TerraMICRO
Mission Success Criteria and System Requirements

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I. Introduction

High Altitude Balloons (HABs) are a low-cost, relatively low-risk vehicles that are a perfect platform for conducting small scale atmospheric studies, remote sensing, and other experiments that make use of the "edge of space" conditions found at altitudes in excess of 65,000 feet above sea level. Atmospheric conditions in the stratosphere are fairly well understood insofar as the humidity, temperatures, and pressures that must be weathered by a flight platform. More specifically, ambient temperatures and pressures between 65,000–100,000 feet altitude see extremes of -60° C and 0.05 atm respectively.

This opens the door to opportunities for generic or payload-agnostic HAB platforms designed to carry an experiment or instruments in conditions that approximate space. One such platform is an avionics architecture called μHAB, which is designed specifically to be a robust and all-inclusive avionics package for HAB vehicles. The Technology Readiness Level of μHAB is TRL 2.

TerraMICRO is a high altitude balloon technology demonstration mission. The key objectives of this mission are to validate the new μHAB avionics architecture, experiment with core technologies which enable long duration flights, and collect high quality images from high altitudes. As a technology demonstrator, TerraMICRO flight systems are intended to be used on future HAB systems. TerraMICRO systems are designed to be generic in order to support any future mission. TerraHAB has selected long duration flights as a target for future missions, and as such many of the systems beyond the core avionics are building blocks toward this goal. At the time of launch, μHAB should be TRL 3, and upon the successful completion of the TerraMICRO mission this architecture will be TRL 5.

This document shall list and describe all mission requirements and their criteria for success, all system requirements and their criteria for performance, and (when applicable) methods by which the aforementioned requiremnts shall be evaluated. The intent of this specification is to quantify and control the criteria by which mission success is defined, and to provide traceability to each subsystem's performance to ensure mission success is achieved by the vehicle's design.

II. Mission Requirements

A. Critical Design Requirements

Regardless of the mission objectives, the HAB system must meet several key design requirements in order to achieve mission success. These requirements serve as success criteria and also as constraints to the design trade space. These criteria stem from federal regulations for unmanned free balloons and other basic functions to ensure a safe, controlled flight.

The flight vehicle must include multiple independent cut-down mechanisms.

The flight vehicle must have at least one redundant system capable of transmitting its coordinates to ground control.

The flight vehicle must remain powered-on and airborne for at least 3 hours.

The flight vehicle must have a total mass of no more than 2.72 kg (6 lbs).

The objectives listed in Table 1 provide the basis for TerraHAB's criteria for success and drive all other mission requirements. These objectives steer the vision and end goals for the mission and every subsystem or feature in the end result should support at least one of these objectives.

There are several design features that are specific requests from TerraHAB engineers. The flight system should meet these requests or provide justification for not including them. These features are not required for mission success as defined in Table 1, but it is expected that the TerraHAB team strives to accomplish these goals. These objectives are listed in Table 2.

Table 1 Engineering & Technology Objectives

In-Flight Balloon Monitoring	A system will be able to monitor the temperature and pressure within a balloon and report that back to the HAB payload.
µHAB Avionics Platform	Flight test µHAB as a flexible, expandable, and cost-effective platform to support many different mission profiles or payloads with all of the basics for a HAB launch included out of the box.
Open-Loop Altitude Regulation	Limit maximum altitude and rate of ascent by the controlled release of helium during flight to prolong the mission duration. Maintain 75,000 feet altitude for at least 30 minutes.
HD On-Board Video	Horizon-looking full color video at 1080p30 fps or better (1080p60fps or 4K30fps preferred).
Video Capture of Balloon Burst	Capture the balloon burst event with minimum resolution of 720p60fps or better. (720p@120fps or 1080p@120fps preferred)

Table 2 Stretch Goals & Desired Features

"Remove Before Flight" Pins	Include externally accessible remove before flight pins to safe or disarm subsystems while on the ground, such as a power pin (included in µHAB), a startup sequence pin, a launch pin, and so on.
Status Inticators & Displays	Include displays and self-test and status check codes to ensure that the balloon is stable and behaving nominally during testing, integration, and preparation for flight.
Simple Balloon Filling	Simple and clear procedures during flight preparations, including a quick-disconnect from helium fill plumbing.
Vegetation Density Experiment	Use NDVI with a commercially available RGB (VNIR) camera to estimate vegetation density from images in real time during flight. Minimum video quality 480p30fps.

III. System Requirements

All of the systems demonstrated by this mission shall be thoroughly tested on the ground prior to launch. Flight data and telemetry recorded during the flight should be consistent with behavior observed during testing.

A. Avionics & Telemetry

B. Bus & Recovery

C. Altitude Regulation