To monitor and control receiver's operation, GVISION software should be installed on the computer and initialized.

To get started quickly, follow the steps as given below.

Step 1 Open the packing box, which contains the following items

- User's Guide
- GVISION for Windows software installation diskettes
- 12-Channel GPS Receiver
- Cables for power and signals

Step 2 Apart from the above, the user will also need the following to set up the receiver and to check it's functionality completely

- Regulated Power supply 5V DC, 1.5-2A (Current should not exceed maximum value of 2A)
- CRO/Probes to check the PTTI pulses

Step 3 Connect the receiver to PC using the supplied cable as shown in Fig I.

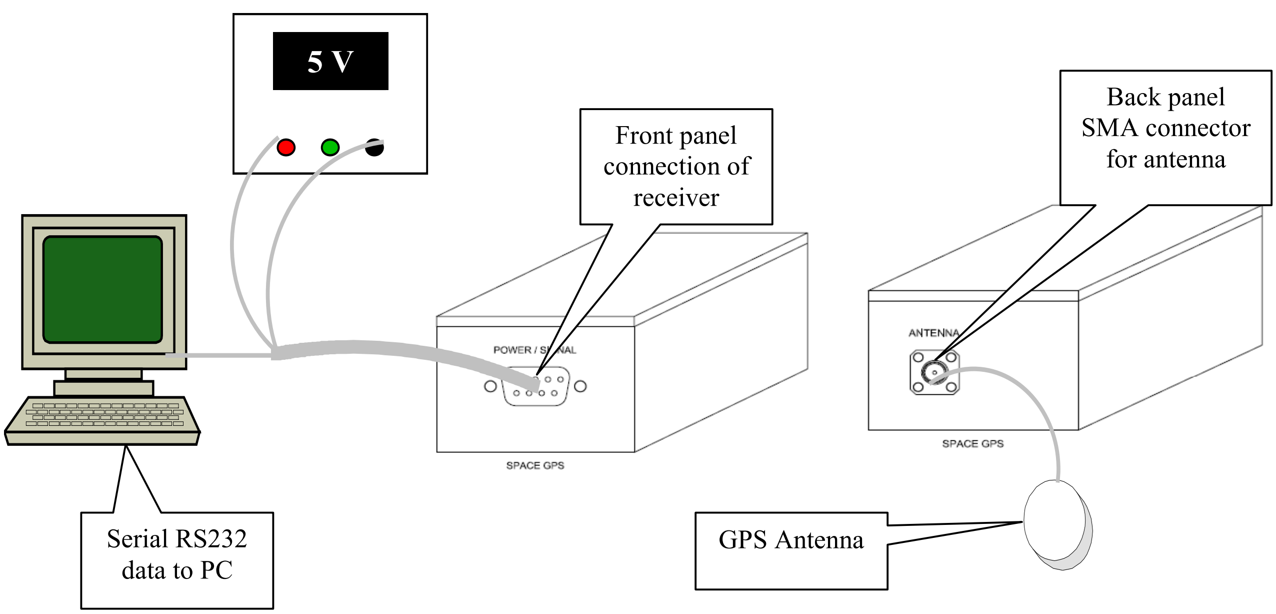


Fig I

Step 4 Fix the antenna on a metallic surface, which is horizontal and smooth. The location of the antenna should be so chosen that it has a very clear view of the sky all round.

Step 5 Connect the antenna cable with the SMA connector to the receiver front panel. Route the cable in such a way that it does not get jammed through the doors or windowpanes.

Step 6 Power the receiver from 5V Regulated Power Supply.

Step 7 Power and boot the PC.

Step 8 Ensure that the receiver is connected to the COM1 port of the PC. If not, you will have to configure the port properly later during **Step 11**.

Step 9 Install SpaceGvision by running set-up file provided in the compact disk

Step 10 Double click on the SpaceGivision.exe that would be in the installed directory

Step 11 Now at the bottom right corner of the screen you must see "**Connected**". If you have connected the receiver to the COM2 port, then you must close the session and reconfigure the port as COM2

Step 12 To view the PTTI pulses, PTTI signal point in the DB-9 external connector should be connected to the CRO. Once the position is available, you can view the PTTI pulses.

User’s Guide Organization

This version of the User’s guide explains the theory of operation of Accord's 12 Channel GPS Receiver for Space Applications. It describes Accord's binary message formats supported on RS232 serial link. It also describes few trouble shooting tips. The organization of the User’s Guide is given below:

Chapter 1: Introduction

This chapter introduces Accord’s SPACE GPS (Global Positioning System) Receiver Chipset solution based on a single floating point DSP from Analog Devices. The highlights of the SPACE GPS chipset along with a glossary of terms used in this guide are included.

Chapter 2: GPS Principles

In this chapter, the principles of operation of the Global Positioning System, its advantages and applications are described briefly.

Chapter 3: Functional Description of the 12 Channel GPS Receiver for Space Applications

In this chapter, the organization and the functions performed by the different sections of the receiver viz., RF, Correlation and Navigation Modules are described.

Chapter 4: Hardware Installation of SPACE GPS Receiver

This chapter includes the test set up procedure, the electrical connections and mechanical details of the receiver and the precautions to be observed before using the receiver

Chapter 5: User Interface for the Receiver

This chapter gives the guidelines about using the receiver and the user interface GVISION, in run time.

Appendix – A: Accord’s Custom Binary Message Format

This chapter deals with Host Communication Interface and details of the various messages supported in the receiver are given.

Technical Support

For technical support contact:

VARADARAJ G S
Group - Manager Business Development
Accord Software & Systems Pvt. Ltd.
No.K-37, K.R.Colony, I Cross, Domlur Layout
Bangalore 560071, INDIA
Tel: +91-80-25350105 / 136 / 138
Fax: +91-80-25352723
Email: contactus@accord-soft.com
Web: www.accord-soft.com

1

Introduction

Overview

Accord has developed an innovative Global Positioning System Receiver based on Analog Device's floating-point processor. The receiver gives a software intensive solution for GPS signal correlation, positioning and navigation. This enables higher flexibility in customizing the product as per the user requirements. *Windows based User interface software (GVISION)* supplied along with the receiver facilitates the user with easier and intuitive interaction with the receiver.

The receiver is capable of tracking simultaneously 12 GPS satellites. It uses the data extracted from each satellite being tracked to compute the user position, and time accurately. The receiver can work in 3-D mode.

Product Highlights of 12-Channel GPS Receiver for Space Applications:

ADSP based solution:

- Provides user's position, velocity and time
- Designed around a real-time executive
- Easy expandability
- Compatible with most RF down converters
- Easy implementation of customized solutions with this chipset
- Interfaces viz., RS232
- Precise Time and Time Interval output
- PC based Graphical User Interface
- Supports Accord's Binary message formats

Acronyms:

AGC	Automatic Gain Control
BITE	Built in Test
C/A	Coarse/Acquisition
DOP	Dilution of Precision
DR	Dead Reckoning
DSP	Digital Signal Processor
ECEF	Earth Centered Earth Fixed
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electro Static Discharge
GDOP	Geometric Dilution of Precision
GMT	Greenwich Mean Time

GPS	Global Positioning System
GPSR	Global Positioning System Receiver
HDOP	Horizontal Dilution of Precision
IF	Intermediate Frequency
LNA	Low Noise Amplifier
OEM	Original Equipment Manufacturer
OTP	One Time Programmable
PDOP	Position Dilution of Precision
PLL	Phase Locked Loop
PRN	Pseudo Random Number
PTTI	Precise Time and Timing Interval
RAM	Random Access Memory
RAIM	Receiver Autonomous Integrity Monitor
RF	Radio Frequency
ROM	Read Only Memory
RTC	Real Time Clock
SA	Selective Availability
SAW	Surface Acoustic Wave
SNR	Signal to Noise Ratio
SPS	Standard Positioning Service
SV	Satellite Vehicle
TDOP	Time Dilution of Precision
UERE	User Equivalent Range Error
URA	User Range Accuracy
URE	User Range Error
VCO	Voltage Controlled Oscillator
VDOP	Vertical Dilution of Precision
VLSI	Very Large Scale Integration

Glossary:

Almanac This is a part of the navigation message transmitted by each satellite, which includes orbital information of all satellites, clock correction and atmospheric delay parameters. GPS receivers need almanac to compute the visibility information about the satellites.

ASCII American Standard Code for Information Interchange. A standard set of 128 characters, symbols and control codes used for computer communications. ASCII characters require seven bits of data to send, but are often sent eight bits at a time with the extra bit being a zero.

Azimuth The angular distance between the true North and the object in consideration in the horizontal plane.

Baud A measure of the speed of data transmission. Baud and bit rate is the same for direct equipment interconnections (e.g.. RS422). Baud and bit rates are not the same for modulated data links, whether radio or wire.

Bit Binary Digit. The smallest unit of information into which digital data can be subdivided and which a computer can hold. Each bit has two values (e.g. 1/0, ON/OFF, TRUE/FALSE)

Bit Rate The rate at which bits are transmitted over a communication path, normally expressed in bits/second.

