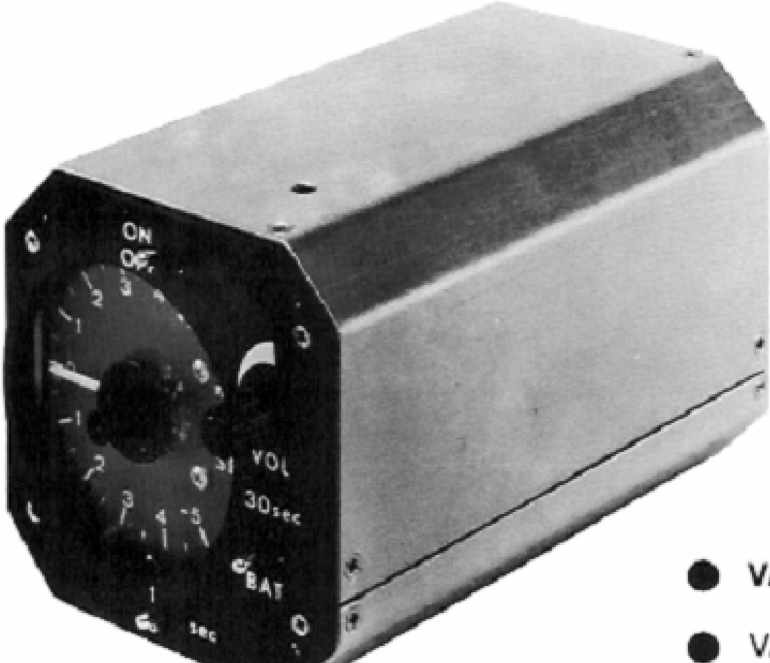
SB-7



- **VARIOMETERSYSTEM**
- VARIOMETRE ELECTRONIQUE
- VARIOMETER SYSTEM

HANDBUCH

- **"EINBAU UND BEDIENUNG"**
- NOTICE D'UTILISATION
- INSTRUCTION MANUAL

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Task of this Manual

This manual gives all information required by the owner or user to understand the functioning of the instrument, to install it, and if necessary to program it, to maintain it, and finally, to use it in flight.

It is not necessary to study this manual in an intensive way in order to be able to use the instrument. It is to give the interested user the possibility to inform himself very thoroughly of the instrument in order to enable him to draw maximum use of it. If necessary, one should be able to find a subject when there is a question.

Because the manufacturers are convinced that a good manual contributes substantially to the users benefit of an instrument, they have invested much effort and experience in writing this manual. It is not only for this reason, that this manual should be well stored.

The right place for this manual is the main file of the aircraft into which it is installed. Ideally, it should be made available to every pilot who uses the instrument.

Before installing the instrument, and under all circumstances before making any electrical connection, the chapter on installation must be read, before any opening of the instrument the chapter on adjustments and programming.

Chapter 5 (The SB-7 Variometer in flight) is thought as an annex for the more advanced and interested pilot. It is written in such a thorough way because the matter offered here is not treated in the literature on soaring.

This manual is continuously being updated, and therefore up to our latest knowledge, as well as adapted to the latest technical state of the instrument. Accordingly it applies only to the serial numbers defined below, and at any rate to the instrument it has been delivered with.

This manual applies to all standard instruments of the SB-7 type from serial number 5515 onwards
(Manufacturer's code SB-702)

State: January 1986

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1. Description of the system

1.1. Principle of measurement

The transducer is a thermal flow measurement device using thermistors at constant temperature, developed by ILEC. It excels by a very good stability of zero output, by a very short response time of 5 milliseconds, and strong independence of calibration of changes in temperature of the instrument. They ensure the instrument's high precision.

1.2. Signal conditioning

The raw variometer signal coming from the transducer is fed to three different electronic filters in parallel. The indicator (visual as well as acoustic) can be switched between the outputs of the following 2 filters:
1-sec-filter: active second order filter with a fast, however strongly damped response.
3-sec-filter: active first order filter with a response equivalent to the one of a good moving vane type variometer.
The third filter has a response similar to the first one, however with a much larger time constant. It serves to determine the average vertical speed (integrator), the value of which appears on the indicator upon pushing the 30-sec- button, or to be read out permanently on a separate indicator.
The behaviour of the 3 filters is treated extensively in the appendix.

1.3. Audio generator

The full scale range of the generator is +/- 15 m/s. In this way vertical speeds far outside the range of the visual indicator can still be perceived.
The method of modulating the frequency of the base tone, developed by ILEC, offers the advantage against the solely interrupted tone, that even after an infinite time one will perceive the absolute value, 0,5 m/s e.g. or 3 m/s, without the need to go back to the visual indication, as is the case with an interrupted tone. With the latter tone, after a few seconds one will only perceive the tendency of the signal (increase or decrease), however one will no more know where on the scale the vertical speed actually is (this stems from the fact that normal human beings have no absolute hearing). In other words: One will not have to look at the indicator as frequently as one would have to with an interrupted tone.
There are pilots who do not want this wider information, or who have become accustomed to the old, well known sound and want to stay with it. For these pilots the type of modulation can be changed to the interrupted one with the help of an internal programming switch.
On top of that one can adjust the frequency of the base tone as well as the frequency of modulation to one1s own preference.
As an option, a base tone consisting of a mixture of 3 different frequencies as with the SB-8, is available.

1.4. Muting in Sink

If the ON/OFF- switch is set to its middle position the tone is muted whenever the vario is in the sink range. This function provides for silence when cruising.

1.5. Battery indicator

On the inner rim of the meter scale a separate battery scale consisting of patterns of points and a 0 is printed. If the pointer stands on, or to the right of the 4 points the battery is still charged to 4/4 of its full capacity, if it is an the 3-point line it is at 3/4 and so on. If the pointer has arrived at the 0 of the battery scale it is definitely empty. However the SB-87can still be run for hours if one takes care to switch off all other loads to the battery as it draws very little current and as it continues to function even at 9 Volts.

1.6. Mc Cready disk

The transparent McCready disk is supported by the central pin in the screen of the indicator. Various versions corresponding to the different gliders are available optionally also unmarked disks.

1.7. Auxiliary indicators

The vario- as well as the vario average signals are brought to the rear terminal. In this way both signals can be read out an auxiliary indicators.
This is interesting for two-seaters but also for single seat gliders in case one wants a permanent read out of the vario average in order to save oneself the pain to push the button.

