B500 VE (Vario Engine) Operation Manual

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1. INTRODUCTION

1.1 Background

Since 1978 BORGELT INSTRUMENTS have been manufacturing instruments for the soaring community. Continuing our commitment to incorporate improved methods and technology whenever appropriate we present to you the **B500 VE (VARIO ENGINE**). The B500VE not only offers the proven features of the B50 but continues our unsurpassed reputation for reliability and ease of use.
Progress in electronic technology has brought many instrumentation options to soaring. However one instrument that is still essential is the variometer. Design of a variometer system to allow response and display of information that is not only useful to the pilot's decision making but minimises the time spent looking at the information is essential. The B500 VE replaces the B50 with the addition of exciting new technology and functions providing a new presentation of information. The "information rich" 2 channel audio and a selection of high brightness LED's give the pilot relevant information at a glance.
However we are mindful of the large variation of experience and expertise of the users of our instruments and careful consideration has been given to design an instrument system which not only serves the needs of early cross-country pilots but delivers high performance to top competition pilots.

Note 1: The initial production release of the B500 has B50 functionality with the addition of the **graphical climb/airmass history** display on the GCD. Some of the features mentioned in this manual are not yet incorporated but are labelled as "future features". We will implement these as soon as possible and the system architecture will allow us to add other features and functions as yet unthought of or not yet mentioned here.

Note 2: We reserve the right to change specifications and features at any time.

1.2 Components

The new **Borgelt B500 VE** variometer system consists of several components designed to be compatible and is a complete GPS linked variometer engine capable of driving almost any glide computer. (e.g. Borgelt B2000 or various PDA based glide computers)
The 'heart' of any vario is the sensor , something we at Borgelt Instruments are proud to have perfected in our varios. Pressure transducers replaced flow sensors in our variometers in 1982 and their reliability and accuracy has been excellent. The B500VE uses surface mount technology in the electronics, and the variometer display is by a small stepper motor driven pointer plus several high brightness LEDs. This provides a display with exceptional resolution and far better contrast than the LCD type pointers (often described as 'muddy' or 'indistinct' or lacking in resolution typically 0.4Kt or 0.2m/s) The LED's allow quick intrepretation minimising scan times. A quick glance delivers the information.
The system components are: 1.2.1 **B500 system unit**

B500 SYSTEM UNIT provides 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) and serial data output including GPS data.

The B500 system unit is 115mm deep including connectors and is available in 57mm or 80mm sizes. An airspeed sensor is included in the B500 which enables calculation and display of advanced variometer functions.

1.2.2 Glareshield Control and Display unit (B500 GCD)

The GCD is a a small unit 30mm high by 82mm wide and only 30mm deep which is designed to mount under, over, in the lip of the instrument panel cover or mounted on the front of it.

The controls are closer to the pilot and the display is very close to his/her line of sight, assisting with orientation and lookout. By separating it from the variometer the variometer pointer does not obscure its displays.
It is supplied with a 0.5m cable with plug which connects to the B500 variometer unit by plugging it in to a socket on the back of the instrument.

The B500 GCD receives GPS and air data from the B500 variome-

ter unit/B500 HP-GPS and in addition to the display of the average rates of climb the B500 is controlled by the GCD. The pilot can enter Macready, bugs contamination, ballast state, control B500 audio volume and balance and in addition a simple **GPS navigation display with turnpoint database, wind** and **final glide computer** can be shown.(future feature)
This will make the instrument ideal for club gliders while the B500 also supplies RS 232 serial air and GPS data to any desired full function glide and navigation computer such as the Borgelt B2000 or any of the PDA type devices. *(see PDA-PS later)

While in theory the B500 could be controlled by a PDA or other air data computer such as the Borgelt B2000, using the GCD keeps the variometer "housekeeping" functions separate from the glide computer which simply picks up these changes in the serial data stream going to it from the B500 VE. This simplifies both the control of the variometer and of the glide computer and provides the advantages of the near line of sight display..

