

# 302 Direct Digital Variometer Manual

Firmware Version F2.6, February, 2003  
Firmware by Phil Schlosser; Text by Dave Ellis

The IGC approval document is on the CD supplied with the instrument.



302 DDV (Actual Size)



303-NAV (Actual Size)

## WARRANTY

All Cambridge Aero Instruments Products are guaranteed against defects for TWO YEARS from date of original purchase, when used in gliders. The warranty is limited to faulty workmanship and/or materials. The unit must be returned to the factory or to an authorized repair station. This warranty is void if failure is due to accident, mishandling, or if repairs are performed by unauthorized persons.

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2003 Cambridge Aero Instruments, Inc.

# **302 Direct Digital Variometer Manual**

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## 1.0 Introduction

The Cambridge 302 Direct Digital Variometer (DDV) has sensors for altitude, airspeed, acceleration, engine noise level, and temperature. It gives visual and audio climb and speed-to-fly information; and it displays climb rate, average climb rate, altitude and MacCready setting. The 302 DDV includes an integral GPS receiver that generates IGC-approved Secure Flight Logs. The instrument supports other Cambridge 300-series products such as the 304 Pocket-NAV graphic display, and the 303-NAV navigation display

Calibration and performance adjustments are firmware based. The DDV is altitude and temperature compensated. Flash memory is used for firmware as well as flight logs. Firmware upgrades are distributed via the Cambridge web site on the Internet.

There are 4 versions of the DDV:

302M Metric dial plate (M/S)	302E English dial plate (Knots)
302M-MG Motorglider (M/S)	302E-MG Motorglider (Knots)

The Cambridge DDV is supplied with ALL parts necessary for installation as follows:

1. A 302 Standard Power Cable (CAA-114)
2. The white-tipped Outside Air Temperature (OAT) probe (CAA-115)
3. The 6 foot (2 meter) beige serial data cable (HA-349)
4. The plastic laminated Operator's Card (MA-012)
5. This User's Guide (MA-013)
6. A CD-ROM with all programs and documents in PDF form.
7. Spare power cable (CAA-116)
8. A small screwdriver for the plug and connector strip (TL-001)
9. 1 meter of soft silicone rubber instrument tubing (WA-044).
10. Three "Tee" (HA-100) and three "Straight" (HA-101) tubing connectors
11. A package of 15 small tie wraps
12. A GPS antenna with SMC connector (HA-435) (302 only)
13. A remote speaker (CAF-031) (302 Motorglider version only)

The DDV supports an auxiliary NIMH battery pack (CA-117). During normal flight the instrument keeps the auxiliary battery charged. If the glider's main battery fails, the auxiliary battery powers a complete Cambridge 300 system for more than two hours.

## **2. Installing the Cambridge 302 Direct Digital Variometer**

Please don't rush to put this instrument into your glider. It is much, much more than a variometer. You will benefit from experimenting with the instrument before flying with it, so we have supplied you with a spare power connector. Connect the instrument to any 12-volt power source so you can play with it at home. Turn the TV set off for several evenings and make friends with your new instrument.

The Cambridge DDV needs to be configured for glider polar, measurement units, and pilot preferences. This is done with 302 Utility Programs using your PC or your Windows CE PDA. Section 4 of this manual has instructions for using the Utility program. The DDV can also be configured from the 303-NAV LCD display.

### **2.1 Mounting the instrument in the glider panel**

The instrument fits any standard 57-mm (2.25") round panel opening. There is an adapter for mounting the instrument in an 80-mm (3.12") hole. The knob shaft at the lower left of the instrument face will fit through the standard instrument mounting screw hole. To remove the knob for installation, snap the knob cover off with your fingernail and loosen the screw. The knob will slide off the shaft. When re-installing the knob, make sure it can be pushed in enough to actuate the momentary pushbutton switch. Be careful to center the shaft in its instrument panel hole. The push-button switch won't work properly if the shaft rubs on the panel.

### **2.2 Pneumatic Tubing Connections**

Cambridge DDV performance is limited by behavior of the glider's pressure sources, rather than by quality and calibration of its pressure sensors. Good performance will be obtained with safe, conservative choices for pressure sources. Performance optimization requires that you, the pilot, understand the issues and be willing to experiment with different sources of static and pitot pressure.

#### **2.2.1 Connections for Airspeed Measurement**

Airspeed is computed from "dynamic pressure", the difference between pitot and static pressure. The upper two ports sense dynamic pressure. Connect the instrument's Static Port (top fitting) to the same source that supplies static pressure to the glider's mechanical Air Speed Indicator (ASI). Connect the Pitot Port (middle fitting) to the same source that supplies pitot pressure to the glider's ASI.

Proper DDV function depends critically on correct airspeed measurement. It is REALLY important that pitot and static pressure connections are correct. Indicated Airspeed (IAS) is shown on DDV Screen #10 (See Section 3). During flight, make sure that your mechanical ASI and the DDV IAS readings agree. If you see a negative airspeed, you have reversed the pitot and static connections. If DDV IAS values seem really weird, check the airspeed display units. (Display units are discussed in Sections 4.3)

## **2.2.2 Connections for Altitude Measurement**

The DDV has two independent barometric pressure sensors that measure altitude. The altimeter reading shown on the instrument's HOME screen comes from a pressure sensor with no pilot-accessible port. This Altimeter also generates the Barograph trace for DDV Flight Logs.

**Note: Flight Log Altitude is based on the standard atmosphere sea level barometric pressure of 29.92”Hg (1013.2mBar)**

The second barometric pressure sensor is used exclusively by the variometer. The fitting for this sensor (TE/Static) is at the bottom of the instrument's rear panel. For diagnostic purposes, altitude measured by this sensor is shown as [Pr Al] on Screen #6 (See Section 3)

To be useful in a modern glider, a variometer must be Total Energy Compensated (TEC). This is because gliders are wonderfully efficient at converting speed into altitude and vice-versa. A non-TEC vario goes crazy during pull-ups into thermals. The glider's Total Energy is the sum of potential energy (altitude) and kinetic energy (airspeed). A TEC vario measures how quickly total energy, rather than just altitude, is changing. A vario with good TE-compensation is insensitive to “stick-thermals” caused by the pilot.

