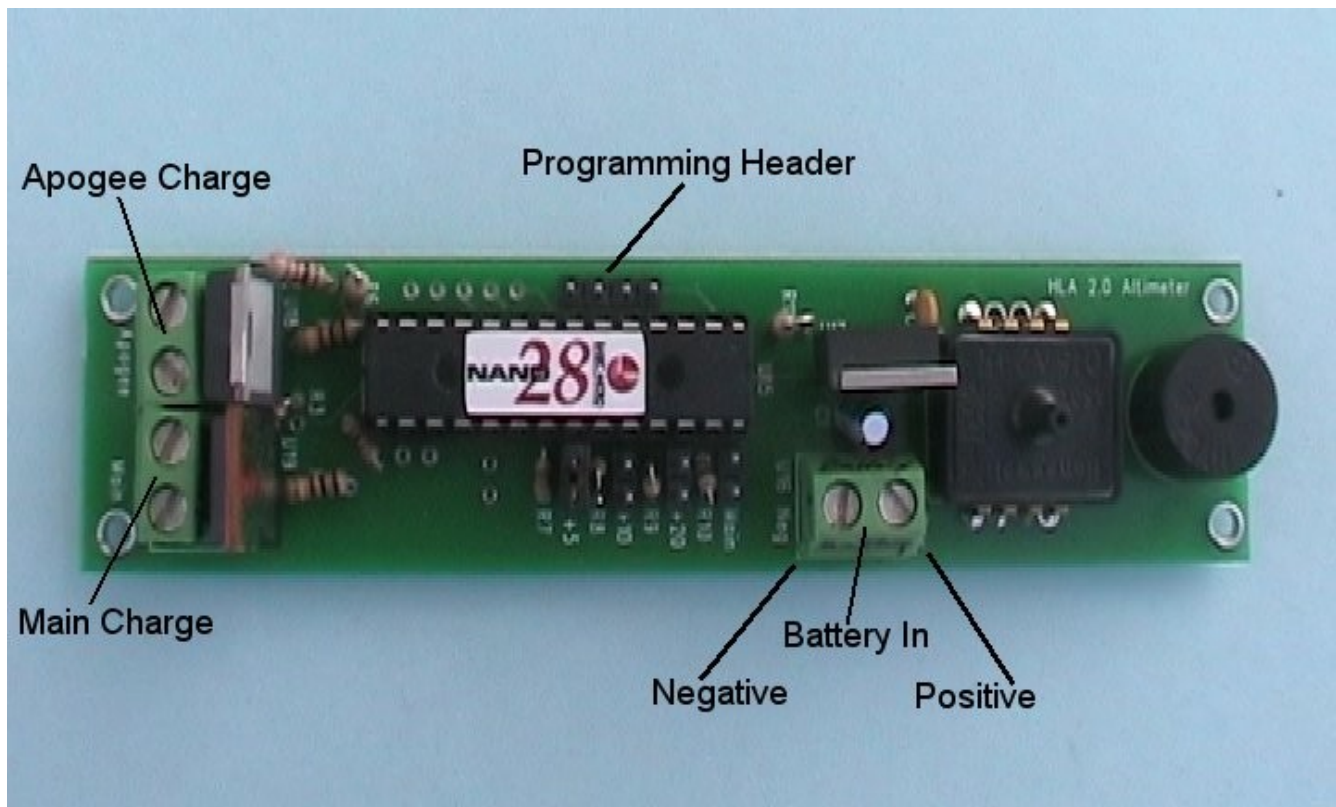


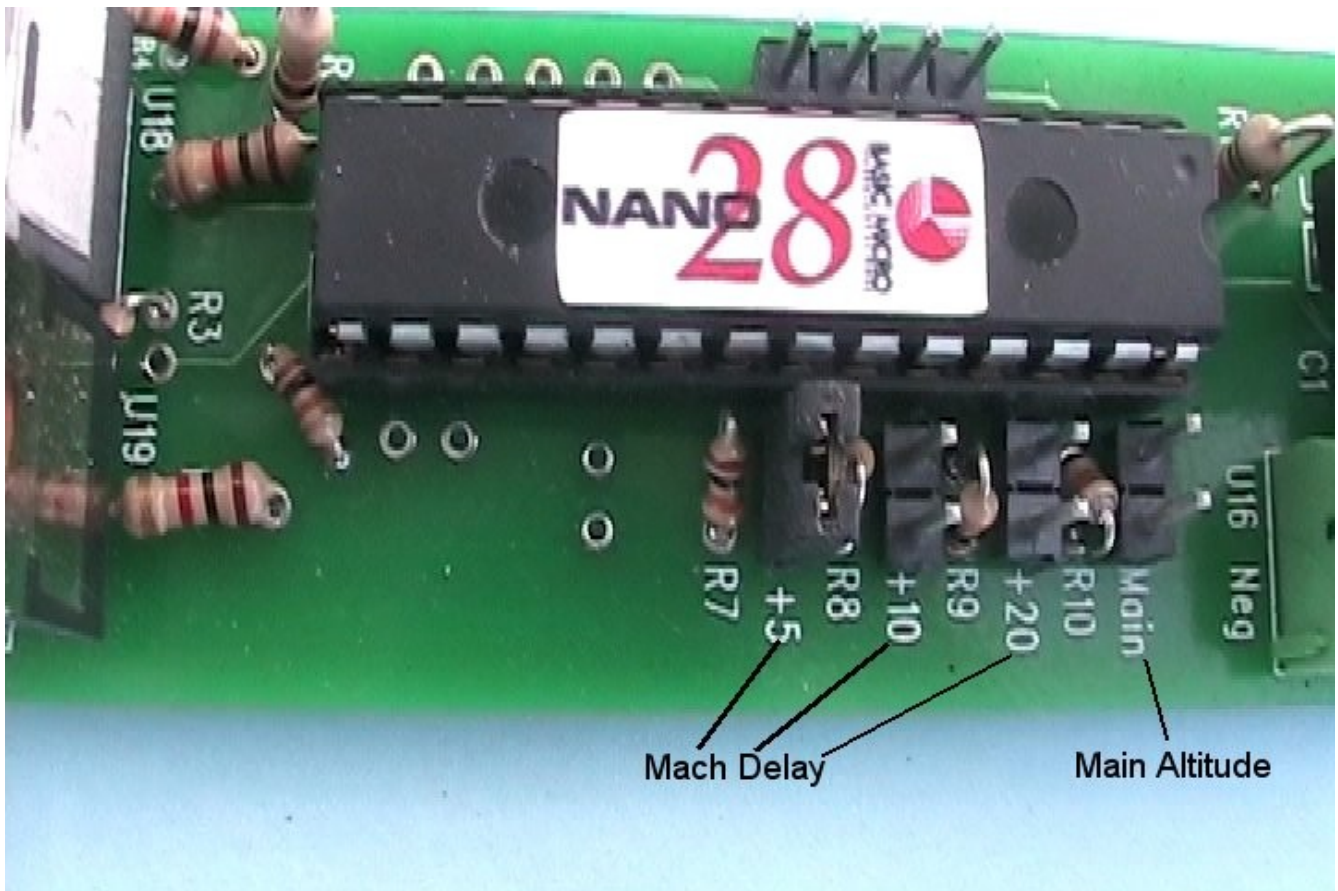
# HLA 2.0 Altimeter Users Guide



Above image shows the HLA 2.0 altimeter with the high altitude (100,000') sensor.

The HLA altimeter is easy to use with a minimum amount of user required set up prior to flight. While it is possible to custom program the altimeter, the unit comes pre-programmed and ready to use. The altimeter requires a battery supply with an input voltage of 6 to 16 volts DC. The battery pack needs to supply adequate amperage to fire the apogee and main deployment charges. Depending on what you use to initiate those charges, a single 9 volt battery may or may not be adequate. I've found most fresh Energizer or Duracell alkaline batteries to be adequate. Always ground test before flying! Battery input is not protected, DO NOT connect power to the unit backwards or it will be damaged! The positive and negative terminals are labeled on the board.

