Air Glide S without frustration ? !

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After publishing an article on "How to set up Air Glide S" on this web site in German, I received comments indicating a large demand for a translation. I tried to do that - with mixed success.

As I am not a native speaker I was happy that Richard Frawley from down-under helped me with a re-editing (let's be honest : it was a re-translation) to get rid of my soddy English. Thanks a bunch, Richard.

The main reason for the demand for this article lies with the poor documentation, which leaves the owner of newly acquired variometers more or less alone.

I have built variometers and flight computers for *myself since 1973.* In recent times I had my own computer tied up to a PNI compass, and my goal was to tweak it to give me a fast and accurate wind indication. Yet, besides the job my time was limited as were my abilities and possibilities to create complex PCBs, and so I did not fully succeed.

When the Butterfly gang first presented their vario at the Deutscher Segelfliegertag in Darmstadt in 2012 (German Soaring Convention), it dawned to me immediately, that they had built the sensor platform I was striving for since years, without success. And so I placed my order right away.

The really new assets of this vario are the turn and acceleration sensors in all axes. Derived sensor values are combined in a complex algorithm to make up a quasi inertial platform. The algorithm is based on Kalman filtering. For those who are interrested, Kalman was a Hungarian mathematician who devised these numerical methods in the 1950-ies. As far as I know they are part of all inertial navigation systems. Now, Stefan Leutenegger and Sam Gisiger adapted them, in cooperation with Butterfly, for what in Butterfly jargon is called "AHRS", an inertial platform to derive athmospheric data (lateral wind, vertical movement).

Back to my order: Like everybody else I had to wait for, as I felt, ages to receive the product, and then to be completely disappointed by what I got - or got not. Many of the features from the papers did not work : No automatic climb-cruise-switching, no usable SC-signal or audio, no usable wind, etc, etc. Beforehand I used a CAI 302, as my measure to judge the Butterfly by and it failed by far.

So, through the complaints, I got in touch with the Butterfly people. Many of the problems I encountered in the Butterfly seemed to be old acquaintances of mine, pretty well remembered from my own years of experience in vario and flight computer construction attempts. And I dared to utter a hint or two.

From the first reluctance to accept unsolicited advice, now after four years, the relation between the Butterflys and me has changed so that they take advantage of my experience and solid hints. I have proudly acquired the status of an alpha-plus to beta tester :-)

I hope Marc Förderer is happy with my presentation of this modest influence I take on the ongoing Butterfly development.

Now two years hence, with the emerging version 1.1 of the SW, IMHO the variometers is pretty fully fledged. My list of requirements and improvements is finite and cleared with Marc, and I know more or less with what priority what will when be added to the SW.

But most importantly, as it is now with V1.1, the vario works perfectly, better than the CAI 302 which was my measure of things in this realm. The wind indication has a swiftness and accuracy not known in any other device. It is exactly the way I wanted it for 20 some years.

The wind indication is so fast, that any Butterfly newcomer falls in doubt if that indication could be really true. But, according to my experience and after all my own doubts have evaporated, I can assure you the indications are correct, even when at a given moment they seem to be implausible. Concerning wind measurement, the Butterfly is from a different world. If we deem an indication implausible, this is due to the fact that until now we never saw such a fast indication, and we had a too simplified model of the wind field around us. Wind is by far not as homogeneous an air movement as we all thought.

The only remaining itch I have is the SC and the SC indication. There is a lot of potential for improvement here, but I also know from Marc, that this is the topmost item on the list.

Now, after this lengthy introduction, here is my list of todo items in order to have a smoothly ticking Butterfly variometer.

CONTINUED BELOW, ON NEXT PAGE

How to make my Air Glide S work properly

Originally written by Horst Rupp.
Many thanks to Richard Frawley who edited and retranslated this article into proper English.
2014/11/21.

The basic prerequisite for the Air Glide S, in particular the AHRS part, to work properly so that the extraneous 'noise' (gusts, wind shifts, perturbations etc) can be removed is to ensure that it is set up correctly. The instrument is very sensitive and the installation needs to be done in a way that ensures that only the correct inputs are being sensed.