Byte A set of contiguous bits that make up a discrete item of information. A byte usually consists of a series of 8 bits, and represents one character.

C/A Code This is Coarse Acquisition code, which is a pseudo random noise sequence, modulated on the GPS L1 signal and transmitted by all the GPS satellites for ranging. C/A code is a Gold code of 1 millisecond in length at a chip rate of 1.023 MHz.

Chip The length of time required for transmitting either a 1 or 0 in a pseudo random code.

Chip rate Number of chips per second.

Control Segment The ground based segment of the GPS, consisting of Monitor stations, Master Control Station and Ground antennas.

Dilution of Precision(DOP) DOP is a measure of the contribution of the relative geometry of the user and the GPS satellites to the error in the position fix. This is inversely proportional to the volume formed by the tetrahedron with the satellites and the user constituting the four corners.

ECEF Cartesian coordinate system where X direction is the intersection of the prime meridian (Greenwich) with the equator. The vectors rotate with the earth. Z is the direction of the spin axis.

Elevation Angle made by the line joining the user and the satellite with the horizontal plane.

Elevation Mask Angle A measure of the minimum elevation angle, above the horizon, above which a GPS satellite must be located before the signals from the satellite, will be used to compute a GPS location solution. Satellites below the elevation angle are considered unusable. The elevation mask angle is used to prevent the GPS receiver from computing position solutions using satellites, which are likely to be obscured by buildings or by mountains.

Ephemeris Part of the Navigation data transmitted from each satellite containing precise orbit information and clock corrections for that satellite. The receivers to compute the precise position coordinates of the satellites used for ranging use ephemeris.

Firmware A set of software computer/processor instructions that are permanently or semi-permanently resident in ROM.

Geometric Dilution of Precision GDOP describes the DOP in position as well as the time computed using the GPS satellites.

(GDOP)

$$GDOP^2 = PDOP^2 + TDOP^2$$

GPS The Global Positioning System (GPS) is a space based radio positioning, navigation and time transfer system which operates at all times of the day, under all weather conditions and everywhere on or near Earth.

GPS L1 signal Transmitted by all GPS satellites at a carrier frequency of 1575.42 MHz. This signal is modulated by the C/A code and navigation data.

Horizontal Dilution of Precision (HDOP) HDOP is the horizontal position component of GDOP.

Monitor station Group of stations located around the world as a part of the GPS Control Segment to monitor satellite clock and orbital parameters.

Navigation Data Data modulated on the C/A code, which contains ephemeris, almanac and other information. The data is transmitted at 50 bits/sec.

NAVSTAR The name given to the group of satellites, which is built by Rockwell International.

Position Dilution of Precision (PDOP) PDOP is the DOP in the position fix. PDOP includes the contribution in all the three dimensions of the position fix.

$$PDOP^2 = HDOP^2 + VDOP^2$$

Pseudorange Measure of apparent transit time from the satellite to the receiver antenna expressed as distance. The pseudo range is obtained by multiplying the apparent transit time by the speed of light. Pseudorange differs from true range due to the fact that the clocks in the receiver and the satellites are not synchronized.

RTCM Radio Technical Commission for Maritime Services has been setup to define data link standards for Differential GPS.

RAIM RAIM means Receiver Autonomous Integrity Monitoring. This means that, when more measurements (m) are available than required (n), we use this method. We calculate the position based on n measurements. The computed position is used to calculate the other m-n measurements and compared with actual measurements. This will help in eliminating the 'wild' measurements which are so much offset from the computed measurements. Hence they will not be further used in the calculations. Generally this is required in safety critical navigations like aviation.

Selective Availability (SA) An U.S. Department of Defense program to control the accuracy of pseudo range measurements, whereby the user gets erroneous pseudo range measurements by certain controlled amount.

Serial Communication System of sending bits of data on a single channel one after the other, rather than simultaneously.

Serial Port A port in which each bit of information is brought in/out on a single channel. Serial ports are designed for devices that receive data one bit at a time.

Space Segment GPS Space Segment consisting of 24 satellites in six orbital planes.

Spread Spectrum The received GPS signal is a wide bandwidth, low power signal (-160dbw). This property results from modulating the L-band signal with a PRN code in order to spread the signal energy over a bandwidth, which is much greater than the signal bandwidth. This is done to provide the ability to receive all the satellites unambiguously and to provide some resistance to noise and Multipath.

Standard Positioning Service (SPS) This is a civil positioning and timing service which will be available to all GPS users on a worldwide basis at an accuracy level set by the United States Department of Defense.

Start Bit In asynchronous transmission, the start bit is appended to the beginning of a character so that the bit sync and character sync can occur at the receiver equipment.

Stop Bit In asynchronous transmission, the stop bit is appended to the end of each character. It sets the receiving hardware to a condition where it looks for the start bit of a new character.

SV Satellite Vehicle or Space Vehicle.

Time Dilution of Precision (TDOP) Contribution of the relative geometry of the satellite constellation and the user's position, DOP, to the error in the time fix.

$$GDOP^2 = PDOP^2 + TDOP^2$$

User Equivalent Range Error (UERE) The component of the system accuracy, which is independent of location, and time, that represents the receiver ranging error based on the satellites in view.

User Range Accuracy (URA) A statistical indicator of the ranging accuracy's achieved with a specific satellite based on historical data.

User Range Error (URE) The error component along the line of sight between the user and the satellite being used for measurement.

User Segment The GPS Segment consisting of the receivers.

VDOP Contribution of the relative geometry of the satellite constellation and the user's position, DOP, to the error in the vertical dimension of the position fix.

Z-count GPS satellite clock time at the leading edge of the next data sub-frame of the navigation message (expressed as an integer multiple of 6 seconds).

2

GPS Principles

Overview:

The Global Positioning System (GPS) is a space based radio positioning, navigation and time transfer system which operates at all times of the day, under all weather conditions and everywhere on or near Earth. GPS consists of three segments viz., Space, Control and User. The Space Segment is the set of 24 satellites orbiting the earth once in 12 hours in six orbital planes with four satellites in each orbital plane. Control Segment based at four locations on the earth monitors and controls the satellites. User Segment is the Global Positioning System Receivers (GPSR) used by a large number of users all over the world. GPSR provides accurate and absolute position, velocity and time.

GPS Receiver finds diverse range of uses such as:

- Intelligent Vehicle Highway System (IVHS)
- Personal navigation by Land, Sea and Air
- Management of fleet of taxis, buses & police vehicles
- Land and construction Surveying
- Mapping to create highly precise maps
- Animal tracking
- Synchronization of time
- Vehicle security systems
- Communication sets with GPS for Police
- Integrated navigation solutions

The decisive advantages of GPS over other navigation systems are:

- 24 hour worldwide coverage
- Independence from weather conditions
- Precise 3 dimensional position and time information
- Resistance to jamming
- Easy integration/adaptability with other systems
- Can be used on Land, Sea or Air

Theory of Operation of GPS:

The GPS system consists of three segments (Refer to Fig. 2.1) viz.,

- Space Segment
- Control Segment
- User Segment

Space Segment

Space Segment consists of a set of 24 satellites orbiting the earth once in 12 hours. The satellites are placed at an altitude of approximately 10,898 nautical miles above the surface of the earth and these satellites are arranged in six orbital planes inclined at 55° with four satellites in each orbit. Each satellite continually transmits the following signals:

L1 signal at 1575.42 MHz

L2 signal at 1227.60 MHz

The above frequencies are phase modulated by two ranging signals viz., P-code for military users and C/A code for civilian users. In addition, navigation messages are modulated and transmitted along with the ranging signals. Satellites use precise atomic clocks for synchronization with GPS time.

Control Segment

Control Segment consists of a master control station, four monitor stations located strategically around the earth to maximize satellite coverage and ground antennas. The monitor stations receive satellite data and communicate to the master control station. The master control station updates navigation messages to all satellites through the ground antennas.

User Segment

User Segment consists of a large number of GPS receivers (GPSR) used all over the world. The GPS receiver, which is of current interest, receives and processes satellite signals to compute user's position, velocity and time.

The principle of computation of the user’s position using the GPS satellite signals in a receiver can be described in short as follows. The GPS constellation of satellites is so designed that sufficient number of satellites is visible at any point on the surface of the earth at all times. Each of the set of 24 GPS satellites transmits a unique pseudo-random code continuously. GPS receiver uses correlation techniques to acquire satellite signals; extract navigation messages and performs ranging measurements. GPS receiver measures transit time of the signal and hence range from satellites to the receiver. Range measurements from four satellites are needed to locate precisely the user's position in the three dimensional space. Ranging measurements from three satellites are necessary to compute user’s position in 2 dimensions.

