Manual for B50 SUPER VARIO

Introduction

BORGELT INSTRUMENTS are proud to present the **B50 SUPER VARIO** which is the latest in our range of variometer systems. We have been manufacturing instruments for the soaring community since 1978 and we have continued to incorporate improved methods and technology whenever appropriate. Pressure transducers replaced flow sensors in our variometers in 1982 and their reliability and accuracy has been excellent.

Why have we named this instrument the B50 SUPER VARIO ?

There are many electronic variometers on the market which provide the basic total energy variometer/audio functions and likewise there are many instruments which incorporate glide computers and navigation systems as well as speed command, netto and/or relative netto functions.

The **B50 SUPER VARIO** provides the basic total energy variometer/audio functions and ALL the advanced variometer functions of averager, speed command, netto/relative netto and speed command audio, with all functions properly altitude compensated to 22,000ft (6,700m) in one instrument which requires only 2 x 57mm (2.25") instrument panel holes, which can be operated **stand alone** or with compatible navigation/glide computer/GPS instruments.

What about the advanced features of glide computation, GPS ?

The **B50 SUPER VARIO** has been designed to allow optional expansion to a Glide Computer with GPS interface. An optional digital data module fitted inside the B50 system unit enables serial data to be transmitted to a compatible navigation instrument.

B50 SUPER VARIO Installation Guidelines:

To get the most out of your **B50 SUPER VARIO** some straight forward installation guidelines should be followed. Please take the time to read these guidelines in full BEFORE commencing installation.

AT ALL TIMES EXTREME CARE SHOULD BE USED TO PREVENT ANY INTERFERENCE WITH FULL CONTROL MOVEMENT OF THE SAILPLANE. WE STRONGLY SUGGEST THAT YOU HAVE A QUALIFIED PERSON INSTALL OR CHECK YOUR INSTALLATION BEFORE FLIGHT.

Mechanical:

1. Install the B50 into a standard 57mm panel hole using the 3mm bolts provided.

2. Install the ADU into the appropriate 57 or 80mm panel hole (dependent on size purchased)

3. Cruise/climb switch - to be installed in a convenient location. Suggested places are on the control column beside the radio press-

to-talk switch. (many sailplane factories offer this option in new sailplanes); on flap handle in flapped sailplanes. (switch shaft requires 1/4" hole)

4. Mount the speaker supplied in a convenient location. e.g. on instrument panel, facing aft toward the pilot.

Optionally: an 8 ohm CB style extension speaker may be installed. This will provide slightly improved sound with increased volume available.

5. Optional Outside Air Temperature probe should be installed in the air vent.

Electrical:

Follow the wiring diagram attached to the top of the B50*.

All wiring attaches to an external connection board (XCB) by way of screw terminal connectors. **DO NOT OVERTIGHTEN THE SCREWS** on the XCB as the connector may suffer damage. After the power, mode switch, speaker(+optional OAT) have been attached to the XCB the cable tie (supplied) may be used as a strain relief for these wires. Use any 2 of the 4 M3 holes in the XCB for this. Three M3 machine screws attach the XCB to the rear of the B50, these may be removed and the board then gently detached from the rest of the instrument allowing wiring to remain in the aircraft in the event that servicing of the B50 is required. If changing polar the B50 top cover may be removed and the XCB temporarily reattached to allow setting of a new polar.

Extreme care should be taken to ensure correct polarity power is connected to the B50. While reverse polarity protection has been fitted, we do not guarantee that under all circumstances this will necessarily protect the B50 from damage. A 1 AMP fuse (M205 type) is fitted. A SCHOTTKY protection diode (1N5189RL) is attached to the rear of the XCB.

