ILEC FINAL GLIDE COMPUTER GPS - ASR

1. About this manual

This manual should be added to the accompanying manual of the SB-8. That one should be held in the file of the aircraft into which the whole system is installed. This way it will be available to every pilot who wants to know how the system works and how to use it.

The general chapters of the SB-8 manual about installation, cabling, etc. have of course their validity also for this instrument.

This manual is regularly updated. It applies to instruments with the serial numbers defined below, at any rate to the instrument it has been delivered with.

This instrument applies to instruments of the GPS-ASR model.
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2. Description of the System

2.1. Functions

The GPS-ASR serves as final glide computer in combination to the SB-8 vario-speed command computer. The indicated altitude of approach is always the altitude required for the residual distance. There are two from each other independent functions to choose from :

a) Final glide computer without GPS :
Manual input of distance to the turnpoint or goalpoint. The wind component is flown on a measuring route (adaptive wind-computer) and set at the wind knob. Display of residual distance as well as required altitude of approach.

b) With GPS-Information : Automatic takeover of the GPS-distance display and calculation of the wind component. Display of residual distance as well as required altitude of approach.

2.2. Mode of Action

The GPS-ASR uses the following information from the SB-8 : dynamic pressure, McCready - value, wing loading, polar selected, mode (vario / speed command). At the GPS-ASR itself are to be set : wind component, distance (without GPS), function (final glide computer with / without GPS-coupling). With the GPS-ASR itself the altitude is measured (pressure) to convert the dynamic pressure into the required velocities.
The distance covered with reference to ground is continuously computed on the basis of true air-speed (TAS), wind component, time and mode (vario / speed command) in the mode glide computer without GPS (AR). In the mode GPS the distance from the GPS is taken over. The required altitude of approach is computed on the basis of distance to goal, the optimum glide speed in vertical calm air and the safety altitude in which the goal is supposed to be reached (FA = Final Altitude).

ATTENTION: One must fly at the speed given by the speed command of the SB-8.

The (adaptive) wind component measures the time interval during wind has had an influence. Starting for that is the moment of the last actuation at the distance knob at the beginning of the measuring route. The computer takes the momentary set wind component for each one of its calculations. The drift distance calculated (which is being attributed to wind alone) is being added to the flight distance with reference to air (which it has counted up all the time). The sum of both routes is the distance displayed. If now the distance displayed coincides with the real distance covered on ground, then the wind was set correctly. Otherwise the adjustment at the wind knob must be changed until the length of the measuring route coincides with the display. This will then be the correct wind component for the calculation of the altitude of approach and the flight.

By "inverse calculation" any further parameter can be determined. The parameter to be computed (McCready - value, e.g. which enables to reach an arbitrary goal over a residual distance, and from a given altitude). To do that, one keeps turning the relevant knob (for example the McCready knob) until the result is the one sought. Now all the set parameters are correct. (By playing with the different knobs one will learn quickly to assess the influence of the different variables on the possible distance or the glide ratio programmed into the instrument.)

2.3. Accuracy

a) Distance Measurement

The total error for measuring distances is the sum of errors of the measuring pressures (normally less than 2%), plus the error of the speed transducer in the SB-8, plus the calculation error of the ASR itself. The calculation accuracy of the ASR is better than 2% for altitudes up to 18.000 feet, above this altitude it will slowly decrease to the upper operating altitude of GPS-ASR at 33.000 feet. The velocity for the ASR to work properly is in the range from 30 to 150 kts. In day to day flying the above stated accuracy willnot be met for the following reasons :

* Flight path has not been straight
* Mode has not been set correctly (flight on path in position vario)
* The wind component was not set correctly (it varies with altitude and time).

