Instrumentation of UAV for 6-DOF Modeling

Quarterly Review of the NASA/FAA Joint University Program for Air Transportation Research

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Introduction

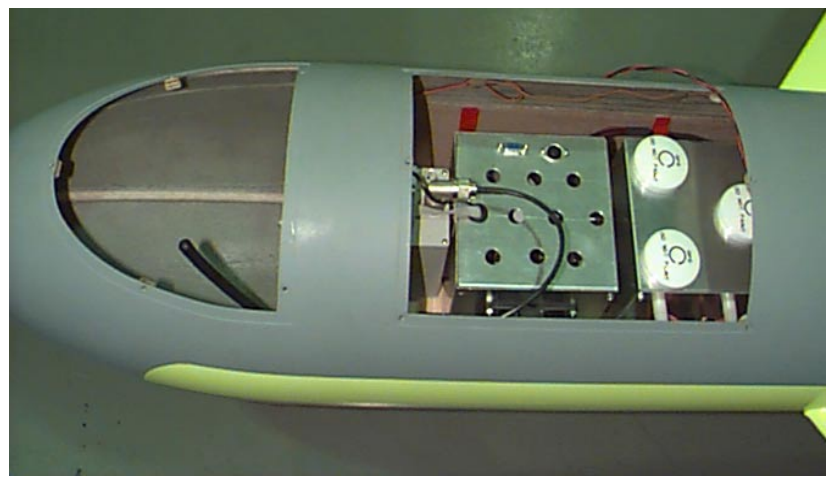
- Brumby Aircraft Specifications
- Past and Future Projects
- Instrumentation for 6 DOF Modeling
- Development Path

Brumby Specifications

- Delta Wing Aircraft
- Wing Span (8.27 ft)
- Dual Fins
- Fuselage Length (6.46 ft)
- Payload Weight <= 17.6 lbs
- Air Speed > 100 Knots (40 – 60 min.)
- Pusher Propeller Configuration (7.2 hp)
- Fiberglass Composite Fuselage
- 10 Channel Radio Control Receiver
- Take Off and Land from Grass or Paved Surfaces