A Total Energy (TE) probe is an air pressure source that incorporates both kinetic and potential energy measurement. See any textbook on gliding for an explanation. Section 2.2.3 explains how to connect the DDV to a TE-Probe.

The Cambridge DDV measures kinetic energy (derived from its airspeed sensor). It can achieve Total Energy compensation by electronically adding potential energy (altitude) and kinetic energy (airspeed). Section 2.2.4 explains how to connect the DDV so TE compensation is done electronically without using the glider's TE probe.

## **2.2.3 Total Energy Compensation using the TE-Probe (Recommended!)**

Connect the DDV TE/Static port to the glider's Total Energy (TE) probe. The probe provides TE compensation. This configuration **REQUIRES** that you set the TE percentage shown on Screen #9 to ~0%. (No electronic TE compensation).

## **2.2.4 Electronic Total Energy compensation.**

Connect the DDV TE/Static port to the glider's Static pressure source. In this case, the Airspeed Static Port and TE/Static port are connected together. This configuration **REQUIRES** that you set the TE percentage shown on Screen #9 to ~100%. (Complete electronic TE compensation)

### **2.2.5 Using Prandtl Tube or “Triple Probe” pneumatic sources**

A Prandtl Tube or “Triple Probe” is an excellent source of both Static and Pitot pressures. These devices generally measure airspeed more accurately than pitot and static sources on the glider’s fuselage. If your glider is equipped with either device, connect the DDV Pitot and Static ports to the Prandtl tube. If possible, avoid connecting your mechanical airspeed indicator to the Prandtl tube Pitot & Static sources.

### **2.2.6 The special case of Motorgliders**

A motorglider propeller creates turbulence at the glider’s vertical fin where the TE probe, pitot source, and “triple probes are usually mounted. This turbulence won’t damage the DDV pressure sensors, but it will certainly make the variometer jump around. Contact your Cambridge agent for advice on motorglider pneumatic sources.

### **2.3 GPS Antenna Installation**

Thin fiberglass instrument panel covers are transparent to GPS signals, so mount the antenna under the cover. The GPS antenna supplied by Cambridge is non-magnetic and will not interfere with the glider’s compass. Make sure the antenna has a good view of the sky. Don’t hide it under another instrument or directly under the compass. Be careful to keep the connector from rotating as you tighten the threaded connector nut.

### **2.4 Outside Air Temperature Probe Installation**

The probe must be placed in a ventilation duct in contact with moving outside air. Drill a hole slightly larger than the probe tip into the ventilation duct. Insert the probe, making sure the tip does not touch the duct wall. Do not bend the probe near its tip. Hold the probe in place with hot-melt or silicone glue on the cable. Use tie-wraps to fasten the cable to the glider structure for strain relief.

Note: Don’t put hot-melt or silicone glue on the tip of the temperature probe

## 2.5 Power and Logic Wiring

A screw-type 10-position connector is used for all individual wires that go from the instrument to various locations in the glider. The label on the DDV case shows the numbering scheme for this connector.

### Power and Ground Connections

Four of the ten pins are associated with supplying power to the DDV.

Pin 10 is the one and only ground connection. It is at the TOP of the connector when fitted to the 302 DDV. It is used for all logic lines as well as the primary and backup battery. The CAA -114 Power cable includes a pre-wired terminal strip that provides separate ground connections for each battery or logic circuit.

Pin 1 is for un-switched power to the DDV. If the glider battery (+) terminal is connected to pin 1, the DDV will be ON whenever power is supplied to it.

Pin 2 is for switched primary power to the DDV. When the battery is connected to pin 2, the DDV is turned on and off with its pushbutton knob or the 303 ON button.

Pin 3 is ONLY for the optional Cambridge auxiliary battery (CAA-117). It supplies power if the glider's battery fails, and is automatically charged during normal DDV operation. If the glider is flying, the auxiliary battery will provide power until it is exhausted. If the glider is not flying and the glider's battery is disconnected, the DDV is smart enough to recognize this situation, and shut itself off after about 2 minutes of inactivity.

### The External Speaker

Pins 4 and 5 are for an optional 8 ohm external speaker. The external speaker wires MUST NOT be grounded. Don't connect these wires to your glider's VHF Radio speaker. 302-MG versions REQUIRE the external speaker. We recommend mounting the external speaker in the cockpit just behind your head. Volume can then be turned way down so the variometer audio is not annoying.

### The Event/ON Switch

An external, panel mounted push-button switch connected between pins 6 and 10 serves two purposes. It can be used to turn the instrument ON if switched power (Pins 2 and 10) has been chosen. It is also used to log Pilot EVents (PEV) in the flight log as mandated by the IGC. Flight Recording is fully automatic and begins when the glider starts to move. When the flight is being recorded (logged), pressing the external Event/ON button does three things. First, you will hear a short beep. Second, a PEV record is put into the flight log. Third, the instrument logs 15 fixes at the rate of 1 fix per second.

### **Note:**

**303-NAV "ON" and DDV "Event/ON" pushbuttons have the same function.**

## The Airbrake and Landing Gear Warning Switches

A switch on the airbrake actuator connects pin 7 to pin 10. The switch contacts must close when the airbrakes are UNLOCKED. A switch on the landing gear actuator connects Pin 8 to Pin 10. The switch contacts must close if the landing gear is not fully extended and LOCKED. Because each glider design requires different switch locations and mounting, we do not supply the switches.

The audible warning is a “European Police Car” sound. Warnings are heard even though the audio volume control is set to zero. Alarms are cancelled by correcting the condition, or by tapping on the instrument knob.

Warnings depend on presence or absence of airspeed as well as the switch contacts. Here is the logic:

Unlocking the airbrakes connects pin 7 to ground. When airspeed rises above 25 knots, the alarm sounds. The alarm is cancelled when the airbrakes are locked. During flight with the landing gear retracted, unlocking the airbrakes connects pin 7 to ground and sounds the alarm. Lowering the landing gear opens the connection between pin 8 and ground and cancels the alarm.