1.8. Remote speaker

A remote speaker can be placed in a good spot in case the built in one should not be sufficiently loud. Connection according to the wiring diagram in figure 2. Its input resistance must be at least 8 Ohms. The built in speaker should be disconnected to save current.

1.9. Precision

For general specifications see leaflet.

1.10. Altitude error

The calibration factor of the measurement transducers depends an air density
and therefore an altitude (all other systems are also dependent an altitude only in a different manner).
When measuring vertical speed, the speed indicated decreases at 5% per 1000 meters increase in altitude measured against the value which relates to IAS. This value takes into account the increase in TAS at constant IAS with increasing altitude, it is the only correct one for speed command.
In the altitude band from 200 to 2200 m NN the altitude error remains within +/- 5 %, at 1200 m, the calibration altitude, it is zero. The resulting error for the optimal cruise speed is only half that, or +/- 2,5 %, it can easily be neglected.
We must add here that for the mast used altitude band, the one defined above all errors of the SB-7 added together, meaning inclusive the altitude error are smaller than the calibration error alone of many other instruments.

2. INSTALLATION

2.1. Unpacking, packaging

Unpack instrument carefully and inspect it for possible external damage by transport. In case of damage keep packaging material to substantiate claim for indemnity against carrier and to return instrument. Leave protective caps on hose connectors until installing the instrument.

When packaging the instrument, for any reason whatsoever, take care to close the rear pneumatic nipple to prevent contamination of the measuring system! Use large case and fill void with styrofoam chips for shock absorption.

2.2. Warranty

Warranty of the manufacturer covers failures in material and manufacturing of the product for a period of

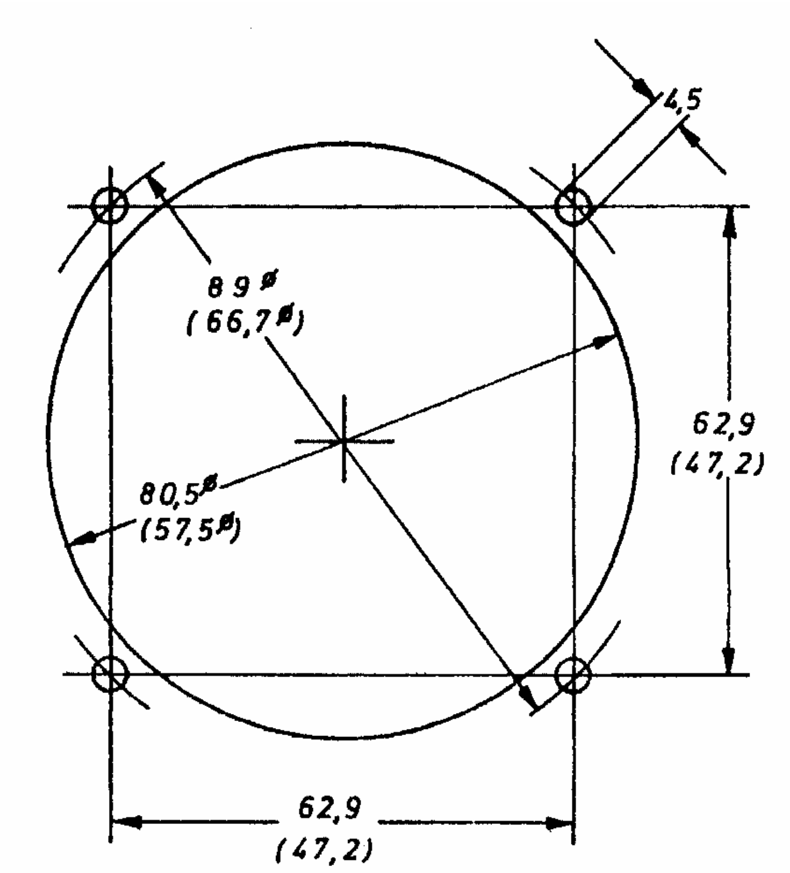
2 years after delivery. ILEC will replace or repair parts of the instrument, which have failed in the warranty period, provided the instrument has been returned free of charge to the manufacturer or his authorised representative, and provided it had been operated within the limits specified in this manual and in the prospectus. ILEC cannot be held responsible for consequential damages caused by the failure of an instrument, or its improper use.
In particular, no warranty can be claimed in cases where any liquid (water) or foreign particles have been allowed to penetrate into the pneumatic port of the instrument.
In case of trouble, describe the problem as exactly as possible, to avoid unnecessary enquiries (statements such as "vario out of order" e.g. will not always do the job). Please state a telephone number where a person competent can be reached.

2.3. Mechanical installation

When choosing the place where the instrument is to be installed the following points should be taken into account: as the variometer is red rather frequently the vario indicator should be placed at the upper rim of the instrument panel (main instrument or remote indicator for the vario signal, depending on configuration).
If a compass is installed in the panel all other non magnetic instruments should be grouped around it (altimeter, air speed indicator, moving vane variometer); all electrical instruments at a distance of at least 10 to 15 cm. The same applies to compasses mounted on the cover over the panel: the loudspeaker at the rear end of the instrument may disturb in this case.
Remedy: mount SB-7 further down, or have loudspeaker taken out by manufacturer and use remote speaker. When respecting these hints, a compass will not be disturbed by more than +/- 15 degrees and can be compensated to good precision, say +/- 5 degrees easily.
Instruments which are read infrequently, radio sets e.g. should be placed low on the panel.
During transport, take off and landing, the glider will be submitted to rather severe shock which should be kept away from ALL instruments. Contrary to a widespread opinion, the best suspension is the one that will link all instruments to the primary structure of the fuselage in the most RIGID way (the fuselage itself is very stiff and has a large mass). For this reason instrument panels should be designed for maximum rigidity and linked to the fuselage in the most rigid way. Nothing is more damaging to instruments than the shocks handed out as a softly supported panel hits the structure limiting its free travel.

Openings in the panel, fixing bolts

Figure 1 shows the dimensions of the 80 mm and 57 mm openings to be machined in the panel. If they are not yet there work with precision. It must be possible to insert the instrument and in particular the bolts freely without any jamming, otherwise the nut inserts may be damaged.
Fixing bolts delivered are M4, non magnetic, Philips head size 3.