Short Base Line GPS Attitude Determiation

- Conducted By Matt Harris and Dr. Dan Aloi
- 3 Marconi Allstar GPS Receivers

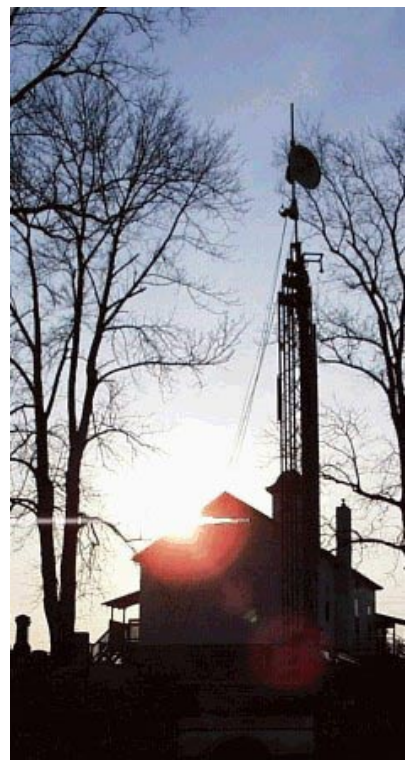


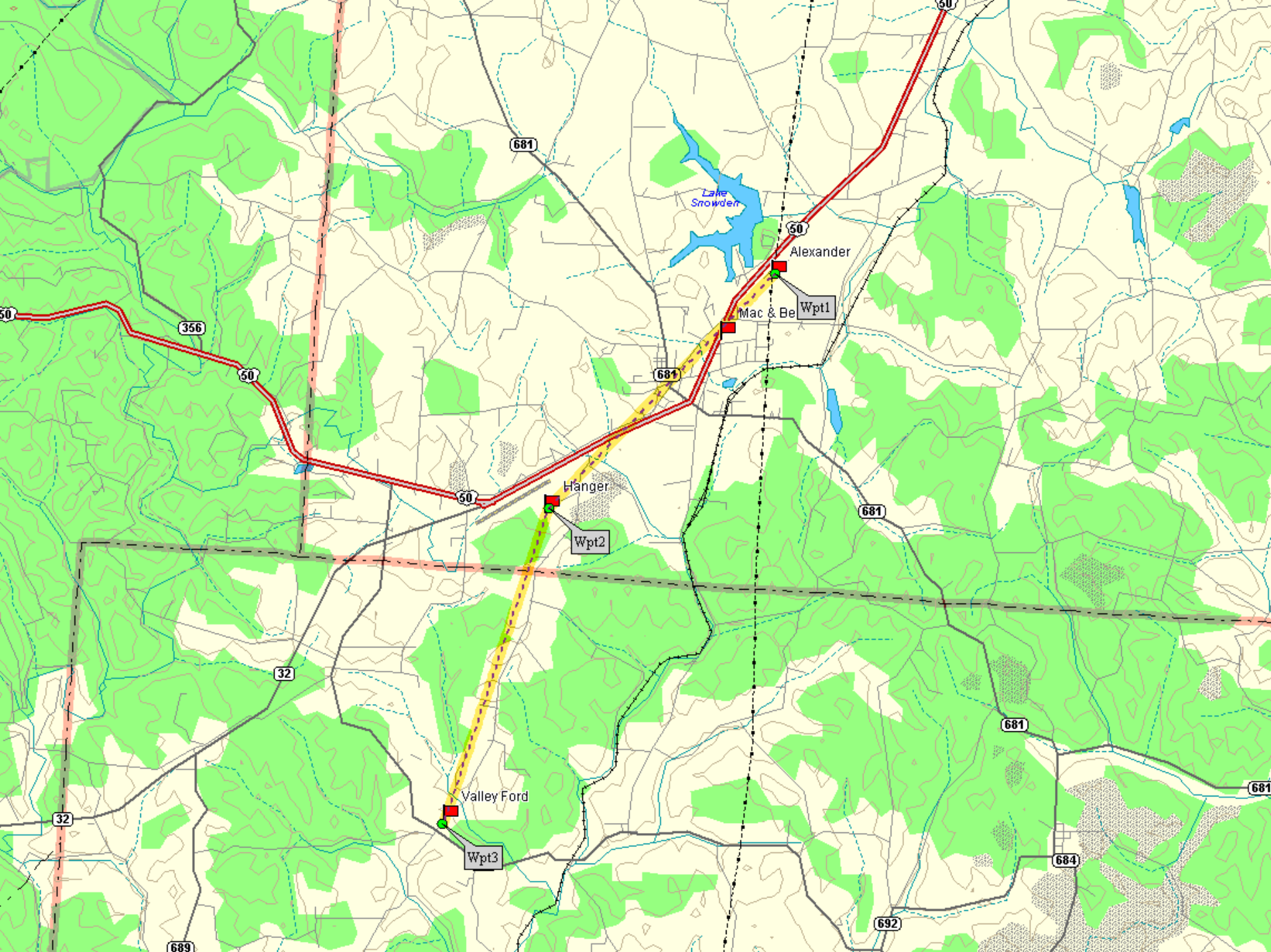
Digital Divide Goals

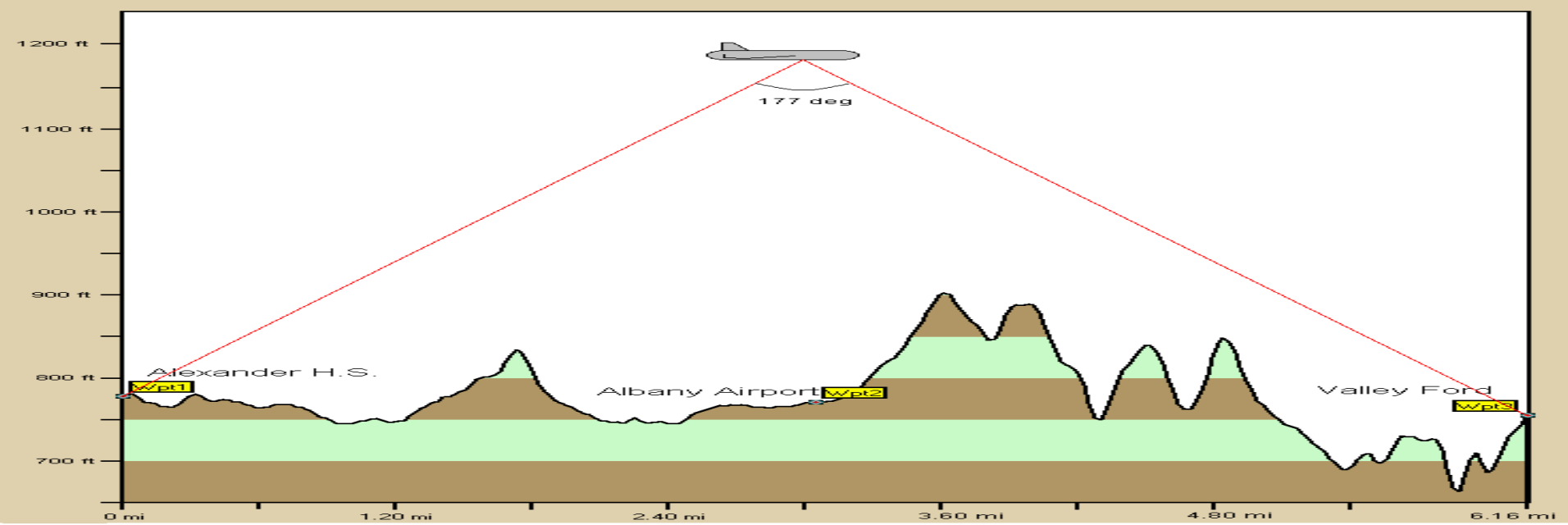
- For Service in Areas where the Subscribers are Separated by > 1 km.
- Service
  - » Single Subscribers: DSL Equivalent (500 kbps into the service, 2-4Mbps from the network to the subscriber)
  - » Businesses: 25-50 Mbps, Symmetrically.
- Use of Spot Beams
  - » Frequency reuse
  - » Scaling and Adaptability