Try each of the alarm situations regularly during normal glider operation. This tests the switches. You will also become familiar with the alarm sound, and get some practice correcting each alarm condition. This will help you respond quickly and calmly in a real emergency situation.

Make no connection to pins 7 & 8 if you choose not to install the warning system.

## The External Cruise/Climb Switch

The Cambridge DDV switches automatically from cruise mode (with speed-to-fly arrows and tones) to climb mode. If no cruise/climb switch is installed, mode switching is based on changes in GPS track. Automatic mode switching typically occurs about 7 seconds after initiation of circling or cruising flight. The delay keeps the instrument from switching back and forth between modes based on short-term GPS track behavior. The pilot can also control the mode using the external switch. When combined with the Cambridge “Smart Averager”, the Averager can be reset at any time by switching modes. (See Section 7 for a description of the Cambridge “Smart Averager”.)

The cruise/climb switch is connected between Pin 9 and Pin 10. The DDV is forced into Climb mode when the contacts are closed. In Climb mode the circling annunciator on the DDV LCD screen is turned on. The toggle switch can be mounted on the control stick (contacts close when the lever points up or back for climb), or on the flap handle (contacts close when flaps are in climb settings). When the toggle switch contacts are closed the DDV Averager is reset and the instrument is forced into Climb mode. For automatic cruise/climb switching, the switch must be left in the open position or simply not installed.

### 3. The 302 Operator's Guide

This section introduces the Cambridge DDV functions. It complements and extends topics covered by the laminated 302 DDV Operator's Card.

#### 3.1 Instrument Control

- The knob can be pressed or turned.
- Press the knob once to advance Screen Index # at the right side of the screen.
- Press the knob twice (quickly) to see the HOME screen.
- Press the knob to reset an alarm condition.
  
- With optional switched power (Power to pin 2 on the 10-pin connector):
  - Turn the instrument ON by pressing the knob.
  - Turn the instrument OFF by holding the knob in for 3 seconds.

#### 3.2 The LCD Screens

**The HOME Screen shows Altimeter reading, the glider's climb rate averaged over 30 seconds, and MacCready Setting. Averager trend is shown by pointers above and below the average climb rate value. If you are flying too fast, an UP arrow at the top of the screen is lit. If you are flying too slowly, a DOWN arrow at the bottom of the screen is lit.**

**The DDV has two in-flight modes: cruise & climb. The instrument automatically detects climb mode (circling). A circular arrow on the LCD screen shows that the DDV is in climb-mode.**

**GPS signal status is shown at the far right side of the HOME LCD screen. One horizontal bar means the GPS receiver is working but has not detected any satellites. Two bars means some satellites have been detected but the receiver does not have a 3-D fix. Three bars indicate that GPS reception is OK for flight logging.**

#### **Change Audio volume by turning the knob on the HOME Screen**

**Screen #1** is for changing the MacCready setting.

The MacCready setting is expressed in Knots or Meters/second. Technically, it should be set to the climb rate expected in the next thermal. It controls the instrument's speed-to-fly function. Higher MacCready settings mean higher cruise speeds (more aggressive flying). Higher cruise speed requires more altitude for a final glide, so the MacCready setting is often adjusted to optimize the arrival altitude on a final glide.

**Screen #2** is for setting Sea level barometric pressure (inches of Mercury or Millibars). This adjustment works just like the knob on a mechanical altimeter.

**Screen #3** shows the Glider's battery voltage, [SUPP.1]  
Turning the knob shows voltage of the optional NIMH Auxiliary battery, [SUPP.2].  
Auxiliary battery voltage depends on whether it is being charged or discharged.  
If instrument power comes from the main glider battery, a fully charged auxiliary battery will read above 9.5 volts. When instrument power comes from the auxiliary battery, it will indicate about 9.2 volts when fully charged.

**Screen #4** shows audio [Au] variometer response time (to 67% of its final value). Turn the knob to select a different response time. We recommend starting with 2.3 seconds. A faster audio variometer lets you correlate sound and your "seat-of-the-pants" (kinesthetic) sense of air mass motion. Try the audio at 1.0 seconds. Properly used, a fast audio variometer helps you distinguish between real lift and horizontal gusts.

**Screen #5** shows variometer pointer [Poi] response time in seconds. We recommend a 2.3 second response time (similar to a Winter mechanical variometer). The pointer then shows the short-term average reading of the audio variometer.

**Screen #6** (English units) shows Flight Level (FL). This is the Standard Atmosphere (29.92 inches Hg) altitude as measured by the internal altimeter sensor. This altitude is recorded in the flight log. Turning the knob shows altitude from the GPS receiver [G AI], and pressure altitude [Pr AI] as measured by the absolute pressure sensor that is connected to either the TE probe or the glider's Static source.

**Screen #6**(Metric units) shows Altitude in feet rather than meters. Turning the knob shows Flight Level in either meters or feet, GPS altitude, and pressure altitude measured by the absolute pressure sensor connected to either the TE probe or the glider's static source.

**Screen #7** shows the percentage of maximum water ballast. The glider's maximum water ballast is part of the polar configuration. If the water ballast tanks are full, turn the knob to 100%. This adjusts the glider polar for proper speed-to-fly and glide altitude computations.

**Screen #8** shows the threshold airspeed for the Slow Alarm tone in km/hr or knots. Turn the knob to adjust threshold airspeed. Set the threshold about 10% above the glider's stall speed without ballast. Stall speed depends on wing loading. Wing loading depends on water ballast and on the instantaneous g-force. The instrument automatically adjusts the threshold airspeed to account for these factors.

**NOTE:**

**Slow Alarm threshold cannot be changed if you have turned the Utility Program Configuration lock ON.**

**Screen #9** is for adjusting the level of Electronic Energy Compensation. Set this to 0% if the DDV Altimeter Static port is connected to a TE probe. INCREASE the number if the vario reading goes down when you pull up. (UNDER-compensated). Set this to 100% if the DDV Altimeter Static port is connected to a glider static source. INCREASE the number if the vario is UNDER-compensated.

Technical note: 100% means dynamic pressure gain = barometric pressure gain.