1.2.3 GPS unit for B500 VE (B500 HP_GPS)

A small high performance 16 channel GPS unit is part of the B500 VE and plugs in to a connector at the rear of the B500 VE. This GPS uses the latest low power technology and draws less than 30mA at 12 volts as well as providing genuine 4Hz fixes

Total energy is by probe. TE probes provide by far the best and most reliable TE compensation. There is a B500 mode where the pilot can select static (uncompensated)vario or pitot/static compensation for the motor glider case. (future feature)

The B500 has an **Outside Air Temperature** probe (OAT) and the temperature is displayed on one of the GCD pages and when fitted the temperature is used in the internal calculations

The **B500 VE** allows optional expansion to a Glide Computer (e.g. Borgelt B2000, various PDA type devices) by transmitting serial data, GPS and air data from the B500 in the form of serial messages at 1 Hz in the same manner as done by the B50. The decode of this message is available on the Borgelt Instruments website under "manuals- B50 -DDM".
See **www.borgeltinstruments.com**

The B500 VE is then the "variometer engine" for these systems.

2. INSTALLATION

To get the most out of your **B500 VE** some straight forward installation guidelines should be followed. Please take the time to read these guidelines in full BEFORE commencing installation.

Good Practice - Mechanical
Plan your instrument panel layout for optimum scan.

- Require assistance with layout? Contact Borgelt Instruments

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.

2.1 Install the B500 System Unit into a standard 57mm or 80mm panel hole (dependent on size purchased) using the 3 x M4 screws provided. – note push button switch lower left. Make sure the button operates freely in the hole.

2.1.1 All wiring attaches to an external connection board (XCB)
DO NOT OVERTIGHTEN THE SCREWS on the XCB as the connector may suffer damage.
Power +12V (+11 to +16 volts) and Ground (-) to marked screw terminals.
Extreme care should be taken to ensure correct polarity power is connected to the B500. While reverse polarity protection has been fitted, we do not guarantee that under all circumstances this will necessarily protect the B500 from damage. A 1 AMP fuse (M205 type) is fitted.

2.1.2 Cruise Climb Switch (Switch closed - climb mode, switch open - cruise mode)
screw terminal connectors on XCB and install switch 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)

2.1.3 Audio speakers - left and right side of cockpit. Note: the B500VE will operate with only one speaker attached, however you lose the features of the 2 channel audio.

2.1.4 Temperature Sensor - should be installed in the air vent.

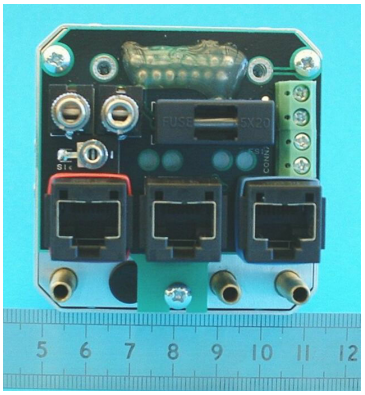
2.2 B500 HP-GPS Mount the GPS using the M5 nylon bolts. Note orientation

2.3 B500 GCD Install the GCD using a bracket under or in front of the glare shield – note position should be within usual eyescan (this minimises time of scan) and should NEVER obscure any part of the normal view from the cockpit.

You may use the two case mounting screws on each side of the GCD to attach it to the bracket. DO not substitute longer screws.

Rear view of B500 System Unit showing XCB (centimeter ruler used in photo)

The cable (RJ45) connectors with strain reliefs are colour coded (matching heat shrink on the socket and corresponding cable)



RED – B2000/PDA
BLACK - GCD
BLUE -GPS

After the power, mode switch, speakers, temperature sensor 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 B500, 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 B500 is required.

Good Practice - 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 B500 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 B500 will perform properly down to a battery voltage of 10 volts. This voltage may be monitored on the digital display on the GCD.