All dimensions in mm, dimensions in brackets are for 57-mm-air-norm (auxiliary indicators e.g.)

Figure 1: Opening in the instrument panel

2.4. Electrical Installation

General remarks

- MAIN SWITCHES in the electrical system can be a source of serious Trouble, in particular where there are radio sets connected to them. When turning on the main switch with the radio on, heavy negative going pulses may be generated on the bus line during the typical 1-ms-bouncing periods of the main switch. They can destroy instruments, if not at once, then in the long run. We have measured pulses of more than 10 Amps!
- They are a nuisance and should be avoided on gliders altogether!
- If they are not, individual instruments MUST be switched ON AFTER the main switch, and OFF BEFORE it.
- The SB-8 has been hardened against the above described pulses, yet other
- instruments might suffer.
- The smallest possible number of switches, cable connectors, sockets, fuses, etc in the wiring: contact problems! This applies to main switches also! * All current carrying parts must be insulated: short circuits!
- All connectors must have a solid mechanical lock: danger of opening!

- Exclude all possibilities of false polarity connections by using colour codes, and better, keyed connectors.
- Use *only* professional components, no cheap automotive or do-it-yourself components, they are unreliable!
- Cables should be fixed at critical points, no pull may be transmitted to them: they may break!
- When crimping or screwing wire, never tin: tin flows under stress and releases tension: open circuits or intermittent contacts!
- Every conductor going to the battery MUST have a fuse as near to the battery as possible: danger of burning wires!
- Use *only* cable with flame retarded insulation material: development of smoke can be mortal! (use Mil-spec or aircraft type cable)
- If possible, one fuse per instrument: otherwise all instruments will be dead in case of a short circuit somewhere
- Use *only* female connectors on the battery electrical side: protruding pins are a short circuit hazard!
- Insulate connector solder lugs with rubber sleeves or shrinking tube after soldering: short circuits!
- Use soldering pin compatible with the size of contacts to be made, a 1 Kg, 100 Watt iron is definitely not fit for the fine work required here!

To reduce electromagnetic interference to ALL instruments, in particular that caused *by* the transmitter, to a minimum:

- All wires must be as short as possible.
- Keep the antenna cable *away* as far as possible from any other wire.
- All ground wires must be returned to one single common point. Cases of the instruments also are to be connected to this "ground". The central grounding point itself must solidly be banded -via a very short wire -to the structural metallic ground of the aircraft (the steering system e.g.), this not only far the above reasons, but also to protect the pilot against a lightning strake!
- A very good central grounding point is a metallic instrument panel, therefore it is to be preferred against a panel of insulating material, GFP, e.g.! It will be sufficient then to band the panel to the aircraft ground.
- The negative terminal of the battery must be linked to the banding point by a very short heavy wire.

Cable harness

Battery, auxiliary meters, and remote speaker are connected at the rear terminal, see wiring diagram figure 2 below. The battery connection is marked by a blue (negative) and a red (positive) colour mark additional to the numbers. Auxiliary indicators are delivered with their proper cables.

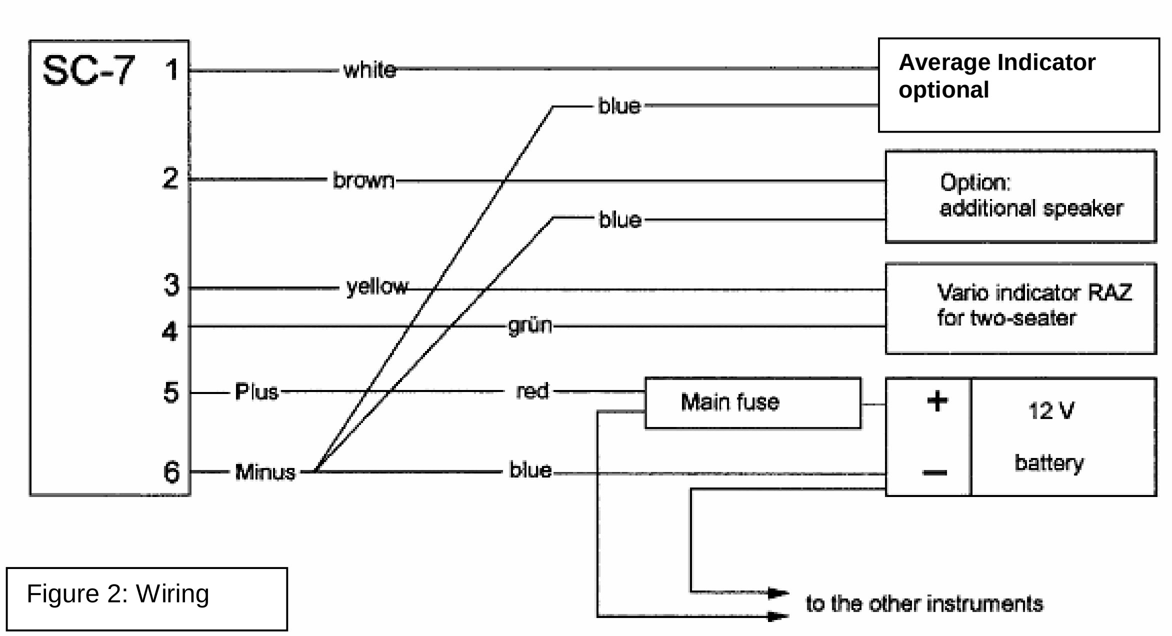


Figure 2: Wiring

Special remarks:

- The battery cable must have a cross section of at least 0,5 qmm (AWG 20), and should be as short as possible.
- Numbers indicated are identification numbers on insulator of terminal. * Wires of remote indicators are colour coded as are the connectors.
- As far as possible, all inputs and outputs of the instrument are protected against false connections. However,- it must be said -it is not possible to foresee all possibilities of false connections executed in practice, and therefore a total protection is not possible! The nearly only dangerous connections are those where the negative outlet of the battery is linked to a signal out-, or input, and its positive terminal to the Minus input of the instrument. Inversion of the battery polarity on its proper cable otherwise, is harmless, therefore:
- Never hook up the battery to anything else than its proper cable and input terminals!
- ILEC will not give warrant y in case false electrical connections have caused damage to the instrument.