Most legacy instrument installations take all pressures from probes at the rudder fin. And most unfortunately, many of them use the total energy (TE) pressure from the fin to feed in parallel a mass-measurement variometer with a capacity flask (in Germany mostly a Winter) and a pressure sensor probe variometer such as the Air Glide S (no capacity flask).

There are many publications indicating the deterioration (mostly damping) of the pressure sensor probe measurements by the stream of air mass in and out of the capacity flask. So, it is obviously a somewhat bad idea to do that to your Air Glide S. This interference with a mass measuring instruments is certainly not compliant with the above mentioned basic prerequisite.

Fortunately, the Air Glide S can be compensated by total pressure (called electronic compensation as opposed to TE compensation). This is a new feature of the Air Glide S arriving with V 1.1.

Total pressure and TE pressure carry more or less (depends on quality of probe) the same information - but for the sign : Total pressure is static pressure PLUS pitot pressure, TE pressure is static pressure MINUS pitot pressure (probe compensation factor (~)-1).

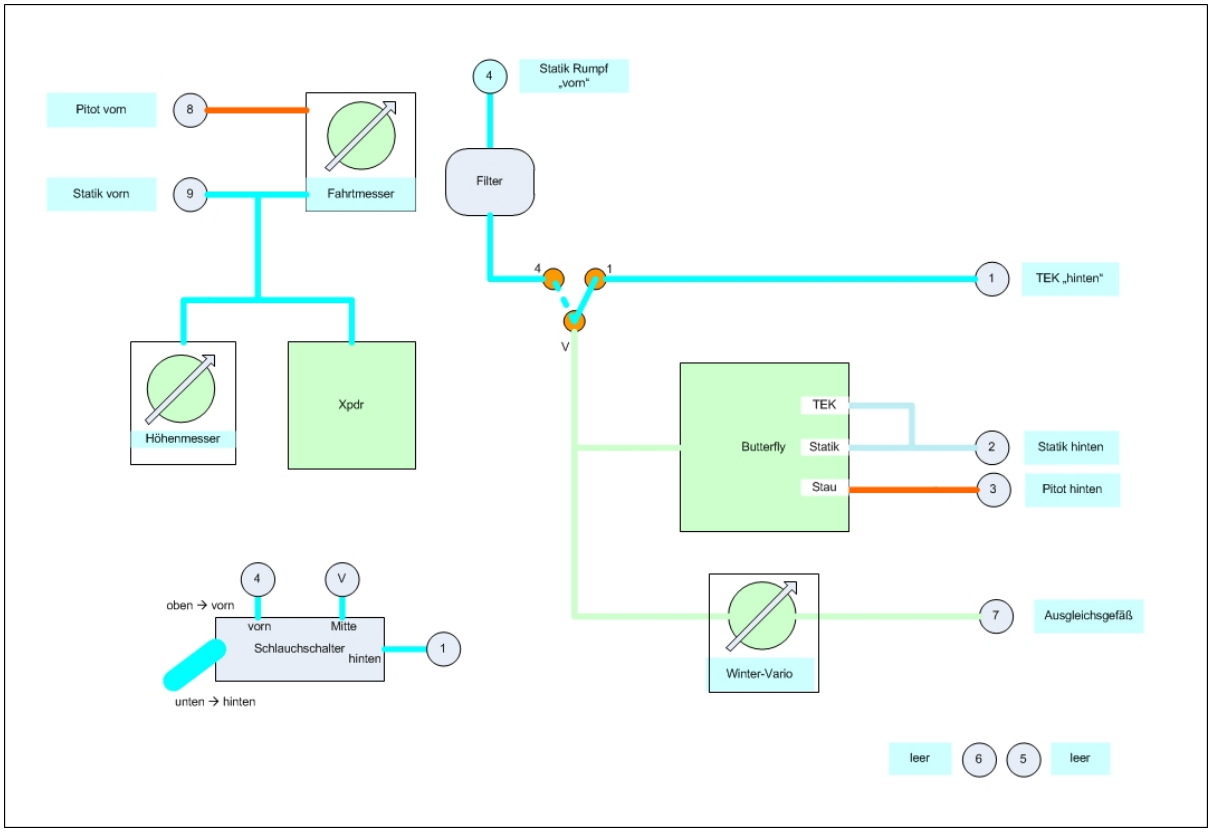
Thus, for a modern flight computer like in the Air Glide S it is no problem to derive the compensation signal from total pressure (electronic compensation).

