

ZLog

Altitude Data Recording and Monitoring System



Introduction

ZLog was designed to provide a lightweight, compact device for measuring and recording altitude over time. It was designed specifically for use onboard a radio controlled (R/C) aircraft, but should be useful in other applications. ZLog provides live altitude information at the field, via its onboard digital display, and recorded altitude data through a serial or USB interface.

How It Works

The ZLog module uses a high-resolution barometric pressure sensor system to detect the minute changes in air pressure that occur due to changes in altitude. It is sensitive enough to detect altitude changes of less than one foot. Since it is so sensitive, it is also sensitive to changes in weather and local pressure variations. The designed use of this device is for measuring short-term altitude changes in R/C aircraft. Long-term altitude readings will vary considerably due to the varying atmospheric conditions. It is best used to measure relative changes in altitude.

Key Features

- ❑ Displays altitude information in real-time.
- ❑ Tracks maximum altitude – find out how high your aircraft flew!
- ❑ Record altitude data for later review.
- ❑ PC Interface for configuration and data download/review.
- ❑ Local controls allow configuration in the field.
- ❑ Records altitude either periodically or when triggered from an external signal.
- ❑ Firmware upgradeable.
- ❑ Lightweight at only 8 grams.

System Requirements

- ❑ PC with one of the following operating systems: Win98, Windows ME, Windows NT, Windows 2000, Windows XP.
- ❑ CD-ROM drive.
- ❑ Available Serial Port (9-pin connector) or USB port.
- ❑ 2 megabytes Hard Drive space.

Hardware

Figure 1 shows the ZLog hardware module. The module includes an onboard digital display for indicating current altitude or maximum altitude. Two pushbutton switches (S1 & S2) are used to configure the device and to select current or maximum altitude display. The 3-pin connector is used to connect to a radio-controlled aircraft's onboard receiver, which powers the ZLog module. A modular connector is used to interface to a PC for configuration and to download altitude data.

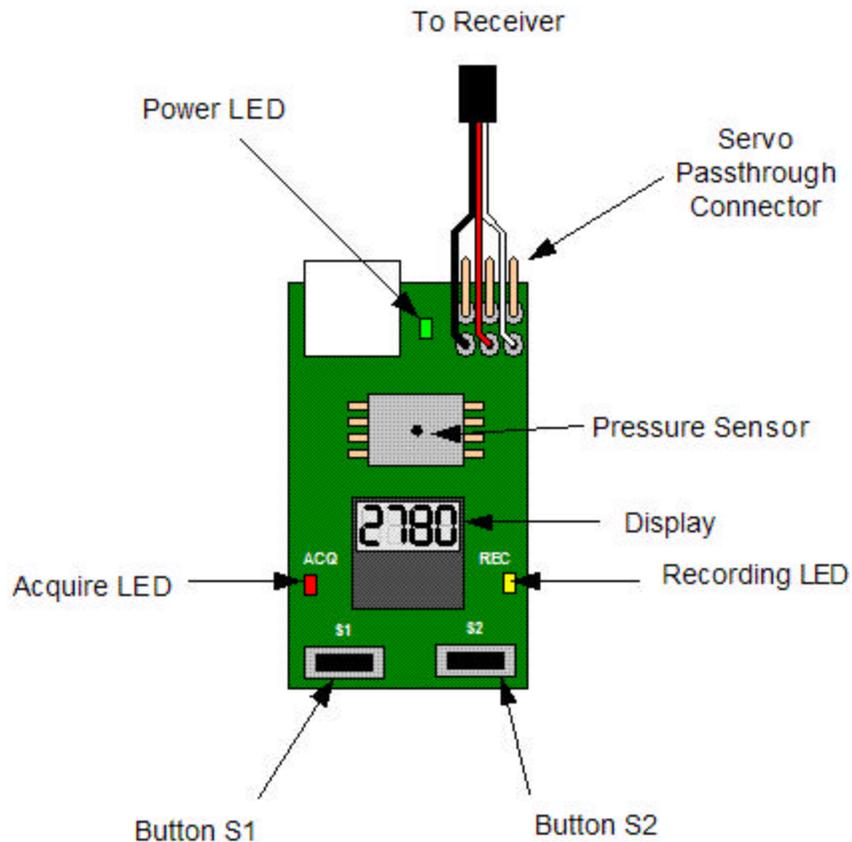


Figure 1. The ZLog Hardware.

Using the ZLog module

Powering the module

To power the ZLog module, plug the 3-pin connector into a spare receiver channel on the R/C aircraft. If you do not have an open receiver channel, you can plug the ZLog into the receiver, and the plug that channel's servo into the ZLog servo pass-through connector. Be sure to observe proper polarity when plugging the connector into the receiver. For non-R/C use attach a battery to the servo pass-through connector. A JST style connector can plug directly into the 3-pin pass-through connector. Again, be sure to observe proper polarity, or damage may result. The 3-pin pass-through connector is oriented with the same polarity as the adjacent servo wires.

Mounting the module

The ZLog module can be mounted in one of two ways:

- ❑ Inside the fuselage of the aircraft. There should be an opening of at least 0.25 sq. in. to allow air pressure inside the fuselage to equalize with the atmospheric pressure. For many aircraft, the fuselage is not airtight and is sufficiently vented to the outside air.
- ❑ On the outside of the aircraft. The pressure sensor should be at a right angle to the airflow for maximum accuracy. This means the air stream is flowing across the hole in the pressure sensor, not directly into or away from it. If possible, mount it away from the prop wash. With a 70 watt power system, the measured altitude can increase by over 20 feet due to airflow from the prop.