2.5. Pneumatic connections

Input pressures

The instrument must be connected to a TE probe via the nipple on the rear.
As the quality of the variometer response depends entirely on the quality of the TE pressure, a good TE probe should be used. It should be sufficiently insensitive to slip and changes in angle of attack. It should be placed in a good position, generally high up on the tail fin.
ILEC has developed a probe with excellent properties, see leaflet on ILEC TE probes. For more detailed information read our brochure: '"Total energy compensation in practice", which we, or our-representatives, will send to you.

Protection against water and dust

Any pneumatic instrument can be damaged by dust or water ingested. Therefore a water separator must be inserted into any line leading outboard. As on top of that most tubing on gliders is contaminated by dust from sanding, small gasoline filters, available in car shops, must be inserted in the tube next to the instrument. They should remain there forever, also when returning an instrument to the manufacturer. Certainly they should never be reversed: this would be the best way to drive the dust collected so far right into the instrument. These filters are excellent water separators at the same time!

It must be repeated here that ILEC will refuse warranty where instruments have suffered by water or dirt ingestion.

Connecting the tubing

Nipples are for hoses with inner diameter of 4 to 5 mm. In case a tube sits too tight: do not pull with brute force, cut it open carefully without damaging the nipple. Use an adapter where tubing is too wide or too narrow, collets are normally unreliable. Best tubing is rubber tubing with textile shroud (= gasoline tube): it remains elastic at low temperatures, never becomes soft, maintains seal after years, is easy to pull off, does not shut off in tight bends, and finally holds water ingested in a film without forming drops that clog the line. Have it run straight into the nipple, without bend. Transparent PVC tubes 5 x 1,5 mm are acceptable, become hard when cold. Beware of cheap tubing:

tension on nipples will relax with time, breaking seals: the vario will stop to work, in the most awkward situation, according to Sod's law.

Leak tightness

The line from the measuring head of the TE tube up to the variometer must be absolutely air tight if the quality of the response is not to suffer. The following or any other suitable test should be done:
1. Press tube next to Variometer.
2. Seal off TE probe (finger or adhesive tape).
3. Release tube: vario produces a pulse in positive direction.
4. Wait one minute.
5. Open TE probe: vario produces a pulse in negative direction of about the same magnitude as above. If not, the system is not tight.

Very often the problem is the seal between TE tube and its receptacle: seal by slipping over a piece of silicon tube.

Mutual interference between Variometers

Where an SB-7 is run alone on a TE tube there is normally no problem, as its flask is only 90 cubic centimetres against 450 of the normal moving vane vario. Are there other large cavities (moving vane Varios with 1 litre flask volume, or so called gust filters e.g.) hooked up to the same tube: caution! The response of the SB-7 may be distorted by the large air flow in the system. A test flight with all other instruments disconnected should be done for comparison, under all circumstances.

Never should there be capillaries or so called gust filters in the conduit between TE tube and the SB-7. At best they would only cause a delay of the response of the SB-7. Contrary to a wide spread opinion, errors of the TE compensation cannot be cured in this way, only on the TE probe itself! (In case of doubt consult “TE compensation in practice") .

3. Maintenance

3.1. General indications

The SB-7 normally does not need any maintenance, nevertheless some hints are given to ensure reliable operation and long life.

- Too much heat is of no good to any instrument, therefore the glider should not be abandoned in the naked sun without the cockpit being covered. Temperature in a cockpit not covered can easily reach 70 degree C in the sun. Such heat will cause at least some momentary measurement errors. If no cloth is available, then at least open the cockpit for ventilation!
- All tubing must be checked from time to time -and at any rate at the beginning of the flying season -for leak tightness, good tension around the connecting nipples, sharp bending and squeezes. Tubes gone hard must be replaced! This particularly so in the case of soft PVC tubing!
- Most failures are due to leak problems!!
- Protect the instruments, and particularly the tubing against dust and dirt!
- When doing repair on the aircraft shut off all ends of tubing!
- Must be checked from time to time: Connectors, switches, fuse holders, for good contact, insulation; and all cables for chafing, kinks, jamming, in order to spot possible sources of intermittent contacts.
- Use only new, flawless fuses, never try to repair them! If a vario fails during a long distance flight this is rather painful.
- An old, feeble battery or a doubtful one must be replaced immediately. The battery test function of the SB-7 will help in the evaluation.

- Recharge the battery systematically after every day of flying.
- The instrument board hitting structure of any kind when bouncing around in a takeoff or landing because of too sloppy a suspension is to be avoided absolutely.

3.2. Verifications

Mechanical zero

The pointer of the built in indicator must be within +/- 0,1 m/s around 0 when the instrument is off (about the width of the pointer). Normally a correction is never necessary. As a consequence of an extremely hard shock, during transport e.g., one of the 2 spiral springs of the meter movement may become trapped in its support; the needle then, mostly, will be wrong by 0,5 m/s about, and will show much friction. Here the instrument must be returned to the manufacturer.

Electrical zero

Shut off the pneumatic connection of the instrument or leave the aircraft in a constant temperature environment for at least an hour (in the hangar e.g.). The instrument must be on for at least 15 minutes. The needle of the indicator now should be within +/- 0,1 m/s of the mechanical zero. In case the offset is larger, the zero must be readjusted, see chapter 4. (After a very long rest period, several weeks or months e.g. a larger error may show up, however it should disappear gradually, after a few hours at most.

REMARK: in case the -accumulated -zero error of one of the transducers becomes more than +/- 0,3 m/s in the first 2 years, this indicates failure of a component. In this case return the instrument, this is a warranty case!

It is not necessary to carry out the zero check more often than once a year, be it, there is a reason to suspect a serious error.

3.3. Cleaning the instrument

For cleaning of the exterior, the meter screen e.g., one must never use a strong organic solvent like tetra, or nitrocellulose, because they will damage or even destroy the plastic parts. Well suited are: lighter gasoline, turpentine, or watered alcohol with a concentration of max.40 %. Turpentine should be alright for all cases.

The screen of the indicator is of Plexiglas and sensitive to static electricity. It should not be rubbed with a dry cloth. In case the needle gets trapped by static charges humidify screen and cleanse with antistatic product.

4. ADJUSTMENTS AND PROGRAMMING

4.1. General

Normally there is no need to adjust or program anything as the instrument is adjusted and programmed by the manufacturer as specified by the customer. This chapter is intended for the case where the customer wants to change something by himself.