The advantage of electronic compensation is twofold: It makes the tubing so much simpler and it gets rid of the above mentioned deterioration.

You may reserve the existing TE compensation pressure for the mass measuring variometer, as in legacy installations, but there is no need for a TE compensation pressure connection necessary at the Air Glide S.

If you go that avenue, you will end up with a "free" inlet at the Air Glide S sensor box. This inlet should then be connected to static pressure (in parallel to the dedicated "static" pressure inlet. In the Air Glide S setup there is a setting to tell the instrument it should use the electronic compensation method. The appropriate value in the Air Glide S setup has to be set to 100% (see details below).

According to my experience the vario function of Air Glide S speeds up by a factor of 2 – 3 when the TE probe is disconnected from a mass-measuring variometer and electronic compensation is used instead. In my plane I had to increase the damping factors.



The most crucial point for the proper functioning of your Air Glide S is where and how the Air Glide S sensor box is fitted to your ship. The place to put the box must be free of all varying magnetic fields, be it the compass, moving magneto-metallic parts, or electrical gear or cables which run a lot of current and are switched on and off intermittently or periodically.

There is an immediate yet coarse test for this condition. Switch to the horizon page and observe the compass course indication. Now move flaps, gear and brakes and rudder. The compass should stay stable. Then (except for the Air Glide S itself ☺) switch on and off your electronic gadgetry. Here also, the compass should stay stable.

On top of that, the Air Glide S sensor box should be fixed exactly in flight axis and without any big elevation angle error (positive or negative) relative to the plane in even flight attitude. Sure, you will not be able to attain that with absolute accuracy. Small errors in azimuth are compensated by the algorithm described further down, small errors in elevation are not compensated but they are not really relevant. They do lead to a horizon picture in the Air Glide S display where the horizon is a bit high or low, but they do not prevent the AHRS from working.

Next step is the compass compensation flight : A pattern of 8, starting in direction north. Start with a full circle left at 40° bank. When reaching north again, immediately start another circle to the right at 40° bank. As you fly through the pattern the compass compensation quality indication should climb from 0 to 9. It might even go up and down a bit, but it should end at 8 or 9 when you are through the second circle and you straighten out for a north course again. The Air Glide S will eventually say “compensated” and it squeaks a bit, as the Kalman filters get new starting values and have to adjust. The system needs about 15 minutes to completely stabilize after the compensation before it becomes fully reliable. The Kalman filters are adaptive, that is to say the output of the inertial platform is getting better with usage time.

You may check at once if the compensation was truly successful. Go to the horizon page, it should show an even horizon. If the horizon is askew, the compensation was no good.

Don’t be afraid when the compensation does not work the first time. Do it again. Only if after 5 tries you do not reach 8 or 9 as quality factor, look for a different location for the box or think about interfering factors which could be eliminated. After many trials I had to ban my AirPath compass from the cockpit. It always messed up the compensation. It took a while to find out.

When, after you gave the system half an hour to settle, you fly an docile circle in calm air, you should see the wind arrow smoothly turn with your circle, and the wind speed should not vary by more than +-3 km/h.

If the speed varies in a larger interval then you should consider using the IAS-CAS correction possibilities (see at the very end of the paper). It might happen that the total pressure measurement in your ship is a tiny bit off (it is so in most ships). There are two error sources for that :

> *The air mass flowing along the fuselage is accelerated by the volume dislocation of the fuselage and it might still be a tiny bit fast in relation to the non-disturbed air around your ship when it hits the fin probe.*
>
> *If on your plane’s static and total pressures happen to be taken from the nose and the side of the fuselage, there is a systematic mismeasurement of your plane’s speed (most plane types show this behaviour, check your Owner’s Flight Manual).*

When CAS at the sensor input is too big, then in the downwind part of a circle the wind will be calculated as too small, vice versa in the headwind part of the circle as too big.