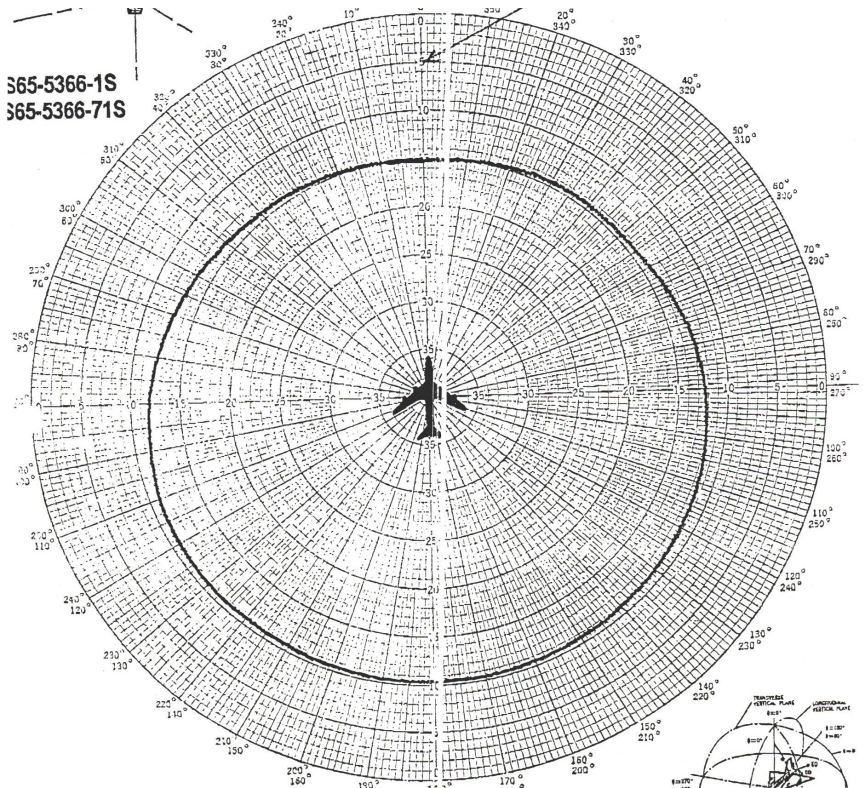
Possible Platforms

Digital Divide Datalink Demonstration




Lake Snowden
Alexander
Mac & Be
Wpt1
Hanger
Wpt2
Valley Ford
Wpt3
681
50
356
32
684
692
689


