ALTIMETER DESIGN AND OPERATION

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AGENDA

- Barometric Altimeter Theory & Design
- Altimeter Operation
- Hints and Tips for Best Performance
- Q&A

Barometric Altimeter Theory

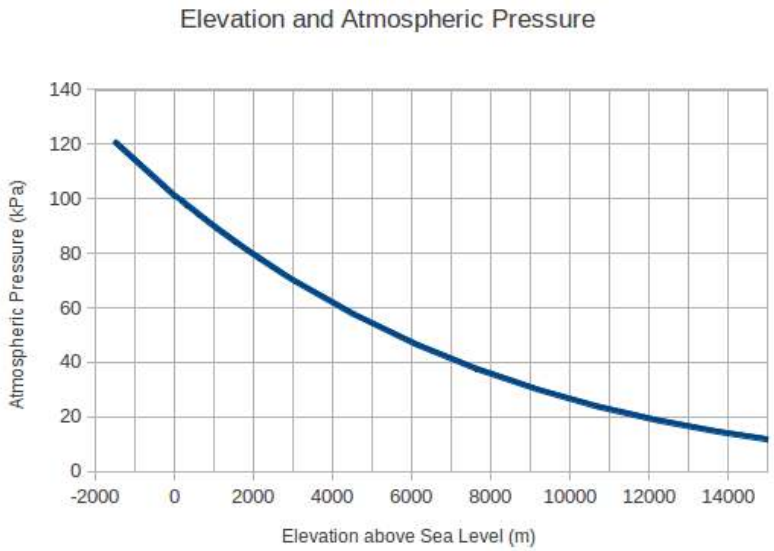
Air pressure decreases with increasing **altitude**. The **pressure** at any level in the atmosphere may be interpreted as the total weight of the air above a unit area at any **elevation**. At higher elevations, there are fewer air molecules above a given surface than a similar surface at lower levels.

The pressure versus altitude relationship has been studied extensively and a standard atmosphere equation defined.

Definitions

Barometer – Device used to measure the change in air pressure, typically at a fixed or base station location. Used to predict changes in weather.

Barometric Altimeter – Device that uses changes in air pressure to determine changes in altitude. Typically used in aircraft.

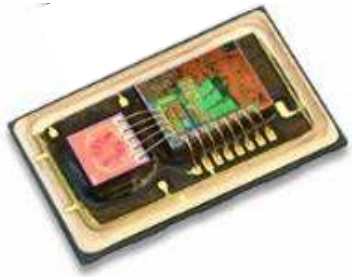


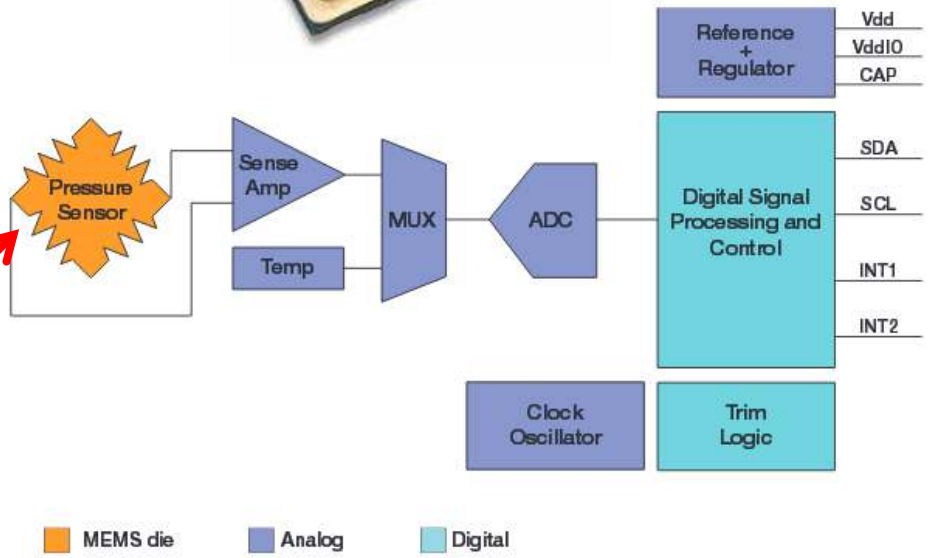
If we can accurately measure the air pressure then we can determine the altitude accurately as well.

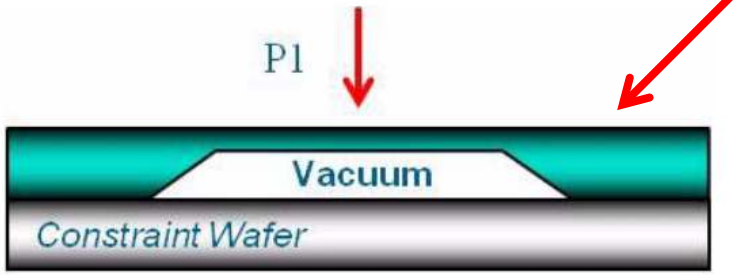
Digital Barometric Pressure Sensor Design

Today's Digital Barometric Pressure Sensor

- MEMS Based Sensor
  (MEMS = Microelectromechanical systems)
- Analog to Digital Converter
  (High resolution – 19 to 24 bit)
- On-board Digital Signal Processor
- Calibration Coefficients
  Each sensor calibrated at multiple pressures and temperatures







