

Wind Profile Estimation Using a TIDGET™ Payload on Weather Balloons

Amir Matini, Alison Brown, and James LaMance

NAVSYS Corporation
14960 Woodcarver Road
Colorado Springs, CO 80921
719-481-4877 Fax 719-481-9042

BIOGRAPHIES

Amir Matini

Amir Matini is a member of the NAVSYS technical staff. His responsibilities include design and development of antenna, RF, and microwave systems for GPS applications. He is also responsible for the resolution of electromagnetic compatibility and electromagnetic interference problems. Mr. Matini received his BSEE and MSEE degrees from the University of Colorado at Colorado Springs and is continuing studies towards a PhD. His research interests include electromagnetic thermography, antennas, RF and microwave circuits.

Alison Brown

Alison Brown is the President of NAVSYS Corporation, which specializes in developing GPS customized products and services. Dr. Brown has over 15 years experience in GPS receiver design and has seven GPS related patents. She has published numerous papers on GPS applications and is on the editorial board for *GPS World* and *GIS World* magazines. She is currently on the ION Council and is a member of the USAF Scientific Advisory Board. Dr. Brown received her BA and MA in Engineering from Cambridge University, an MS from MIT, and a PhD from UCLA.

James LaMance

James LaMance is a Senior Engineer at NAVSYS Corporation, where he is involved with GPS navigation systems design and analysis. Dr. LaMance has worked in the areas of GPS, remote sensing, and orbit determination for the past six years. Dr. LaMance holds a PhD and MS in Aerospace Engineering from the University of Colorado at Boulder, and a BS in Aerospace Engineering from Auburn University, Auburn, AL.

ABSTRACT

Wind profile data is collected at ranges prior to the launch of high dynamic vehicles as a safety measure and to insure navigation accuracy. To date, radars have been the primary source for range wind profile information, using weather balloons to carry a reflector kite which is tracked with a radar system. Usually several balloons are released in variable time intervals prior to the launch of every vehicle. The data collected is analyzed for wind velocity. This information is then programmed into the control and navigation system of the vehicle for appropriate navigation corrections.

The main problem to this approach is the high cost associated with maintenance and operation of high resolution radar systems. Another problem is that as the balloon travels farther away from the radar, the range and direction measured become less accurate. Also, since the velocity measurements are made based on time intervals and distances between fixes, this exaggerates the error in the wind profile data.

An alternative to radar tracking is to use a low cost GPS sensor on the balloon payload. The TIDGET™ tracking system developed by NAVSYS is less costly than radar and provides measurements of the balloon position and wind-speed in real-time. In addition, the accuracy of this system is generally better than radar. This paper compares test data taken using TIDGET and radar data from wind profiling at the Kauai Test Facility of Sandia National Laboratories.

OVERVIEW

The TIDGET Windsonde tracking system is a GPS translator based system capable of generating position and velocity information in near real-time. The system

provides instantaneous velocity measurements rather than differencing the position between two fixes over the traveled time. Figure 1 shows a block diagram of the TIDGET Windsonde tracking system.