*Further explanation of the wiring diagram:

The B50 requires positive(+) polarity (11-16 volts) and ground(-)

Mode = cruise/climb switch (Switch closed - climb mode

switch open - cruise mode is selected)

Outside air temperature (OAT) probe is optional

Temp In = temperature connection on OAT probe (white wire)

Temp Pwr = power to OAT probe (red wire)

Temp common = power return from OAT probe (blue wire)

Meter Common= common for meters 1 & 2 (blue and black wires)

Meter 1 = the round meter (white wire)

Meter 2 = the vertical edge meter or optionally another round meter (SAM) (red wire)

M2R = meter 2 repeater

M1R = meter 1 repeater

COM R = common for repeaters (blue and black wires)

SDO = Serial Data Out) these are only active if digital

SDI = Serial Data In) data module is fitted

Pneumatic:

All tubing must be in good condition and should be a very tight press fit over the fitting to avoid air leaks. Even a small air leak will compromise any variometer's performance. For extra insurance against air leaks we supply small, thick walled elastic `donuts' which you may install over tubing several inches past the end. After the tubing is properly attached to the fitting on the instrument, slide the `donut' back toward the end of the tube so that it supplies extra squeeze around the tubing/fitting area. Do not use electronic type nylon cable ties or twisted wire as this will guarantee a leak.

There are 3 connections - connect the tubes leading from the sailplane PITOT and STATIC and T.E. source to the pneumatic connections on the rear of the B50 labelled `PITOT' and `STATIC' and `TE PROBE'. Providing a good pitot and static source is very important. A Prandtl probe works well and has minimal position error. Position error will result in incorrect speed commands and netto computation. This may be compensated for by redefining the

polar in terms of IAS (indicated airspeed) instead of CAS (Calibrated airspeed). See section on `Setting up the Polar' and consult aircraft flight manual for IAS/CAS relationship.

Leak check the system following installation.

Good Practice

Mechanical

Plan your instrument panel layout for optimum scan.

Electrical

Separate power circuits for the radio and vario systems are highly recommended. The reason for this is that varios draw 100-200mA and a typical radio on TRANSMIT draws 2 AMPS. If the radios and varios share the same power bus any resistance in the circuit is multiplied by the 2 AMP current draw of the radio on transmit instead of the 200mA of the vario circuit resulting in a much larger voltage drop. This can result in your vario failing to work properly during radio transmissions particularly if the battery is low. Of course it is a good idea to minimise resistance in the power wiring for optimal radio performance. Sources of unwanted resistance are poor switch contacts, poor fuses, poor fuseholders, poor battery connectors, wire gauge too small and bad soldering. We recommend 18 gauge or larger **aircraft** wire, electronics industry type switches (not automotive as these sometimes have unplated brass contacts which oxidise) and CANNON type latching connectors for the battery. (4 pin - pin 1 positive, pin 4 ground. 3 pin - pin 1 positive, pin 3 ground.)

Extremely effective radio interference protection is built into the B50 and no difficulties should be experienced. However it is good practice not to run antenna coax and power leads in close proximity for any great length. The B50 will perform properly down to a battery voltage of 10 volts. This voltage may be monitored on the digital display on the front of the B50.

Pneumatic

The most common mistake in variometer installations is to connect two vario systems to one Total Energy line with a T-piece at the instrument panel. The only time that this is permissible is when both instruments are of the pressure transducer type. That is no flasks hence no flow. Flow sensor type instruments cause significant flows in the line to the T.E. probe and these flows can cause these instruments to interact with each other or with a pressure transducer type variometer causing weird behaviour or a general slowing of the response of both instruments connected to the T.E. probe.

The T-piece in the T.E. line should be as close as possible to the T.E. probe although in practice it has been found that if the T.E. line is split under the pilot's seat, further aft behind the seat or near the trailing edge of the wing no problems will result.

Maximising the flow resistance between two vario systems and minimising the flow resistance between each system and the outside air is the aim here. DO NOT place restrictors or gust filters in the T.E. line and then split the line to two vario systems. Place a separate restrictor or gust filter in each line to the separate vario systems. Try also to ensure that there is no excessive flow resistance in the T.E. probe mount or in the probe itself.

If a paper element filter is installed in the TE line the filter body MUST BE EXTREMELY RIGID otherwise the static pressure changes during a pullup will cause spurious variometer readings. This applies also to any gust filter bottles which may be installed ANYWHERE in the T.E. system.