2.4 Pneumatics – static, pitot, T.E.

Total energy compensation is by probe. TE probes provide by far the best and most reliable TE compensation.
If you require a good TE probe, Borgelt Instruments offer a modified Irving TE probe (2 hole style).
There is a B500 mode where the pilot can select static (uncompensated)vario or pitot/static compensation for the motor glider case.(future feature)
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 B500 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' in Appendix 1 PC support and consult aircraft flight manual for IAS/CAS relationship.

- **Leak check the system following installation**. (see “leaks” article on our website)

Good Practice -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.(for example a B500 and B400 or B50 and B40 or any combination of these) 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. We do not recommend this practice.

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.

2.5 Maintenance & Care

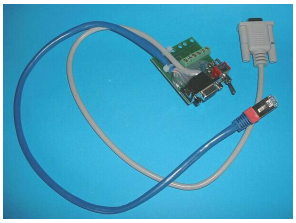
All aircraft instruments contain glues, paints and plastics. Their life may be extended by not subjecting them to extreme heat. It is good practice to use a canopy cover if the sailplane sits in the sun before and after flying and also to insulate under the black antireflection cover. `Space blanket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

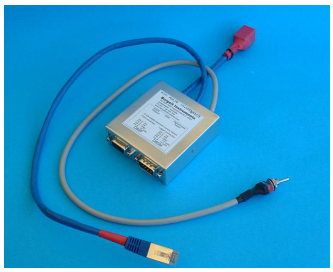
2.5.1 Cleaning:

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.

2.6 **Options** -

Borgelt B2000 Tactical Glide Computer –
easy installation using supplied
B2000 panel
mount connector
DB9 plugs into rear of B2000,
RJ45 into rear of B500





PDA-PS For those using a PDA(palmtop computer) for a glide computer there is an optional PDA power s
upply(PDA-PS) that plugs in to the B500 and provides 5 volt power and data to the PDA. There is also a connection for a logger on this unit and a panel mountable switch which allows connection of the logger direct to the PDA for declarations and optionally allows selection of Logger GPS or B500 air data/GPS for flight information.
Installation is simplified as 12 volt power must be supplied only to the B500 and the PDA-PS distributes power and data to and from the logger and PDA.

The PDA-PS will also supply power and data to a B2000 glide computer as well as to the PDA.

Specifications:

Weights B500 VE (excluding speaker)

57mm 550 gr (19 oz)

	80mm	630 gr	(21 oz)
Speakers (each)		160 gr	(5 oz)

B500 power consumption (depending on audio volume)
Approx 100-150 milliamps at 10 to 16 volts DC
All B500 variometer functions are altitude compensated to 22,000ft.

3. OPERATION:

General
On power up the B500 goes to full scale down for a few seconds, back to zero then all LED's light momentarily, then the pointer moves slightly down then slowly goes to zero 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 B500VE is powered up.

In Flight

In flight, information is available from audio, round meter/LEDs and GCD (Glareshield Controller Display).

The vario pointer is driven by a miniature stepper motor. The variometer scale has been expanded and 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 older varios giving 12 degrees per knot, a 25% increase.

3.1 **Climb Mode** (Mode or cruise/climb switch closed)

The rate of climb is shown on the round display and has a range from 10knots(5m/s) sink to 12 knots(6m/s) climb. Red and green LEDs are located near the "zero" point of the variometer. When climbing the green LED is ON when the variometer is above the running 20 second value , the red LED when below and the audio climb "beeps" change on/off ratio above and below this value.

The audio ranges from 10 knots sink to 15 knots climb beginning at 10 knots sink with "clicks" which become a solid tone above 5 knots sink and above zero the tone becomes interrupted.

When current rate of climb is below the 20 second average rate of climb the audio beeps are on 70%, off 30%. When above on and off 50%. This provides clear information about the good and bad parts of the circle and also warns of the thermal weakening.

The audio is muted and restored by pressing the push button in the lower left mounting screw position.