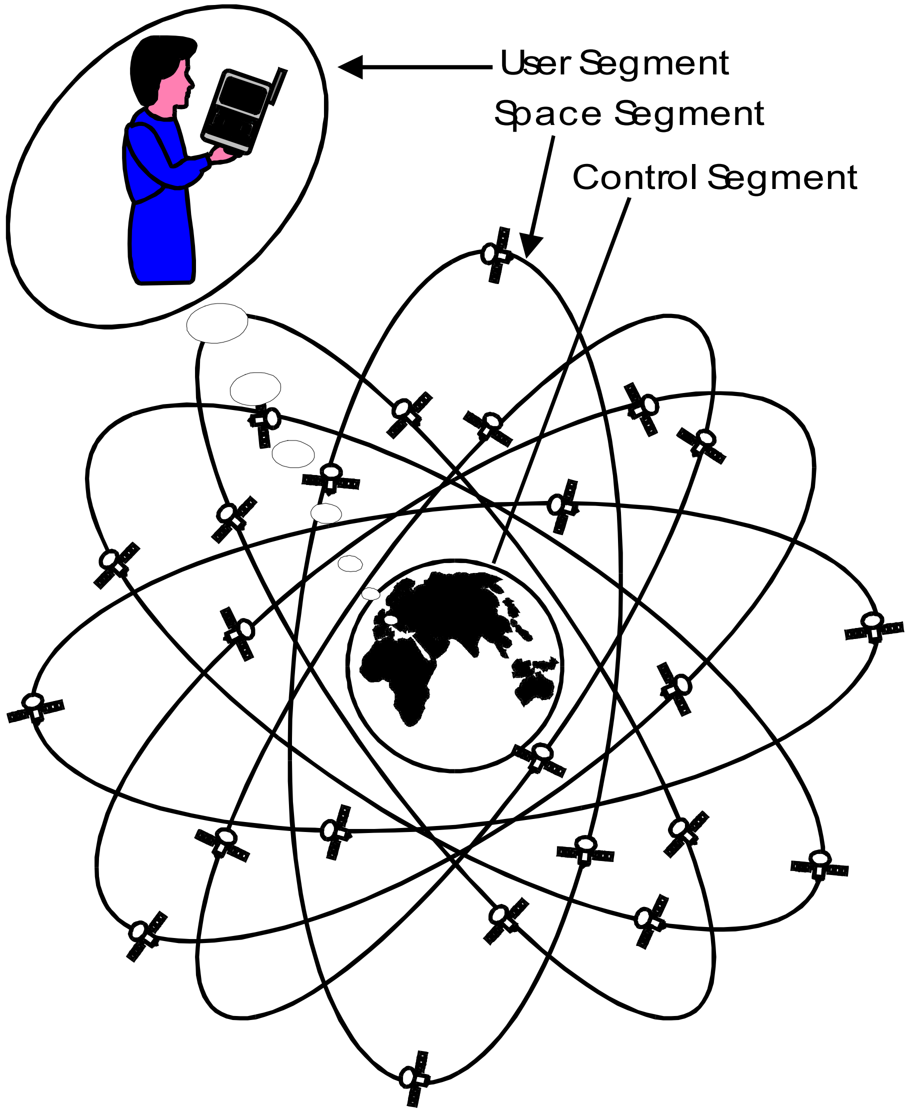


Fig 2.1 Three Segments of GPS

Functional Components of a GPS Receiver:

A GPS receiver used in various applications has the functional components as shown in Fig 2.2.

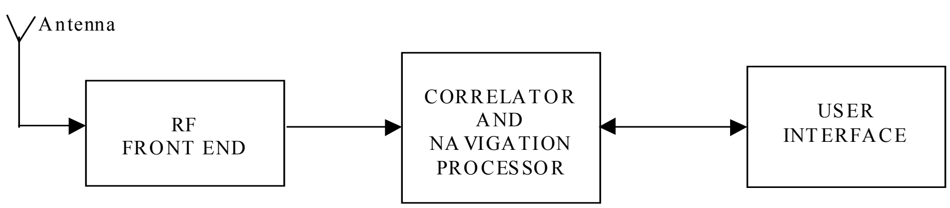


Fig 2.2 Functional components of a GPS Receiver

Antenna The Antenna operates at 1575.42 MHz to receive the GPS L1 signals from all the visible satellites.

RF Down Converter The RF Down Converter amplifies, filters and down converts the L1 signal to give a low IF digital signal suitable for processing by the Correlator.

Correlator and Navigation Processor The Correlator acquires the satellite signals, extracts the navigation data and performs Range and Doppler measurements. The Navigation data and the measurements are used by the Navigation Processor to compute the user's position, velocity and time. The Navigation Processor computes the user's position, velocity and time from the measurements generated by the Correlator.

User Interface This forms the serial communication standard on which the Accord's Binary messages are transmitted.

Functional Description of 12-Channel GPS Receiver

Overview

Accord's 12-Channel GPS Receiver, (Fig.3.1), is designed around a programmable platform 32 bit floating point DSP with on-chip SRAM and integrated I/O peripheral support.

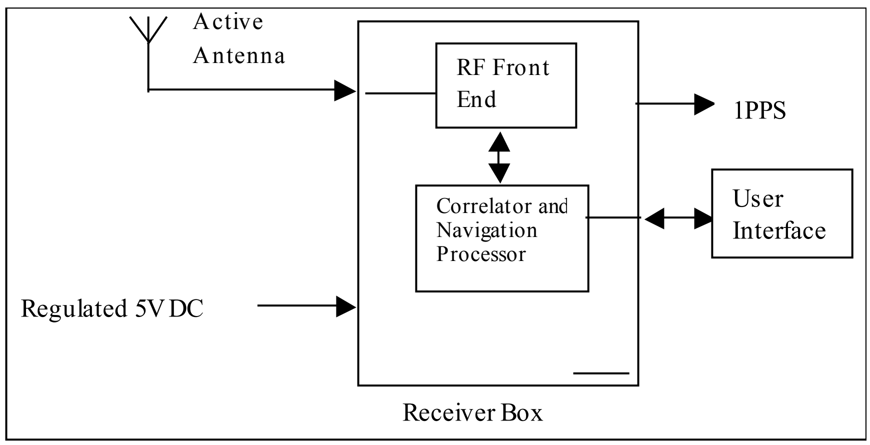


Fig 3.1 System block diagram

The software along with RF front end and GPS antenna forms a complete GPS receiver.

The receiver is designed to simultaneously acquire and track 12 GPS satellite signals and compute user's accurate position, velocity and time. Accord's GVISION software provides a Graphical User Interface for the GPS receiver on a PC, which can be connected, to the GPS receiver through an RS232 link.

Functional Description

The receiver consists of (Fig. 3.2):

- RF Front End
- Correlator and Navigation Processor
- User Interface

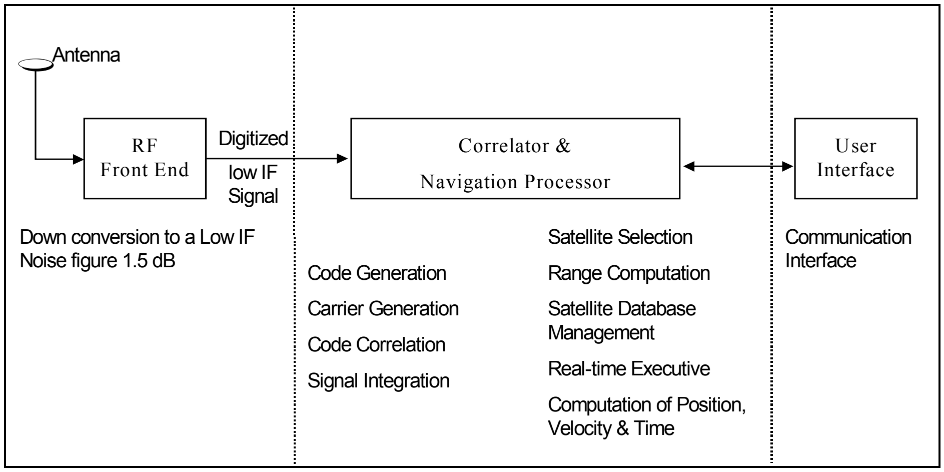


Fig 3.2 Different Sections of the Space GPS Receiver

The L1 GPS signal, received through an active antenna, gets down converted to a low IF in the RF front end - designed around a VLSI down converter. This IF signal is sampled at a predefined rate and then quantized in an A/D converter inside the RF front end. The quantized samples of the IF signal are received serially by the Digital Signal Processor (DSP) and stored in an internal buffer. The down conversion of this stored IF signal to base band, correlation of the signal with the local code, carrier & code tracking loops and computation of user's position, velocity and time as well as the communication interface to a host are all implemented in software running on the DSP.

RF Front End

RF Front End is designed around a commercially available VLSI RF down converter with a set of RF passive components. It receives the input signal from the antenna and provides down converted digitized IF signal to the correlator. RF front end consists of the following major components:

- Low noise amplifier
- Band-pass filter
- VLSI Down Converter
- LC filter
- SAW filter
- Reference clock

The L1 GPS satellite signal is first passed through a low noise amplifier, then a band-pass filter and then down converted to a low IF in the VLSI down converter.