Cross section of absolute pressure-sensing element

Highly Accurate and Low Cost Sensor

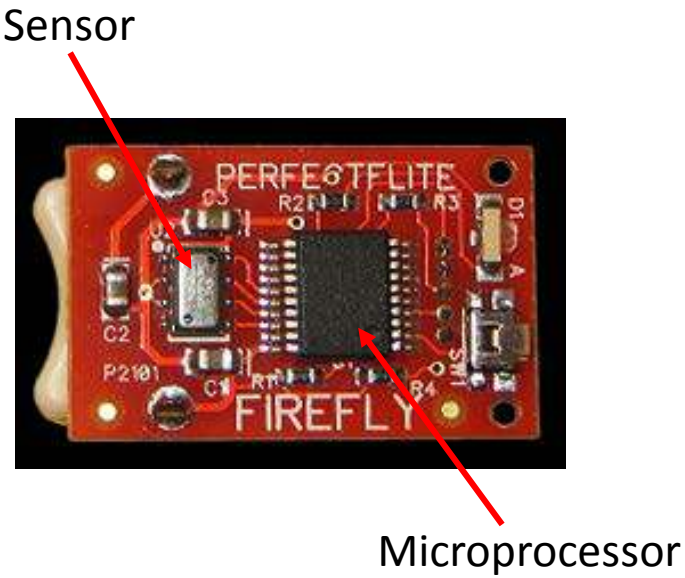
Rocketry altimeter

A rocketry altimeter is a device with the a digital pressure sensor and a microprocessor.

The microprocessor “reads” the data from the pressure sensor and converts it to altitude using the formula at right following this sequence.

1. Measure/save launch site pressure.
2. Detect Launch (sudden pressure change).
3. Continue to read pressure (10 times or more per second) until apogee is detected (readings change from decreasing pressure to increasing pressure).
4. Calculate altitude from pressure difference of launch site pressure to apogee pressure.

Note: Altimeters also do filtering of the data for noise. Recording altimeters also save all the data collected for flight profile review.



H= 44330.7249 *(1 - (P/P0)^0.1902632))

H = Altitude of flight
P = Apogee pressure
P0 = Launch site pressure

Assumes 59F temperature. All commercial altimeters make this assumption except for ALT-BMP where launch site temperature can be used.

Altimeter Operation

Considerations for Using an Altimeter in a Rocket

1. Place in separate compartment sealed from engine ejection gases
2. Mount securely (avoid allowing it to move around)
3. Avoid direct sunlight during insertion in rocket
4. Payload compartment should be opaque
5. Payload compartment should have vent holes

Compartment Diameter	Compartment Length	Four Holes Equally Spaced
< 1.5”	6”	0.12” (small pinholes)
1.6”	6”	0.12” (small pinholes)
2.1”	6”	.021”
3”	8”	.057”
3”	12”	.085”
3.9”	8”	.101”
3.9”	12”	.151”

PERFECTFLITE ALTIMETER BEEP/BLINK SEQUENCES
PNUT AND FIREFLY

SEQUENCE STEP	PNUT AT POWER-UP	PNUT POST FLIGHT	FIREFLY AT POWER-UP	FIREFLY POST FLIGHT
1	Prior Altitude beeps	Extra Long Tone (start of sequence)	LED on for 1 second	Long Blink (start of sequence)
2	2 second pause	Max Altitude beeps	Pause	Max Altitude blinks
3	Battery voltage beeps	Long Separator Tone (Higher Pitch)	Prior Altitude beeps	3 second pause
4	30 second pause (load in rocket now)	Max Velocity beeps (Higher Pitch)	30 second pause (load in rocket now)	Long Blink
5	1 second chirp	5 second pause	LED blinks once per second	Max Velocity Beeps
6	Launch Rocket	10 second warbling Siren Tone	Wait ay least 60 seconds from power on	8 second pause then repeats
7		10 second pause then repeats	Launch Rocket	

PERFECTFLITE ALTIMETER BEEP/BLINK SEQUENCES
APRA and STRATOLOGGER

SEQUENCE STEP	APRA AT POWER-UP	APRA POST FLIGHT	STRATOLOGGER AT POWER-UP	STRATOLOGGER POST FLIGHT
1st	Prior Altitude beeps	Extra Long Tone (start of sequence)	Beeps selected preset	
		Max Altitude beeps		
2nd	2 second pause	Long Separator Tone (Higher Pitch)	2 second pause	
3rd	Battery voltage beeps	Max Velocity beeps (Higher Pitch)	Main deploy alt. setting then optional apogee delay	
4th	30 second pause (load in rocket now)	5 second pause	2 second pause	
5th	1 second chirp	Warbling Siren Tone	Prior Altitude beeps	
	Launch Rocket	10 second pause then repeats		

Altimeter Hints and Tips

1. Although the Firefly is cheaper, consider spending more for the Pnut and the download cable (or borrow one). Looking at flight profile is helpful for both ascent and descent analysis.
2. Pnut warble tone and other beeps is helpful for locating rocket on the ground.
3. Cushion the altimeter in the compartment for hard landings and minimizing ejection spikes.
4. Listen for ready chirp (Pnut) or look in vent hole for ready blink (Firefly) to make sure altimeter is still armed right before flight.
5. Altitude reported by an altimeter assumes air temperature is 15C (59F). Altimeter will under report the actual altitude if it is warmer, it will over report the actual altitude if it is colder.

Corrected Altitude = Reported Altitude * (273.15 + Launch Site Temp C)/288.15

Q & A