## History

This project started some time ago. I worked on it from time to time over the past few years spurred on by encouragement from my friend Gilbert Roberts. Gilbert is the inventor of the classic Roberts vario. Although now rather out of style, it still sets the standard for response time. The FlyBoy® aspires to be the legitimate heir to the legendary instrument. Gilbert has shared with me all his long experience with components and techniques required to achieve this kind of accuracy. To this I've added my own experience with digital electronics and software development along with a sound economic idea to create this great instrument.

FlyBoy Vario
Owner's Manual
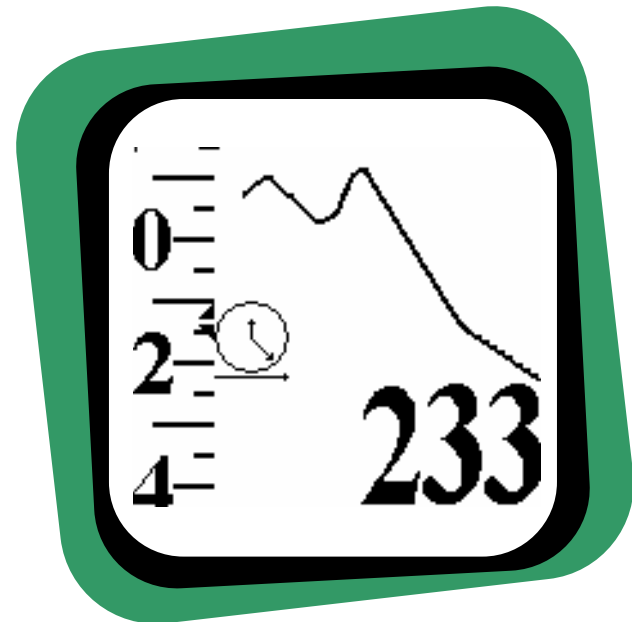
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most accurate and useful instrument at the lowest price possible. The GameBoy® includes an easy to read video mapped display, sound, buttons, proven robustness at a cost between $10 and $90 depending the type and source. There is also a variety different GameBoy® models with different features and a variety of useful accessories such as wireless headphones and the like which are also widely available at a reasonable price. Given the relatively small size of the market for this kind of product, any attempt to make a custom unit with all these features and options will necessarily result in a high priced item. The developers of the FlyBoy® have chosen to concentrate their efforts on those aspects directly related to vario function – leveraging on the superb user interface features already available in the GameBoy®.

- Does this alter the GameBoy®?

No. All the specialized electronics and software required to transform any GameBoy® into a precise and sophisticated flight instrument are contained on the FlyBoy® cartridge. At any time, this can be removed and the GameBoy® will be available for playing your favorite game.

- Is this legal?

As far as we can tell – yes. No copyrighted components are used in the FlyBoy®. Nintendo has been very aggressive about suing businesses which traffic on pirated Games. After some failed attempts to discourage add-ons like the FlyBoy®, it seems that they have decided to ignore it.

- What's the point of making it so accurate? Do we really need altitude to less than a foot?

This is necessary in order to get good response time. Let's look at an example. Suppose an instrument has resolution to within 1 meter. And suppose we take two readings one second apart. The first reading is 1000 meters (+/- one meter) and the second is 999 meters (+/- one meter). Thus the sink rate could be

Introduction

The Flyboy® vario is a flight instrument for hang glider and paraglider pilots. It is packaged as cartridge compatible with a Nintendo GameBoy® game player. It can be inserted into almost any GameBoy® to create a full featured flight instrument.

OEM Interface

The FlyBoy® vario can also be used with a number of GPS which use a simple 0-5 volt serial communication protocol. The advantage of these units is that they can be powered from the FlyBoy® GPS connector which supplies 0 and 5 volts and therefore don't require an extra set of batteries for the GPS. However, the GameBoy® batteries will be consumed approximately twice as fast. Connection to such a unit should be made according to one of the two columns labeled OEM Interface in the table above. Connecting the FlyBoy® according to oe

- Locate the power ground of the OEM unit. Connect this to pin 5 of the USB connector. This should be a red wire.

- Locate the 5 volt power input for the OEM unit. Connect this to pin 1 of the USB connector. This should be a black wire.

- Take a guess as to whether your GPS uses OEM Interface 1 or 2 from the above table and make connections accordingly.