The large number on the main page of the GCD is the current 20 second running average rate of climb and the graphic on the right hand side shows the last one minute history of the rate of climb.

3.2 **Cruise Mode**(Mode switch open)

In cruise mode the red and green LED's indicate when the airmass is rising or sinking and the vario becomes optionally TE vario, netto or Relative netto.
Speed to fly is indicated by blue and amber LEDS. "Fly slower" lights up one blue LED, "fly lots slower" two. Likewise the two amber LEDs indicate "fly faster".

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

The "fly faster" and "fly slower" sounds are the same as in the B50 - two alternating tones for "fly slower" and two very rapidly alternating tones for "fly faster". There is a silent zone at around the correct speed to fly and the audio will not make any sound on the "fly faster" side unless you are flying slower than the speed for zero Macready. This makes the audio more pleasant and less annoying in gusty conditions.

If you wish the audio speed command to operate in the usual way with a symmetrical silent zone around the optimum speed to fly, please contact BORGELT INSTRUMENTS.

The silent band is adjustable. We recommend initial flights are made with the factory settings.

When the relative vario goes above the Macready setting the sound changes to the normal climb TE vario warning of a significant lift encounter.

The audio is muted and restored by pressing the push button in the lower left mounting screw position.

In cruise mode the large numbers on the GCD display are the NETTO(AIRMASS) average over the last 23 seconds and the graph shows airmass movement over the last minute. NETTO(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.

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

- **DO NOT EXCEED PLACARDED AIRSPEEDS FOR THE PREVAILING CONDITIONS**

3.3 Audio

The B500 has a two channel audio and is supplied with left and right speakers. The audio sounds can be switched depending on various circumstances. (future feature)

Future feature - When thermalling the sound is switched to one speaker when the circle should be opened in that direction. When cruising the speed command sounds come from the side where the next turnpoint lies.(depends on final glide computer)

Various B500 audio functions are customisable by connecting the unit to a PC, including the audio silent zone.

3.4 B500 GCD OPERATION

The B500 GCD has a RED push button top left and under it a **Black** rotary encoder with push button action and the rest of the area is occupied by a 122 x 32 graphics LCD with display area measuring 60.5 x 19 mm.
The RED push button changes the display page (4 pages)and the **Black** rotary encoder push button moves the cursor to the variable the pilot wishes to change whereupon rotating the encoder changes the variable. There is no "enter" function.
Some variables able to be changed are: **Macready setting**, **Bugs, Ballast, Volume**, **Audio Balance, Display contrast**, **vario speed of response.**
Other information ais available such as **Battery voltage, OAT**

Example 1. on the main page the Macready setting is the only variable so just rotating the encoder is all that is required to change Macready setting.

Example 2. To change volume bugs, ballast or volume press the RED page button to get to the next page where these are displayed. The cursor is on Volume when you switch to this page so to change volume just press the RED button to get to this page and rotate the encoder. To change the other variables press the **Black** encoder knob to move the cursor to **Ballast** for example and then rotate the encoder to change the ballast setting.

Macready: 0-8Kt = speed to fly in 0.5 knot increments to 8 knots
0-4m/s = speed to fly in 0.25 m/s increments to 4m/s
Ballast = ballast state 1.0 = sailplane lowest flying weight adjustable to 1.6 times lowest flying weight.
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.

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4. MAINTENANCE OF THE B500

Being a software based instrument various B500 functions are customisable by connecting the unit to a PC. Software updates are accomplished the same way. Many of these functions are user selectable (see 3. SETUP), however default setup will be performed prior to purchase for those not willing/able or ready to perform setups. Customer preferences can also be incorporated at this time.

Entering a new polar in the B500: is performed by software upload - if requested at time of order this will be done by the factory
The B500 uses a quadratic polar approximation for the netto and speed command functions. This requires 3 coefficients labelled a, b and c. 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. If you have any queries regarding software upload, please contact your supplier or BORGELT INSTRUMENTS for guidance.