According to specialist pilots, one will have to reckon with an error from 5 - 10% in real life.

b) Altitude Computation

The computational accuracy depends on a great number of variables. Normally it is in the order of 1%. Since for great values of altitude, or distance which is based on the computation, the 1%-error can be larger than one digit of the display, therefore this latter one may jitter. This happens in particular if the wind computer runs very long.

c) Polars

Some polars published are not necessarily made to honour scientific truth, but rather to promote sales. Some are really honest curves. The polars that were used for the programming of this instrument, were all subjected to scrutiny. By principle only measured polars have been used. Since the measurements were done with clean aircraft, we have generally "worsened" the polars by 5%.
ATTENTION : This does not constitute a reserve, it only takes care of the experience. (A reserve, for example, can be considered through the approach distance, or by adjusting the McCready - value to at least 2 kts.
Bugged polars are "worsened" the same way as normal polars, only stronger, depending on the type of plane in general by 20 - 30%. Where the polar in question could not be approximated exactly by a polynominal of the second order, slow flying has been favoured in the process.

3. Operating Instructions

The distance and final glide computer GPS-ASR is turned on and off with the main switch at the SB-8 vario.

3.1. Setting of Safety Altitude FA (Final Altitude)

If on moves the function switch (AR - GPS - W/A) to the right and holds it there, the safety altitude (FA) can be set with the input-rotary knob.
So two hands are needed for the adjustment - this adjustment should be done on ground before the flight. An accidental change is being excluded by the "two-hand-operation". The safety altitude is automatically being added to the altitude required by the air route. To carry out a decent final approach with a safe landing at the arrival at the air field, a reseve of at least 300 - 500 feet (3H - 5H) should be entered.

3.2. Operation en Route

The function switch is either switched in position AR (when operating without GPS) or in position GPS. In the right side of the display window always the distance to the goal- or turnpoint is indicated; in the left side of the display window the required altitude to that (inclusive of the safety altitude FA). The smallest dispresal of the distance display is 0.1nm and 100 feet (1H) for the altitude display. A display of 30H, e.g., means that 3000 feet are necessary. If one sets the altimeter on QFE, the altitude displays must coincide. The computer indicates the ABSOLUTE ALTITUDE one should have at the moment to reach the choosen goal at the final altitude under the condition of CALM AIR and under the keeping of all other prerequisites (distance, wing loading, polars, wind component, mainly however, the McCready - value). In real life these prerequisites will rarely be fulfilled, therefore an approach must be ACTIVE SUPERVISED. (This doesn´t have anything to do with the computer). The influence of further parameters becomes clearly, if one shifts these.

On the SB-8 vario the following adjustments are done :
a) Normal polars PN or bugged polars PX
b) wing loading (this has great influence during headwind)
c) McCready - value
If one reckons with an area of sinking air during the final glide, then the glide should always be started with a MC adjustment larger than 0 kts. During approachment to the goal this adjustment can be reduced. If one reckons with an area of even up- and downdrafts, the approach can also be begun with a MC adjustment of 0 kts and then later one can try to collect reserve on the way. However, this is riskier and demands a conscientiuous keeping of the speed command.

At the final glide computer GPS-ASR the wind component is set with the potentimeter on the left hand side of the instrument. The wind scale has a subdivision into 5 kts. and has a range from - 30 kts. headwind (opposite pointed arrows) to + 30 kts. tailwind (even pointed arrows). The determination of the wind component on course can only lead to a correct result, as long as one really flies on course. The calculation of wind in the GPS - mode is different from the AR - mode and will be explained further down.

3.3. Operation en Route with GPS - data

The function switch is in position GPS. As long as no GPS - data is received, the display will indicate "GPS OFF". After the beginning of the automatic data transfer the same distance to the turn- or goalpoint as on the GPS-receiver will appear in the right side of the display window. In the left side the required altitude for this air route will be displayed. This altitude still depends on the parameters named above (polars, McCready-value, wing loading and the wind component).
The determination of the wind component takes place automatically due to comparison of the TAS (True Air Speed) with the TGS (True Ground Speed). The TAS is measured via the

dynamic pressure adjacent to the SB-8; and its altitude is corrected by a pressure transducer in the final glide computer. The TGS is determined by the GPS-receiver. The wind component can be checked by switching the function switch for a very short time in position W/A (W = wind). It is important to do this very quickly; otherwise the function Adjust Safety Altitude will appear (FA).
This wind component can then be adjusted with the wind potentiometer. A minus on the display means ´adjust headwind´- opposite pointed arrows on the wind scale. A wind display without a minus means ´adjust tailwind´- even pointed arrows on the wind scale.