**NOTE:**

**TE compensation level cannot be changed if the Utility Program Configuration lock is ON.**

**Screen #10 (0)** shows sensor readings as follows:

- Indicated Airspeed (IAS) in knots or km/hr.
- Airspeed Indicator (ASI) zero offset (should be less than 1000).
- Yaw axis (U) g-meter reading (+/- n.nn g, ~1.00 g on the ground).
- Roll axis (H) g-meter reading (+/- n.nn g, ~0.00 g on the ground).
- Outside Air Temperature (O) reading.
- Instrument Temperature (I) reading.
- Engine Noise Level (ENL) reading (0 – 999) (Not activated in V. 2.5)
- Average GPS receiver Signal/Noise Ratio (OK > 45).
- Instrument security seal status (gOOd SEAL), (bAd SEAL).  
FAI badges and competitions require a good seal.  
Flights are recorded even if the seal is broken.

**Screen #11** is for checking the display pointer and LCD

The knob moves the pointer.

The variometer pointer should be on Zero when the number = 540

All LCD segments are turned on when the number = 540

### **3.3 The Power-ON Screens**

When the instrument is first turned on, the LCD screen shows [300] [CAI].

After about 1 second, the screen shows the 4-digit serial number on the top line.

The Firmware Version is shown on the bottom line.

Screen # 2 is shown after a delay of about 10 seconds. Turn the knob to set the Sea Level Barometric pressure (Altimeter Reading) on Screen #2 at the beginning of each flying day. Press the knob once to check glider battery voltage on Screen #3. **Press the knob twice quickly to see the HOME screen.**

**On the HOME screen, the knob is the audio volume control.**

## **4. Configuring the DDV with the Utility Program.**

### **4.1 Introduction**

The Cambridge 300 Utility program is used to configure the Cambridge Direct Digital Variometer (DDV). The Utility program also transfers flight logs and can also be used to make task declarations. There are three versions of the Utility Program:

3UTPC253.exe ---- Desktop or laptop PCs  
3UT15253.exe ---- Compaq1500 & 2100 series, Casio E11, E100 series  
3UTiQ253.exe ---- Compaq iPAQ 3600, 3700, 3800, & 3900 series (WindowsCE 2002)

### **4.2 Installing the Utility Program on your PC or PocketPC**

Select the version appropriate for the computer on which the program will run. Installing the PC version is straightforward. Double-click on the executable file to start the Utility program. Installing the Pocket-PC version is more involved. We recommend copying the program to the Compact Flash (CF), MultiMedia (MMC), or Secure (SD) card used by your Pocket PC. With the card installed in the Pocket-PC, use File Explorer to copy the file to the "Start Menu" folder in the "Windows" folder. The Utility program filename will appear on the PocketPC Start Menu.

It is also possible to transfer the utility program via Microsoft ActiveSync. This requires that file transfers be activated from within the ActiveSync program. The advantage of CF transfer is that you have the Utility program accessible even after the PocketPC's batteries have been fully discharged.

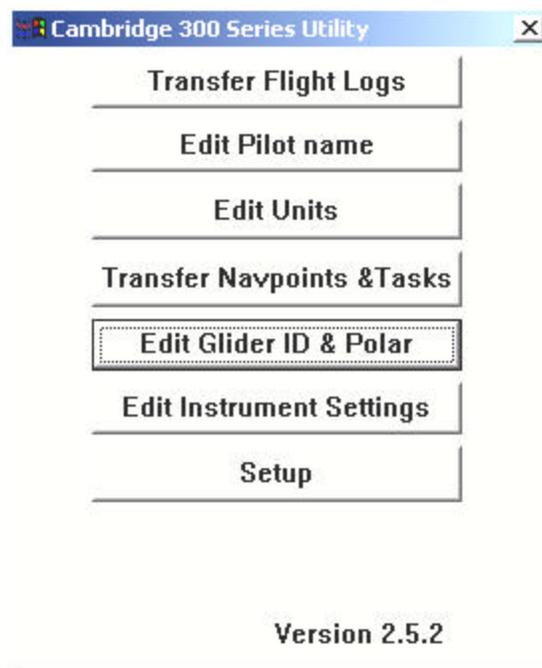
### **4.3 Running the Utility Program**

Connect the DDV to your PC using a standard serial cable, or to your Pocket-PC using the Pocket-NAV cable or Cambridge 304 Pocket PC mount. Click on the "302 Utility" icon to see the Main Menu Screen. Click on one of the 7 buttons to access the labeled functions

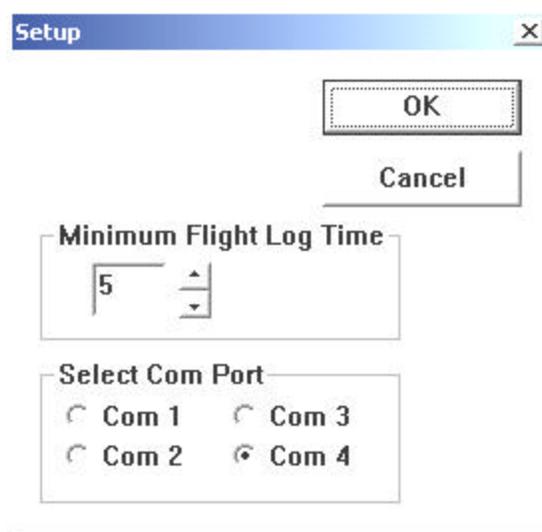
Screens from the PC version of the Version 2.52 utility program are shown on the following pages. V2.53 screens look the same as V2.52 screens. The name at the top of each screen corresponds to the button label. Press the X box at the upper right return to the main Utility Program screen. On the main Utility screen, pressing the X box exits the Utility Program.

#### **Technical Note:**

The Utility program releases the PocketPC serial dataport when it is not being used for data transfer. You can leave the Utility Program active in your PocketPC; it will not interfere with other programs that use the PocketPC serial dataport.