The down conversion of L1 frequency is performed in three mixer stages to generate IF frequencies. The local oscillator frequencies required for mixing operations are generated in a frequency synthesizer that gets input from the reference clock. A band-pass filter and an amplifier follow each stage of the mixer.

The final output from the RF front end is a digitized low IF signal, which is processed in the next section, correlator. RF Front End also provides signal interfaces for BITE (self test), correlator clock signal and AGC level.

The main functions of the RF Front End are:

- Reception of L-band GPS signal from the antenna
- RF signal amplification and filtering
- Down conversion of RF signal to a low IF in three mixer stages
- Digitization of the low IF output signal
- On-chip PLL including VCO

Correlator And Navigation Processor

Correlator receives digitized low IF output from the RF Front End and performs measurements on the satellite signal. The measurement outputs are sent to the Navigation module, which computes the user's position, velocity and time.

The Correlator consists of:

- Buffers to store sampled low IF signal
- Carrier generator
- Code generator
- Code correlator

The main functions of the Correlator are:

- Reception and storage of digitized low IF signal in buffers
- Down-conversion of low IF signal to base-band
- Parallel processing of 12 channels
- Generation of the local carrier
- Generation of local C/A codes for 32 satellites
- Correlation of prompt and dither samples of incoming code
- Interface to Navigation Module

The software solution for correlator provides more efficient and flexible algorithms.

Navigation Module receives measurements performed on the satellite signal by the correlator. The pseudorange and Deltarange measurements for the satellites being tracked by the correlator are used by the Navigation Module to estimate the user’s position and other parameters.

The Navigation module consists of the following modules:

- Satellite database manager
- Satellite selection
- Channel manager
- Position, Velocity and Time solution
- Interface to Correlator
- Real time multitasking executive
- Measurement data processor
- Precise Time Generator
- RS-232 interface

User Interface

User Interface software supplied along with the SPACE GPS receiver runs on an IBM-PC connected to the receiver on a RS232 link.

Using the software, you can:

- Monitor satellites being searched, tracked
- Monitor the Receiver status information
- View computed user’s position, velocity and time

Specifications of 12-Channel GPS Receiver

Physical Characteristics

Box dimensions	125 x 55 x 40

Electrical Characteristics

Supply voltage	5V
Power consumption	< 2 W (With out antenna) <2.5 W (With antenna)

Performance Characteristics

Receiver	12-channel L1- C/A code SPS

Time to First Fix (TTFF)

Cold Start (without almanac, time, position)	90 seconds +/- 30 seconds (typical)

Accuracy (With PDOP < 3.0)

Position (Horizontal)	10 (2-sigma) meters
Velocity	0.12 m/s

Dynamics

Velocity	12000 m/s

Position update rate

1 second

Pulse Per Second

Pulse width	Minimum of 1 ms Maximum of 2 ms

Environmental Characteristics

Operational temperature range in Thermovac	-25°C to +65°C
Storage temperature range	-40 C to +85° C
Vibration	15 g for 120 sec on all the three axes.
Radiation level	Better than 10K Rads

Communication Interface

PC / Host Communication

Interface:	RS232 compatible
Baud rate:	9600 baud
Message formats:	Accord’s proprietary binary
Start bits:	1
Data bits	8
Stop bits:	2
Parity check:	None
Flow control:	None

Protocols Available

Accord's custom binary Input / Output Message consisting parameters of receiver’s navigation data and the status of the receiver.

4

Hardware Installation of SPACE GPS Receiver

Overview

To monitor and control SPACE GPS receiver operation, GVISION or similar software should be installed on the computer

Precautions

Electrostatic Considerations The SPACE GPS boards contain assemblies sensitive to damage by ESD (Electrostatic discharge). Use ESD precautionary measures while handling the board.

Thermal Considerations Operating temperature of the GPS receiver is from -25°C to 65°C. Before installation, it must be ensured that the temperature of the environment is not too high. The air circulation should not be poor.

Grounding Considerations The receiver is grounded through pin 5, 9 and 7 of RS232 connector and through the outer casing of the front panel connectors. The mounting holes of the board are connected to the case.

Packaging After opening the package, check for any damage to the connectors, cables, etc. Using any damaged part does not guarantee proper working of the SPACE GPS receiver.

Test Setup Procedure

It is essential to install the equipment properly to avoid any degradation in its performance. The test set up is shown in Fig I. (Refer **Quick Start Guide** at the beginning of the User's Guide).

Electrical Connections

The SPACE GPS receiver gets power input through the front panel connector. The connector also has data transmission, External reset signal and precise time output. The back panel consist of SMA connector to provide RF signal to the system. The details of different connectors and other electrical connections are given below. (Refer Fig I)

Connectors:

Antenna Connector:

This is a SMA connector used for connecting the antenna cable to the SPACE GPS Receiver. With antenna receiver takes maximum additional current of 60mA @ 5V.

Note: The antenna should be a 5V active antenna with minimum 33 dB gain.

Pin no.	Signal name	Description
1	RF signal	Center pin
2	Ground	Outer case

Front Panel

Power-Signal Connector:

<u>Pin detail / input status of signals at the 9- pin board connector</u>

Pin No	Connection	Remark	Signal level	
1	PCTX1	GPS Data Main RS232 Output	Output voltage swing	+ /-5V (Min)
2	EXTRST	External reset to DSP RESET → 3.3V Active LOW pulse of width greater than 50 msec and nominal value should not exceed 3.3V as shown in FIG 4.1	V_{IH} V_{IL}	2V (Min) 0.8 (Max)
6	PPS	Pulse per second output of width 1-2 ms (3.3V Active high pulse) shown in FIG 4.2	V_{OH} V_{OL}	2.4 (Min) 0.6 (Max)
4	PCTX2	GPS Data Redundant RS232 Output	Output voltage swing	+ /-5V (Min)
3 & 8	DVCC5	A regulated +5V DC power supply input. There is no over voltage and reverse polarity protection for power supply input. So care should be taken to see that voltage does not exceed the specified limit (5V +/- 0.1V). Also ripple on this supply should not exceed 40 mv p-p	Nominal current drawn is 0.40A @ 5V +/- 0.1V	
7,5 & 9	DGND	Digital ground		

Note: Power supply for DVCC5 should be with in 4.9 to 5.1 V range, else it may lead to the damage to receiver.

1 .Connect the front and back panel connector provided along with the SPACE GPS receiver and power-on the system.

2. Connect RS232 output to PC ,open Gvision Application.

3. Then GVISION should show connected and satellite ID 1 to 12 should be programmed sequentially in channels 1 to 12.

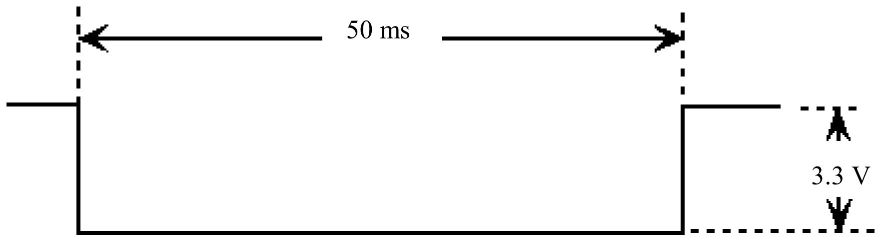


FIG 4.1: Timing waveform of External Reset

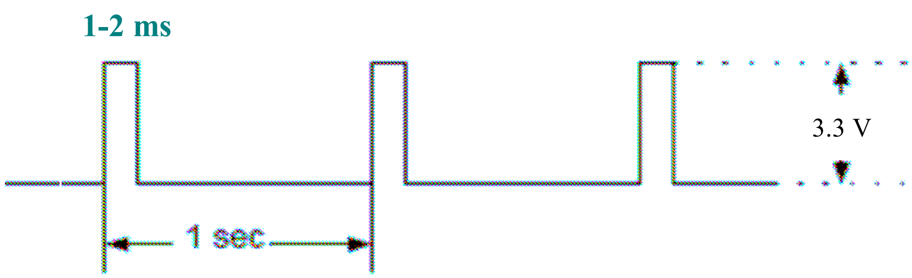


FIG 4.2: Timing waveform of PTTI signal

Mechanical details of SPACE GPS unit:

a. Box Front View

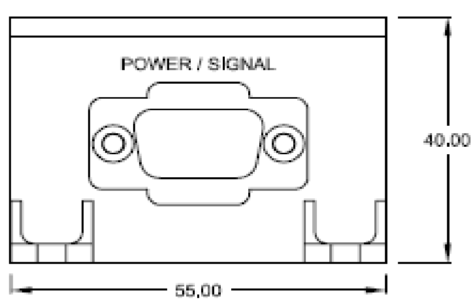


Fig 4.3 Mechanical Drawing of SPACE GPS unit-Box front View

b. Box Rear View:

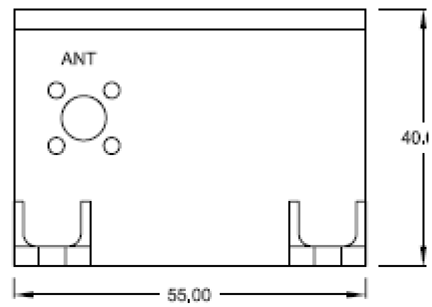


Fig 4.4 Mechanical Drawing of SPACE GPS unit-Box Rear View

c. Box Side View

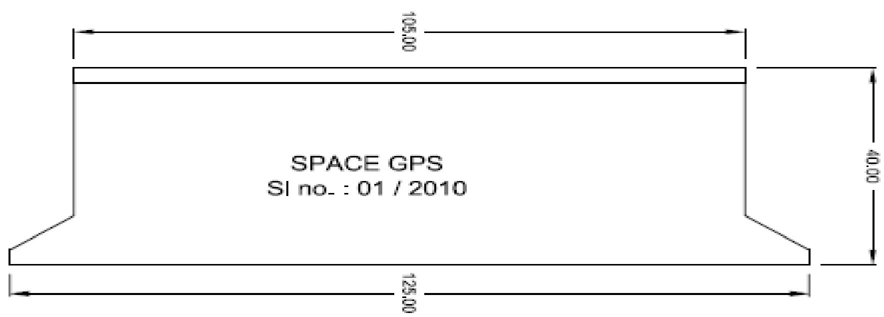


Fig 4.5: Mechanical Drawing of SPACE GPS unit: Box Side View

d. Box Top View

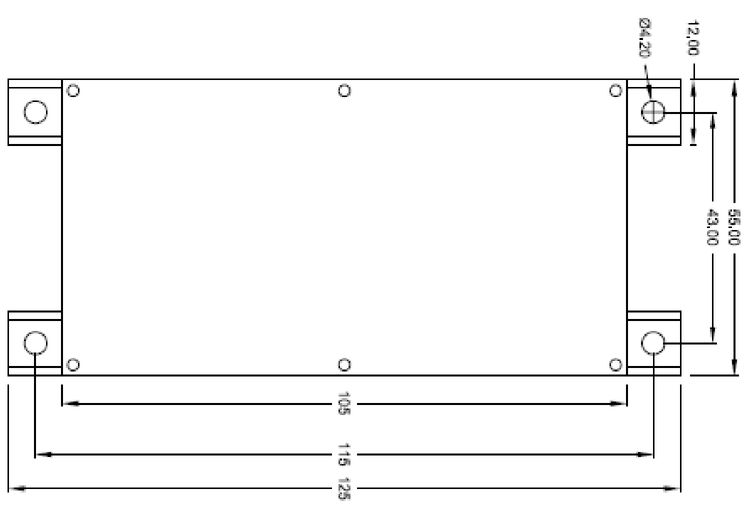


Fig 4.6: Mechanical Drawing of SPACE GPS unit: Box Top View

5

User Interface for the Receiver

This chapter describes how to operate the 12-Channel GPS receiver, using the GVISION User Interface.

GVISION For Windows 95/98/2000 is a PC based user interface for GPS receivers. It allows the user to monitor the receiver and use it as a navigational aid.

Features:

- Provides a real-time display of user's position, velocity etc., in both text and graphics
- Facilitates recording of GPS data for offline analysis
- Checks and displays the connection integrity status between the PC and the receiver

System Requirements:

Processor	Pentium II or higher
Operating System	Windows'98 or higher
Memory	16 MB RAM
Video	VGA adapter with Color Monitor
Disk	At least 5 MB free working space
Serial Port	COM1 or COM2 or COM3 or COM4

Even though Pentium II may be adequate to run Windows'98, it is highly recommended that a faster processor be used for better performance.

Software Installation:

To install GVISION on the hard disk, follow the steps given below

Step 1 Start Window 98/2000/XP.
Step 2 Insert the CD containing GVISION.
Step 3 Open the CD & Double click on the setup file.
Step 4 Follow the prompts given below

Welcome screen: This screen displays the copyright of GVISION.
Choose **Next** to continue.
At any point during the installation process, it is possible to go to the previous screen by choosing **Back**.
During installation, it is possible to terminate and quit the installation process prematurely by choosing **Cancel**.

Uninstalling GVISION from your System:

If at some point you want to Uninstalling GVISION from your system, you can do so relatively easily.

To UNINSTALL GVISION, follow the steps given below
Step 1 Choose ‘Settings’ from the ‘Start’ menu.
Step 2 Choose ‘Control Panel’ from the ‘Settings’ menu.
Step 3 Choose ‘Add/Remove Program’ from the control panel
Step 4 Choose GVISION from the list of programs displayed and click the ‘OK’ button

Communication with the Receiver:

The receiver can be connected to COM1, COM2, COM3 or COM4 serial ports of the PC. The port can be specified in GVISION by selecting GVISION mode/Real-time menu item from the Main Menu or by clicking the flag icon from the Tool Bar.The COM Port configuration is default set to 9600 Baud, 2 stop bits, No parity bits & 8 Data bits

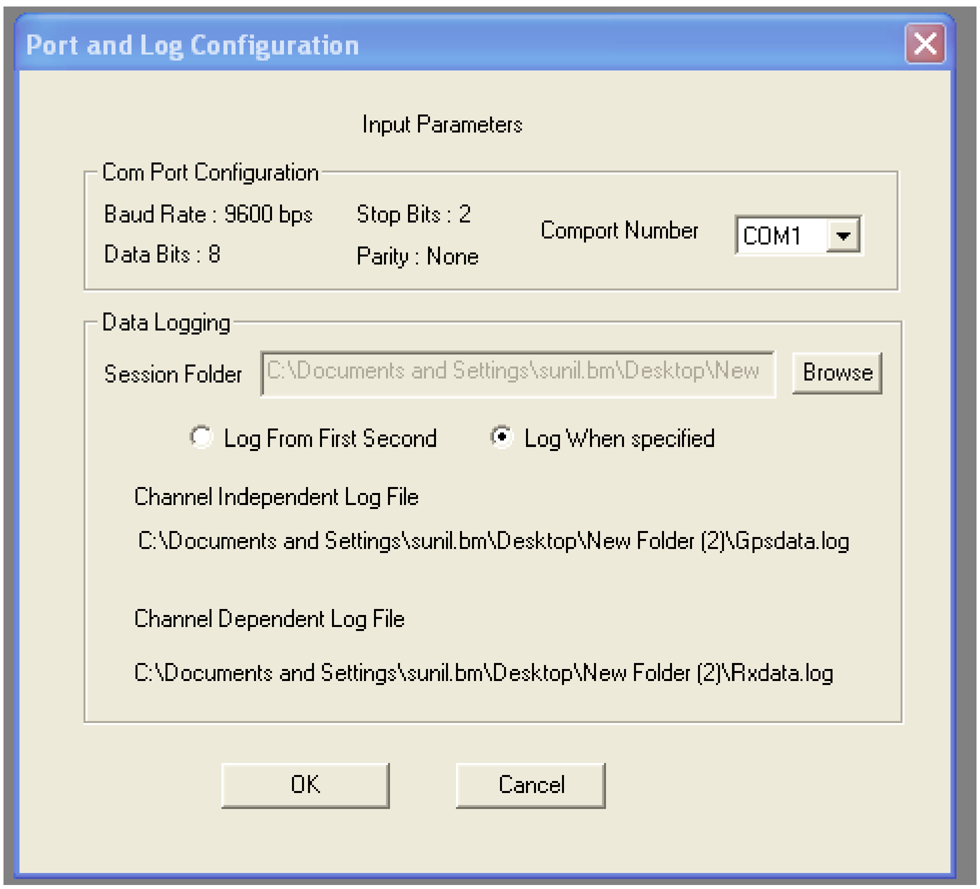


Fig. 5.1 Com Port Setting

Communication Protocol:

The 12-Channel GPS Receiver communicates with the host through a message protocol, Accord's custom binary format, defined in Appendix-A