1200 ft
1100 ft
1000 ft
900 ft
800 ft
700 ft
177 deg
Alexander H.S.
Wpt1
Albany Airport
Wpt2
Valley Ford
Wpt3
0 mi
1.20 mi
2.40 mi
3.60 mi
4.80 mi
6.16 mi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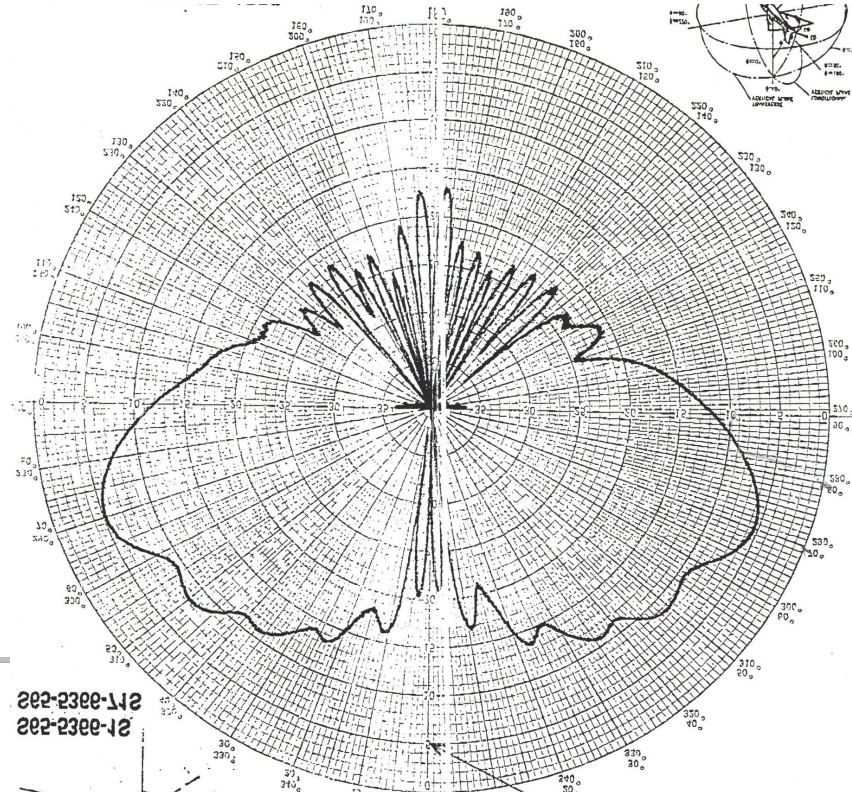
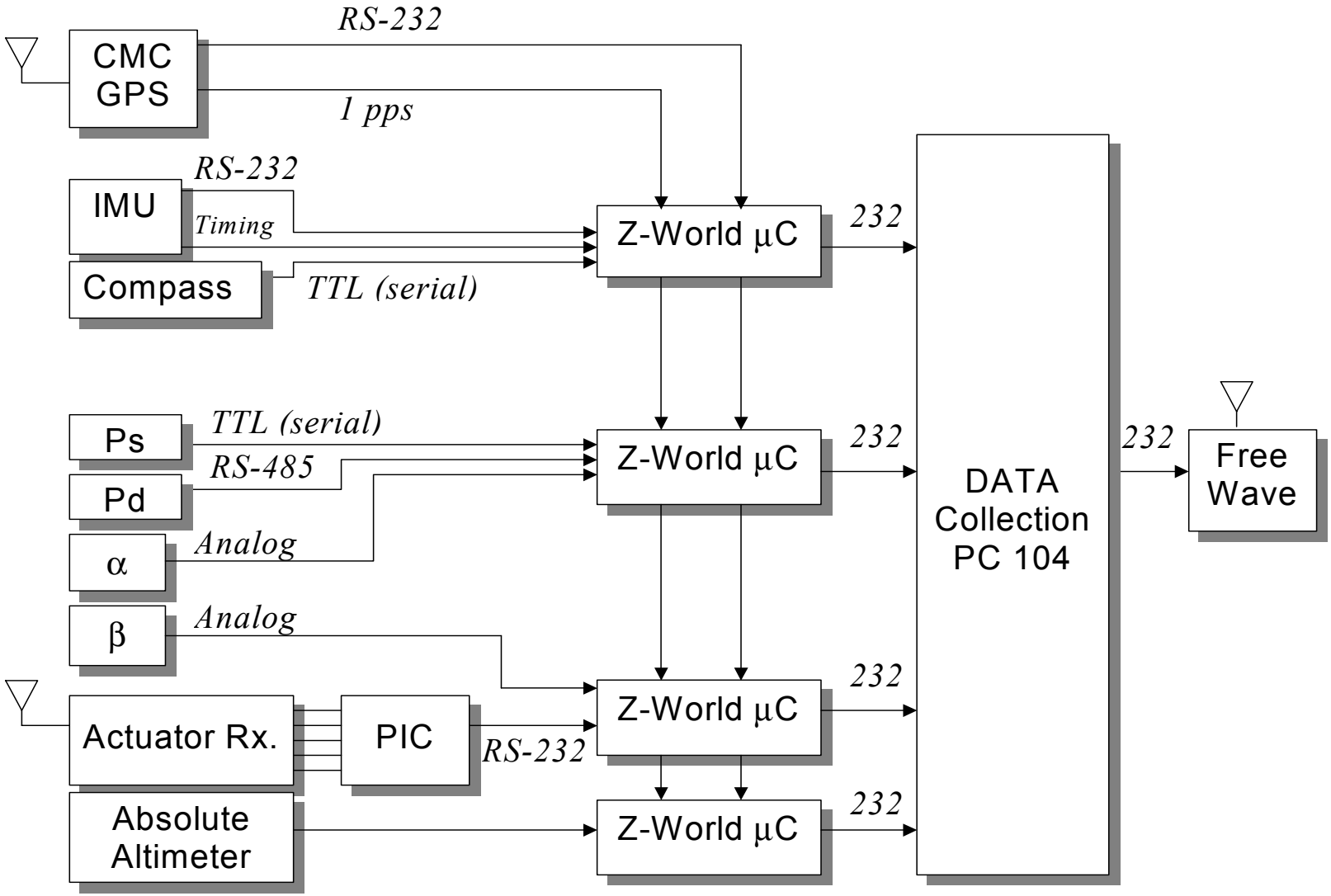


