3 Prototype Design

In order to demonstrate the feasibility of the glidersonde concept and to test the navigation and control systems, several prototype airframes were constructed. During the prototype stage of this project, concern with high wind speeds was minimal so the philosophy used to design the prototype was encompassed in the following criteria:

1) Ease and quickness of construction
2) Ample room for prototype electronics
3) Ability to use an engine to achieve altitude(rather than a balloon)

3.1 Airframe design

The prototype design in shown in Figure 3-1.

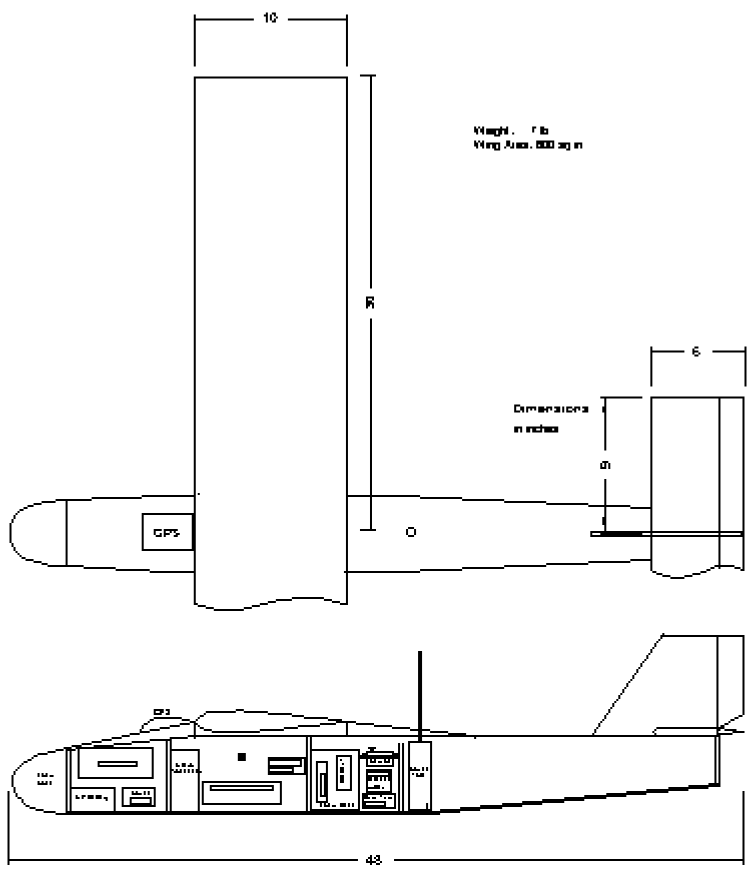

Figure 3-1 Prototype Glidersonde Configuration

The prototype wing consisted of 1.0 lb/cu ft foam hot-wired to a NACA 0012 airfoil and covered with a very thin foam-board coated with a Mylar film. A dihedral of two deg was constructed into each wing half. The center section was braced with high-density balsa (8-10 lb/cu ft) and covered with fiberglass cloth and epoxy resin for additional strength. A wing span of 60 in and a wing chord of 10 in was chosen for the prototype to maintain relatively slow airspeeds for testing purposes.

The prototype fuselage had a rectangular cross section with slab sides constructed of lightweight plywood (2.5 mm thickness), an aircraft-plywood firewall, and balsa-wood formers behind the firewall. The bottom of the fuselage was also light-plywood. The top hatches were constructed of balsa wood. The horizontal and vertical stabilizers were typical model airplane slab construction.

For engine powered tests, a 0.45 cu in model airplane two-cycle engine was mounted on the firewall in place of the foam nose shown in the figure. A 4-oz fuel tank was placed in the compartment immediately behind the firewall.

The overall weight of the prototype with all of the equipment listed in Table 4-1 (except for the parachute, which was not used in the prototype,) was 7 lb or 3.1 kg. With the engine on the front, the weight was about 0.5 lb or 227 gm higher. The engine-powered version was hand-launched and had sufficient power to climb at about five feet/second. When the prototype was launched on a helium balloon, the ascent rate was slightly greater than 20 ft/second (7 m/sec) on a full tank (6 cubic m) of helium.

A component not shown in Figure 3-1 is a release mechanism for attaching the balloon to the Glidersonde. This small mechanical device captures a J-shaped metal hook inserted into it and, when actuated, releases the hook. The hook was tied to the balloon via a 3-mm diameter nylon cord about a meter long. The release mechanism was actuated with a servo (balloon release servo) placed in the fuselage just behind the wing.

A burndown timer, located in the glider fuselage, was electrically connected through a pullout connector to a short length of nichrome wire wrapped around the nylon cord to provide a backup release system in the event the other release systems failed. Although it was never needed because the computer actuated or the RC release mechanisms did not fail, it was used as a backup on the higher altitude flights.