There are only (2) user settings you must make prior to flight. You can set a mach delay from 5 to 35 seconds in 5 second increments, and you can set the main chute deployment altitude to either 500' or 1,000'. Those settings are made by inserting or removing shunt pins from headers on the PCB.



The image above shows the user selectable header pins. In this image there is a shunt in the mach delay 5 second position. This would set mach delay to 5 seconds. The shunts are cumulative, that is you simply add the seconds from each shunt to get total mach delay. A shunt in the 5 second slot and the 20 second slot would give you 25 seconds total of mach delay. No shunts on any mach delay slots would be no mach delay at all.

The main altitude setting is set to deploy the main chute at 500' if no shunt is installed and 1,000' if the shunt is installed.

The transistors that fire the deployment charges are rated at 5.6 amps continuous and 15 amps for short duration. That should supply more than enough current for all common e-matches, igniters and flash bulbs.

### **Using the Altimeter:**

First decide on how much, if any mach delay is needed and insert shunts into the mach delay slots accordingly. Be careful not to select too much mach delay. An excessive amount of mach delay will cause the altimeter not to detect apogee and fail to deploy. Next decide what altitude you want the main chute to deploy at, if 500' is fine, then don't insert a shunt in the main slot, if you want to deploy at 1,000' then insert a shunt in

the main slot.

Next connect your e-matches to the apogee and main terminal blocks. Make sure the leads are well connected and not shorting each other. A gentle tug once the terminal is tightened is a good test.

You will need to install a switch of some sort between one of the battery power wires going into the altimeter. Since the altimeter doesn't have a power capacitor, a single switch in line with the battery is all that is required to "safe" the altimeter. There are about as many ways to use/make a switch as there are people flying rockets, so I'll leave the choice of a switch up to the user. Once a battery is installed in the rocket it should be considered "live" and treated like a loaded gun.

Once the rocket is on the pad and ready to launch, turn on the switch to supply power to the altimeter. After a warm up of about 4 seconds you should hear two beeps, a pause, then repeating... These two beeps indicate good continuity on both apogee and main channels. If you hear only one beep, you only have continuity on one channel. The altimeter has also sampled the atmospheric pressure at this time and recorded this data in RAM memory.

### **Rocket Flight:**

While the altimeter is beeping out continuity, it is also sampling barometric pressure to detect lift off. When the altimeter detects an increase of 350' altitude, it goes into apogee search mode. Make sure your flight exceeds 350' or the altimeter will not function. The altimeter now goes to mach delay if you had any set. Once the mach delay has timed out, the altimeter starts searching for apogee.

Once the altimeter has determined the rocket has reached apogee, the apogee pyro channel will fire. The fire duration is one second. The unit now starts searching for the main altitude deployment altitude. Once the main chute deploy altitude is reached, the main pyro channel fires for one second. The altimeter now begins beeping out apogee altitude in feet above ground level.

### **Reading Altitude:**

The altimeter reports altitude by a series of beeps. Short beeps are part of one digit, long beeps are a zero. So, a series of 6 short beeps, short pause, 8 short beeps, short pause, 2 short beeps, short pause, 1 long beep, long pause... Would be 6,820' AGL. The altimeter rounds off the altitude to 10' so it will always end in a 0. One little quirk I had to leave in the code, the altimeter will beep out a zero before the first altitude digit if you fly below 1,000'. That should be a rare occurrence and perhaps never even happen. So a

flight to 940 feet would beep out: One long beep, short pause, 9 short beeps, short pause, 4 short beeps, short pause, 1 long beep, long pause...

Once power is removed from the altimeter, all altitude data is lost. Make sure you record the altitude before turning off power.

Note: For those intending to program or play with the program. You can store a limited amount of data in the MCU's on board EEPROM. Peak altitude could be recorded and later retrieved even if power were lost before you heard the altitude beep out. Contact me if you'd like the code.