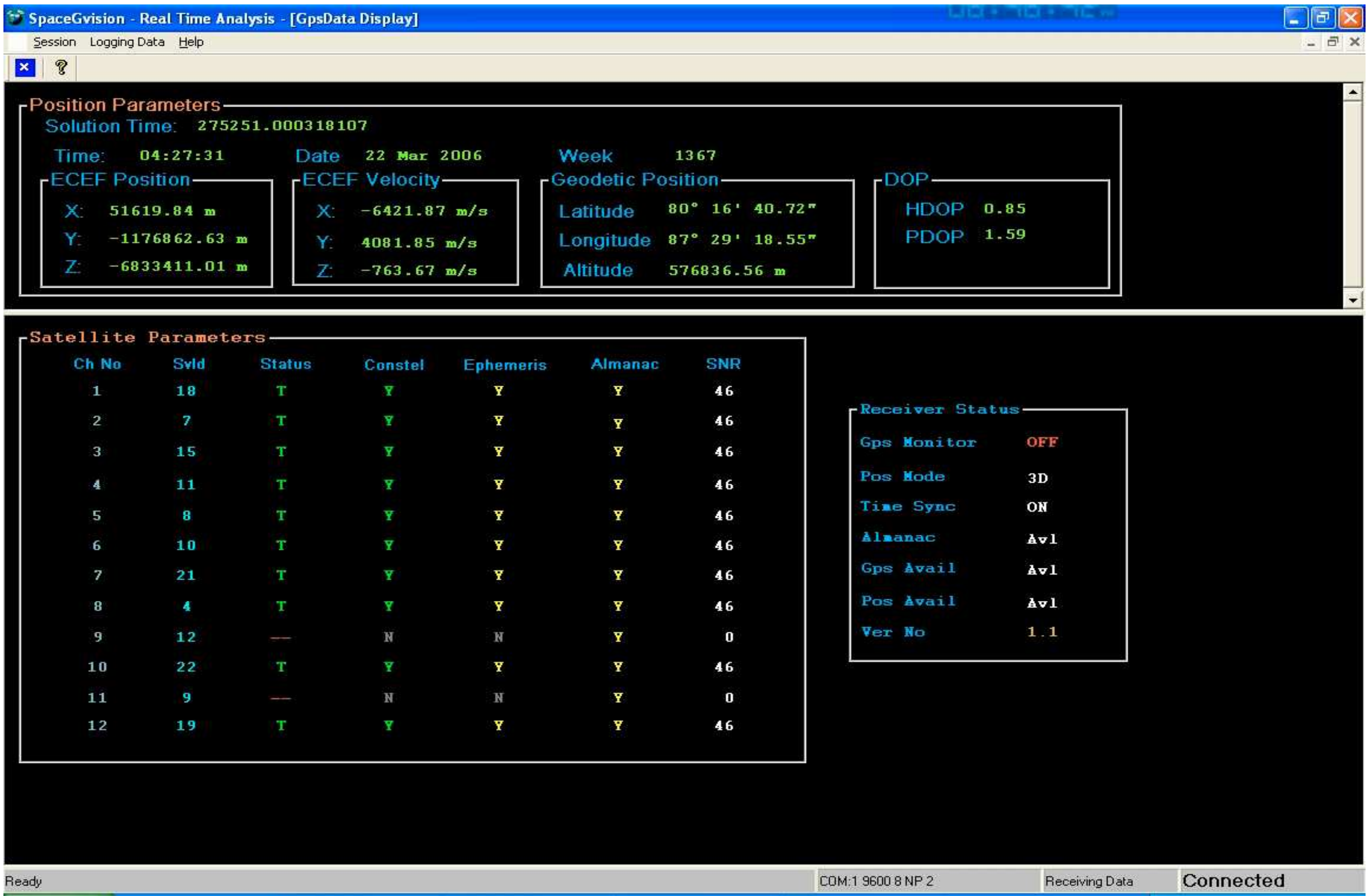


Fig 5.2: Viewing GPS Data information

Viewing the Receiver's GpsData status

The receiver's real time status can be observed in the GpsData window. A typical GpsData window is shown in the Fig 5.2.

Satellite parameters:

Channel No(Ch No) corresponds to the 12-channels in the receiver where 12 different satellites can be tracking.

Satellite ID (Sv ID) indicates satellite vehicle number.

Status indicates the status of the channel. ***T*** indicates the satellite in the corresponding channel is being tracked and ***A*** indicates that the satellite in the corresponding channel is being searched. **–** indicates the status is idle.

Constel specifies the satellites used to compute position solution by *Y* or *N*.

Ephemeris *Y* or *N* indicates the availability of ephemeris data for corresponding satellites.

Almanac *Y* or *N* indicates the availability of almanac data for corresponding satellites.

SNR Signal to noise ratio of the tracked signal in dB-Hz.

Receiver status

GPS monitor This represents the working status of receiver. Toggling of this data between ON and OFF represents receiver is running.

Pos mode : *2D or 3D* indicates the nature of position fix

Time sync: Become ON after getting time from the tracked satellite.

Almanac: Avl indicates the availability of almanac data for all satellites. If complete almanac data set is not available then **Almanac status** indicates *NA*.

GPS avail: Avl indicates that the receiver is giving position fix. If it is not giving the position fix, the pos status indicated will be *NA*

POS avail: Avl indicates the GPS position estimate is available & it is valid for 90 sec else it shows NA.

Ver No: Represent the version number of the firmware.

ECEF position:

X: X position of the receiver in meters

Y: Y position of the receiver in meters

Z: Z position of the receiver in meters

ECEF velocity:

X: X velocity of the receiver in meters/second

Y: Y velocity of the receiver in meters/second

Z: Z velocity of the receiver in meters/second

Geodetic position:

Latitude: Geoditic latitude of receiver in Degree/Minutes/Second

Longitude: Geoditic longitude of reciver in Degree/Minutes/Second

Altitude: Geoditic altitude of reciver in meters

DOP:

HDOP: Horizontal dilution of precision

PDOP: Positional Dilution of Precision

Time/Date/Week:

Represents the civilian date and time. Week represents GPS week.

Solution time:

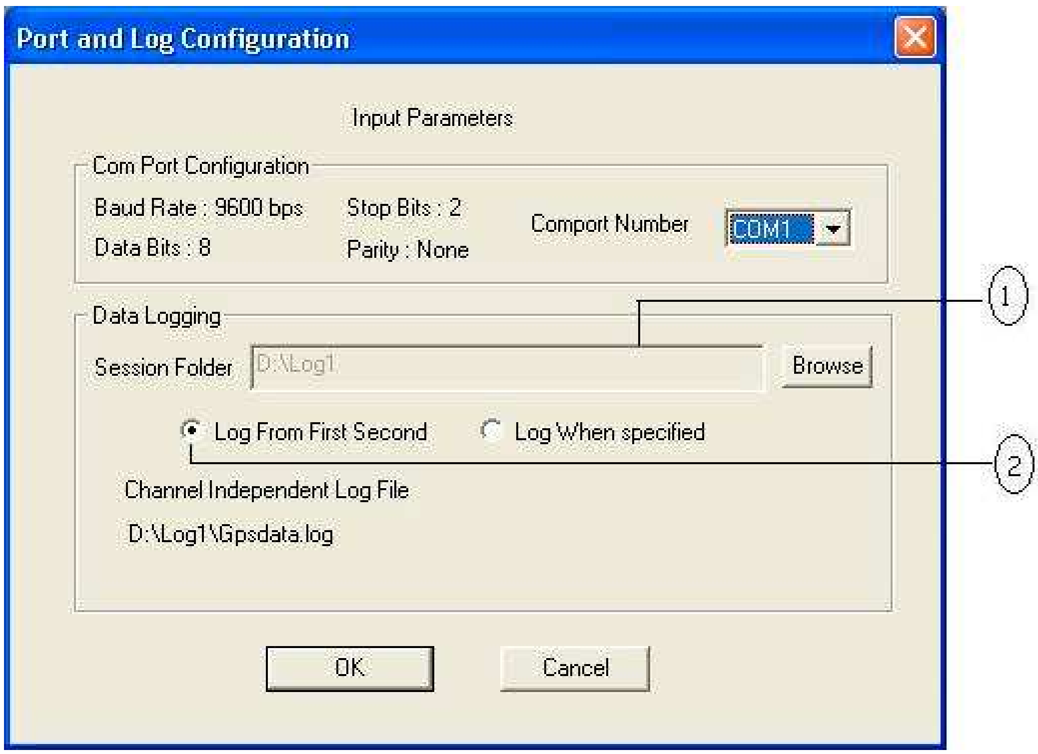
GPS time reference for ECEF position, velocity and other parameters.

Logging data to a file:

Session Folder : Gps Data file will be logged in the specified path, by selecting one of the below mentioned methods
.

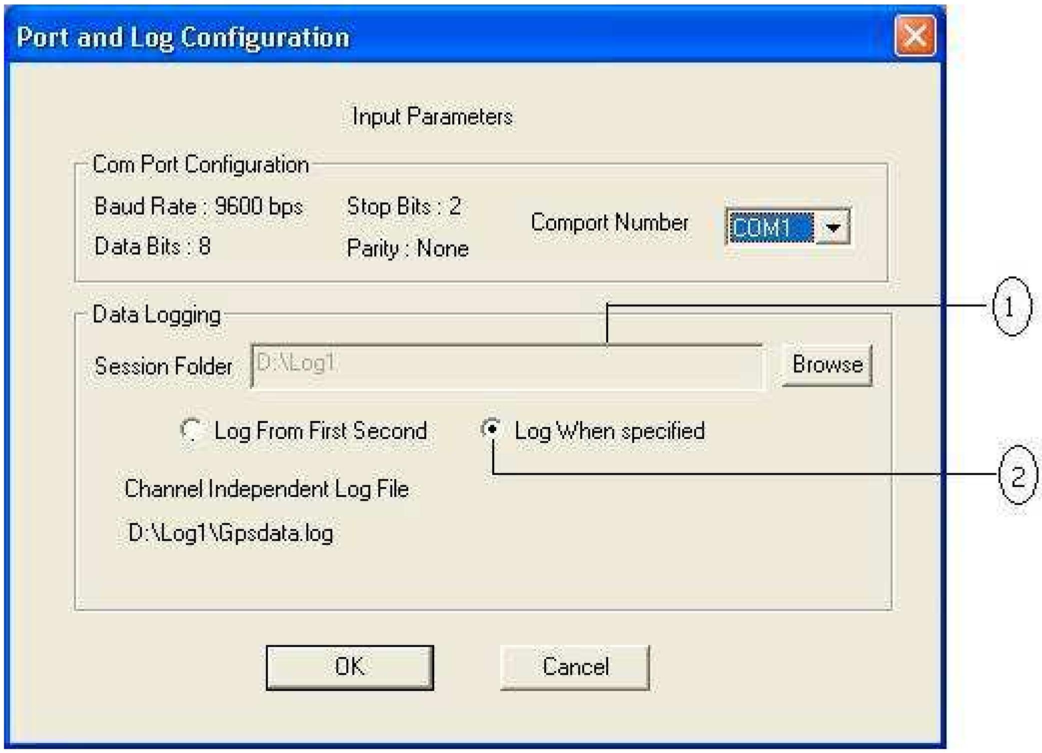
- **Log from First Second**: When this option is selected the GPSData file will be created and logged from the start of the Session.