The module can be mounted using double stick tape, cable ties, or Velcro. Velcro is recommended so that the module can be removed and interfaced with the PC for downloading altitude data.

Be sure that the module is not touching any metal surfaces. Shorting the metal contacts on the module could short the power system, resulting in a radio system failure.

Also be sure to keep the module away from water, fuel, or other liquids.

Always range check the aircraft's radio system before flying with the ZLog module installed to verify that there is no system interference or glitching.

Operation

The module operates in one of 3 modes, depending on the position of the pushbuttons switches at startup. These modes are shown in the following table:

Mode	Startup	Display	Description
Normal	S1 not pressed S2 not pressed	Altitude	Normal operating mode – displays altitude, interfaces with PC.
Config	S1 pressed S2 not pressed	“Cfɡ”	Configuration mode – used to configure the module via the pushbuttons.
Program	S1 not pressed S2 pressed, or initiated by firmware update from PC software.	“Prog”	Program mode – used to put the module into a programming mode for loading new firmware updates to the module. Don't use this mode until specifically instructed to do so by the PC application software during an update.

Table 1. ZLog Module Modes.

Each of the modes is discussed in more detail below:

Normal Mode

Normal mode is how the module will be used most of the time. In this mode, the module continuously displays altitude. The display updates four times per second. Note that this does not necessarily correlate to the sampling period. The following controls are available in normal mode:

- ❑ Current / Maximum altitude select – pressing S1 will toggle the display between current altitude and maximum altitude. The display differentiates the two by flashing the maximum altitude. The maximum altitude is the greatest altitude recorded since the module was turned on.
- ❑ Zero altitude – pressing S1 and S2 simultaneously will zero the display. This will cause the current altitude to be set as the zero point with all subsequent readings being relative to that point. Pressing S1 and S2 simultaneously while the altitude is already zeroed will clear the zero point, causing the absolute altitude to be displayed.
- ❑ Recording Start/Stop – pressing S2 toggles recording of altitude data to the memory. When recording is enabled, the REC LED will flash once per second. Also, each time a sample is acquired and recorded, the ACQ LED will blink once. When recording is disabled, the REC light will remain dark. Each time recording is started, a new data set is recorded. When recording is stopped, the data set is closed. If the module is powered off without stopping the recording, the data is not lost, however, the module will not have recorded the number of samples, so when downloading the data, a few extra samples may be downloaded. The PC application has a feature to correct for this. Note that the number of data sets is limited only by the amount of free data storage memory available.

Config Mode

Config mode allows the module to be configured using the two pushbuttons. To enter Config mode, hold the S1 button while the module is powered on. Continue holding until “CFG” is displayed. Using the display and the buttons, the user can navigate a simple menu as shown below in Figure 2:

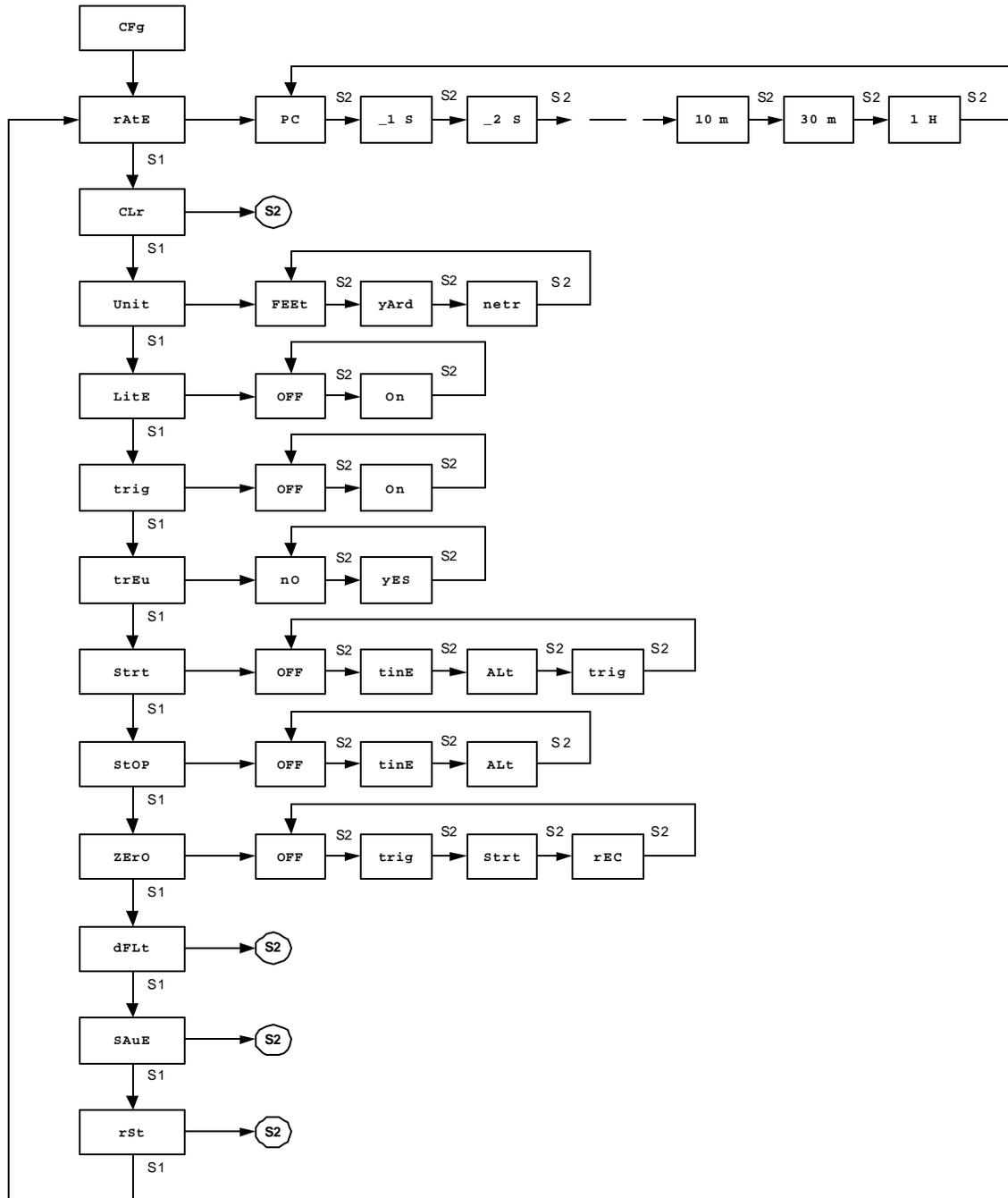


Figure 2. Menu Structure.

Pressing S1 switches between configurable options and commands, and pressing S2 changes that option or executes the command.

Note: due to display limitations, several alphabetic characters cannot be accurately rendered. The decimal point in the rate values appears as an underscore, “m” appears as an “n” with an overbar, and “v” looks like a lower case “u”.

RATE – This option selects the sampling period. Most selections are a number followed by a character. “s” refers to seconds, “m” refers to minutes, and “h” refers to hours. “.1” (_ 1s) means 0.1 seconds. “PC” indicates that the value has been set by the PC software, and does not match any of the predefined sampling intervals. The PC software can configure the module for any interval between 0.1 seconds and 4 hours, whereas, due to interface limitations, the local setup is limited to those selections in the menu.

CLR – This command clears the data memory. All data will be erased. Press S2 to execute the clear command.

UNIT – This option selects the altitude units.

LITE – This option selects whether the display backlight is Off or On.

TRIG – This option selects whether external trigger recording is Off or On. When On, each time an external trigger is detected, it is recorded with the next altitude measurement. When downloaded to the PC, this will add markers to the displayed data, indicating the time and altitude of the trigger event.

TREV – This option selects normal or reversed action for the servo triggered altitude capture. If your stick movement on your transmitter is backwards, change this option to reverse it.

STRT – This selects between auto-start recording options. Choices are:

- Off – auto-start is disabled.
- Time – recording will start after the specified number of seconds after powerup. Note that the time in seconds can only be specified on the PC Config page. Default time is 10 seconds.
- Alt – recording will start after the altitude measured exceeds the specified value. The altitude value is specified in the PC Config page. Default altitude is 20 (feet/yards/meters).
- Trig – recording will start after the first trigger

STOP – This selects between auto-stop recording options. Choices are:

- Off – auto-stop is disabled.
- Time – recording will stop after the specified number of seconds. Note that the time in seconds can only be specified on the PC Config page. Default time is 60 seconds.
- Alt – recording will stop after the altitude measured falls below the specified value. The altitude value is specified in the PC Config page. Default altitude is 15 (feet/yards/ meters).

If using altitude for both auto-start and auto-stop, the auto-stop altitude should be less than the auto-start altitude.

ZERO – This selects between auto-zero altitude options. Choices are:

- ❑ Off – auto-zero is disabled.
- ❑ Trig – the altitude measurement is automatically zeroed after the first trigger. Once the first trigger occurs, this is disabled until next powerup.
- ❑ Pwr – the altitude measurement is automatically zeroed at powerup.
- ❑ Rec – the altitude measurement is automatically zeroed when recording is started. Once the first recording is started, this is disabled until the next powerup.

DFLT – This command resets the configuration values to defaults. The default values are: Rate = 1s, Units = Feet, Blank = On, Trig = Off, Trev = No, Strt = Off, Stop = Off, and Zero = Off. This will also clear any calibration values.

SAVE – This command will save the changed parameters. None of the option menus will be effective until the save command is executed. Press S2 to execute the save command.

RST – This command will reset the module. This is useful after saving changes to the options to switch back to normal operating mode without have to power off and on the module.

Program Mode

Programming mode allows new firmware to be loaded into the ZLog module through the PC interface. Do not enter this mode except when instructed to do so by the PC application, when downloading a firmware update.

PC Interface

The PC interface serial adapter connects to the ZLog module's 4-pin serial interface. Note that when connected to the PC, the ZLog module still requires external power through either the 3-pin cable connected to an R/C receiver or through the servo pass-through connector.

The PC interface USB adapter connects to the ZLog module's 4-pin serial interface. When connecting the USB adapter, you can also plug the 3-pin receiver cable into the 3-pins of the USB adapter to power the ZLog module. Ground (black) is toward the center of the USB board.

