



High Altitude Photographic Balloon (HAPB)

Hitchhiker Program

HAPB is an unmanned high altitude balloon designed to be launched, tracked, take photographs of the curvature of the Earth, perform various high altitude experiments, and be recovered. HAPB currently operates under the exempt rules of FAA Part 101 subpart “a” governing unmanned balloon flight and flies to altitudes above 90,000 feet. HAPB has been setup to accommodate additional experiments referred to as a “hitchhikers” and is designed to promote earth sciences, mathematics, and engineering by utilizing shared resources.

The fundamental principle behind the concept of a hitchhiker is to use shared computer resources for individual experiments while primary mission objectives and flight operations are in progress. The optimal hitchhiker would utilize the multi-processor based Propeller designed by Parallax where Cogs, code space, and power are provided to participants. A Propeller based application is not required to be eligible for the program. Any PIC based microcontroller may be used as long as it meets the standards as defined in the PCB requirement sections of this document. Experiments that do not require power are also eligible to participate in the program.

The Hitchhiker Program is open to individuals, schools, and organizations that wish to conduct upper atmospheric experiments without the expense of developing their own balloon launching, tracking, and recovery system for small lightweight payloads.

Qualifications

To qualify as a hitchhiker and get a free ride into near space, applicants must submit a description of the project. The subject line should read “Hitchhiker Program”.

The description must include:

- Your name and contact information.
- If you are interested in getting involved in flight operations and ground tracking which are described in the Flight operation section of this document.
- Identify which type of allocated resources will be used.

- Description of the experiment.
- A statement that you have read and understood the limitation of available resources and capsule space.
- A statement declaring that while you understand that every effort will be made to recover the payloads there is no guarantee of recovery and we are not liable for loss or damage of your experiment.

Submit project by email to earl@hapb.net. Selected participants are responsible for engineering experiments and associated costs. You will be notified at least 4 weeks in advance if your project is selected.

Only 2 hitchhikers are selected per flight. Flight dates are tentative and based on seasonal weather patterns, upper winds, and flight predictions. Flights usually occur from May to October and are launched from Lake Whitney State Park, Whitney, Texas. A minimum of 2 flights will be flown per year. Additional flights may occur depending on funding.

Experiment Guidelines

Restrictions

It is important to understand that HAPB currently operates under exempt status of the FAA for unmanned balloons. Adherence to weight and size limitations are strictly enforced. Experiments that could potentially cause harm to others will not be allowed.

Additional:

- No animals or insects are allowed.
- Objects may not be dropped from the capsule.
- Experiment payload limited to 0.5 lbs including PCB.
- Inside capsule space is limited to 3" x 3" x 3" for each hitchhiker, excluding PCB.
- Probes for experiments requiring contact with outside atmospheric conditions are permitted and do not count against the inside capsule space. Weight limitations do apply.
- External experiments must be able to be easily and securely attached to the main capsule by using simple fasteners such as tape or screws. Placement of external devices is at the discretion of the program director.

Any deviation will result in a "Hold Status" of hitchhiker flight until the discrepancy is fixed or resolved. If the deviation can not be fixed hitchhiker status will be revoked and reassigned to another participant.

Suggestions

Experiments can be as simple as launching seeds to determine the effects of exposure to space-like conditions on their growth or more complicated such as measuring greenhouse gases. Simple weather stations can be used to measure

temperature, humidity, and pressure. Radiation and light intensity can be measured and recorded at the different altitudes. There are numerous experiments that can be performed based on the type of equipment used and the next section describes the provided resources that the Hitchhiker Program provides to help your experiments succeed.

Provided Resources

HAPB is a Propeller based platform using 6 Cogs to perform flight operations and primary mission objectives. Participants have the option of using a subset of available resources from the platform, their own PIC based microcontroller, or non microcontroller projects. Available resources are outlined in this section and are based on the type of project selected.