Make sure your GPS is set for NMEA output. Connect to the Flyboy® with your new cable and power up. Your FlyBoy® vario should be operating with GPS input. Check this out by navigating to the groundspeed/compass display and verify that it shows your current groundspeed (usually zero at this point).

Troubleshooting Serial Connections

A number of problems can occur when connecting GPS input to the FlyBoy®.

- Double check that the GPS is emitting NMEA output data at 4800 baud.

- Many RS232 cables and connectors may not agree with the description above. Try interchanging the signal and

conditions. After about 30 seconds, the display should look like this.
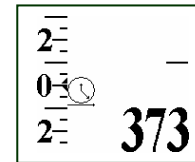
• Vario – a "sliding" scale indicating climb/sink rate in either 100's of feet per minute or meters per second. When the instrument is turned on – this will show 0 at the pointer.

• Altitude – will show altitude to the nearest foot or meter.

• Graph Display will be blank except for a "clock" icon in the lower left hand corner and a "creeping" line from the right which will advance at one dot per second. The icon identifies this display as altitude vs. time. The line shows relative altitude for the last 128 seconds at the rate of one dot per meter change.

The vario is now ready to use.

Sound

Whenever an increase in altitude is detected, the Flyboy® will emit a beeping sound through the GameBoy® speaker or headphones. As climb rate increases, the beeps will increase in frequency and pitch. When sink rate is below 600 feet per minute, an AAAOOGA sound is emitted. The volume can be adjusted by means of the volume control on the GameBoy®. If this volume is not sufficient, the best solution is to purchase a booster speaker. Search the web for "GameBoy® sound accessories" to find one appropriate to your GameBoy®.

It will mate with a standard mini-USB 2.0 type B cable. Such cables usually include a permanent molded on mating male connector. These cables are commonly available at a reasonable price and can be used as a starting point for creating a cable which connects your GPS to the FlyBoy®


CONTACT No. 1

The FlyBoy® vario can accept two types of connections from GPS. One is a standard RS232 serial connection which many GPS units use to connect to a personal computer. The other is a 0-5 volt signal which is supplied by many OEM GPS units. The FlyBoy® CANNOT be connected to a GPS which relies on a USB interface. Connection for each of these two types is summarized in the table below.

FlyBoy® Pin Number	Description on USB connector	RS232	OEM interface 1	OEM interface 2
1	4.5-5.0 volts (red)	Not used	May power GPS	May power GPS
2	Data – (white)	TXD pin # 3	Signal 5/0 v	Signal Ground connect to pin 5
3	Data + (green)	Signal Ground connect to pin 5	Signal Ground connect to pin 1	Signal 5/0
4	N/C			
5	Ground (black)	Not used	May power GPS	May power GPS

Airspeed

If the pitot tube is installed and airspeed sensing is enabled, the following displays are also available. One can navigate to between this group and the basic one with the up/down joypad buttons

Glide Path

Airspeed

Wind Velocity
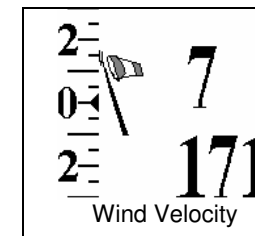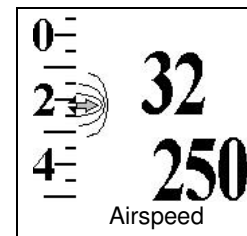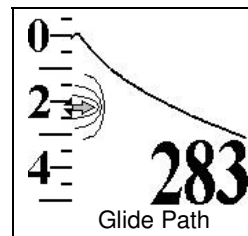
Glide Path

This is similar to the Altitude vs. Time graph above. The difference is that each dot on the horizontal axis represents 10 meters (33 feet) travel through the air at the current airspeed. So the slope of the line will represent the current glide ratio and, by implication, current Lift/Drag ratio of the glider. Using this display, the pitch of the glider can be adjusted to maximize the glide ratio. Note that the vertical scale is 1 meter per dot while the horizontal scale is 10 meters per dot. So a glider with a glide ratio of 10 to 1 will show 45 degree angle on this display. Also note that this display will vary in lift and sink and be can be used to maximize glide in these conditions. However, wind direction is NOT taken into account. So if there is significant head or tail wind, the glide ratio shown in this display will be significantly different than glide over the ground.