Other Projects

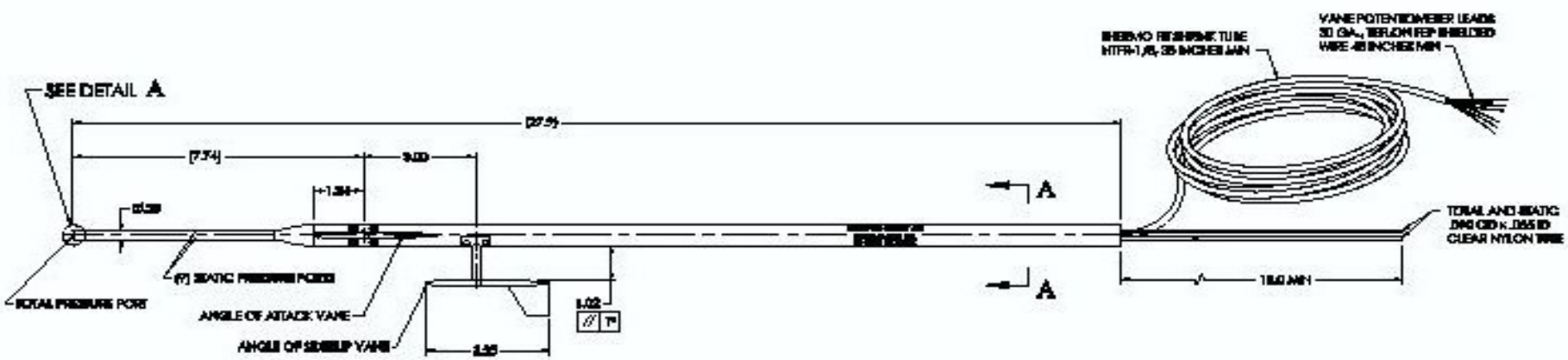
- Development of
  - GPS/Low Cost IMU Integration
  - Brumby Autopilot
    - Airborne Control
    - Automatic Landing
  - More…

Data Collection Component Diagram



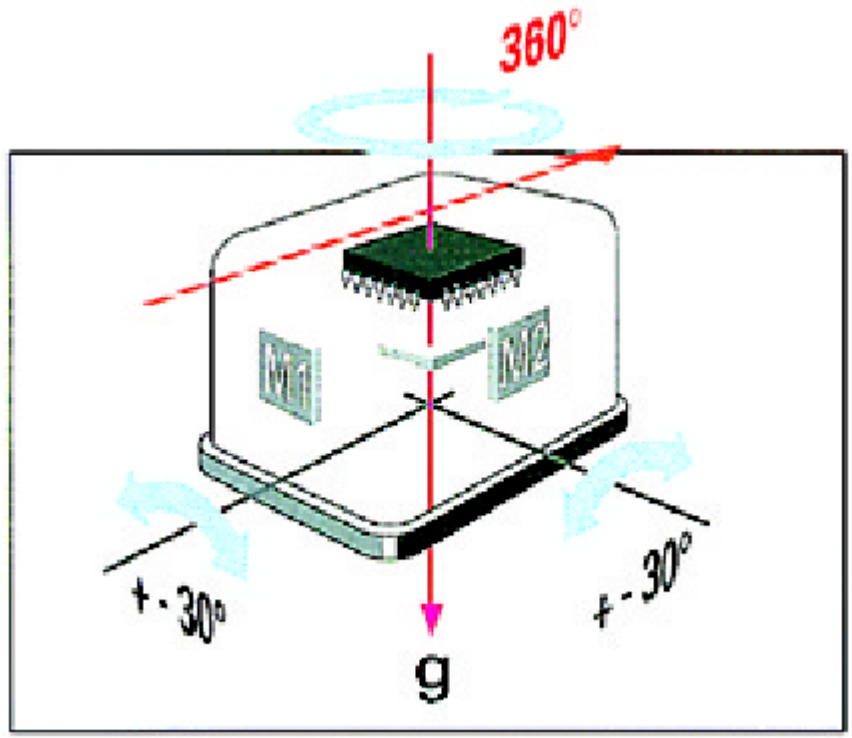
Air Data

- Static and Dynamic Pressure (psi)
  - RS-232 / RS-485 Outputs
  - 5.5 – 30 VDC / 22 – 35 mA Input
  - 5 oz. Each Transducer
- Angle of attack and slide-slip (deg)
  - Analog Output (potentiometer leads)
  - 1.5K ohms / 1 Watt PR
- Mini Air Data Boom
  - Approx. 6 oz.