There should be no leaks in any of the plumbing and long lengths of tubing should be of the less flexible plastic or rigid nylon pressure hose. This prevents problems with the sudden static pressure changes in the fuselage during zoom or pushover causing weird transients in the T.E. vario readings due to these presssure changes being transmitted through soft tubing in the T.E. line. Tubing should be securely tied down.

Specifications:

Weights B50 570gm 1lb 4oz (excluding speaker)

ADU 57mm 270gm 9.5oz

80mm 310gm 11oz

B50 power consumption (depending on audio volume)

50 to 100 milliAmps at 10 to 16 volts DC

All B50 variometer functions are altitude compensated to 22,000ft.

General:

All aircraft instruments contain glues, paints and plastics. Their life may be extended by not subjecting them to extreme heat. It is good practice to use a canopy cover if the sailplane sits in the sun before and after flying and also to insulate under the black antireflection cover. `Space blanket material' works well. Make sure the material does not short any electrical connections.

B50 OPERATION

Explanation of Controls and Displays:

BALL. = ballast state 1.0 = sailplane lowest flying weight adjustable to 1.6 times lowest flying weight.

STF 0-8Kt = speed to fly in 2 knot increments to 8 knots

0-4m/s = speed to fly in 1m/s increments to 4m/s

This is also known as Macready setting.

BUGS % = sailplane performance is degraded by bugs or rain on the wings which changes the polar and hence makes the netto/relative netto and speed command inaccurate. The bugs control may be adjusted to reflect the degradation in best L/D up to a maximum 30% degradation.

Volume (symbol) adjusts audio volume

Top switch - selects the data on the digital display.

Av. = 23 second variometer averager in climb mode, 23 second netto averager in cruise mode

V = battery voltage

C = Outside temperature as measured by probe (if fitted)in degrees Celsius.

Bottom switch - selects speed of response of the variometer.

position Up = **Fast** (symbol)

Down = **Slow** (symbol)

Vario - total energy rate of climb is displayed on the round meter (meter 1) in climb mode.

In cruise mode NETTO (or RELATIVE NETTO) will be displayed on the round meter (meter 1). Factory default is RELATIVE NETTO.

Speed to fly is displayed on meter 2 at all times (vertical edge meter if ADU is installed). Each scale division represents 2 knots (1m/s if metric) of lift or sink. That is if cruising on speed (pointer in middle) and the air changes by 2 knots of lift or sink the pointer will indicate one division up or down. It is of course irrelevant when climbing in thermals in CLIMB mode. Pointer above zero means you are flying too fast, below zero means too slow.

At all times it is the pilot's responsibility to fly the glider within its safe flight envelope.

Explanation of Audio - the output is directly linked to the meter(s).

Climb mode: In lift a chopped rising tone is heard which saturates at 15 knots of lift, sink provides a solid tone which becomes `clicks' if sinking faster than 5 knots.

Cruise mode: speed to fly audio provides a `fly faster' tone (rapidly alternating tones) and a `fly slower' tone (slowly alternating tones).

In cruise mode the audio will automatically switch to CLIMB sound when the RELATIVE vario exceeds current STF (Macready) setting. For this to work the round meter MUST be set to indicate RELATIVE. For this reason we now recommend setting the round meter to indicate RELATIVE.(Factory default)

If you really want ordinary NETTO(airmass) indication consult the factory.

CAUTION: AT ALL TIMES THE FLIGHT ENVELOPE OF THE SAILPLANE MUST BE ADHERED TO.

DO NOT EXCEED PLACARDED AIRSPEEDS FOR THE PREVAILING CONDITIONS.

Silent band increases slightly in width with increasing airspeed. The silent band is adjustable. We recommend initial flights are made with the factory settings.

FLYING WITH THE B50

On power up the vario needle will go up momentarily before going full scale down for a few seconds and then slowly return to zero. This is the normal warmup cycle.

With the mode switch in CLIMB position the digital readout is an AVERAGER with a time constant of 23 seconds and the round meter is a vario. The digital averager shows achieved climb rate over the last one to two circles providing a good guide as to when the thermal is weakening. It is useful in making you work harder (i.e. 3Kts let's try for 3.5). The AUDIO chopped tone for CLIMB has a wide dynamic range (goes over range to about 15 Kt so that strong thermals may be centred even with the vario pegged.) The averager reads to ±19.9 knots or m/s.