For all adjustments one of the 2 half shells of the case must be removed. To do this first remove the 6 corresponding self tapping countersunk screws and pull off the half shell up- or downwards. Never take away both half shells at the same time as the instrument's parts will no longer be held together. After finishing the job mount the half shells again.

ATTENTION!

- When remounting the half shells, first turn the self tapping screws backwards, until they fall back into their old track, then turn forward. The threads in the plastic parts can be destroyed by brutal handling!

- When mounting the lower half shell take care not to squeeze the silicon tubes!
- Observe most stringent measures of cleanliness. Even the smallest magnetic particles can disturb seriously the meter movement!
- Always PULL off the BATTERY connector before opening or closing the case!
- Do not touch sealed trim pots, calibration would be lost!

4.2. Zeroing of the transducer

Proceed as described under 3.2. Take away upper half shell after having pulled the battery connector. Reconnect battery. For adjustment turn trim pot identified on photo of last page using small screw driver and no brute force, until zero is correct. (switch to 3s response). Pull battery connector, close instrument.

4.3. Audio generator

If not specified otherwise by the customer the ILEC tone will be programmed. To change to the interrupted tone: (see photo last page) change the wire spring on the 2nd printed circuit board from the left to the right one.
For adjustment of the frequency of the base tone or frequency of modulation turn the corresponding trim pots.

One should test the effect of an adjustment one makes on the audio generator. For this, open the upper half shell, then re-connect instrument to the cable oom of the glider and switch on. Make the vario play with the help of a piece of flexible tubing connected to the nipple and shut off at the end, and listen to the sound.

Remark: low frequencies are poorly perceived in flight!

5. THE VARIOMETER SB-7 IN FLIGHT

The following chapter has been written in order to help the user to draw maximum benefit from the information offered by the instrument. It is always worth while to read it, as the matter treated here is rarely or not at all found in the general literature on soaring.

5.1. The 1-second-, and the 3-second response

Figure 3 shows what happens upon flying through an idealised thermal, and the corresponding responses of the 2 different filter outputs, or otherwise, the indication of the vario needle when one or the other response has been selected. For the example a standard class glider with normal wing loading has been assumed. Airspeed be 90 km/h, and constant.

The thick square trace 1 shows the updraft as a function of time: in front of it there is calm air, within, it the air climbs at 2 m/s, diameter be 100 m.

Before entering, the plane sinks steadily at 0,7 m/s. Upon entering it is accelerated upwards, the pilot will feel this clearly on his pants. The transition to the new vertical speed is fast, with a time constant of 0.4 seconds. (Gust)-acceleration at the beginning is 0,5 g, the G-meter will jump from 1 g to 1,5 g.(When leaving, the same happens, however, this time downwards.) Curve 2 shows the response of the sailplane. Curve 3 describes the indication by the 1-second filter: after a short hesitation of about 0,2 s the needle swiftly swings upwards, after 2 s already 90% of the change are reached, after 2,5 s 100% of the real climb rate of the glider of 1.3 m/s are attained. The indicator needle remains there to the very end of the updraft, and returns to the original vertical speed as fast as it mounted.

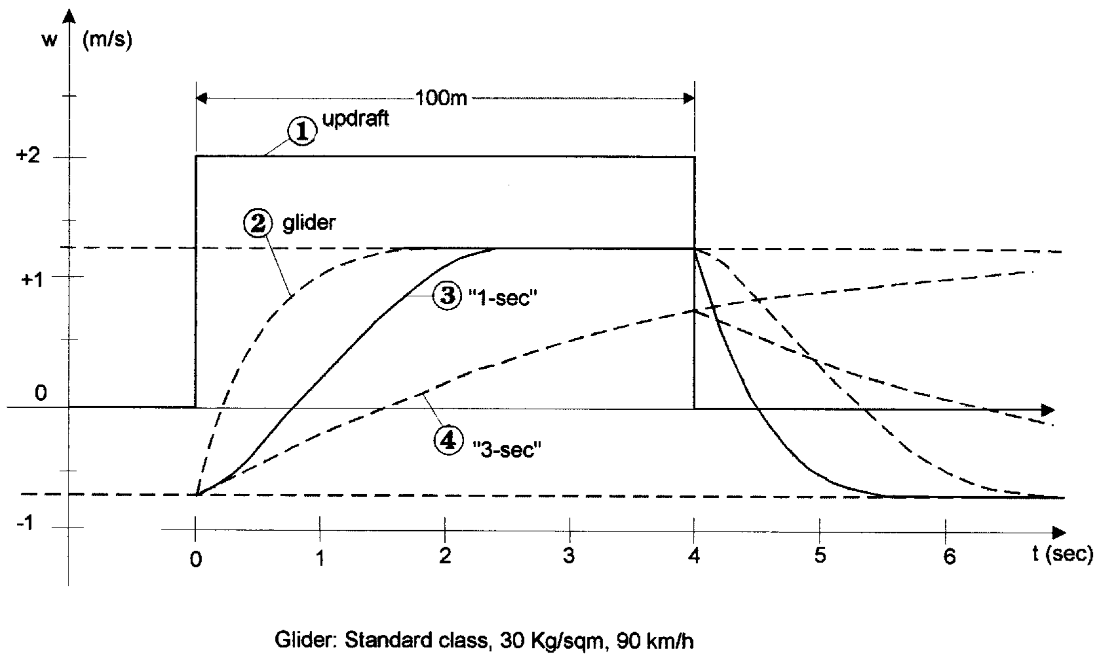


Figure 3: Passing through an updraft

REMARK: For a first order filter to be as fast, its time constant would have to be 1 second. Such a filter would be useless in normal thermal conditions as one would not be able to read it because of its permanent random movement induced by turbulence. The 2nd order filter used here suppresses the disturbing higher frequencies of the input signal roughly 10 times as much as the first order filter: Only in this way the high speed indication is possible.

Curve 4 shows the behaviour of the slow 3 s filter, which corresponds to the one of a good moving vane vario: The output creeps up slowly. To reach 90% of the change in input, one would have to wait 7 seconds. When reaching the end of the thermal it will just have climbed to 0,8 m/s, from here onwards it falls off just as slowly again.