PC Software

Installation

To install the ZLog PC software, insert the CD into your computer. It should auto-run the setup program. If not, open an explorer window for the CD drive and open the Setup.exe file. This setup

program will guide you through installation of the ZLog program. If you have the USB interface, select the USB driver installation when asked to select the install components.

Startup

The setup program installs a shortcut to the ZLog software accessible as follows:

Start – Programs – ZLog – ZLog

Note: if you changed the default install location, your path will differ.

When you execute ZLog, the following screen will appear:

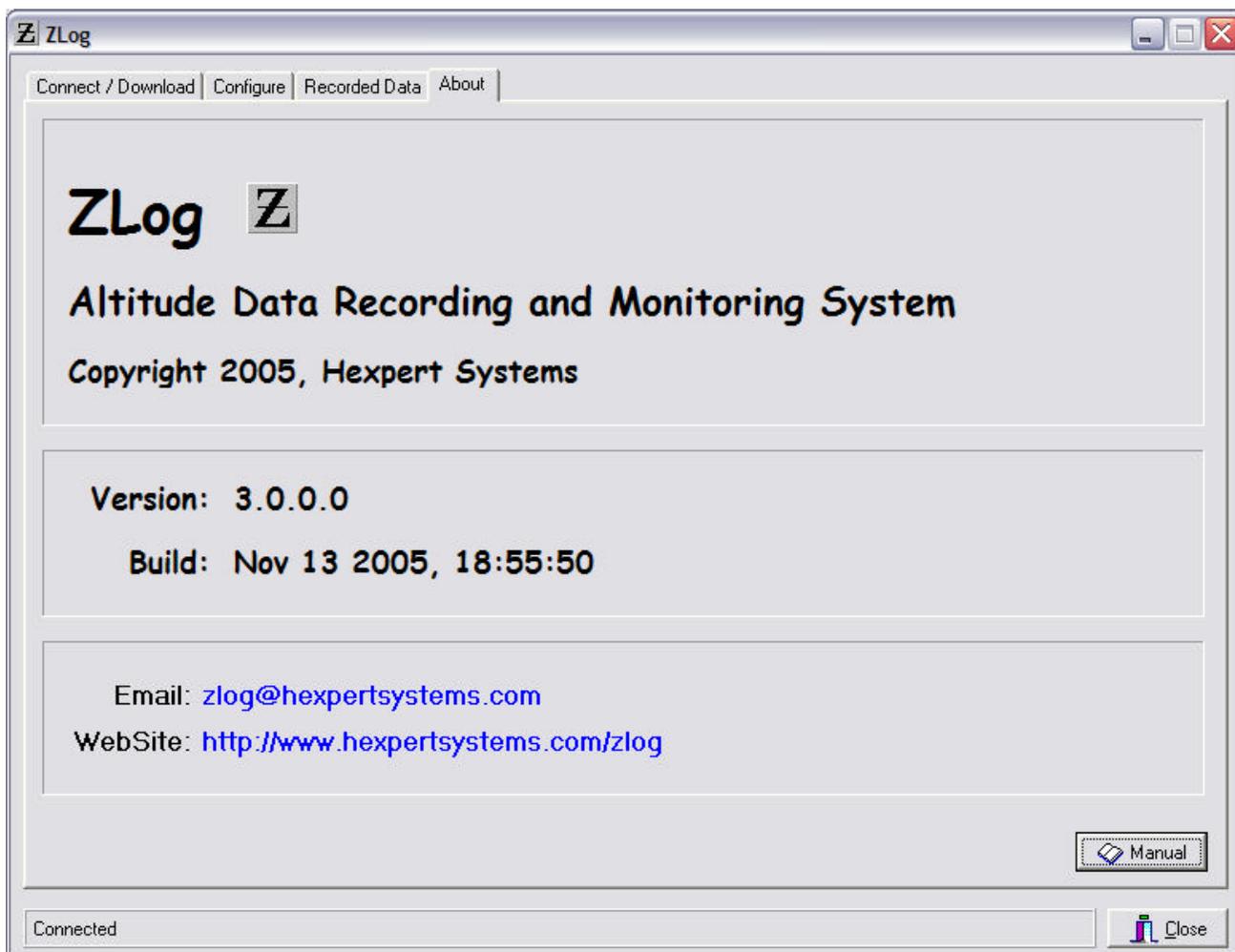


Figure 3. ZLog About Screen

To contact Hexpert Systems via email, click the blue email address line. To access the ZLog web page, click the blue web address line. To view the manual, click the manual button. After several seconds, the program will switch to the Connect page.

Connecting to the hardware

The Connect page is shown below:

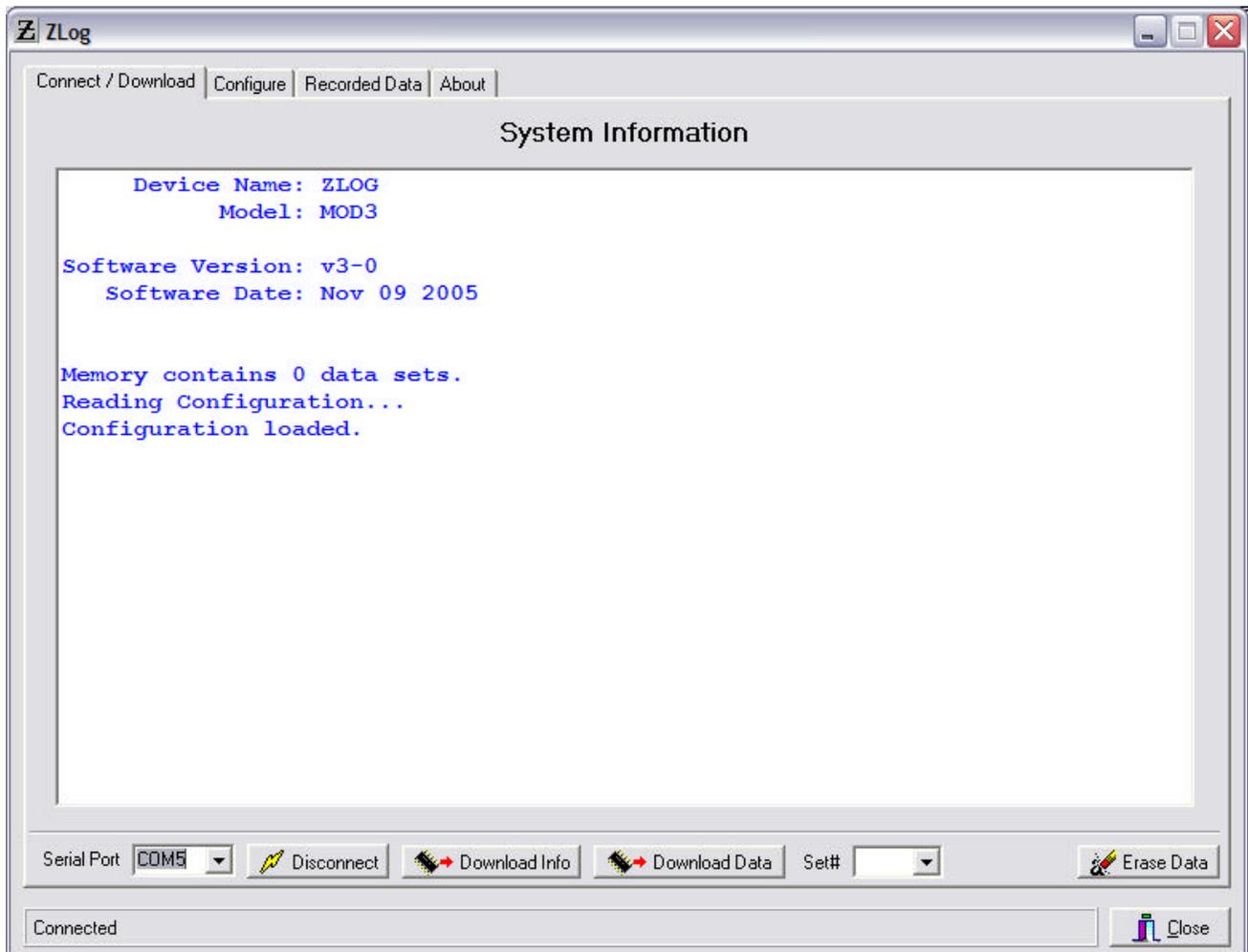


Figure 4. Connect and Download Screen

Before connecting you must first specify which serial port the ZLog module is connected to. Do this using the drop-down box and select the proper COM port. Note that the USB adapter drivers will install a virtual COM port for the USB connection. First apply power to the module, then click “Connect” to establish communications. The program will open the serial port, and attempt to read the device configuration. The system information window displays the status. If the connection was successful, the bottom status line will indicate “Connected”. Once connected, click “Download Info” to read the device information. This will indicate the ZLog module’s version and build date, and will display the number of data sets recorded in the device’s memory.

To download data from the ZLog module, select which data set you wish to download using the “Set#” drop-down box, then click “Download Data”. When downloading is complete, the Information window will indicate the number of data samples loaded. To view the data, select the

“Recorded Data” tab. Select “All” in the drop-down box to download all data sets stored in the module.

To erase all data in the device, click the “Erase Data” button.

Configuring the ZLog Module

To configure the ZLog module, select the “Config” tab. The Config window is shown below:

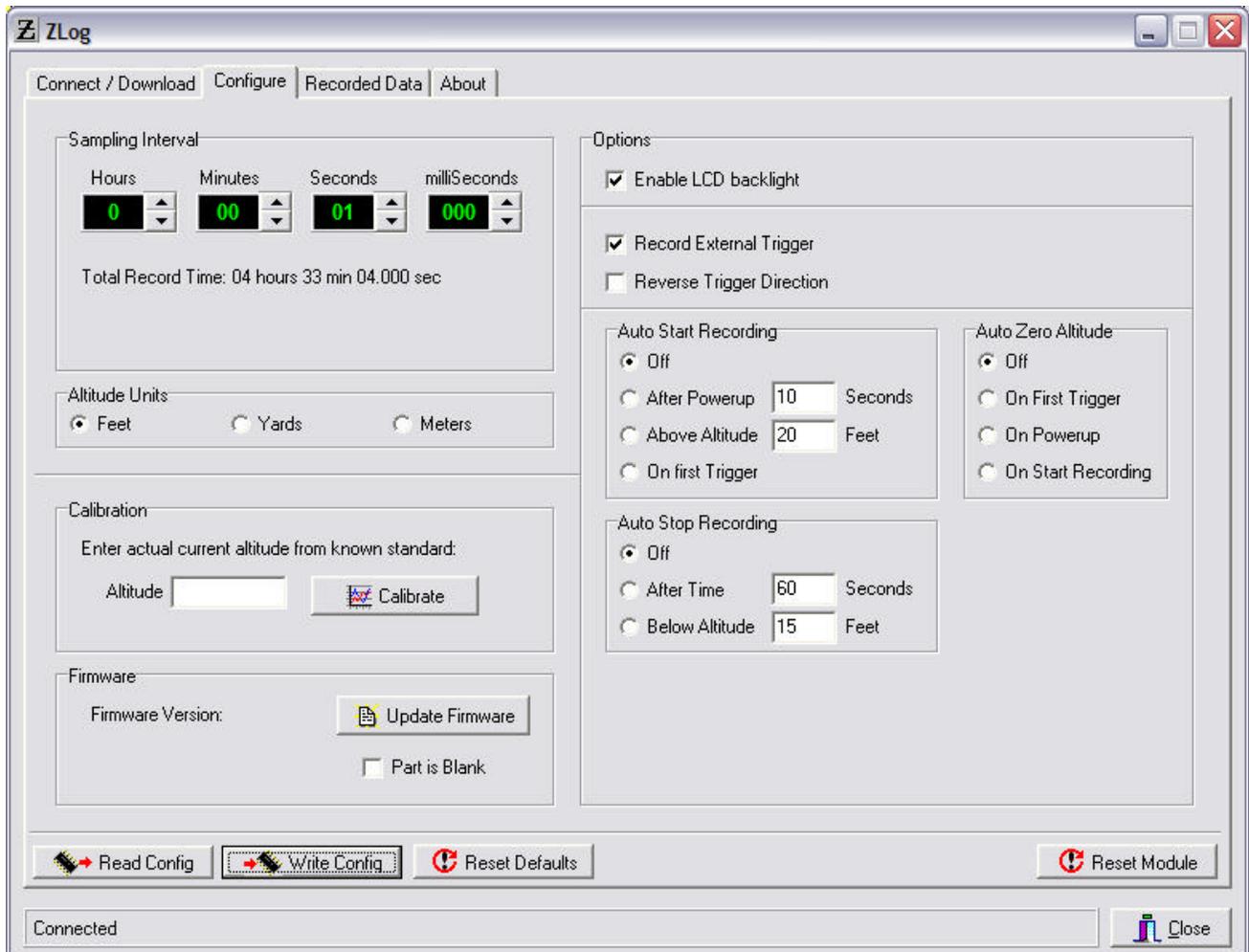


Figure 5. Configuration Screen

Sampling Interval

Use the up and down arrows in the Sampling Interval box to adjust the sampling interval for the ZLog module. This will be the interval at which the module will record altitude samples. The minimum value is 100 milliseconds (0.1s) and the maximum is 1 hour.

Altitude Units

This sets the units for the module's displayed and recorded altitude.

Blank Display (MOD1 or MOD2)

This enables or disables display blanking. When enabled, the display will go blank after 30 seconds of inactivity (no buttons pressed) to conserve power. When disabled, the display will remain on continuously.

Enable LCD Backlight (MOD3)

This enables or disables the display backlight.

Record External Triggers

Check this box to enable trigger capture from an external trigger. This is designed for R/C aircraft used for aerial photography. When using a receiver channel to trigger a camera shutter, the ZLog module can be connected to the same channel with a Y-cable. This allows the module to detect when the camera shutter is triggered, and will then simultaneously mark the next altitude measurement. When downloaded to a PC, the altitude plot will also mark the time and altitude of each camera trigger event.

Reverse Trigger Direction

When using an external trigger for the altitude capture, this will reverse the direction the transmitter stick or switch must move in order to trigger the capture.

Auto Start Recording

This selects options to auto-start recording. Choices are:

- Off – auto-start is disabled.
- After Powerup – recording will start after the specified number of seconds after powerup.
- Above Altitude – recording will start after the altitude measured exceeds the specified value
- On First Trigger – recording will start after the first trigger.

If the option changes, the module should be reset before the option will take affect.

Auto Stop Recording

This selects options to auto-stop recording. Choices are:

- Off – auto-stop is disabled.
- After Time – recording will stop after the specified number of seconds.
- Below Altitude – recording will stop after the altitude measured falls below the specified value. If using altitude for both auto-start and auto-stop, the auto-stop altitude should be less than the auto-start altitude.

If the option changes, the module should be reset before the option will take affect.

Auto Zero Altitude

This selects options to auto-zero the altitude. Choices are:

- Off – auto-zero is disabled.
- On First Trigger – the altitude measurement is automatically zeroed after the first trigger. Once the first trigger occurs, this is disabled until next powerup.
- On Powerup – the altitude measurement is automatically zeroed at powerup.
- On Start Recording – the altitude measurement is automatically zeroed when recording is started. Once the first recording is started, this is disabled until the next powerup.

If the option changes, the module should be reset before the option will take affect.

Calibration

Since the ZLog module uses a barometric pressure sensor to measure altitude, it is subject to variations in atmospheric pressure due to weather and other localized phenomena. To set the altimeter to read correct altitude for your location, enter the actual altitude at your location in the calibration box. The units for the value should be the same as the module's configured measurement units. Click the "Calibrate" button to upload the information to the module. It will store the altitude correction and apply that correction to all subsequent measurements. To clear the calibration, click the "Reset Defaults" button. Note that changing atmospheric conditions will affect the calibration. If using the module for absolute altitude measurements, daily calibration is recommended.