Propeller Projects

- Capsule space
- Supported languages
 - Spin
 - Assembly
- Code space limited to 2000 longs
- 2 Cogs(One shared one independent)
 - The shared Cog (processor) runs in serial fashion
 - The independent Cog is your main program processor running in parallel with other Cogs
- 2 general purpose I/O pins
 - Can not to exceed 20 mA
 - Can not exceed 35 mA source/sink total for the pair at once
- 1 GPS I/O PIN (RX Only)
 - GPRMC
 - GPGGA
 - GPGSV
 - PGRME
 - PGRMB
- Power supply: 5vDC@ 300ma
- Access to NMEA 0183 GGA stored data during flight through the use of variable calls
- Post flight data

PIC Based or Electronic Projects

- Capsule space
- Power supply: 5vDC@ 300ma
- 1 GPS I/O PIN (RX Only)
 - GPRMC
 - GPGGA
 - GPGSV
 - PGRME

- PGRMB
- Post flight data

Un-powered Projects

- Capsule space
- Post flight data

Propeller based experiments must be delivered 2 weeks prior to scheduled launch for integration testing. All other experiments must arrive at least 1 week prior to launch.

PCB Requirements

Participants may elect to etch their own PCB. Two types of PCBs are available for experiments; a small PCB (figure 1) and a larger 6"x4" PCB (figure 2). PCBs and electronics count against weight restrictions. Connector J1 may be excluded if no resources will be used from the main computer.

For single sided PCBs electronics must not stick up higher than 1 inch. If a double sided PCB is used, in addition to the above restriction the underside must not stick out further than 3/8". External connections to off-board devices should be made at 90 degrees. The Hitchhiker PCB blank template files are also available for download in ExpressPCB format.

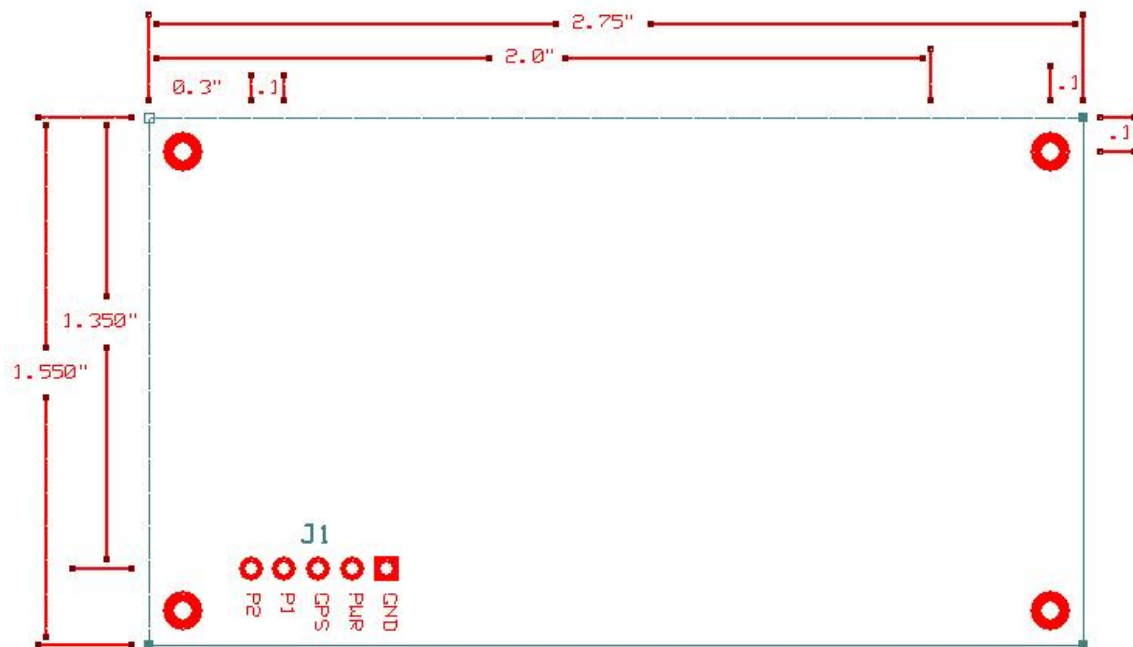


Figure 1- Small PCB

Connector J1 is used to connect to the main computer. Pins 1 and 2 provide 5vDC power and ground. Pin 3 is used for receiving GPS data. Pins 4 and 5 are general purpose I/O connectors from the main computer and are reserved for

Propeller users. A Molex 0.1" KK 5-Pin 90 degree style connector with the contact (long) pins facing out is required for proper connectivity.