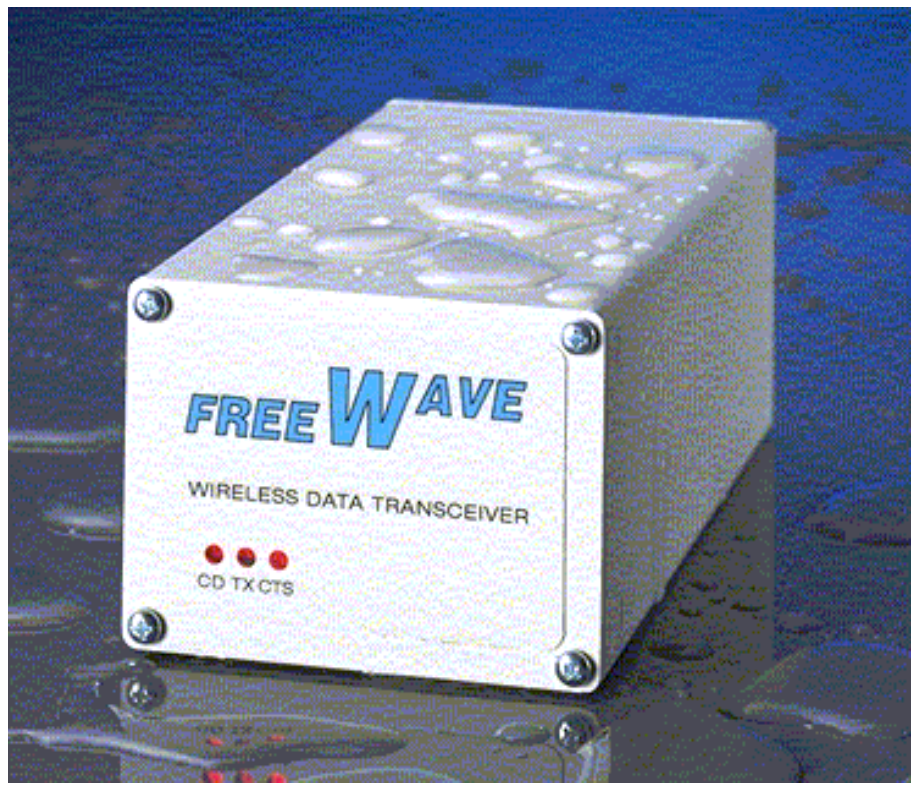
Electronic Compass

- Accuracy
  - Azimuth +- 6mils (1σ)
  - Tilt +- 3mils (2σ)
- Range
  - Azumuth 360°
  - Tilt +- 30°
- 15VDC +- 10%, 0.5 Watts
- Weight 3.75 oz.
- RS-232 Interface
- User Definable Internal Calibration Constants



Free Wave
Wireless Data Transceiver

- Frequency 902 to 928 MHz
- Range: 20 mi (unity gain antenna)
- Output Power
  - 650 mA at 12V for 1W (Transmit Current)
- RS-232 Interface
- Weight: 15.56 oz.



Control Surface Sensor

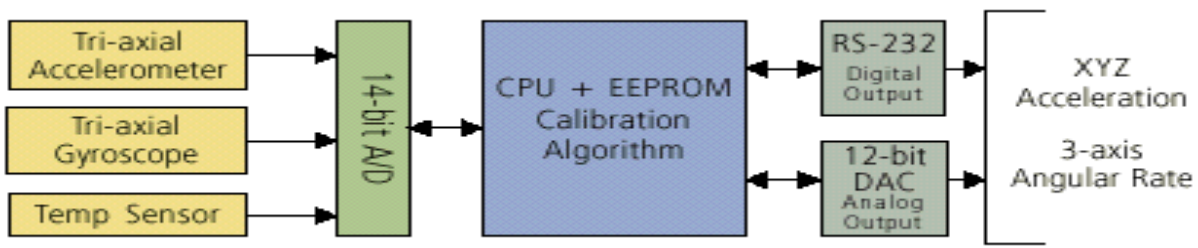
- Decodes 10 Channels from a "Dummy" Radio Control Receiver
- Built In House
- PC-104 Form Factor
- 7-25 VDC, 40mA
- Weight 3.95 oz.
- RS-232 Output

Marconi Allstar GPS Receiver

- 5.0 VDC Input
- 1.4 Watts at 5.0 VDC Typical
- 2 serial RS-232 (TTL Level) outputs
- Weight 1.76 oz.
- Altitude: -1000 ft to 60,000 ft
- Dynamic Limitations
  - Velocity: 514 m/s
  - Acceleration: 4g
  - Jerk: 2 m/s