All further preparations of the Air Glide S are done by configurations in the various SETUP-menus of the variometer. Be warned. It is easily possible to misconfigure the device in such a way that it can be rendered pretty much useless in flight. However, the below set of baseline setup values will give you acceptable results right away and you can always fall back to these values.

This warning should not stop you from modifying and potentially optimising these values for your aircraft and flying style as you get acquainted with understanding how settings work and interact.

Menue : Setup / Vario

First picture :

Speed command error filter set to 0.0 sec !! In this way the current SC indication works best – IMHO.
I am not happy with the SC signal behavior and I am in constant discussion with Butterfly about this issue. I do hope there will be improvements soon.

Third picture :

The plane „DGNeu“ is from my own collection of polar curves (glider.xml). If you have no file „glider.xml“ on the USB stick in subdirectory <polars>, then Butterfly uses a built-in collection of polar curves from which you can choose. The DG800 polar curve in that collection seemed a bit conservative for my taste. So I replaced it.

TE Kompensation 100.0 % means electronic compensation by total pressure.

0 % means „compensation via TE probe“. All values between -10 and 100 % are possible, indicating the mixture between the compensation sources. Butterfly recommends values of 100 % for electronic compensation and between -10 to +10 % for TE compensation (al gusto).

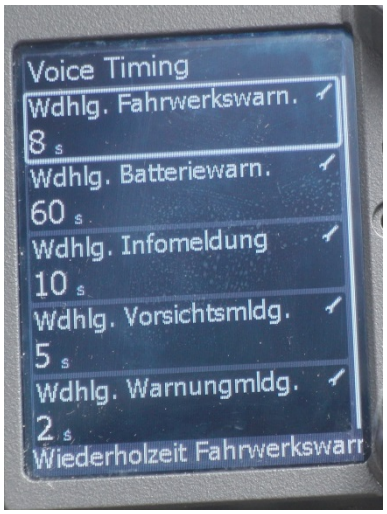
Menue : Setup / Voice

First picture :

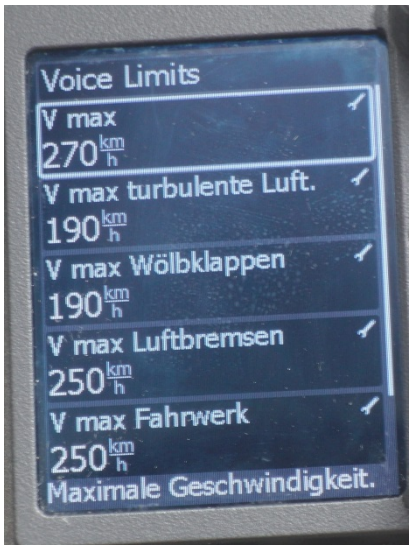
SF Vario tunes ….
When selected, the SC audio is replaced by vario audio tunes during climb in cruise mode.

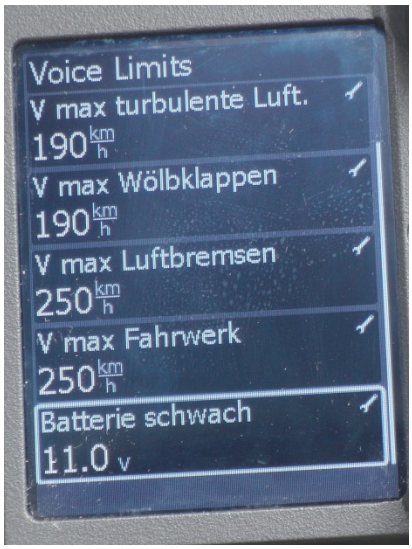
There are three possible criteria to decide when the SC tune is replaced by the audio tune – or you can select „no tune replacement“ and you will always listen to the pipiep-pipiep-SC-audio signal.