In CRUISE mode the round meter becomes a RELATIVE NETTO variometer.(Sometimes called SUPER NETTO)

You will see the rate of climb which would be achieved if the sailplane was circled at its normal circling speed regardless of the actual airspeed at the time. (The airspeed and hence glider sink rate is compensated for in the RELATIVE NETTO computation)This is useful when deciding whether or not to circle. The cruise audio will change to climb sound if the indication exceeds the current Macready setting.

The rest of the time you need to remember that you are in still air when the round meter indicates approximately 2 knots sink and that the AIRMASS that you are flying in is rising for any indication above about 2 knots sink. This is regardless of the actual airpeed at which you are flying.

You can optionally mark the outside of the vario scale with a small piece of white tape at the 2 knot sink point.

The AIRMASS indication is most useful for picking the best path through the air between thermals and for meteorological awareness of what the AIRMASS you are flying in is doing.

The digital display shows NETTO(AIRMASS) average over the last half minute or so.

The vertical meter is SPEED TO FLY in CRUISE mode. The AUDIO is `slowly alternating tones' for fly slower and `rapidly alternating tones' for fly faster. The audio silent band increases in width with airspeed. The change from CLIMB to CRUISE and back again occurs instantaneously with the throwing of the mode switch, so don't feel inhibited about using the switch to get the instrument to give you the most useful information when you need it.

T E Compensation

For the B50 to perform properly a source of correct Total Energy compensation is required. Probes which provide correct compensation are available from BORGELT INSTRUMENTS.

MAINTENANCE OF THE B50

Cleaning:

LCD - if required use only a soft cloth and gently wipe the display, taking care not to scratch the surface. Caution: the LCD is easily damaged. Solvents MUST NOT BE USED on LCD or labels.

Meter glass: use a soft cloth dampened with water or a proprietory glass cleaning solution.

Entering a new polar in the B50:

The B50 uses a quadratic polar approximation for the netto and speed command functions. This requires 3 coefficients labelled a,b and c. Inside the B50 top cover are instructions for switch settings and trimpot access to set these coefficients. Contact BORGELT INSTRUMENTS or your dealer for the correct coefficients for your sailplane. BORGELT INSTRUMENTS has available a small computer program to derive these coefficients from a given polar. Polar entry should be done with the ballast control on 1.0 and NO BUGS degradation. The values of the coefficients are then shown on the digital display on the front of the B50. If you have

any queries regarding data entry, please contact your supplier or BORGELT INSTRUMENTS for guidance.

There is also a `d' coefficient which is the offset applied to a netto vario (shows rate of climb/descent of the airmass being flown through) to turn it into a `relative netto' (this shows the rate of climb which would be achieved if the sailplane was circled in the current airmass). i.e. it is the sink rate of the glider while circling. By turning the `d' trimpot fullyanticlockwise this coefficient is equal to zero and the vario is ordinary netto in cruise mode.

Do not forget to return all switch settings to FLIGHT positions after setting the polar (or performing zero adjustment).

Zero Adjustments:

The round meter has a mechanical zero adjuster in the centre of the glass. The electrical zero adjust trimpots are accessible through two small holes on the rear of the B50 (see label on top of instrument).

Under normal conditions the variometer zero will not require readjustment. DO NOT TRY TO ADJUST VARIO MECHANICAL OR ELECTRICAL ZERO IN CRUISE MODE. (The netto/relative netto vario always has some zero offset in cruise mode which is perfectly normal)

The Airspeed zero may require adjustment occasionally (once a year at most). The top cover of the B50 must be removed and the instructions inside the cover followed. DO NOT TRY TO ADJUST AIRSPEED ZERO UNLESS THESE INSTRUCTIONS ARE FOLLOWED **EXPLICITY.** Adjustment of audio silent band in cruise mode:

After the B50 top cover is removed a single trimpot will be seen approximately in the centre of the top circuit board. Turning anticlockwise widens the silent band, clockwise narrows it. BE CAREFUL as this control is sensitive. A few degrees is all that is required.