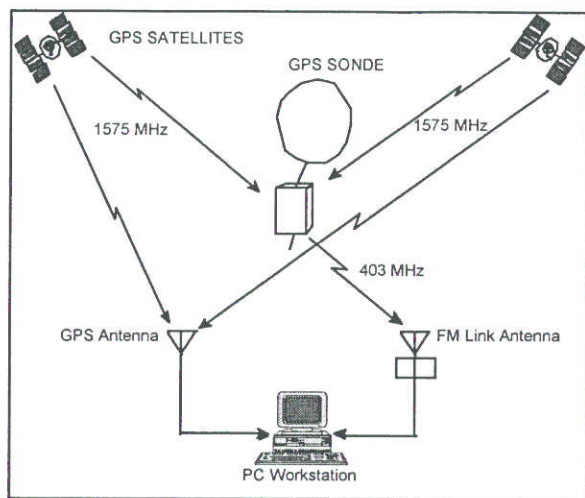


Figure 1 TIDGET Windsonde System

The TIDGET GPS sensor includes fewer components than a GPS receiver card, which results in a smaller package size, lower power consumption, and lower cost in volume. The digitized GPS data provided by the TIDGET sensor is FM modulated and transmitted to the ground processing station. The system uses the 400 MHz frequency range already allocated to the meteorological applications for data transition. The ground processing station uses internally generated differential correction for greater accuracy. The preparation of the sensor prior to release is minimal and no calibration is required. The TIDGET tracking system is a PC based system and is enclosed in a rugged and compact housing. A photo of the ground processing system is shown in Figure 2. The wind profile information is available for display on the monitor, or as an output through a serial port, or can be logged to disk.

SYSTEM ARCHITECTURE

The system consists of an airborne segment (TIDGET windsonde) and a ground station processing segment which is a PC based system.

TIDGET Windsonde: The TIDGET sensor is a digital GPS translator with a small physical size (less than 6 cu.in. including the GPS antenna). A block diagram of the TIDGET windsonde is illustrated in Figure 3. The TIDGET sensor operates at the L1 frequency and can be programmed to automatically output periodic data packets.

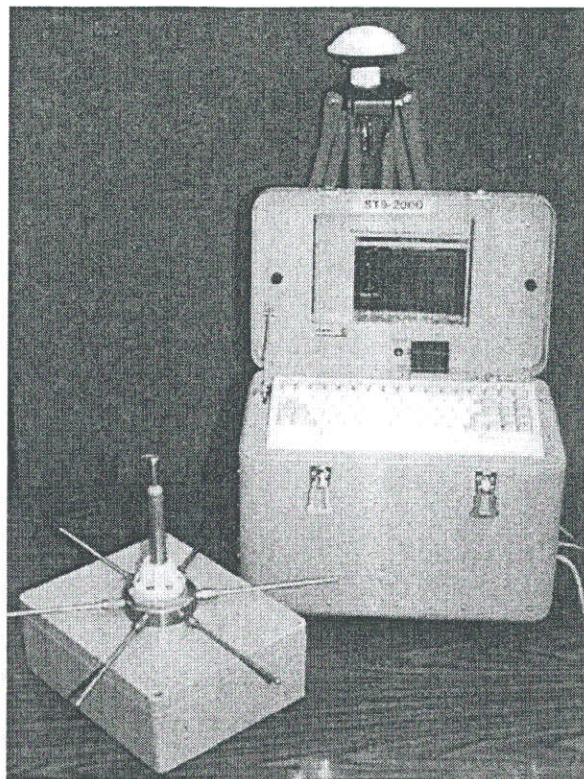


Figure 2 TIDGET Processing Station

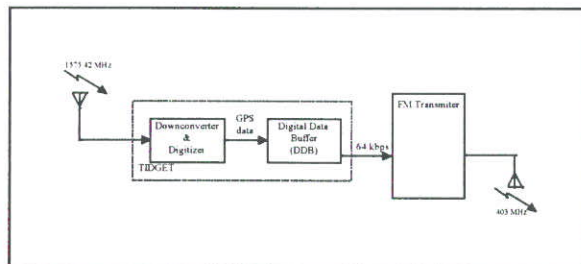


Figure 3 TIDGET Windsonde Block Diagram

The transmitted data is in the form of packets. Each packet contains a snapshot of the raw GPS data plus other information. The TIDGET also has a 16 channel multiplexing capability which allows it to include optional sensor data in each packet. Although the TIDGET default output data bit rate is set to 64 kbps, it may be programmed from 200 Hz to 2 MHz using an EEPROM. The TIDGET is interfaced to a FM transmitter for data modulation and downlink over the 400 MHz meteorological bandwidth of the frequency spectrum.

TIDGET Workstation: The TIDGET workstation is a portable PC which interfaces to two antenna modules, one for the GPS reference receiver, and one for the 403 MHz FM link.