When comparing the 2 responses it becomes obvious, how much clearer the fast filter “marks” the up current flown through, than the slower one, and on top of that with less delay. Therefore it is superior to the slower filter always there, where it counts to determine directly the real vertical speed of the glider, which means when thermaling.

Thanks to the small delay of only 2 s it is no longer necessary, by comparison to a moving vane vario, to mentally shift back in time the values just read. The instrument shows the real momentary climb rate of the glider.

Which response to use to search for thermals? As the main problem here consists of discriminating between gusts and useful lift, a short consideration: diameter of the general thermal is of the order of 150 m. This distance at a speed of 90 km/h will be covered in about 6 s, at 180 km/h in 3 s. With this in mind one can say that it is worth while to take on a thermal only when the climb lasts at least 3 to 5 seconds, and when on top of that it has the minimum strength looked for, be it, one is convinced to have cut the lift just on its border. If now we look at figure 3 we can set up a rule very quickly (which has proven its validity in practice): When the vario climbs to the lift waited for, then count to 3. If the needle is still there, then take it, if not, continue!

In case the slow filter has been selected, one will have to not only observe the position of the pointer, but also its tendency: Does it still climb after 3 seconds, and does it indicate at least half of what is waited for, then take it! In case it stands still or even falls, then continue on the way!
Another possibility consists in switching to the fast response, upon suspecting a good lift, and then continue as above. No waiting time is required, as the 2 filters permanently “see” the input and build their output continuously. Merely one or the other of the 2 outputs is connected to the indicator, and, at the same time, to the audio generator.

5.2. Turbulence and gusts

Everything which is shorter than a useful lift is only a disturbance Ideally a variometer should suppress these gusts. However, this is impossible so long as we require an indication with little delay (the vario would have to wait first to see what has become of the gust, before it would be allowed to indicate something!). This being so, we will have to content ourselves to filter out the gusts without loosing too much in speed of response. With the electronics available to us today this is feasible. However the task is rendered very difficult by total energy compensation required for the fast gliders of our days. The changes in air speed caused by turbulence create TE pressure changes which act in the same way as vertical gusts, and that mostly in a much stronger fashion than thermals.

To demonstrate this we assume the following situation: A standard class glider flies at 150 km/h. On the one hand it enters a thermal of a meteorological vertical speed of 2 m/s, on the other a zone with wind shear or a whirl with horizontal axis such that the plane's airspeed increases suddenly by 2 m/s. What happens in both cases? Figure 3 shows it for the first case, with the exception that the initial sink rate is 1,8 m/s rather than 0,7, and that the initial vertical acceleration thrust is stronger. The plane is accelerated up from -1.8 m/s to + 0,2 m/s, 150 /90 times as much as in figure 1, because of the higher airspeed. The g-meter would bounce from 1,0 to 1:8 g (easily to be noticed on the pants!) and return again to 1,0 with a time constant of 0,25 s. The response of the variometer is as in fig.3, the curves only lie a bit lower.
In the case of the horizontal gust the airspeed indicator jumps from 150 to 157 km/h, damped by its inertia. The plane is going to be accelerated only a little bit, in contrast to the first case, namely at 0,1 g. The further trajectory is mainly determined by the pilot's reaction. He can continue at the increased airspeed, or swap the kinetic energy gained for a bit more altitude (in the example this would be 8,7 m !) and then continue with his original airspeed. On the response of the TE-vario however the manoeuvre has little influence: at entry the vario “sees” a jump in dynamic pressure corresponding to the above mentioned altitude jump of 8,7 m. It will interpret this pressure jump correctly as a gain in energy and produce a positive excursion. Its pulse will be proportional to the potential gain of altitude. Thereafter, it is irrelevant to the TE-vario whether the potential gain in altitude is realised or not, as there would be no change in total energy involved in the manoeuvre, only an exchange between the kinetic and potential energy components within total energy.

The needle's excursion is larger here than in the first case, as shows figure 4, and the shape of its response curve is different: the excursion dies out quickly, how fast, this depends on the vario response.

To demonstrate the difference between the filter used in the SB-7, curve 3, and an about equally fast classical filter of the 1st order, its response has been drawn as curve 2. One clearly remarks the much more damped behaviour of the SB-7 filter.
The slow 3-second response jumps from -1,8 m/s to + 1,1 und then creeps slowly down again to the initial value. The large time constant leads to the initial excursion being only about half that of the fast filter. To compensate for that it remains on longer, making the pilot think there was some lift, where there is none

any more.
It should not be overlooked that in reality turbulence is rarely as sharp as presented in our model for simplicity. The leading edge of the slow response curve will therefore be rounder generally as shown here.