The wind component can only be determined during approach on course. As during a flight off course nonsensical wind-displays appear on the display, the wind component can not automatically be taken over into the wind calculation. This would lead to nonsensical altitude calculations. That is why the detour via the adjustment on the wind knob was necessary. Only the wind component adjusted at the wind scale is adopted in the calculation. The function of the SB-8 - vario position or speed command position - has no influence on the accuracy of the distance- or altitude-display.

3.4. Operation en Route without GPS - data

The function switch is in position AR. At the beginning the altitude 0H for 0 (Hundert) feet of altitude will appear in the left side of the display window; in the right side 0,0 for 0 Nautical Miles of distance will appear. With the input-rotary knob the distance to the turn- or goalpoint is entered. The distance setting only takes place in entire NM - one NM for every indent of the rachet mechanism. Turning the knob to the right causes an increase; turning it to the left causes a decrease of the input. In the left side of the display the necessary altitude for this air route will now appear.
In contrast to the use of the GPS-ASR with GPS-data, the vario- or speed command-adjustment at the SB-8 at the final glide computer without GPS is very important for the accuracy of the distance measurement. In position vario only the wind drift is adopted in the distance. In position speed command the covered distance is also subtracted from the distance. Therefore it is very important to immedistely switch to VARIO at the beginning of the thermalling, and the other way round to immediately switch to speed command again for the continuing flight on course. In case of deviation from the course, one must coincide the distance display with known landmarks on ground and, if necessary, correct the distance with the rotary knob.

The determination of the wind also differs considerably from the flight with GPS. The (adaptive) wind computer measures the time interval during which wind has had an influence. Starting point for that is the last actuation at the distance knob at the beginning of the measuring route. The computer takes the momentary set wind component for each one of its calculations. The drift distance calculated (which is being attributed to wind alone) is being added to the flight distance with reference to air (which it has counted up all the time). The sum of both routes is the distance diplayed.If now the distance displayed coincides with the real distance covered on ground, then the wind was set correctly. Otherwise the adjustment at the wind knob must be changed until the length of the measuring route coincides with the display. This will then be the correct wind component for the calculation of the altitude of approach and the further flight.

Practical example :
You have just taken your turnpoint photograph and you are setting course for the next turnpoint. The route of 50 nm (which was earlier determined by means of the map) is now entered and an estimated tailwind of 10 kts. is entered at the wind potentiometer. By turning the adjustment knob, the internal time of calculation is set to zero - here the measuring starts. You have enough altitude and fly in position speed command. After 10 nm you fly over some striking railroad tracks. Your final glide computer, however, still

indicates 42 nm of route to be flown - so you have more tailwind as estimated. The wind knob is now turned in direction ´more tailwind´until the distance display indicates 40 nm, the correct distance. With this wind component you can now continue the flight. It is best to now quickly turn the rotary knob for the distance input left or right and to set it back on 40 nm. With that the internal time of calculation is set back to zero again and a new measuring can begin. With this method the wind (which changes with altitude in direction and force) should be controlled constantly, especially during the final approach.
If you don´t use the distance rotary knob for a long time, the value of the internal time of calculation can become very large. This leads to the fact that the product of time x wind becomes extremely large and the altitude display jitters. Remedial action here is taken by turning at the distance rotary knob.

4. Installation and Maintenance

4.1. Mechanical Installation

Opening in the panel according to air-norm 57 mm (2 1/4 inch). Drawing see manual SB-8. The instrument does not disturb the compass, it can be mounted next to it. Do not mount it too low: knobs may be difficult to reach.