Figure 2 – Large PCB

DO NOT install connector J1 unless you have the approved connector. To ensure proper connectivity, the participant can request the Hitchhiker Program to add connector J1 to the PCB at no charge. In addition, each corner will require a 1/8" thru hole placed 0.1" centered from corners for the small PCB and 0.25" centered from corners for the larger PCB. These thru holes allow for stacking of hitchhikers boards and should not be used as a ground.

For a fee of \$25.00 (small PCB) or \$35.00 (large PCB) plus shipping, participants may also elect to obtain an etched, single sided PCB through this program. Trace lines may not be less than 0.020" thick and PCB must be in ExpressPCB format. The Hitchhiker Program will etch your layout, provide connector J1 and drill corner mounting holes. The PCB layout is assumed to be correct upon submission. Participants are required to do their own artwork and are responsible for the electrical accuracy. Component drilling, placement, and soldering of electronics are the responsibility of the participants.

Flight Operations

Pre-Flight operations consist of performing daily path prediction starting 14 days before the scheduled flight, tracking weather patterns in the launch area and

predicted landing zones, and reviewing Notice to Airman (NOTAMS) for any aircraft restrictions in the area.

During the final 24 hour period system checks are performed, data markers are zeroed, payload files are reset, batteries are replaced, helium is obtained, and supplies are loaded into the tracking vehicle(s). Path predictions and weather checks are increased to 3 hour intervals during this period with the final “Go-No-Go” decision made based on the last available report.

The final 2 hour period is used for setting up the launch site, going through Pre-Flight and Capsule Closeout Procedures, and filling the balloon.

Immediately after balloon release, the launch area is cleaned up and mobile trackers begin recovery operations. Remote ground tracking stations can usually begin tracking the payload online when the balloon reaches an altitude of 2000 feet.

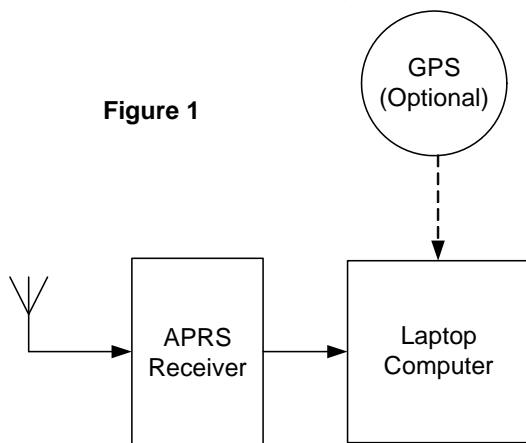
Ground Tracking Stations

Participants may also get directly involved in flight operations as trackers. The Hitchhiker Program uses the call sign KE5HDN-11 on amateur radio frequency 144.39MHz for APRS tracking and 147.38 for flight operation. Amateur radio license (HAM license) is required to talk to flight operations, however, a license is not required to listen or track.

Ground tracking stations are used for real-time or near real-time tracking during flight operations. The most common types of ground tracking include mobile, remote, and spotters. Mobile tracking stations, also known as Chase Vehicles, are used for chase and recovery of the payload. Remote tracking stations monitor and collect data. Spotters visually track the payload and can be mobile or remote. The roles and responsibilities of ground tracking can be divided among several teams or consolidated to a few individuals depending on available resources and personnel.

Mobile Tracker

Mobile tracking stations are used to chase and recover the payload and are typically equipped with an APRS receiver, cell phone, HAM radio, GPS, and a laptop computer running appropriate mapping software as shown in figure 1.



The APRS receiver can be any type of radio that can process APRS data packets or a radio that can connect to a TNC that can process APRS data packets. A HAM license is not required for receiving data packets.

The Kenwood TM-D710A mobile radio is used in the primary chase vehicle as the receiver with its built in Terminal Node Controller (TNC). This is a dual band transceiver. The dual band allows APRS data to be capture to a computer on one band while providing a second band for ground communications with other stations. Use of the second band to transmit requires a licensed HAM operator to be present in the chase vehicle.