3.2 Dual Control System

To allow testing of the navigation system, a dual control system was implemented into the prototype Glidersonde. This dual-control system allowed a ground-based pilot to either fly the aircraft by a radio control transmitter-receiver combination or to turn over the flying to the navigation computer. To accomplish this, two extra channels on the RC transmitter were used to actuate custom designed switches that would direct the appropriate PWM signals from either the RC receiver or from the on-board computer. A block diagram of one of these switches in shown in Figure 3-2.

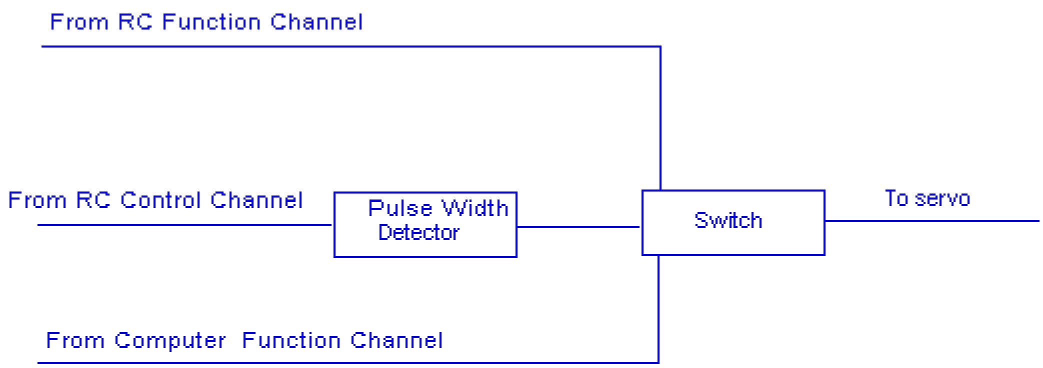

Figure 3-2 Control Function Switch

The RC transmitter was used to control the Glidersonde elevator (and engine, when used) during the whole flight. The rudder and the balloon-release functions could be switched during flight. On the earlier flights, when the navigation code was being debugged, the switching function was very effective in saving the aircraft from disaster. The rudder control was also used to land the glider in the absence of a parachute recovery system.

3.3 Telemetry System

A telemetry system was also incorporated into the prototype Glidersonde. The function of the telemetry system was to transmit GPS data to the ground to assist in the debugging phase of the navigation software/hardware and later to allow the tracking of the Glidersonde when it was out of sight in the higher altitude flight tests.

A diagram of the telemetry system is shown in Figure 3-3. The telemetry encoder receives the GPS sentence, reformats it, encodes it into a packet, and sends it to the transmitter once a second. At the same time, several analog signals from the computer system are digitized and sent in the same packet. The analog signals are pressure altitude from an absolute pressure sensor in the navigation system, processor battery voltage, and telemetry battery voltage. The airborne transmitter produces about 0.5 watts at 146 MHz.

The ground station used a conventional FM receiver and packet decoder, which disassembled the information and sent it to a laptop computer via serial communications port. Windows based program was written to read the telemetry data and to plot a plan view of the flight and the display the Glidersonde altitude and other relevant flight data. All of this data was saved in a disk file for further post-flight analysis.