4.2. Electrical Connections

The rear D-connector, 9-pin female, must be connected to the 15-pin D connector of the SB-8. Normally a tested wiring harness is being delivered with every instrument. Just in case :

ASR		SB-8	
1	red	1	
2	green	9	
3	blue	3	
4	orange	13	
5	white	14	
6	grey	10	
7	black	2	
8	brown	11	
9	yellow		data line to GPS-connection NMEA interface

Important is the mutual ground connection for SB-8, GPS-ASR and the GPS receiver. If disruptions in the radio can be heard, a shielded wire should be used for the GPS-data line The shield must be connected to ground only at the GPS-ASR.

4.3. Maintenance and Functional Checks

Exept that it shuold be treated as carefully as any other onboard instrument, it doesn´t require any maintenance. For details see SB-8 manual.
The window of the liquid crystal display is covered by a polarising film. It must not be cleaned with any aggressive chemicals, or scratched by sharp objects. In case one wants to do something extra; then one should check the speed sensor in the SB-8 (see SB-8 manual).

To check proper functioning (on the ground) : SB-8 in position VARIO, ASR-GPS - function switch in position AR, enter a few kilometers with the input-turning knob, and turn the

wind knob fully clockwise on tailwind. The distance display must now increase by 31 kts. with a tolerance of +/- 5%. Setting wind to zero, the display may only run very slowly; at a maximum speed of 1-2 kts.

ATTENTION : On the ground, when speed is zero, and one has switched to the speed command mode, then the counter runs uncontrolled. This effect is absolutely normal and will stop as soon as there is dynamic pressure (The phenomenon is caused by mathematics !). The running must stop as soon as one sets the wind knob to 22 kts. headwind.

In case the distance indicated when flying should disagree with the distance measured on ground, in a systematic way, even if the above check has been positive and all possible errors due to flying have been zero, then one should carry out a check flight (wind = zero, test track straight, at least some 10 nm long, determination errors of crossing start- and arrival-lines less than 0,2 nm, test track flown over in both directions)
Should the error still be there, then there is a justified suspicion as to an error in the system. It is to be sought all the way down from the pressure ports via the SB-8 up to the GPS-ASR. In this case one should proceed as follows :

1. Check for leaks in the whole aircraft system (this is the most frequent case. See SB-8 manual).

2. Is the TE-compensation in order (it is not personal taste what counts here, but the physical state). (A deviation of x% from the theoretically exact value of TE-pressure will lead to an error of 1/4 x% in distance measurement). Since a glider system, if it is to be flyable, will rarely over- or under-compensate by more than 20%, the error due to compensation will mostly be unmeasurably small.

3. Is the battery okay ? (quite often it is the culprit for everything)

4. Total pressure (measurement pressure of the ASI) is rarely of a problem here.

5. Water in the SB-8 ?

6. If all this is in order : send us your SB-8 and GPS-ASR (of the SB-8 only the main instrument, no cabling or remote indicators). Please give a precise description of the error.

Checking the altitude calculation is extremely complicated. It can be carried out reliably by the manufacturer only, using test cases. Fortunately, mostly, if there is something wrong here, it is seriously wrong, meaning easily spotted. Therefore, in case distance counting is okay and only the altitude calculation is wrong, return the ASR only.

5. Programming

The software of the GPS-ASR is contained in a pluggable EPROM (programmable memory, for non-electronics people); it also contains the polars of modern gliders. The data set to be used is being selected by the blue hexademical rotary switch on the upper printed circuit board. This one becomes accessible after removing the cover (remove the two countersunk screws). In the SB-8, of course, the same aircraft type as in the GPS-ASR has to be adjusted.
The instrument is being programmed by the manufacturer for the glider specified by the customer. If nothing was known, for the DISCUS. If the system consisting of SB-8 and GPS-ASR is to be reprogrammed for another glider, contact the manufacturer for the new settings. The EPROM, which is currently delivered with the instrument, carries the title : GPS 4/ 94 .
The version NMFT stands for the display in nautical miles and feet.