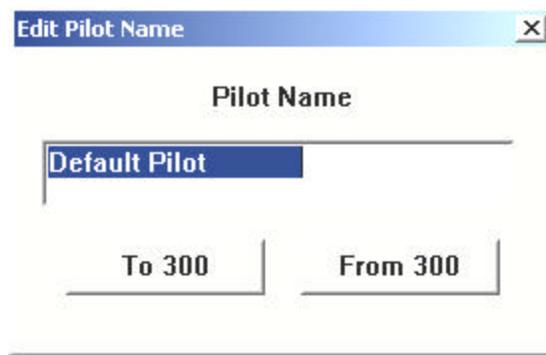


This is the Utility program menu screen. Make sure you are using Version 2.5.2; earlier Utility program versions will not work properly with DDV Version 2.5. Select any of the functions by double clicking on a “button”. Start with [Setup].

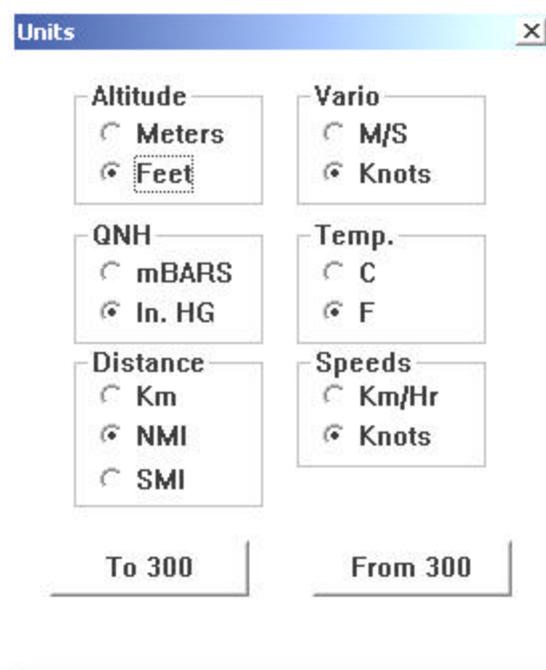


The serial datacom port on most computers is configured as COM1. Try COM2 if COM1 doesn't work. PC card Serial Port adapters are available for laptops that do not have a built-in serial datacom port. These devices are typically configured as COM4.

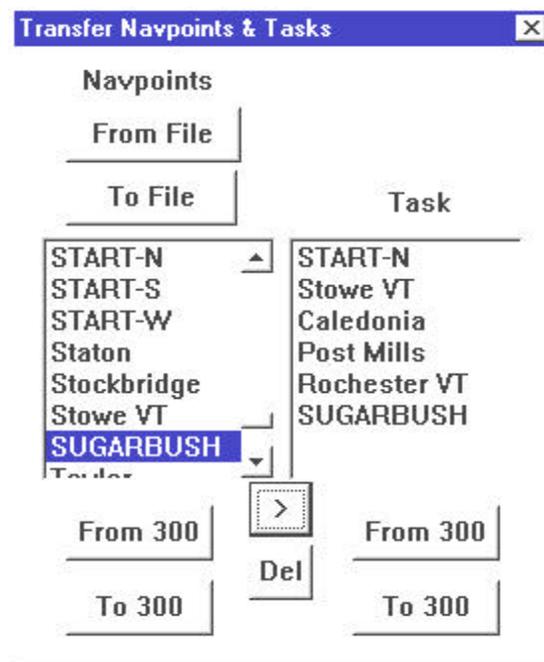
The DDV logs all glider motions. To avoid listing short, non-flight motions on the flight log transfer screen, the Utility program hides flight logs shorter than the Minimum Flight Log time. The default setting for this time is 5 minutes.



Copy the active pilot's name from the 302 by pressing [From 300]  
Type in a new pilot's name and send it to the 302 by pressing [To 300]  
The Utility program deletes ALL pilot names entered via the 303-NAV Display!



Use this screen to choose units for numbers shown on the 302 DDV and 303-NAV displays.



Press the Transfer Navpoints & Tasks button to find and transfer Navpoint files and Tasks into the DDV. The [From File] button opens a standard Microsoft “Browse Window” where you can locate an appropriate Navpoint database file (i.e. Sbush02.dat). There is a complete list of Navpoint database files on the Cambridge CD ROM supplied with the DDV. Alternatively, go to: <http://acro.harvard.edu/SOARING/JL/TP> and download a Navpoint Database for your gliderport. Press [To 300] to transfer the Navpoints to the 302.

You can also copy Navpoint database from a DDV to your PC. Use the [From 300] button to transfer a DDV Navpoint database to the screen. Use the [To File] button to store the database in the PC. This is a convenient way to copy a Navpoint database from one 302 to another.

If the DDV is used without either a 303-NAV display or a PocketPC, you can also declare a badge or record Task using this screen. Select Task Navpoints in the Left window; move them to the Right window with the [>] button. Delete a Task point by selecting it and pressing the [Del] button.



The Utility program looks into the DDV Flight Recorder memory for available flight logs. Logs are listed with the most recent at the top. The listing shows Date when the flight started, flight duration in minutes, and the pilot's name. To transfer a log from the 302 flight recorder, highlight the log and press "Transfer", or double-click on the desired log. You will be prompted to browse for a folder in which to place the flight log. File names conform to the IGC standard. File transfer progress appears at the bottom of the screen.

Note: Files are not saved unless you select "Transfer" or double-click on the log! The "Verify Files" function is used to verify the security of flight log files. Press the "Verify" button and browse to the file you wish to verify. The program will indicate whether the file passes or fails the security check.