  Step 1: Choose the session folder
  Step 2: Select the option Log From First Second

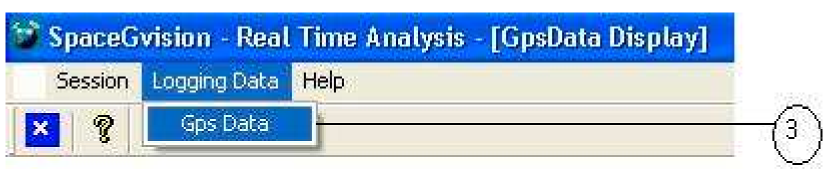


- **Log When specified**: When this option is selected the GPS Data file logging starts only when the user selects the logging menu item.

  Step 1: Choose the session folder
  Step 2: Select the option Log From First Second



  Step 3: Select *Logging Data-> Gps Data* menu.



GPS Data log file will log the values of the below fields,

SolutionTime, ECEF X Pos, ECEF Y Pos, ECEF Z Pos, ECEF X Vel, ECEF Y Vel, ECEF Z Vel, Hdop, Pdop, Tracking SV, Fix SV, Latitude, Longitude, Altitude, Gpstimeofweek, Weekno, Time, Date

Accord's Custom Binary Message Format

Message Structure

Interface:	RS232 compatible
Baud rate:	9600 baud
Message formats:	Accord's proprietary binary
Start bits:	1
Data bits	8
Stop bits:	2
Parity check:	No
Flow control:	None

Output Messages:

User's present position in terms of Latitude, Longitude, Altitude, ECEF/Geodetic coordinates, Time, DOP, Receiver status, Signal to noise ratio, Solution time.

List of Accord's custom Binary Messages

Message ID	Message Name	Units	Message Attributes	Size (Bytes)	Data Type
AC04	Position in ECEF	Cm	T, P	22	Long (32 bits)
AC05	Velocity in ECEF	Mm/s	T, P	22	Long (32 bits)
AC06	Solution Time	Sec	T, P	18	Unsigned long
AC08	Receiver Status	-	T, P	30	Bit fields
AC0A	SNR	dB /Hz	T, P	18	char
AC0B	DOP	-	T, P	14	Unsigned long
AC0E	Geodetic Position	Degree,m	T, P	22	Long
AC0F	Time date	-	T, P	13	Unsigned long

T – Transmit; P – Periodic

Note: The periodicity of these messages is 1 seconds.

The time that comes, as part of Position and velocity message is the instant at which the user state vectors are computed. This is sent only to assist for synchronizing the position and velocity messages with the solution time message. Also, the absolute time that corresponds to 1PPS is the second part of the solution time message

Accord's custom binary message will have the following format:

Field	Meaning	Size in bytes
'3F3F'	Indicates beginning of a binary message	2
Message ID	Message identification	2
Body of the message	Body of the message	Variable length
Checksum	Checksum for all bytes in the message up to the end of the body of the message	1
Line Feed	Indicates the end of the message	1

Checksum Computation
Checksum is computed by logically XOR-ing all bytes till the end of the body of the message.

Definition of LSB and MSB in a given word (16-bit):

MSB	LSB
15	0

For all 4-byte messages, the construction of the word should be as follows:

MSB-word	LSB-word
31 16	15 0

For a byte consisting of bits representing channel information, the byte should be read as follows:

Channel-8							Channel-1
B7	B6	B5	B4	B3	B2	B1	B0
				B11	B10	B9	B8
				Channel-12			Channel-9

Message Details:

Position in ECEF co-ordinates:

3F3FAC041234CL

1 X Position in ECEF co-ordinates – Long

2 Y Position in ECEF co-ordinates – Long

3 Z Position in ECEF co-ordinates – Long

4 GPS time in seconds – unsigned Long

C Checksum

L Line feed

Byte number	Message Field Name	Description	Status
1	3F	Message Type	1 Byte
2	3F	Message Type	1 Byte
3	04	Message ID	LSB
4	AC	Message ID	MSB
5	1-A	X-position in ECEF	LSB
6	1-B	X-position in ECEF	2 nd Byte
7	1-C	X-position in ECEF	3 rd Byte
8	1-D	X-position in ECEF	MSB
9	2-A	Y-position in ECEF	LSB
10	2-B	Y-position in ECEF	2 nd Byte
11	2-C	Y-position in ECEF	3 rd Byte
12	2-D	Y-position in ECEF	MSB
13	3-A	Z-position in ECEF	LSB
14	3-B	Z-position in ECEF	2 nd Byte
15	3-C	Z-position in ECEF	3 rd Byte
16	3-D	Z-position in ECEF	MSB
17	4-A	GPS time in seconds	LSB
18	4-B	GPS time in seconds	2 nd Byte
19	4-C	GPS time in seconds	3 rd Byte
20	4-D	GPS time in seconds	MSB
21	C	Checksum	1 Byte
22	L	Linefeed	1 Byte

Data Type:

Long (4 bytes), has been chosen. The limits of position is between -7500Km to 7500Km. The unit in which position is represented is cm. The range of long, which is, 2^31 = 2147483648 mm/s, is adequate to accommodate the required range of position values.

Velocity in ECEF:

3F3FAC051234CL

1 X Velocity in ECEF co-ordinates- Long

2 Y Velocity in ECEF co-ordinates – Long

3 Z Velocity in ECEF co-ordinates – Long

4 GPS time in seconds – Un-singed Long

C Checksum

L Line feed

Byte number	Message Field Name	Description	Status
1	3F	Message Type	1 Byte
2	3F	Message Type	1 Byte
3	05	Message ID	LSB
4	AC	Message ID	MSB
5	1-A	X-Velocity in ECEF	LSB
6	1-B	X-Velocity in ECEF	2 nd Byte
7	1-C	X-Velocity in ECEF	3 rd Byte
8	1-D	X-Velocity in ECEF	MSB
9	2-A	Y-Velocity in ECEF	LSB
10	2-B	Y- Velocity in ECEF	2 nd Byte
11	2-C	Y- Velocity in ECEF	3 rd Byte
12	2-D	Y- Velocity in ECEF	MSB
13	3-A	Z- Velocity in ECEF	LSB
14	3-B	Z- Velocity in ECEF	2 nd Byte
15	3-C	Z- Velocity in ECEF	3 rd Byte
16	3-D	Z- Velocity in ECEF	MSB
17	4-A	GPS time in seconds	LSB
18	4-B	GPS time in seconds	2 nd Byte
19	4-C	GPS time in seconds	3 rd Byte
20	4-D	GPS time in seconds	MSB
21	C	Checksum	1 Byte
22	L	Linefeed	1 Byte

Data Type:

Long (4 bytes), has been chosen. The limits of velocity is between -12,000 m/s to 12000 m/s. The unit in which velocity is represented is mm/s. The range of long, which is, 2^31 = 2147483648 mm/s, is adequate to accommodate the required range of velocity values.

Solution Time:

3F3FAC06123CL

1 Nanosecond

2 Seconds

3 Week Number

C Checksum

L Line feed

Byte number	Message Field Name	Description	Status
1	3F	Message Type	1 Byte
2	3F	Message Type	1 Byte
3	06	Message ID	LSB
4	AC	Message ID	MSB
5	1-A	Nanosecond	LSB
6	1-B	Nanosecond	2 nd Byte
7	1-C	Nanosecond	3 rd Byte
8	1-D	Nanosecond	MSB
9	2-A	Second	LSB
10	2-B	Second	2 nd Byte
11	2-C	Second	3 rd Byte
12	2-D	Second	MSB
13	3-A	Week Number	LSB
14	3-B	Week Number	2 nd Byte
15	3-C	Week Number	3 rd Byte
16	3-D	Week Number	MSB
17	C	Checksum	1 Byte
18	L	Linefeed	1 Byte

Data Type:

The data type that is used for the solution time is unsigned long.