Firmware Upgrade

The ZLog module supports the ability to upload new firmware to the module. This allows new features to be installed in the field. To update the firmware, click the "Update Firmware" button. The program will prompt for the file path of the new firmware file (*.hex). You should only use a firmware update file specifically provided for the ZLog module. Using an incorrect update file will render the ZLog module inoperable. After specifying the new firmware file, follow the instructions given by the PC application to install the update. Refer to Appendix A for troubleshooting.

Read Config

Click the “Read Config” button to download the module’s current configuration to the PC program.

Write Config

Click the “Write Config” button to upload the new configuration to the ZLog module. The module will store the new configuration in non-volatile memory.

Reset Defaults

To restore the module’s configuration to factory defaults, click the “Reset Defaults” button. This will clear the calibration and reset the config values as follows: Rate = 1 second, Units = Feet, Blank = On.

Reset Defaults

This will reset the module.

Working with the Data

Click the “Recorded Data” tab to display the data window:

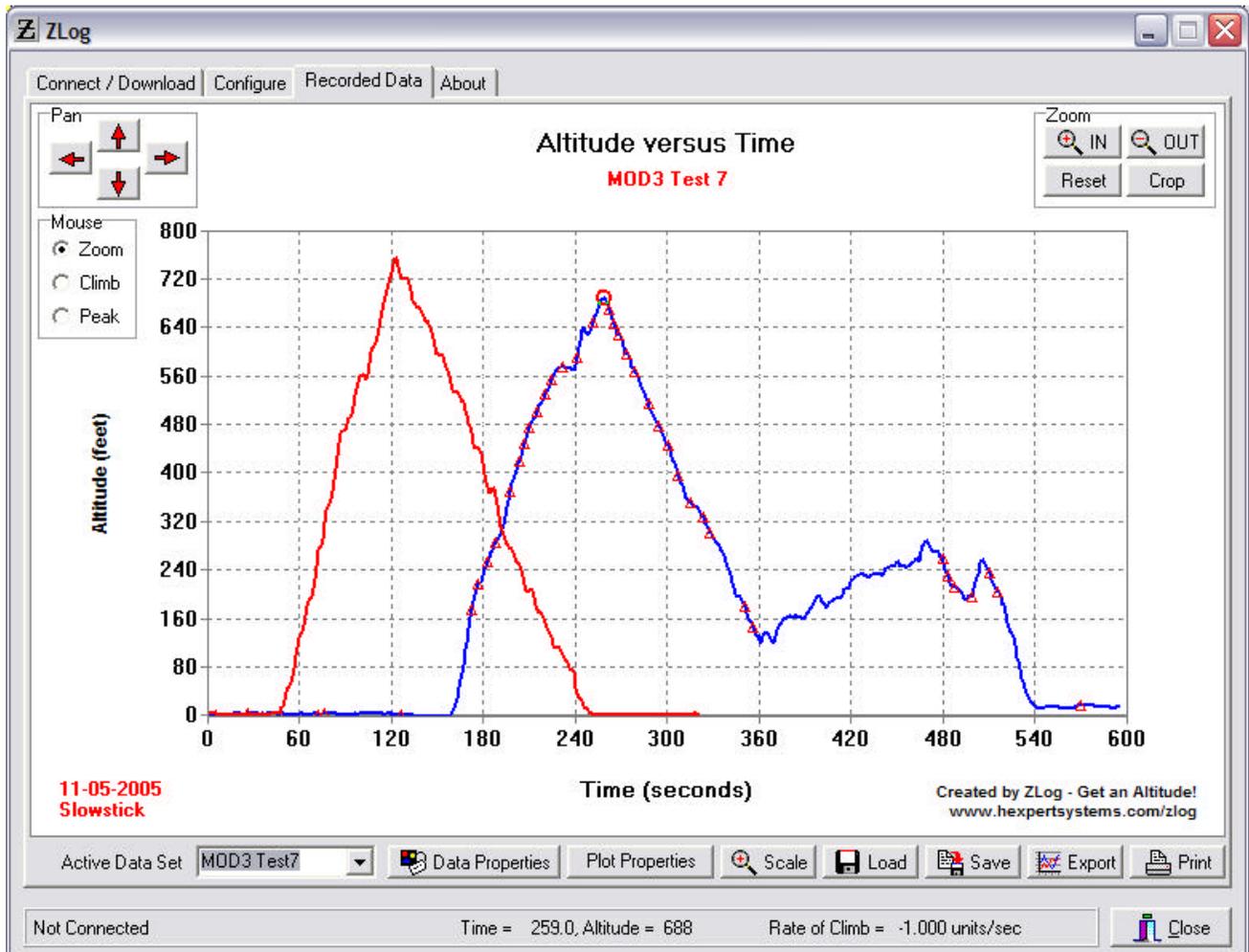


Figure 6. Data Screen

Plot Window

The altitude data is displayed in the plot window, with altitude on the y-axis and time on the x-axis. The position of the data in the plot window can be modified using the keyboard with the following keys (you may need to click in the window before the keys will work):

Shift + arrow keys = move the data in the corresponding direction.

Ctrl + arrow keys = zoom the data in or out in the corresponding direction.

Zoom can also be accomplished by dragging the mouse cursor over the plot area while holding the left mouse button, and drawing a box around the desired zoom area.