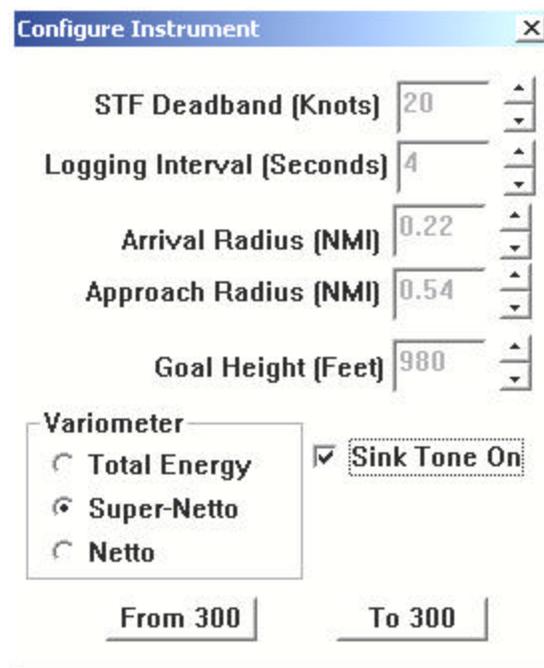
Data can be entered in each field as appropriate. Use the “input panel” or “SIP” to enter data on your PocketPC. The following table describes the fields:

Field	Function:
“Type”	Glider Type (ASW-20, Ventus 2, Flying Plank etc.)
“ID”	Glider competition number.
“Best L/D”	Best Glide Ratio (L/D) for the glider.
“Wing Area”	Wing area (m <sup>2</sup> ) -- Used to compute wing loading
“Best L/D speed”	Speed, in Km/hour, at which the best L/D is achieved.
“V2”	Speed, in Km/hour, at which the glider sinks at 2 meters/sec.
“Dry Wt”	Glider weight, in kilograms, with a pilot but no water ballast.
“Liters water”	Maximum water ballast that can be carried (Liters of water)

1000 ft=305 meters; 1 kt.=1.85 Km/hr; 1 gallon=3.78 liters=3.78 Kg; 1 Kg=2.2 lbs.

The Lock Configuration button locks 302 TE Compensation, Slow Alarm threshold speed, and polar settings. Configuration can be locked only on the PC version of the Utility program; you can see but not change the Configuration Lock on the Pocket-PC. You can see but not change Locked Configuration settings on the 302 DDV & 303-NAV.

The buttons at the bottom determine the fate of the above information. If the instrument is connected to your PC or Pocket-PC when you enter this screen, data stored in the instrument is shown. You can also get data from the instrument by pressing “From 300”. Press “To 300” to send the displayed configuration data to the instrument.



The current instrument configuration is automatically shown if the DDV is connected and turned on. You can also use “From 300” to see its settings. Use “To 300” to send the settings to the instrument.

#### “Sink tone ON”

If this box is checked, you will hear a continuous tone if the glider is going down when the 302 is in circling mode.

#### “Speed-to-fly dead band width”

If you are flying in cruise mode within the Speed-to-Fly dead-band width, the audio will be silent (except if you are climbing!). If you set dead band width to 20 knots, you will not hear cruise tones if you are flying within plus or minus ten knots of the correct speed-to-fly for the current lift or sink rate.

#### “Flight Recorder Logging Interval”

We recommend 4 seconds or less since the DDV has a large flight log memory. Logging is completely automatic. Don’t worry about running out of memory; the DDV automatically erases the oldest log in memory to make space for a new flight log.

## 4.4 Utility program troubleshooting

Communication problems may occasionally occur. If you get an error message during any of the operations requiring communications, check that no other program is using the communications port. Remember that you **MUST QUIT** any Windows CE Navigation program by selecting QUIT on the main menu. Otherwise, the Utility program will be unable to communicate with the Pocket-PC.

If the Pocket-PC CF card is full and you try to transfer a flight log to it, both the Pocket-PC and the DDV will “Crash”. To clear this condition, you **MUST** reset the Pocket-PC, and turn DDV power off and back on.

## 5. Flight Recording with the DDV

### 5.1 Introduction

Cambridge Aero Instruments pioneered Secure GPS Flight Recording for gliding competitions, and for IGC/FAI-certified badge and record flight evaluation. Working in cooperation with the IGC, Cambridge defined the basic security provisions for this class of instruments. We also wrote the draft specification for the .IGC file format now required for all IGC-approved Secure Flight Recorders. You can review the complete IGC technical specification documents at the following Internet address:

[http://www.fai.org/gliding/gnss/tech\\_spec\\_gnss.asp](http://www.fai.org/gliding/gnss/tech_spec_gnss.asp)

Since the IGC standards for GNSS (Global Navigation Satellite System) were first introduced in 1997, numerous modifications and improvements have been made. The original Cambridge GPS-NAV continues to be the premier GPS Navigation and Secure Flight Recording system for gliding, even though it no longer complies with the latest IGC specifications.

The Cambridge 302 DDV incorporates a Secure Flight Recorder that complies fully with current IGC specifications. To maximize reliability and minimize hassle, operation is completely automatic. This is in stark contrast to other GNSS flight recorders that require clearing of memory to avoid loss of flight data. Provided that the 302 DDV is properly installed and GPS signals are being received, absolutely no pilot intervention or care is required to log your flights.

Flight recording begins automatically when the glider begins to move. Pre-takeoff fixes are automatically logged at this time. Flight recording continues for several minutes after the glider stops moving. The DDV can record more than 100 hours of glider flight at 4 - second intervals. There is no way the pilot can erase flight logs. When the 302 memory is full, the oldest flight is automatically erased and replaced with the newest data.

GPS satellites transmit accurate date and time (Universal Time Coordinated, UTC) in addition to position information. The Secure Flight Recorder keeps track of time. A new flight log file is created when there is more than a 5 minute gap in logged points.

The “Header” of a flight log has information about the pilot, the glider, and the declared task. Header information can also be edited in display devices such as the 303-NAV and compatible PocketPC programs. Header data is stored with each flight log file. This means pilot name and task declarations can be changed from flight to flight.

The Secure Flight Recorder provides for annotating Pilot Events (PEV) in the flight log. This is done with an external push-button attached to its 10-pin connector. The 303-NAV ON button can also be used to generate PEVs.

## **5.2 Transferring flight logs from the DDV**

You can transfer flight logs from the DDV to either a Pocket-PC memory card, or an IBM-compatible Personal Computer. This is done with the Cambridge Utility programs on the CD supplied with your DDV.

## **6. Troubleshooting your Cambridge DDV system**

### **A. No GPS position fixes in the flight log**

If your flight logs contain only pressure altitude, the GPS receiver is not working properly. Check the DDV HOME screen for the 3 horizontal bars indicating a 3-D GPS fix. A marginal GPS antenna or antenna mounting will cause interruptions in GPS logging. You can check GPS signal strength on Screen #10 (See Section 3.2 above).