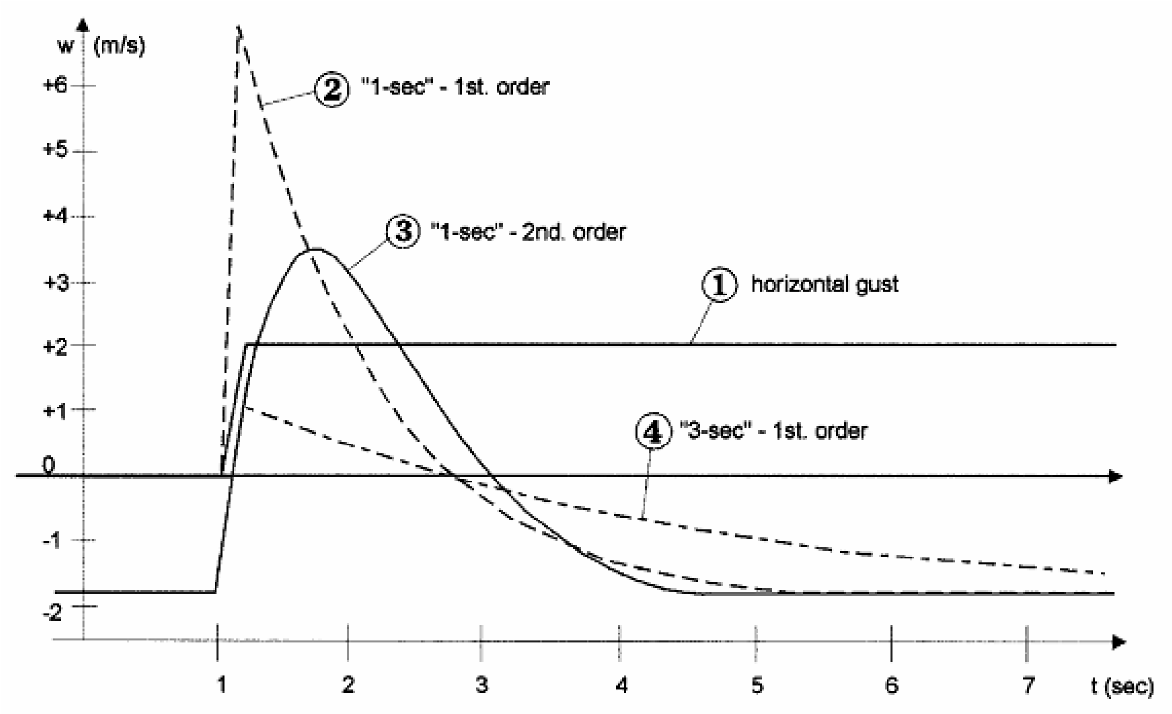


Figure 4: Horizontal gust

Now, which lessons can be drawn from these facts for practical flying?

1. If the vario climbs rapidly, without being accompanied by a strong upward thrust of acceleration, then as a rule, this is a horizontal gust. One can pull up to profit from the increase in airspeed, however, according to Sod's law, one will soon have to push over again as there is a negative jump to follow.

2. If the vario climbs rapidly after an upward thrust of acceleration, then, normally, there is a lift.

3. If the vario climbs slowly, then a wide field of lift may announce itself. Mostly one will not notice any particular vertical acceleration in the context.

In this case it is advisable to follow the speed command and slow down, to observe the variometer carefully, and to turn in only when the lift has reached the strength looked for.

5.3. The averager

The average vertical speed whilst spiralling in thermals is by far the most important value to know for distance flying. It decides whether the thermal one is exploiting at the moment is good enough to reach the goal, and it plays a decisive role when setting the McCready value. Thus it helps to determine the right

speed for cruise. As one will overestimate the average climb rate by 50 to 100% when relying on the vario signal and one's power of
estimation alone, the SB-7 is foreseen with an averaging filter (this function often, in a rather imprecise manner, is called an integrator). It is an analogue to the fast 1s-filter, however with a much longer time constant and damping optimised for that purpose.

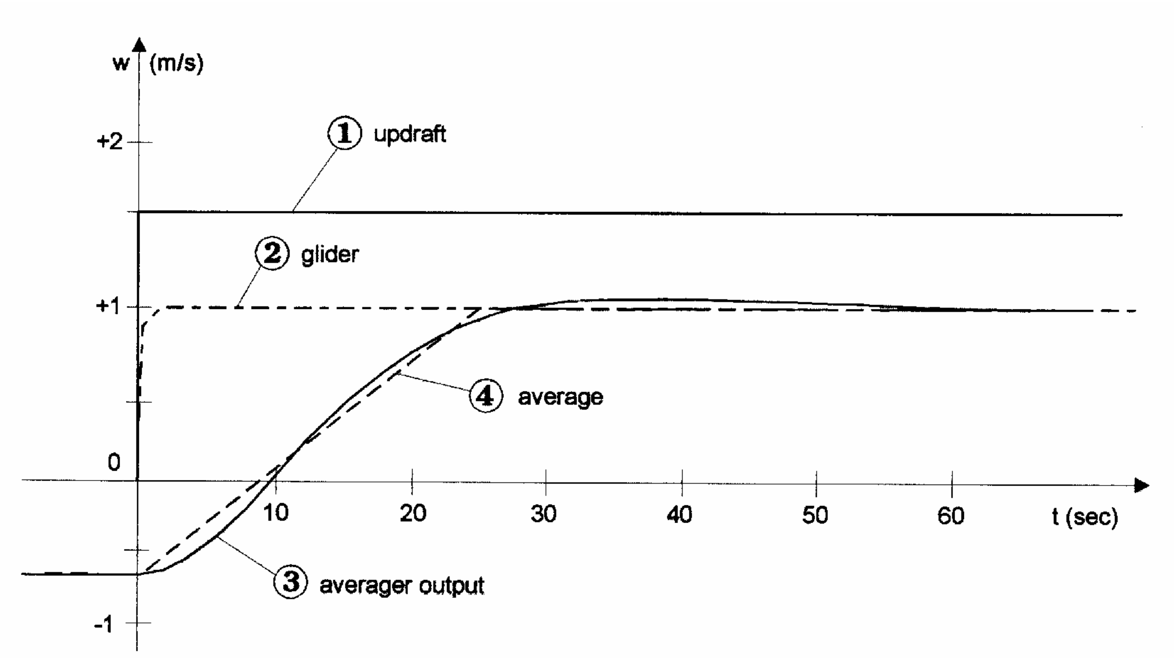


Figure 5: averager

Figure 5 shows the response of the averager (for convenience the averager is called "30 s" on the front face) upon entering and spiralling in a thermal with a constant meteorological vertical speed of 2 m/s (curve 1):
The plane, curve 2, accelerates rather fast, seen ,in this timescale, to its new vertical speed of 1,3 m/s (the increase in polar sink rate in the spiral has been neglected here). After about one circle, 25 s, the averager shows the new climb rate of 1,3 m/s (curve 3). Even during the transition the average of the last 25 seconds is being shown with good accuracy, as can be seen from the comparison between curve 3 and the theoretical average, curve 4. This holds true even if the lift is very irregular, if it oscillates between 0 and 4 m/s e.g.
The averager will indicate decreasing lift immediately after the last circle is finished.

We retain: The averager delivers the running average vertical speed taken over the (running) interval of the last 25 seconds, or differently, the vario average on the spiral just finished.

5.4. Cruise

We will not treat general tactics in transition or dolphin flight here, one will find this in the special literature, see "Reichmann" e.g., we only give some hints to pilot the glider and to interpret the speed command signal.

The McCready disk is turned such that its zero mark (outer point) comes to lie on the McCready value seen on the vario scale. When cruising, one does not read the vertical speed on the vario scale, but the airspeed indicated on the McCready disk by the vario pointer. One is to accelerate if the airspeed indicator shows less than the disk, and one should decelerate if the airspeed indicator shows more than the disk.