Adjusting variometer speed of response:

As supplied the B50 variometer has time constants of approximately 1.0 second (FAST) and 2.5 seconds(SLOW). This will normally allow optimisation for both smooth and rough conditions. The speed command function is somewhat slower (4 and 5.5 seconds).

If desired the variometer time constant in FAST setting may be changed by accessing a trimpot through the 4mm hole in the bottom of the B50. Turning the trimpot fully anticlockwise reduces the time constant to about 0.5 seconds. Most pilots will find this too fast. The total trimpot movement available is 180 degrees which allows 0.5 seconds to 5.0 seconds to be selected. It is recommended that you do not change the factory setting unless you are sure that the two factory settings do not meet your requirements AFTER some flying time.

TO CHECK POLAR IN B50

Set`d' coefficient temporarily to zero.(See polar setup instructions)This sets the round meter to read NETTO or AIRMASS.

Fly in smooth air (no convection or wave)

Stabilise speed at 40 knots or 75km/hr (if possible)

Place B50 in cruise mode, select correct weight (ballast control), BUGS to 0 (zero)

Note NETTO reading

Repeat at 50, 60, 70, 80, 90, 100 knots or 20km/hr increments.

Fill in the following table:

IAS(KTS) 40 50 60 70 80 90 100

IAS(km/hr) 75 95 115 135 155 175 195

NETTO+ (units)

Glider type:

Weight at test:

Minimum flying weight:

Maximum flying weight:

Your name: Address:

Phone/fax:

Send to:**BORGELT INSTRUMENTS**

P.O. BOX 7474

TOOWOOMBA M.C. QLD 4352 AUSTRALIA

fax: 07 46 358796 or overseas Int+61-7-46-358796 or

email: mborgelt@borgeltinstruments.com

or their distributor in your country. A new polar will be derived and forwarded to you.

Conversion to Metric Units:

The ADU or electromechanical meters are available with metric units.

The B50 system unit only requires that the averager be converted. This is accomplished by removing the top of the case, removing the top circuit board and placing a jumper on the two vertical pins near the trimpot close to the centre of the next layer circuit board.

If ordered with metric units this will have been done in the factory.

WARRANTY

If, under normal operating use, any part of the B50 hardware proves to be defective in material and/or workmanship within the warranty period of twenty-four months from date of purchase such defective parts and/or workmanship will be repaired by Borgelt Instruments or their approved agent. All freight charges are to be borne by the owner. This warranty is not transferrable.

This warranty does not cover damage caused by misuse, neglect, accident, reversal of polarity or repair or attempts to repair by unauthorized personnel.

ADDENDUM: B50 ADU II

The new B50 ADU differs fom the original in several ways.
There is an entirely new mechanism for driving the vario pointer - a miniature stepper motor and the speed command edge meter has been replaced by blue and amber LEDS. "Fly slower" lights up one blue LED, "fly lots slower" two. Likewise the two amber LEDs indicate "fly faster". The variometer scale has been expanded and now reads from -10 knots to +12 knots and the 0 to +12 knots occupies 180 degrees of pointer movement giving 15 degrees of pointer angle shift per knot versus the old ADU 's 12 degrees per knot, a 25% increase.
This is now an active device containing a microprocessor for controlling the stepper motor and LED's and now needs 12 volt power unlike the old ADU which was passive being just a pair of electromechanical meter movements.
New production B50's have the XCB modified by the addition of a labelled multicore black cable with DB9 which plugs in to the ADU II. The screw terminal connections , while still present are no longer used. If using a repeater as in the back seat of two seat gliders use the Meter 2 connections for the second ADU II but fused 12 volt power will have to be supplied in addition to these connections. DO NOT try to run two ADU II's from one meter outlet(either meter 1 or meter 2) Use two meter outlets to run two ADU II's. If using both the old ADU design and the new, this still applies but the ADU II is always on Meter 1 so Meter 2 would have to be used for the old ADU. If we are notified that the B50 is for a two seat installation we will wire the XCB with two multicore black cables for the two ADUs. Use a straight through DB9F to DB9M computer serial extension cable to connect to the ADU in the back seat.
The new ADU is the same size as the old one but weighs a little less. It is available in both 57mm and 80mm versions.
On power up the B50/ADU II goes to full scale down for a few seconds, all LED's light , then the pointer moves slightly to -10 knots for about 5 seconds before then indicating the variometer reading. The normal minute or two on first power up is still required before the vario indicates zero(CLIMB Mode only).
There is no mechanical zero adjust knob in the middle of the meter scale. DO not open the case to adjust the mechanical zero. This is done automatically every time the ADU II is powered up.
DATE: AUGUST 2003