Time required for the DDV to lock onto satellites depends on the time the GPS receiver has been off:

Off- time less than 2 hours --- 30 seconds

Off-time more than 2 hours --- less than 30 days --- up to 5 minutes

Off-time more than 30 days or move to new location ---- Up to 20 minutes

Occasionally the receiver will fail to lock onto the GPS satellite constellation. Turn the DDV off and back on again to clear this fault. You may need to wait as long as 20 minutes to get a 3-D fix when the GPS receiver is in this “Search-the-Sky” mode.

### **B. The 302 LCD screen shows [300] [CAI] but nothing else.**

Disconnect any devices on the “CAI Bus” such as the 303-NAV or 306 DDV repeater. If the 302 is then OK, check cables and connectors. If the problem persists, the DDV main processor has failed. Return the instrument to your dealer for service.

C. The DDV LCD screen shows the Serial Number and Firmware version but does not advance to Screen #2.

The red wire of the Outside Air Temperature probe may be shorted to the cable shield. The DDV works without the probe, but wind measurement accuracy is degraded. Repair the probe yourself or purchase a replacement from Cambridge. Check temperature probe behavior on Screen #10.

D. The pointer sometimes does not go to zero when the DDV is turned on.

The DDV pointer is automatically set to zero each time the instrument is turned on. If the variometer dial is in bright sunlight, the optical auto-zero may not work correctly. Shield the dial from bright sunlight when you turn the instrument on.

E. Some settings on the DDV cannot be changed with the knob

The DDV can be configured to keep pilots from unauthorized tampering with safety-related settings. The configuration lock status can only be changed with the PC version of the Utility Program.

F. Vario readings swing wildly when I change airspeed.

Total Energy Compensation is not working correctly. If the DDV is connected to a TE probe, the TE value set on Screen #9 must be near zero. If the DDV is connected only to glider pitot and static sources (Electronic TE), the TE value on Screen #9 must be near 100%.

The DDV has non-pneumatic digital filters to adjust response time of both audio and visual variometer indications. If you want to use a restrictor with a mechanical variometer, put it in the tubing associated with that instrument, not in the tubing connected to the DDV.

G. Wind indications on the 303-NAV or Pocket-PC display have BIG errors.

If a high tailwind is always shown and Groundspeed is displayed, the DDV Airspeed measurement is not working right. Check, on Screen #10 that the IAS reading is approximately equal to the reading on your mechanical Airspeed Indicator. Make sure the airspeed reading is not negative! (reversed Pitot and Static sources)

H. Wind indications are about 10% too high or low.

You may have connected the glider's TE probe to the DDV Pitot or Static port. Troubleshoot as in item G. above.

## 7. Flying with the Cambridge DDV

The DDV switches automatically between Cruise mode and Climb mode if GPS Track changes more than 3 degrees/second continuously for 7 seconds. If installed, a manual cruise/climb switch can override automatic behavior and force Climb mode when its contacts are closed. The circular arrow indicates Climb mode. In Cruise mode the circular arrow disappears; a push or pull arrow appears when you are flying slower or faster than the optimum airspeed as computed by MacCready theory. The configurable audio dead band lets you fly in blissful silence when you are close to the optimum airspeed.

In Climb mode, lift is indicated by a broken audio tone. The tone is continuous in sink. Audio pitch is proportional to lift or sink. In lift, the beep rate is also proportional to the climb rate.

In Cruise mode, short beeps and the UP arrow mean you should slow down (pull up). In Cruise mode, a continuous tone and the DOWN arrow mean you should speed up (push over). The audio Speed-to-Fly (STF) dead band is set using the 300 Utility program or the Cambridge 303-NAV. The broken climb tone appears as soon as the variometer indicates lift even though the instrument is in Cruise mode. The audio is configured as a Super-Netto (Relative) variometer. When you hear the climb tone during fast cruise it indicates the climb rate you COULD achieve IF you slowed down to thermalling speed.

If the instrument is configured for "Sink Tone ON", a continuous tone will be heard if you are silly enough to be losing altitude while the instrument is in Climb mode.

If you are flying below the threshold speed set on Screen #8, the DDV audio changes to its di-di-dah "Slow Alarm" tone. The threshold speed is for an un-ballasted glider in straight flight. The instrument compensates automatically for water ballast and instantaneous wing loading as measured by the DDV accelerometer. With appropriate setting of the slow alarm threshold, the slow alarm tone can be used to optimize your airspeed during thermal climbs.

The Cambridge "Smart Averager" (the lower left number on the face of the instrument) is optimized for glider flying. It averages the variometer reading over the last 30 seconds (67% of full scale in 20 seconds). Upon switching to Climb mode, the averaging time is shortened to one second, and increases to 30 seconds as new data accumulates. In other words, the "Smart Averager" resets and starts over when the DDV switches to Climb mode. The result is an accurate estimate of climb rate within about 10 seconds of entering a thermal.

The small carat that appears on the LCD above or below the Averager reading shows whether your climb rate is increasing or decreasing. The symbol comes on if the average climb for the last 10 seconds is 10% greater than the 30-second averager reading.

## 8. Technical Specifications

Cambridge 302 DDV:

Case Dimensions: 63 mm (2.48 inches) square x 136 mm (5.35 inches) long

Note: 9-pin datacom cable connector extends 50 mm (2") behind case.

Weight: 470 grams (18 oz.), including connectors and GPS antenna.

Power supply: 8-16 volts

Current at 12 volts: 350 mA (302 with antenna and mid-range audio volume)

600 mA with fully charged Compaq iPAQ Pocket-PC

900 mA with iPAQ back-light ON at full brightness)

Auxiliary Battery:

Dimensions: 110 x 55 x 20 mm (4.3 x 2.2 x 0.8 inches)

Weight: 225 grams (8 ounces)

Battery type: 7-cell NIMH re-chargeable, 8.4 Volts

Capacity: 1500 milliampere-hours

Special thanks to Ron Webster for help in editing this manual.