### **Flying at High Altitudes:**

The (100,000' version) altimeter is capable of reading pressure down to vacuum. But there are some issues with that. To be able to read pressure through that range, resolution at high altitudes will not be good. Below is a table of resolution at given altitudes.

Altitude	Resolution 100k' version	Resolution 44k' version
0'	34'	30'
10,000'	42'	31'
25,000'	70'	62'
50,000'	197'	
75,000'	655'	
100,000'	2222'	

The type sensors we use just aren't capable of resolving the minute changes in pressure at very high altitudes. But it's not all as bad as it seems. With decreasing pressure at high altitude, you also have much less dense air, so while from 100,000' it make take several thousand feet of descent before the altimeter fires the apogee charge, the deployment will take place in low density air with much reduced deployment forces on the recovery system.

Temperature has an effect on the barometric sensor. While the sensor is temperature compensated from 32 F. to 185F., there may be times the sensor is in an environment beyond that range. For extreme flights to high altitude, some measures may need to be taken to prevent temperature extremes. Mounting the altimeter near a high thermal mass object would help. Buffering or baffling the air flow away from the sensor would help as well.

The HLA 2.0 (44,000') will report altitudes up to 44,630'. It will continue to work at altitudes above 44,630' but there are 2 limitations. First of course it won't deploy at apogee. In chamber tests I've found the unit will fire the apogee charge when the sensor comes back in range at 44,630'. It also won't report the altitude, the altitude report will come back as all zeros. While you won't get data from flights above 44,630', at least the unit will still give you apogee and main charges, albeit a little late on the apogee side of things.

The HLA 2.0 (100,000') will work above 100,000', it won't report altitudes over 99,999'. What it will do is beep out the altitude, just omitting the 100,000 part of it. So if you have a flight to 108,000', the altimeter would beep out 8,000' and you'd need to add 100,000' to what it beeps out. If you do that, by all means drop me a note of your accomplishment!