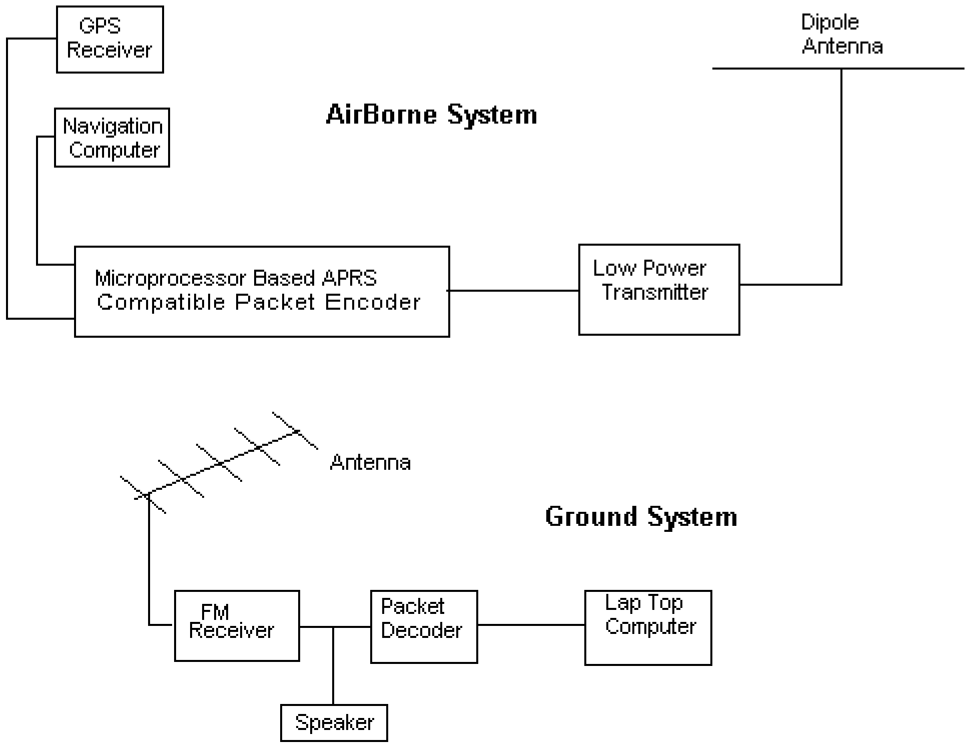

Figure 3-3 Telemetry System Used in the Glidersonde

Figure 3-4 on the following page shows an example of the display of the Glidersonde Data Capture program. This is a screen capture of a replay of the flight but the same screen is seen in real-time as the flight is in progress. The instantaneous position of the glider is indicated by the X and the line emanating in front of the X is the instantaneous heading of the craft. The text display at the left shows the current altitude, the max altitude on this flight and other relevant data. In this particular flight, the balloon release at 7650 ft at the point indicated in figure 3-4. The drop and the turn around can be clearly seen on the display. At the time of this display, the glider was at 4710 ft and had executed its first turn after arriving back home. It continued to fly in circles around home until it reached a lower altitude and was landed by the pilot.

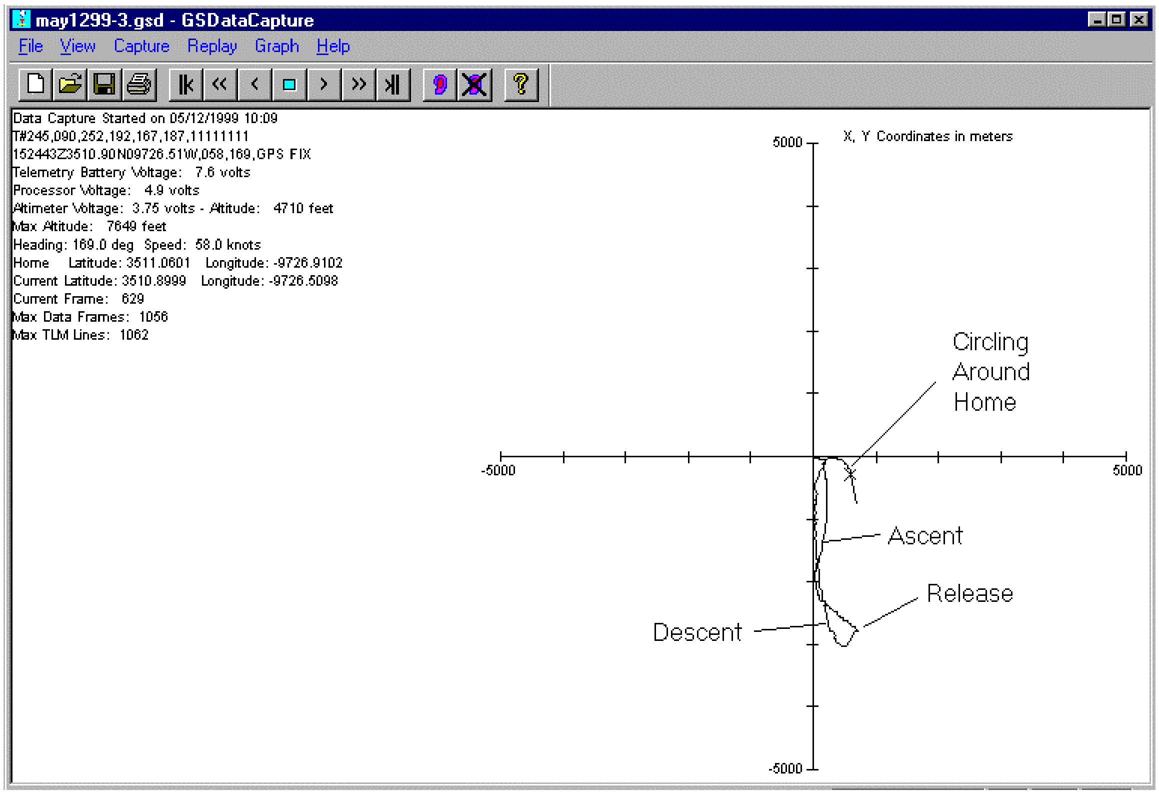

Figure 3-4 Screen Capture of the Glidersonde Data Capture Display