## **Appendix A. DDV Firmware Upgrades**

### **1. Introduction**

DDV Firmware Version # is shown at the bottom of the power-on screen. It is called Firmware instead of Software because the program is stored on a Flash memory chip rather than on a hard drive. Firmware upgrades can be installed with either a PC or a WindowsCE Pocket-PC. A program and a data file are required. Different programs are used for PC's and Pocket-PC's. All programs use the same Firmware data file.

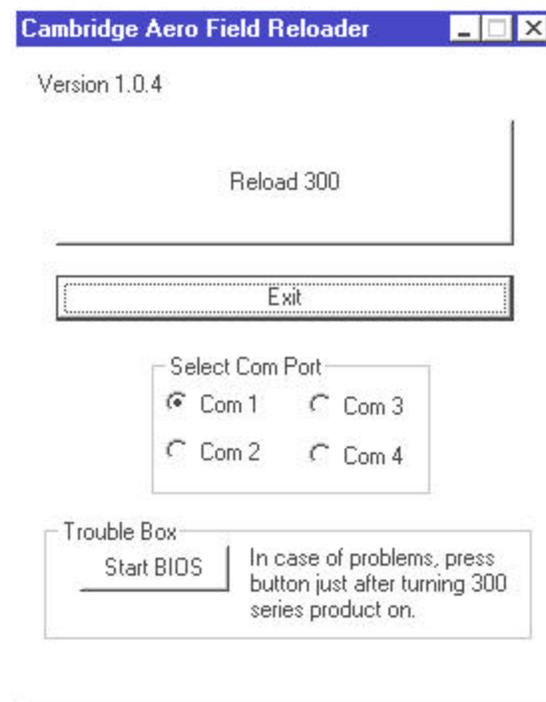
Firmware Upgrade programs:

3REPC105.exe for a PC running Windows 95, 98, 2000, or ME

3RE15105.exe for Compaq 1500 & 2100 series and Casio E11 & 100 series

3REiQ105.exe for WindowsCE 2002 PocketPCs such as Compaq IPAQ

Firmware data file: 300F26000.a37 (Digits 5-7 show detailed Firmware Version #)



## 2. Upgrading with a Personal Computer (PC)

Transfer both the PC Program file and Firmware file to one folder on your PC's hard Drive. Connect the DDV to the PC via a serial datacom cable, and turn the DDV on. From Windows Explorer, start the program by double-clicking on the program filename. Select the COM port (Usually, COM 1), click on "Reload 300", and highlight the Firmware file. Then, click on "Open". The Firmware upgrade process runs by itself.

## 3. Upgrading with a WindowsCE Pocket-PC

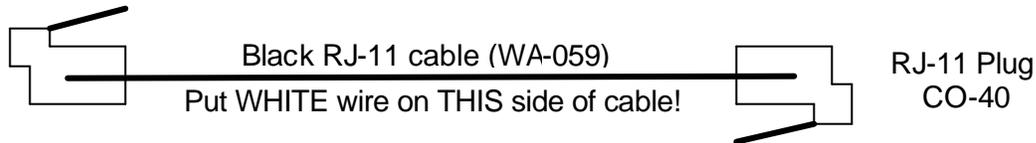
Transfer both the CE Reloader program and the Firmware file to a Compact Flash or MutliMedia card. Don't put the files into a special Folder. Put the card into the Pocket-PC slot, connect the DDV to the Pocket-PC via the normal serial datacom cable, and turn both devices on. Use the Pocket-PC File Explorer to locate the files on the card. Click on the Program file to start the process. Tap on "Reload 300", and highlight the Firmware data file. Then, click on "Open". The Firmware upgrade process runs by itself.

Note: The DDV screen shows ERR 006 during the upgrade process. This just shows that the DDV lost its brain and is waiting for a new one!

## Appendix B. 300 Series Data Communication

### The “CAI Bus”

The 6-pin (RJ-11) connector on the DDV rear panel is for the “CAI Bus”. This is an industry-standard (I<sup>2</sup>C) synchronous serial databus that supports multiple peripheral devices. Older Cambridge products used connector orientation opposite from that for the “CAI Bus”. Older Cambridge instruments used gray cables. The “CAI Bus” uses black RJ-11 cable with the following connector orientation:



Wire color	Blue	Yellow	Green	Red	Black	White
Pin #	1	2	3	4	5	6
Function	SCL	-5V	ON/PEV	+5V	Ground	SDA

SCL ----- Synchronous Clock line

-5V ----- LCD Bias Voltage

ON/PEV -- 303-NAV ON button, Flight Log PEV (same as 302 power conn. pin 6)

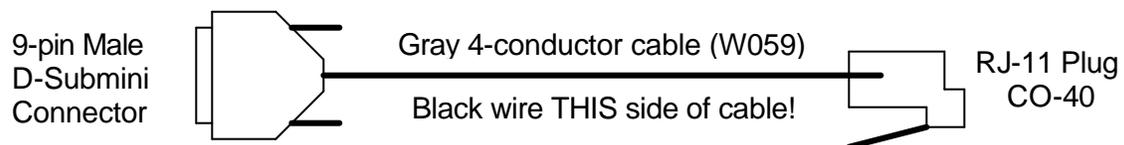
+5V ----- Device power – fuse-limited to 0.9 Amp

Ground --- Power and logic ground

SDA ----- Synchronous Data line

### Cambridge Asynchronous Data Communication

The DDV has a 9-pin female D-Subminiature Datacom connector wired as DCE. Except for pins 6 and 8, Standard RS-232 data communication voltage levels, pin designations and protocols are used. Cambridge uses 4-conductor modular telephone cable for connecting the DDV to Pocket-PC mounts. The table shows pin numbers for the D-subminiature connector, and the cable color code.



Pin #	Wire color	Function
3	Yellow	Data transfer from connected device to 302
2	Green	Data transfer from 302 to connected device
6, 8	Red	+5 volt power from 302 to connected device; fuse-limited to 0.9 Amp
5	Black	Ground for both logic and power

## Appendix C. 300 Series installation for 2-seat gliders

The 302 Direct Digital Variometer (DDV) mounts on the front seat instrument panel. The "CAI Bus" connects the 306 Repeater and two 303-NAV displays to the DDV.

**Note: The DDV serial Datacom port does NOT support simultaneous use of two Pocket-PCs.**