INDEX

B50 Digital Data Module/NMEA message structure

The B50 DDM(Digital Data Module) digitises the positions of the Macready, bugs and ballast knobs, reads the position of the cruise /climb switch and reads the True Airspeed value, current total energy variometer value, Indicated Airspeed squared value and on later B50's the outside air temperature (if the optional probe is fitted). Incoming GPS messages at 4800 baud (9600 is possible) are echoed by the B50 at 4800 baud and proprietory B50 data and B50 serial number sentences are added. Each DDM has a unique 4 digit serial number.
Note that the incoming GPS message is not required to be in NMEA format. Any text input will be echoed. The B50 proprietory sentences will be in NMEA format.
There are two hardware versions of the B50 DDM. The early version has only twelve (2 x 6) pins to mate to the socket on the early B50's and outside air temperature is not read or transmitted on these. There are also no pins for jumpers to set 9600 baud or B57 mode which is a proprietory data sentence mode used only with the Borgelt B57 glide computer. These early DDM's receive and transmit at 4800 baud only and the mode is set by the version of the firmware in the microprocessor.
The definitive version of the firmware is V3.25 and the hardware is recognisable by the 4 pins next to the 2 x 7 pin array on the DDM.
The 2 pins at the edge of the board are ground pins.
No jumpers sets 4800 baud NMEA mode
Jumper between the ground(edge) pin furthest from the 2 x 7 array and the non edge pin furthest from the 2 x 7 array sets B57 mode, 4800 baud.
Jumper between the ground pin nearest the array and the non edge pin nearest the array sets 9600 baud receive/transmit.

Limitations:
The incoming GPS message is echoed. When the incoming sentence in that frame is finished the DDM waits for 100msec then sends the B50 sentences. These must be finished before the next incoming sentence starts arriving. GPS messages which fill the frame and do not allow time for the 100msec wait and the B50 sentence time are unsuitable. Some units have a message frame every second and others every two seconds. Incoming sentences in one frame must not have gaps between them as a 100msec gap will trigger the B50 sentence.
If possible turn off any unnecessary sentences.
The Garmin 35 and Garmin 16 are suitable GPS engines as the messages and the GPS engines can be configured. Early handheld Garmin units are generally suitable. As we don't control what GPS manufacturers do we are not responsible if any particular unit has a problem with the DDM. If no GPS is connected the B50 will transmit the B50

sentences every 2.5 seconds.

NMEA sentence structure:
Speeds, vario, Macready are in knots.
Leading zeroes are suppressed.
Sentence has following format:

$PBB50,AAA,BBB.B,C.C,DDDDD,EE,F.FF,G,HH*CHK crlf

AAA = TAS 0 to 150 knots
BBB.B = Vario, -10 to +15 knots, negative sign for sink
C.C = Macready 0 to 8.0 knots
DDDDD = IAS squared 0 to 22500
EE = bugs degradation, 0 = clean to 30 %
F.FF = Ballast 1.00 to 1.60
G = 0 in climb, 1 in cruise
HH = Outside airtemp in degrees celcius (may have leading negative sign)
CHK = standard NMEA checksum
crlf = standard NMEA sentence delimiter

$PBSER, xxxx (4 digit serial number unique to every DDM)*CHK
The commas are important.

The B50 Flight generator program is available from our website. This lets a PC emulate a GPS/B50 and sends NMEA(or B57 mode) sentences out of the PC serial port. You can vary speed, altitude, heading, cruise/climb, turn rate etc. Glide computer developers will find this a very useful tool as we found during the B57 and B2000 development.