Crossbow IMU

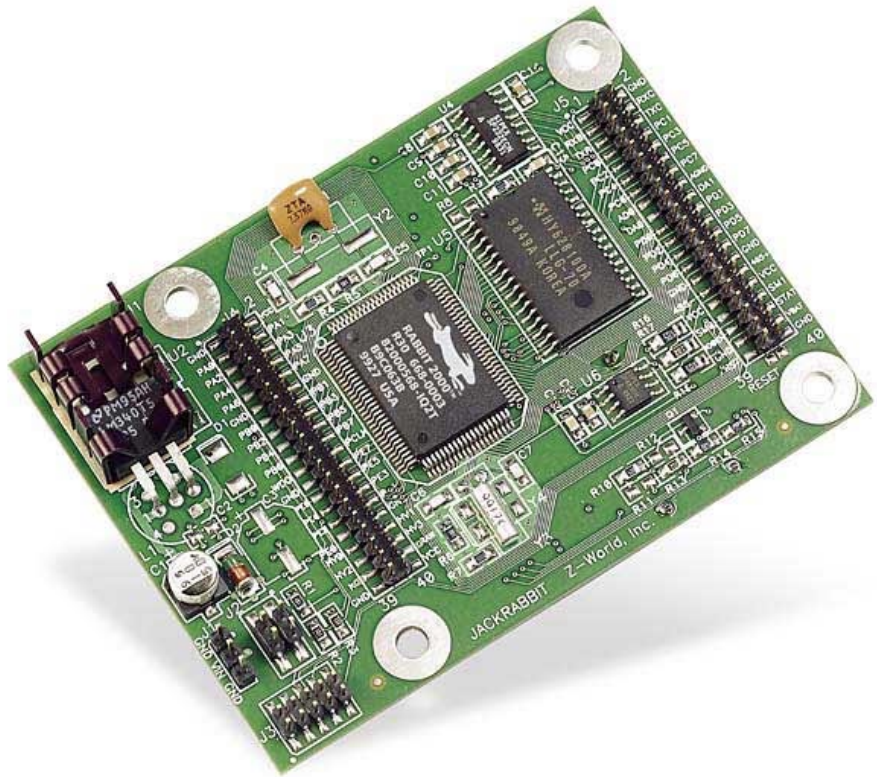
- X,Y,Z Accelerations
- 3-Axis Angular Rates
- 9 – 30 VDC, < 250 mA input
- RS-232 output
- Approx. 20.8 oz.



Z-World Microcontroller

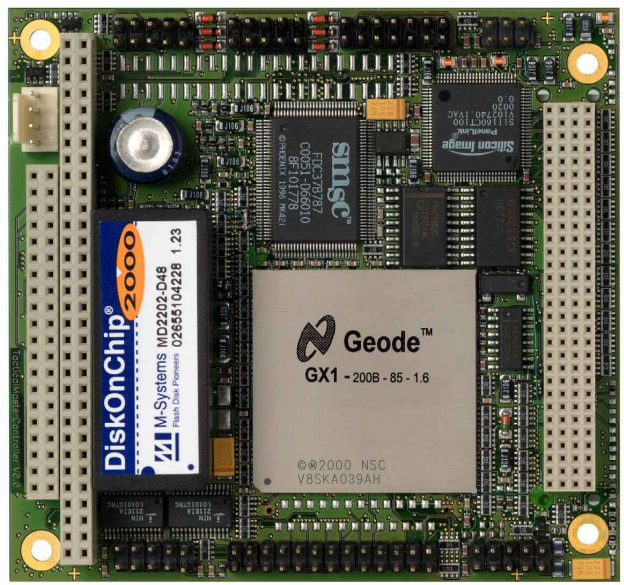
BL1800 Jackrabbit

- **Time-Tags Data to GPS Reference**
  - » **29.5 MHz**
  - » **4 serial inputs**
  - » **1 analog input**
  - » **8–40 VDC, 1.2 W max.**



Data Storage

- Advanced Micro Devices LTD. Multi-Channel Serial Port Controller for PC-104
  - 8 serial ports
  - Individual Configurable R232/422/485 Output
  - 5 VDC / < 800mA Input
- Lippert 300MHz Cool Space Runner PC-104
  - Supports Windows, Linux, QNX, VxWorks
  - On Board:
    - 2 RS-232C Serial Ports
    - 2 USB Ports
    - 10/100 Mb Ethernet Port
    - Infrared Interface
    - DiskOnChip® Flash Drive (96 MB)
    - 128 MB Ram
    - IDE Controller
    - Floppy Drive Controller
    - Video / Keyboard / Mouse
  - 5 VDC / 5.5 Watt Input