Menue : Setup / Voice in General and Setup / Voice Timing



Menue : Setup / Voice / Limits

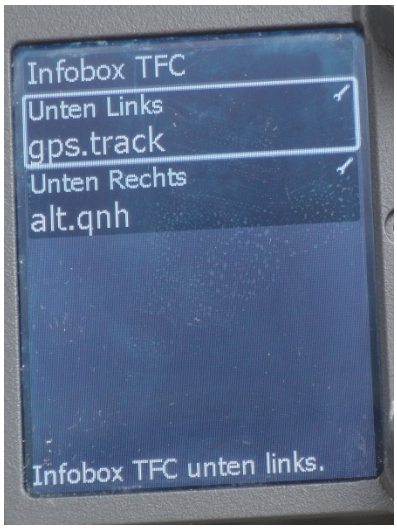


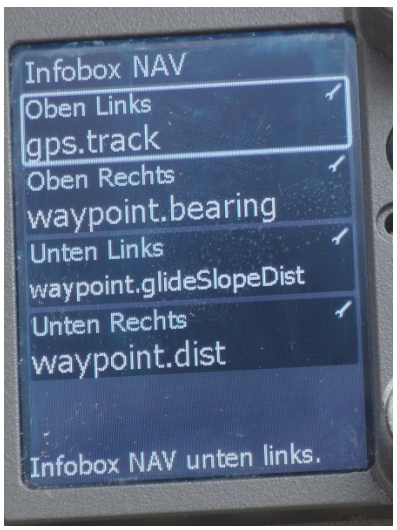


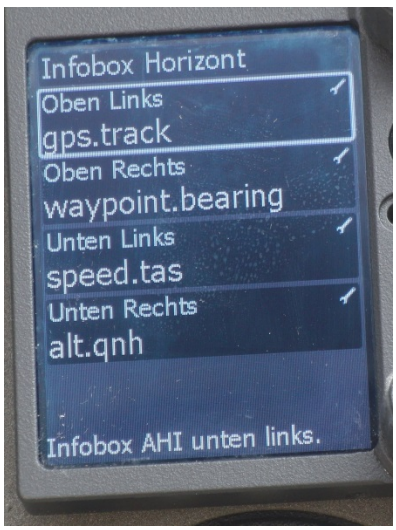
Menue : Setup / Logger

Menue : Setup / NMEA Einheit

Menue : Setup / Gerät und Info-Boxen

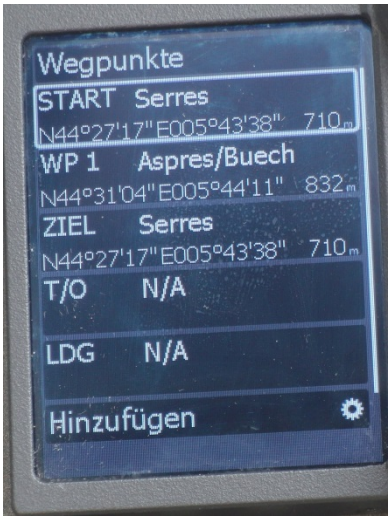


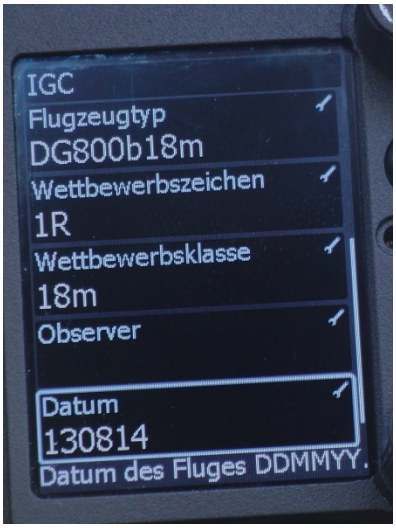




Menue : Setup / Peripherie

Menue : Setup / Route – Wegpunkte - IGC





In expert mode (press ESC then Menue):

Expert-Menue : Setup / ISU

IAS – CAS correction