Zero Adjustments:
The B500 automatically rezeros on startup - no adjustment is necessary.
Under normal conditions the variometer zero **will not** require readjustment.
The Airspeed zero may require adjustment occasionally (once a year at most).
This is done by connecting the B500 to a PC and following the zero set instructions.
(See PC support appendix 1)

This operation must be performed with the instrument switched on and stabilised, no rapid temperature changes (do not do this is the sun) and it must be done in a hangar, on the bench with the instrument removed from the glider or the pitot and static lines must be disconnected and left open or connected together temporarily.

DO NOT TRY TO ADJUST AIRSPEED ZERO UNLESS THESE INSTRUCTIONS ARE FOLLOWED **EXPLICITY.**

Adjustment of audio silent band in cruise mode: See PC support appendix 1
Adjusting variometer speed of response: See PC support appendix 1

TO CHECK POLAR IN B500
Fly in smooth air (no convection or wave)
Stabilise speed at 40 knots or 75km/hr (if possible)
Place B500 in cruise mode, select correct weight (ballast control), BUGS to 0 (zero)
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**

RELATIVE NETTO
(units)

Glider type:
Weight at test:
Minimum flying weight:
Maximum flying weight:
Current A,B,C, NETTO OFFSET numbers
Your name: Address:
Phone/fax: Email:

Send to: **BORGELT INSTRUMENTS**
P.O. BOX 7474
TOOWOOMBA M.C. QLD 4352
AUSTRALIA
fax: 07 4635 8796 or overseas Int+61-7-4635 8796
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 B500 VE is available with metric units. The only difference is a 6m/s label over the 12knots on the meter scale and a metric setup EEPROM file in the GCD. The meter and other necessary calibrations are set on power up.

5. WARRANTY
If, under normal operating use, any part of the B500 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.

5.1 Return for repair MEMO: To All Distributors/Overseas Customers

SUBJECT: Return of instruments

1. Please advise via email, fax or phone if intending to return an instrument for repair or modification giving model number and serial number and brief reason. Await our response before shipping. We may be able to guide you through a repair to remove the need to ship it to us. Or it may be an installation problem that we can get you to check.
2. Method of return

(i) for goods with a declared value of less than A$1000 you may use post - airmail or express all optionally insured. We can complete the customs clearance by fax and there is currently NO ENTRY CHARGE imposed by customs for this type of clearance. We will return goods by the same method.

If you elect to use UPS, FEDEX or DHL we will pass on the ENTRY CHARGES to you (currently approx $52)

(ii) for goods with a declared value of greater than AUD$1000 you may use POST (airmail or express) , FEDEX, DHL or UPS (to your account). There is an entry charge for all of these methods, we will pass on this charge to you.

For POST parcels, Australian Customs Service charge a fee for manual entries performed by us - currently AUD$44.25 Also because they post notifications, there is a delay of several days added to the shipping time. For COURIER (i.e. DHL, FEDEX, UPS) parcels, Australian Customs Service charge a fee for entries performed by -the courier company – currently approx AUD$52.

At all times shipping and clearance costs are to be borne by the customer unless advised otherwise by BORGELT INSTRUMENTS.

Package must be clearly labelled 'GOODS BEING RETURNED T0 MANUFACTURER FOR REPAIR'.

A note must be attached which includes shipper's name and address, value (must be greater than AUD$0), description and reason for return for customs clearance purposes.

IMPORTANT: a copy of the note must be forwarded to us separately by fax or email as it is required for clearance documentation.

We accept VISA, Mastercard and Bankcard for payments.

Aug 2005

6. FACTORY/DEALER CONTACT

Current addresses can be found on our website

www.borgeltinstruments.com

email: mborgelt@borgeltinstruments.com

alternatively contact BORGELT INSTRUMENTS

Phone: 07 4635 5784

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Outside Australia +61 7 4635 5784

Fax: +61 7 4635 8796

7. INDEX **page(s)**

Appendix 1

PC Support

TBA