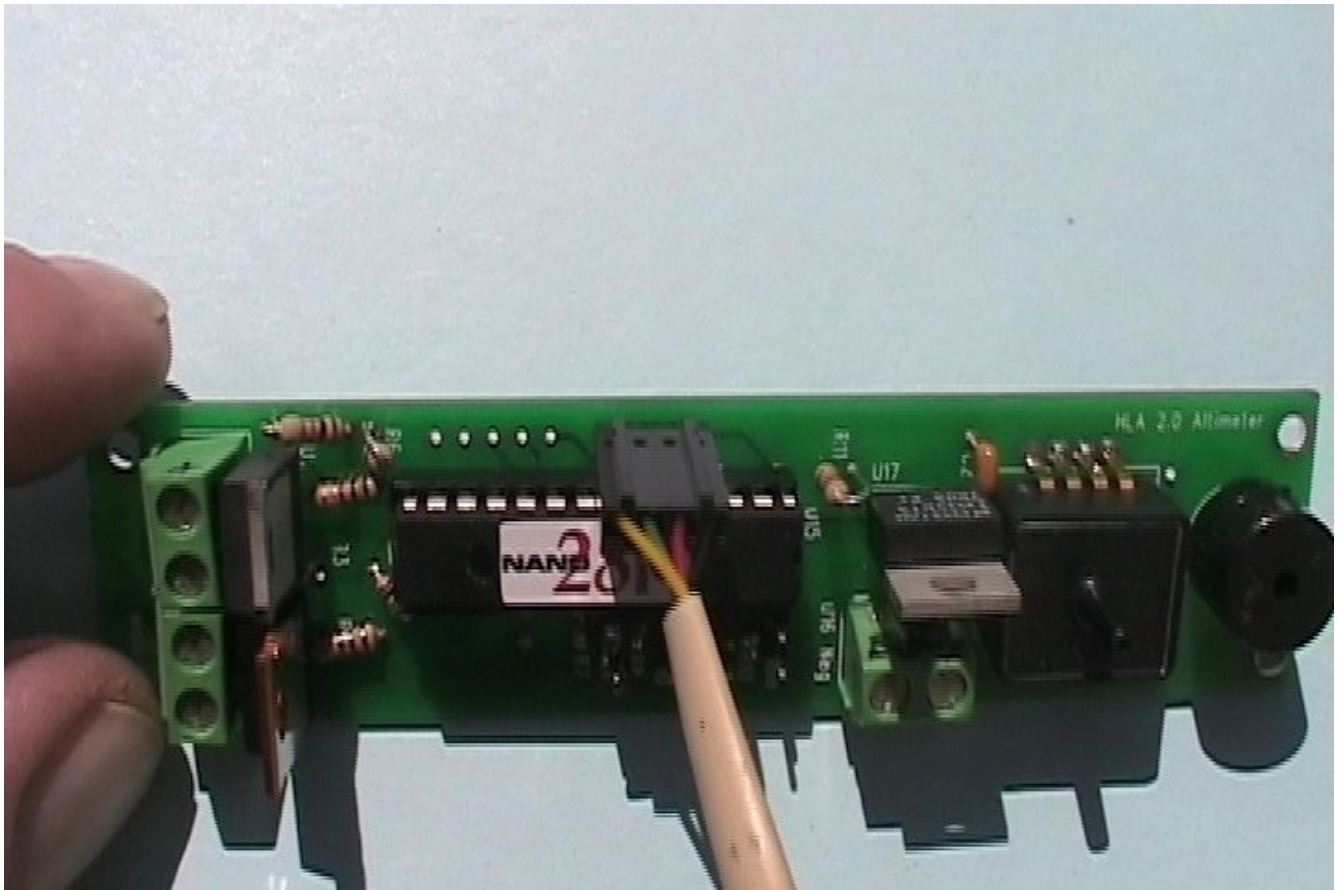
### **Ambient Pressure Ports:**

Make sure the altimeter vent ports are located in a portion of the rocket that has smooth air flow across it. Keep it away from transitions and protrusions, several body tube diameters or more below the nose cone is ideal. I use (3) equally spaced 1/4" diameter ports on all my rockets from 3" to 8" diameter. The 1/4" ports also make a fine entry point for accessing a switch in the electronics bay. What I've found from my experience is that providing the port isn't overly large or overly small, port size isn't that significant. I've flown small rockets and big rockets up to mach 2, always using barometric apogee sensing with 1/4" ports and never had a problem.

### **Programming The HLA 2.0 Altimeter:**

Should you decide to add features or reprogram the altimeter, the following information should help.

The altimeter is based on the [Atom Nano 28](#) microprocessor which is a PIC 16F886 with a bootloader designed to be programmed with [Basic Micro's IDE](#). A simple 3 wire USB to serial adapter is available from Basic Micro, or any RS232 serial converter should work as well. It would be entirely possible to program a regular, non-bootloader version of the PIC chip as well, information on that process is not included here.