In other words: Accelerate if the pointer of the vario goes down, and reduce speed if it goes up!

The by far most important parameter to set is the McCready value. It is to be set according to the tactical situation. The basis for that is always the average climb rate EXPECTED in the next thermal, as long as tactical considerations do not determine it alone, as when flying over an obstacle e.g.
It must be taken into account here that even large deviations from the theoretically correct setting will lead to negligible losses in average speed only. Therefore one better sets the McCready value to a smaller number than theoretically correct, in order to avoid unnecessary risk.
It is not only of no advantage but stresses the pilot's physical condition as much as it makes average speed suffer, to practice aerobatics instead of speed-to-fly by following the pointer of the speed command always and blindly. It is of no use to change speed within short stretches of up- or downdraft. Only when a speed-to-fly error lasts longer, or is expected to last, one should correct cruise speed. One should, therefore, observe the indication carefully and react only when one thinks a correction is worth while!

NOTA BENE: The correction to be applied to cruise speed must always be the pilot's tactical decision, adapted to the particular situation. There must be no automatic reaction!

How to change airspeed in cruise ?

When increasing airspeed, being above the speed of minimum sink, the range in which one normally will fly when cruising, proper sink rate of the glider
will increase. This means that the vario pointer will sink even more when one accelerates. By this, the indication on the McCready disk will also increase: the optimal speed to fly will be larger than the speed indicated on the disk! (except when one flies actually at the optimal speed itself!) By how much is it larger ?

Rule of thumb: To the difference between the indications on the disk and on the airspeed indicator add one half: this will be the amount by which the airspeed is to be changed.

There are 2 good methods to execute an adjustment in flying speed of a known amount:

a) As a habit, the nose of the glider is pushed down or pulled up by the same angle, say 15 degrees e.g., each time speed is to be changed. Then the speed increase or decrease this way is proportional to the time the nose is down or up. Therefore the doses, the time to accelerate or decelerate, is made proportional to the speed correction to be applied.
The method leads to a style of steering which may become a bit too rough for light weather, if one does not adapt the angle of inclination to the meteorological conditions. Therefore some pilots may apply the other method.

b) The acceleration or deceleration time is held constant, at 5 seconds e.g. and the angle of inclination is adapted to the speed change to be effected.
This method automatically adapts itself to the meteorological conditions. However it is a bit more difficult to execute.

SB-7

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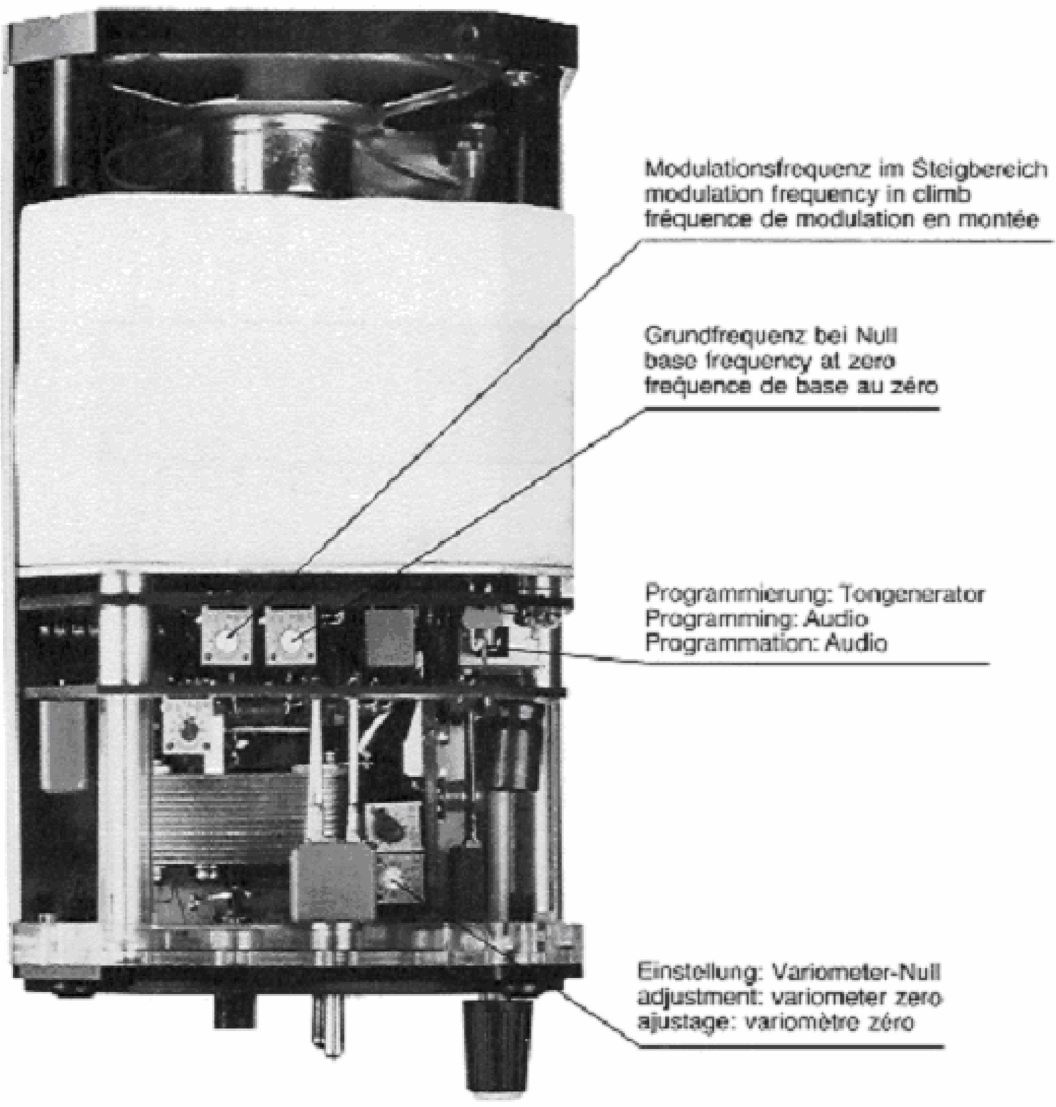

Achtung: Lackierte Potentiometer nicht verstellen!
Caution: Do not touch sealed potentiometers!
Attention: Ne pas toucher les potentiomètres scellés!