Receiver Status:

3F3FAC08123456CL

1 8-bit SV ID for channel 1 to 4

2 8-bit SV ID for channel 5 to 8

3 8-bit SV ID for channel 9 to 12

4 1 bit ephemeris for channels 1 to 12 + 4 dummy bits

1 bit constel for channels 1 to 12 + 4 dummy bits

5 2 bit Channel Status for channels 1 to 12,

Dummy byte

6 1 bit Almanac flag for channels 1 to 12 + 4 dummy bits,

8 bit Version number,

1 bit GPS_mon flag, 2
bit Pos Mode, 1 bit
Time Sync flag, 2 bit
Almanac avail flag, 1 bit Pos
avail flag, 1 bit GPS
avail flag,

C Checksum

L Line feed

Byte number	Message Field Name	Description	Status
1	3F	Message Type	1 Byte
2	3F	Message Type	1 Byte
3	08	Message ID	LSB
4	AC	Message ID	MSB
5	1-A	SV ID1(Satellite ID from 1 to 32)	LSB
6	1-B	SV ID2	2nd Byte
7	1-C	SV ID3	3rd Byte
8	1-D	SV ID4	MSB
9	2-A	SV ID5	LSB
10	2-B	SV ID6	2nd Byte
11	2-C	SV ID7	3rd Byte
12	2-D	SV ID8	MSB
13	3-A	SV ID9	LSB
14	3-B	SV ID10	2nd Byte
15	3-C	SV ID11	3rd Byte
16	3-D	SV ID12	MSB
17	4-A	1 bit Ephemeris flag for channels 1 to 8 Bit1 corresponds to channel-1 and MS-bit for the 8th Channel. If ephemeris bit is set for any channel, then it means that the satellite has ephemeris.	LSB

18	4-B	1 bit Ephemeris flag for channels 9 to 12 LS bit corresponds to channel-9 and bit4 for the 12th Channel. If ephemeris bit is set for any channel, then it means that the satellite has ephemeris. 4 dummy bits	2nd Byte
19	4-C	1 bit Constel flag for channels 1 to 8 Constel's LS bit corresponds to channel-1 and MS-bit for the 8th Channel. If constel bit is set for any channel, then it means that the satellite is used for Position computation.	3rd Byte
20	4-D	1 bit Constel flag for channels 9 to 12 Constel's LS bit corresponds to channel-9 and bit3 for the 12th Channel. If constel bit is set for any channel, then it means that the satellite is used for Position computation. 4 dummy bits	MSB
21	5-A	2 bits of status for channels 1 to 4 2-bit field for each channel. 00(2nd; 1st) –IDLE 01 –ACQUISITION 10-TRACKING 11 – UNUSED; 1st and 2nd bit corresponds to channel 1;7th and 8th corresponds to channel 4	LSB
22	5-B	2 bits of status for channels 5 to 8 2-bit field for each channel. 00(2nd; 1st) –IDLE 01 –ACQUISITION 10-TRACKING	2nd Byte

		11 – UNUSED; 1st and 2nd bit corresponds to channel 5;7th and 8th corresponds to channel 8	
23	5-C	2 bits of status for channels 9 to 12 2-bit field for each channel. 00(2nd; 1st) –IDLE 01 –ACQUISITION 10-TRACKING 11 – UNUSED; 1st and 2nd bit corresponds to channel 9;7th and 8th corresponds to channel 12	3rd Byte
24	5-D	Dummy byte	MSB
25	6-A	1 bit Almanac flag for channels 1 to 8Almanac Lsbit corresponds to channel-1 and MS-bit for the 8th Channel.	LSB
26	6-B	1 bit Almanac flag for channels 9 to 12/ Almanac Lsbit corresponds to channel-9 and bit3 for the 12th Channel. Dummy (4-bits)	2nd Byte
27	6-C	Version	3rd Byte
28	6-D	1 bit GPS_mon flag(This bit corresponds to the GPS receiver monitoring. This bit continuously toggles, reflecting that the receiver is healthy. This bit can be tapped to check the Hardware integrity at first glance before proceeding further.), 2 bit Pos Mode (00- 3D, this bit is valid only if GPS avail flag bit is set. 01–2D, this bit is valid only if GPS avail flag bit is set. 10- reserved 11- reserved) + 1 bit Time Sync flag(If this bit is set, it indicates that the receiver has computed GPS time.)	MSB

		+ 2 bit Almanac avail flag (The definition of the bits are as follows: 00- Available 01- Unknown 10- Older than six months 11- Almanac Not available) + 1 bit Pos avail flag (This bit corresponds to position estimate available. If this bit is set it indicates that the position estimate is available. Once set it remains high for 90 seconds. When cleared, it means that the estimate is not available.)+ 1 bit GPS avail flag(If this bit is set, it indicates that the GPS position is available. If cleared, it indicates no position)	
29	C	Checksum	1 Byte
30	L	Linefeed	1 Byte

Note: GPS_mon flag can be taken out to say that the receiver is working fine. This bit toggles continuously, reflecting that the receiver health is okay.

SNR:

3F3FAC0A123CL

1 SNR for channels 1 to 4

2 SNR for channels 5 to 8

C Checksum

L Line feed

Byte number	Message Field Name	Description	Status
1	3F	Message Type	1 Byte
2	3F	Message Type	1 Byte
3	0A	Message ID	LSB
4	AC	Message ID	MSB

5	1-A	SNR for channel 1	LSB
6	1-B	SNR for channel 2	2 nd Byte
7	1-C	SNR for channel 3	3 rd Byte
8	1-D	SNR for channel 4	MSB
9	2-A	SNR for channel 5	LSB
10	2-B	SNR for channel 6	2 nd Byte
11	2-C	SNR for channel 7	3 rd Byte
12	2-D	SNR for channel 8	MSB
13	3-A	SNR for channel 9	LSB
14	3-B	SNR for channel 10	2 nd Byte
15	3-C	SNR for channel 11	3 rd Byte
16	3-D	SNR for channel 12	MSB
18	C	Checksum	1 Byte
18	L	Linefeed	1 Byte

Data Type:

The data type that is used for the above is unsigned int and it's units is dB/Hz.

DOP:

3F3FAC0B12CL

1 2 bytes of HDOP and 2 bytes of PDOP

C Checksum

L Line feed

Byte number	Message Field Name	Description	Status
1	3F	Message Type	1 Byte
2	3F	Message Type	1 Byte
3	0B	Message ID	LSB
4	AC	Message ID	MSB
5	1-A	HDOP	LSB
6	1-B	HDOP	MSB
7	1-C	PDOP	LSB
8	1-D	PDOP	MSB
9	2-A	Gps second	LSB
10	2-B	Gps second	2ND Byte
11	2-C	Gps second	3rd Byte

12	2-D	Gps second	MSB
13	C	Checksum	1 Byte
14	L	Linefeed	1 Byte

Data Type:

The data types for HDOP and PDOP is unsigned int and for GPS second it is unsigned long.

Geodetic Position:

3F3FAC0E1234CL

Byte number	Message Field Name	Description	Status
1	3F	Message Type	1 Byte
2	3F	Message Type	1 Byte
3	0E	Message ID	LSB
4	AC	Message ID	MSB
5	1-A	GPS time of week (SECOND)	LSB
6	1-B	GPS time of week (SECOND)	2nd Byte
7	1-C	GPS time of week (SECOND)	3rd Byte
8	1-D	GPS time of week (SECOND)	MSB
9	2-A	Latitude	LSB
10	2-B	Latitude	2nd Byte
11	2-C	Latitude	3rd Byte
12	2-D	Latitude	MSB
13	3-A	Longitude	LSB
14	3-B	Longitude	2nd Byte
15	3-C	Longitude	3rd Byte
16	3-D	Longitude	MSB
17	4-A	Altitude	LSB
18	4-B	Altitude	2nd Byte
19	4-C	Altitude	3rd Byte
20	4-D	Altitude	MSB
21	C	Checksum	1 Byte
22	L	Linefeed	1 Byte

Data Type:

The data types for latitude, longitude and altitude is long and for GPS time of week (second) it is unsigned long. Latitude and longitude, the units is degrees and altitude is meters. Latitude and longitude is scaled by 1e7. Altitude is scaled by 1e2 and it's units is meters.

Time and Date Message:

3F3FAC0F1234567CL

Byte number	Message Field Name	Description	Status
1	3F	Message Type	1 Byte
2	3F	Message Type	1 Byte
3	0F	Message ID	LSB
4	AC	Message ID	MSB
5	1	Hours	LSB
6	2	Minutes	2nd Byte
7	3	Seconds	3rd Byte
8	4	Date	MSB
9	5	Month	LSB
10	6	Year (LSB)	2nd Byte
11	7	Year (MSB)	3rd Byte
12	C	Checksum	1 Byte
13	L	Linefeed	1 Byte

Data Type:

The data type is unsigned long