A cell phone and/or HAM radio is used to communicate with other tracking stations. Updates of the current status are provided to team members. If numerous tracking stations are used, communications are coordinated via a designated central command station. All tracking stations report their status and provide updates to the coordinator who in turn directs tracking activities to ensure proper team member placement and performance of duties during flight ops.

The optional GPS performs several functions during flight operations. The driver of the chase vehicle uses the GPS to determine best possible route to the predicted and actual landing site. This increases the chance of being present when the payload lands and prevents getting lost in rural areas. The same GPS is also connected to a laptop computer running tracking software allowing the team to quickly determine their location with respect to the payload. The computer is connected directly to the APRS receiver allowing the tracker to record incoming data directly to a file and provide visual indication of the payload in real-time.

The chase vehicle also carries a handheld GPS that is used by the trackers if the payload has landed where there are no roads available to the recovery site.

Remote Tracker

Remote trackers can use a computer connected to the Internet. No radio or APRS devices are required. There are numerous free software packages available for tracking. Two of most popular packages are from FINDU.COM and Google Map APRS which provide near real-time tracking capabilities and data acquisition. Both applications run online and do not require installation on your computer.

Google Map APRS is the recommended online program which provides additional services that are unique. Google Map receives APRS packet information from HAM radio Internet gateways (I-Gates) and automatically updates the map with the balloon tracks. A web link is provided on the HAPB website that will direct the participants to the tracking site. Raw packet data is available online for up to 24 hours and can be retrieved by the team during or after recovery operations.

Spotters

Spotters are individuals who are not assigned to monitoring computer screens, collect data, or coordinate activities. Their duty is to scan the skies and look for the payload. Payloads can be seen at extreme altitudes without the aide of optics depending on sky conditions. Spotters should bring binoculars to help them locate the payload.

Data Acquisition

HAPB In-flight primary mission is to photograph and video the earth. Photographs are taken every 20 seconds. Digital video is captured throughout the flight. GPS GGA data is recorded every 4 seconds providing over 3000 data points for analyzes. Additional independent GPS data such as bearing, horizontal and vertical velocity, inside capsule temperature, and power supply voltage are also collected.

GPS Data Format

The main computer captures NMEA0183 sentences using the standard GGA format and is provided here for reference.

Global Positioning System Fix Data (GGA)

\$GPGGA,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,M,<10>,M,<11>,<12>,*hh,<CR>,<LF>

- <1> UTC time of position fix, hhmmss format
- <2> Latitude, ddm.ddd format (leading zeros transmitted)
- <3> Latitude hemisphere, N or S
- <4> Longitude, dddmm.mmm format (leading zeros transmitted)
- <5> Longitude hemisphere, E or W
- <6> GPS quality indication
 - 0: Fix not available
 - 1: Non-differential GPS fix available
 - 2: Differential GPS (DGPS) fix available
 - 6: Estimated
- <7> Number of satellites in use, 00 to 12 (leading zeros transmitted)
- <8> Horizontal dilution of precision, 0.5 to 99.9
- <9> Antenna height above/below mean sea level, -9999.9 to 99999.9 meters
- <10> Geoidal height, -999.9 to 9999.9 meters
- <11> Differential GPS (RTCM SC-104) data age, number of seconds since last valid RTCM transmission (null if not an RTCM DGPS fix)
- <12> Differential Reference Station ID, 0000 to 1023 (leading zeros transmitted, null if not RTCM DGPS fix)

Example

\$GPGGA,131400,3255.6723,N,09635.9902,W,1,06,1.4,168.6,M,-27.8,M,,*77

Post Flight

High altitude unmanned ballooning is a fun, challenging, and learning activity that can provide valuable insights into our planet. Upper atmospheric conditions are extremely hostile with temperatures at -60 degrees Fahrenheit and no breathable air. Payloads can reach speeds of over 100 mph during flight and are at the mercy of the upper winds. Landing sites vary with the terrain and capsules have been retrieved from cow pastures to reservoirs.

Post flight information will be made available within 1 week of the recovery. Photographs, video, and raw data will be transferred to a DVD and sent to the participants along with their experiment.

Participants are asked to provide a post flight write-up describing the results of their experiments for our webpage. You may also provide a link to your website where your information can be found.