Airspeed

The FlyBoy® measures dynamic air pressure with a Pitot tube. This measurement is used to calculate the true airspeed. This calculation takes into consideration that fact that a glider "floats" upon a "cushion" of higher pressure air under the wing. Once the glider is no longer flying, this number is no longer valid. Hence, on

number refers to the equivalent airspeed at sea level. The stall speed of a glider increases with altitude. Each 4000 meters (12000 feet) of altitude increases stall speed by about 40 percent. The FlyBoy® automatically takes this into account In determining when the stall alarm is to be sounded. For example, if the stall alarm were to be set for 25 kph (15 mph) and the glider were flying at 4000 meters (13200 feet), the stall alarm will sound when airspeed drops through 35 kph (21 mph). That is, the stall alarm useful to signal the proper time to flair at all altitudes.

- The same explanation applies to the VNE (Velocity Not to Exceed) alarm. At higher altitudes the alarm will sound at a higher airspeed. This is consistent with the fact that the stress on the glider components is proportional to the lift and drag on the structure which, for the same airspeed, diminishes at higher altitude.

Select Aircraft

For Alarms and stall speed, the FlyBoy® maintains separate settings depending on the type of aircraft selected. This permits multi-wingual pilots to switch from one group of settings to another just by selecting a different aircraft. The last aircraft selected determines which settings are to be used. Navigate right/left to select a particular aircraft type.

	Hang Glider
	Paraglider
	Balloon
	Sailplane

Groundspeed

Speed and compass heading over the ground as determined by the GPS.

Wind Direction

Given input from the Pitot tube and GPS while the glider travels at various headings, it is possible to determine the wind velocity and heading. This display shows the heading and velocity of the glider in relation to the glider. That is, it provides a "virtual windsock". In the above illustration:

- The best estimate of the wind direction is shown as a dark dot from the source of the wind. In this example, this is the 2 o'clock position relative to the glider heading.

- Wind velocity is estimated to be 7 miles per hour.

Wind is by nature variable. Our procedure for estimating wind direction and velocity requires time. So our estimate for these variables will include at least some uncertainty.

- This wind velocity reading may "bounce" every second between a maximum and minimum estimate. Although it can't be shown in this printed manual, this number is actually "bouncing" between 5 and 7 miles per hour. This range should have a 67% probability of including the actual wind velocity. In this case, that means that there is a 67% chance that the true wind velocity is between 5 and 7 miles per hour.

- Wind direction estimate is surrounded by a by a "crescent" indicating the certainty of the estimate. In the example above, the wind is coming from between the 1 o'clock and 3 o'clock direction with 95% certainty. Note that there are 5 dots. These may coalesce to one dot if there is high confidence in the estimate. They may spread apart if there is lower confidence in the estimate. The center dot is the best estimate. The adjacent dots

down. As each sound icon is displayed, a sample of the sound is played.

	Doodle-ooldle-do …
	Buzzzzzzz!
	Booonnnggg!
	No sound

Alarm Threshold

Navigating to the right will permit one to specify at which point the

alarm sounds. This will add the ⬇ icon to the display. The threshold is displayed according to the alarm being set.

- For vario alarms (climb and sink), this will slide the vario display up/down to the desired set point

- For altitude alarms (max and min), the altitude display will show the alarm setting rather than the current altitude.

- For airspeed displays, the airspeed setting at sea level

  next to the ⬇ icon.

Notes on alarms

- Note that the screen shows the current selections and one can move to a previous one by navigating left with the joy pad. The screen shows all the current choices. For example, if one is configuring the sink alarm threshold

Using Radio Buttons to Facilitate Display Navigation

So far we've described three groups of displays of three displays each. One can navigate from group to group via the up/down buttons on the joypad. The small icon on the lower left of the graph display indicates which group is currently selected. Within a group one can change displays via the left/right buttons on the joypad. That is, the displays are arranged as a three by three table selects the next display with one of the joy pad buttons. This is easy enough to do in flight. To make this even easier, one can assign each of the A and B radio buttons to one's favorite displays. Once such an assignment is made, one can jump directly to the display with one press of the assigned radio button. Pressing the same radio button again will return to the original location.

To assign a radio button to a particular display:

- Navigate to the desired display.

- Hold down the desired radio button.

- Press and release the "Select" button.

- Release the radio button.