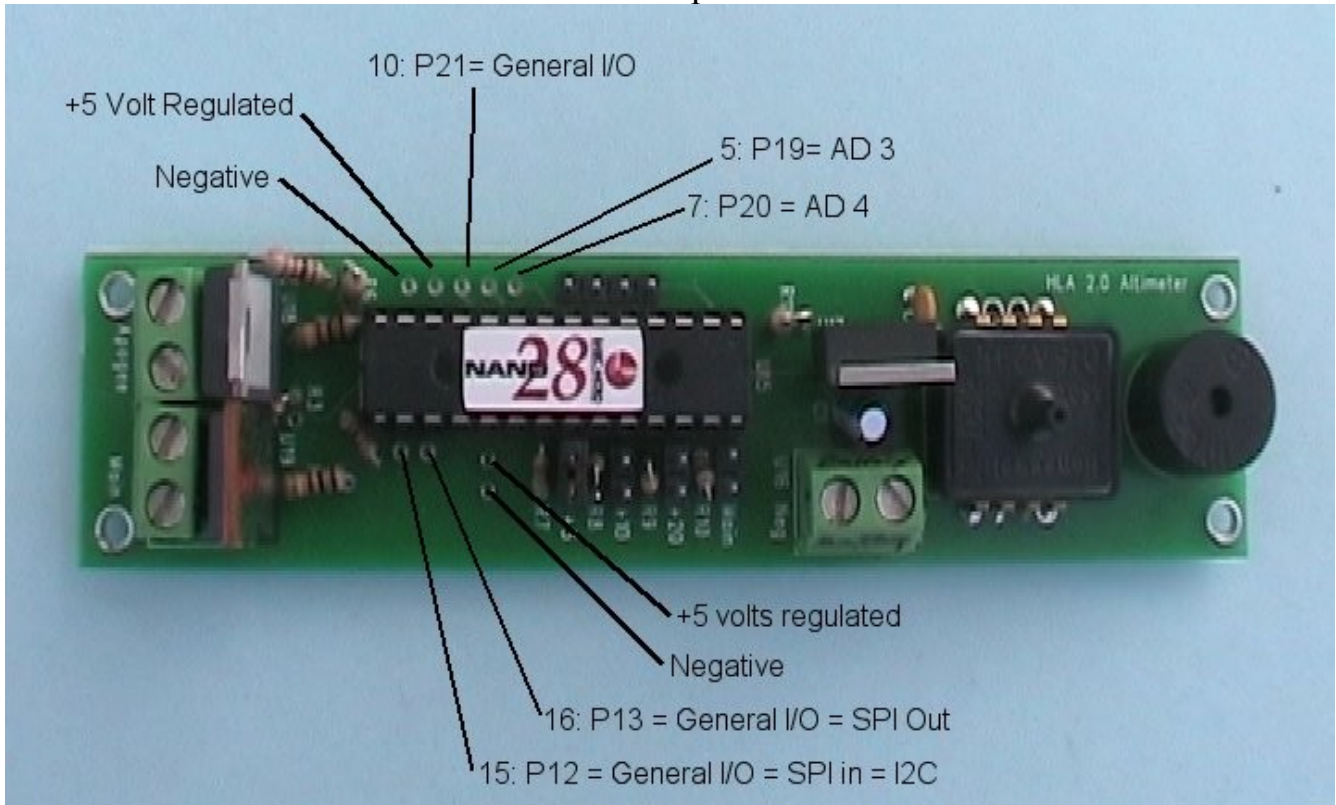


In the picture above you see a 4 pin connector plugged into the board for programming.  
All header pins are .1" pitch.



Here is the USB to serial converter from Basic Micro. It's about the size of a big postage

stamp.



The above image shows extra pin outs from the microcontroller to through holes on the PCB. On the top side of the image there are 5 holes, from left to right you have a hole connected to ground then one to +5 volts. The next hole is connected to physical pin 10 on the MCU which is labeled P21 in Basic Micro IDE, P21 is a general purpose input/output pin. Next is physical pin 5, P19 on the IDE which is analog to digital channel 3. The last hole is connected to physical pin 7, P20 on the IDE which is another A/D channel, 4.

On the bottom of the board are 4 more through holes. Physical pin 15 and physical pin 16 are connected to the first 2 holes, the last 2 holes are once again ground and +5 volts. You could add headers to these holes and connect daughter boards, or simply solder wires to the holes for external devices.

In theory it wouldn't be that hard to add a couple of more sensors to the altimeter as daughter board(s), as well as EEPROM for data logging. Of course you'd have to entirely re-write the code...

## Mounting:

4) #40 bolts

Suggested mounting on (4) nylon standoffs .2" or higher. The bare altimeter will fit in a 1.125" ID tube, without mounting standoffs. The altimeter may be mounted in any orientation, (i.e. upside down or flat is fine).

## Specifications:

Width: ~1.04"

Length: ~4.5"

Weight: 30.7 grams (no battery)

Input Voltage: 6 – 16 Volts DC

Current Draw: 14 - 20 mA (typical, no pyro event)

Operating Temperature Range: [0 °F to 185 °F] Temperature compensated

Minimum Flight Altitude: 350'

Peak Altitude: 99,999' (100,000' version) 44,630' (44,000' version)