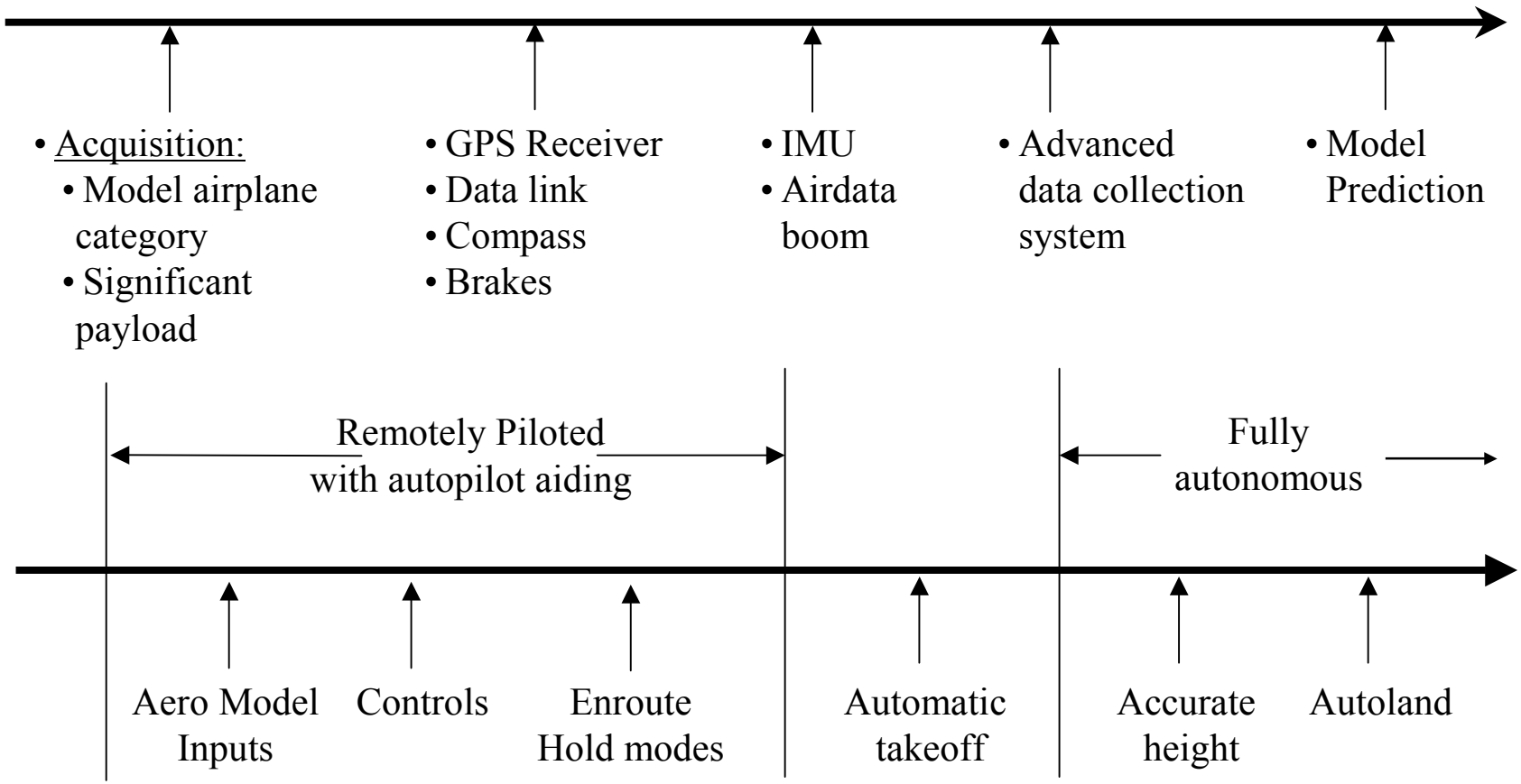


Power Budget

Device	Requirements	Supply Draw, 5 Volts	Supply Draw, 12 Volts
Lippert 300MHz PC-104	5 VDC / 5.5 Watt	1100mA	
AMPLTD 8 Port Serial Card	5 VDC / < 800mA	800mA	
(4) Z-World 1800 Microcontroller	8–40 VDC, 1.2 W		400mA
Crossbow IMU	9–30 VDC, < 250 mA		250mA
Marconi GPS	5.0 VDC, 1.4 Watts	280mA	
Electronic Compass	15 VDC, 1Watt	-	-
PPT Pressure Transducer	5.5–30 VDC / 22–35 mA		35mA
HPA Altimeter	5.5–30 VDC / 22–35 mA		35mA
Freewave Data Transceiver	12V, 650 mA		650mA
Control Surface Sensor	7-25 VDC / 40 mA		40mA
Total		2.2A	1.4A
Supply		4A	1.7A
Available		1.8A	0.3A

Weight Budget

Device	Weight
Lippert 300MHz PC-104	5 oz. *
AMPLTD 8 Port Serial Card	3 oz. *
(4) Z-World 1800 Microcontroller	5.76 oz.
Crossbow IMU	20.8 oz.
Marconi GPS	1.76 oz.
Electronic Compass	3.75 oz.
PPT Pressure Transducer	5 oz.
HPA Altimeter	6 oz.
Air Data Boom	6 oz.
Freewave Data Transceiver	15.56 oz.
Control Surface Sensor	3.95 oz.
Total	**76.58 oz (4lbs, 13oz.)**
Max Payload	**17lbs, 10oz.**
Available for Batteries, Fuel, Wiring, etc.	**13lbs, 3oz.**

* Indicates Exact Weight Not Available, Weight Estimated to Similar Products

UAV Instrumentation Plan