When moving the mouse over the plot area, a read circle will appear on the data points, indicated the nearest value. The time and altitude for that point are shown in the status bar at the bottom of the screen. Also shown is the rate of climb between that point and the previous point.

You can also use the “Pan” buttons in the upper left of the window to move the plot area in relation to the data. The Zoom buttons to the upper right will allow you to zoom the plot area in or out. Clicking “Crop” will delete any data outside the plot area. After zooming in or out, you can click “Reset” to return to the last scaled plot size.

To annotate peaks in the data, select the active data set to mark, select “Peak” from the Mouse options box, and click the data where you want a data point to be marked. A crosshair with label will appear at the closest data point. To delete the mark, click in the same location again.

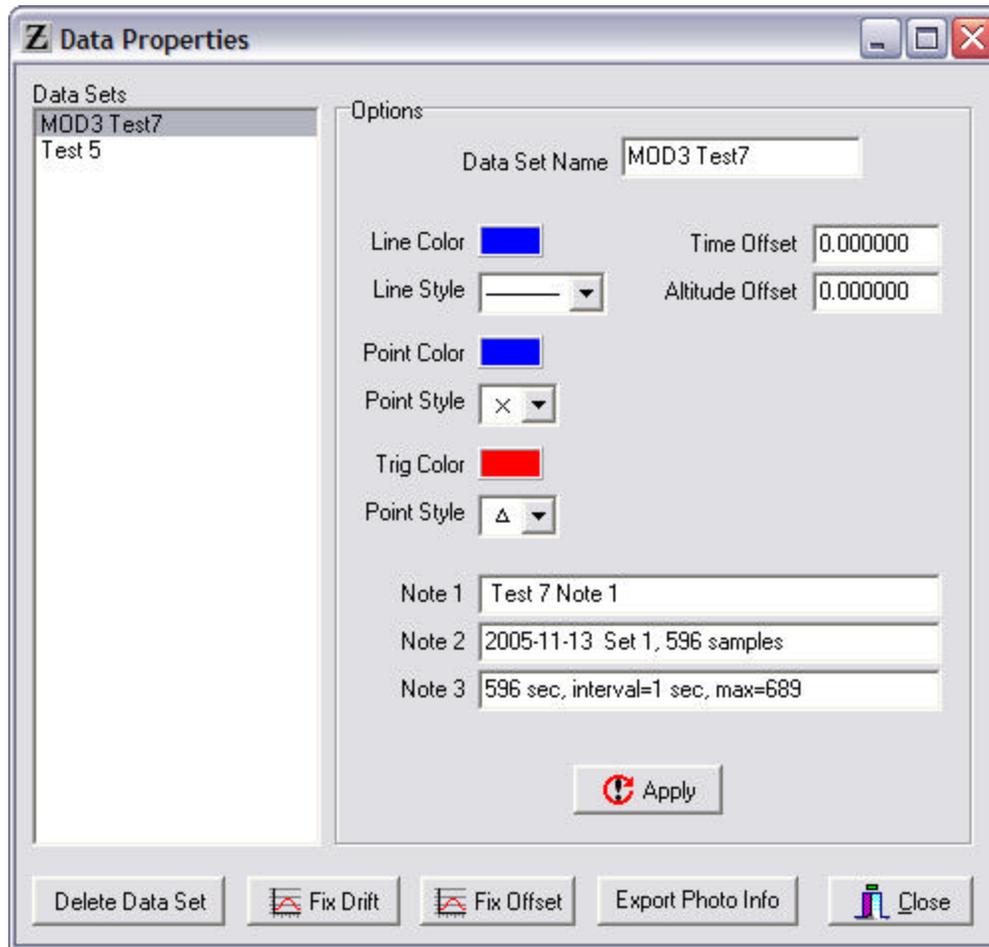
To calculate a climb or descent rate over a region of the data, and select the active data set, select “Climb” from the Mouse options box. Click and hold the mouse button on the plot at the location you want to start measuring, drag the mouse to the end of the data range while continuing to hold the button, then release the button. The software will calculate the climb or descent (negative value) over the range and mark the value above the range.

Active Data Set

This drop down box selects which data set is currently active. Moving the mouse across the data or marking peaks and climbs is performed on the active data set.

Data Properties

Clicking this button will display a dialog box allowing you to edit the properties of the displayed data sets:



The left column displays the list of data sets. Click on one to select it and edit its properties.

The right area allows you to modify the properties of the data set, including colors for the line, data points, and trigger points, line style, and data set name. You can also add an offset to the time or altitude axis. This may be useful for lining up several data sets for comparison. Also, you can add notes here to your data to record any parameters regarding the flight. Notes 1 and 2 are filled in automatically when you download the data, but you can edit them to whatever you desire.

Delete Data Set

Click this button to delete the currently selected data set.

Fix Drift

Clicking this button will modify the selected data set to compensate for pressure drift over time.

Fix Offset

Clicking this button will modify the selected data set to remove an offset in the data. For example, say you forget to zero your altitude before takeoff, this will remove the ground level altitude, so that the data is referenced to zero.

Export Photo Info

This will allow you to export a data file containing a numbered listing of each photo trigger event, including the time and altitude when the event occurred. Note that this button is only available for data where triggering was enabled.

Edit Plot Properties

Clicking the “Edit Plot Properties” button will display another window, which allows customization of the plot:

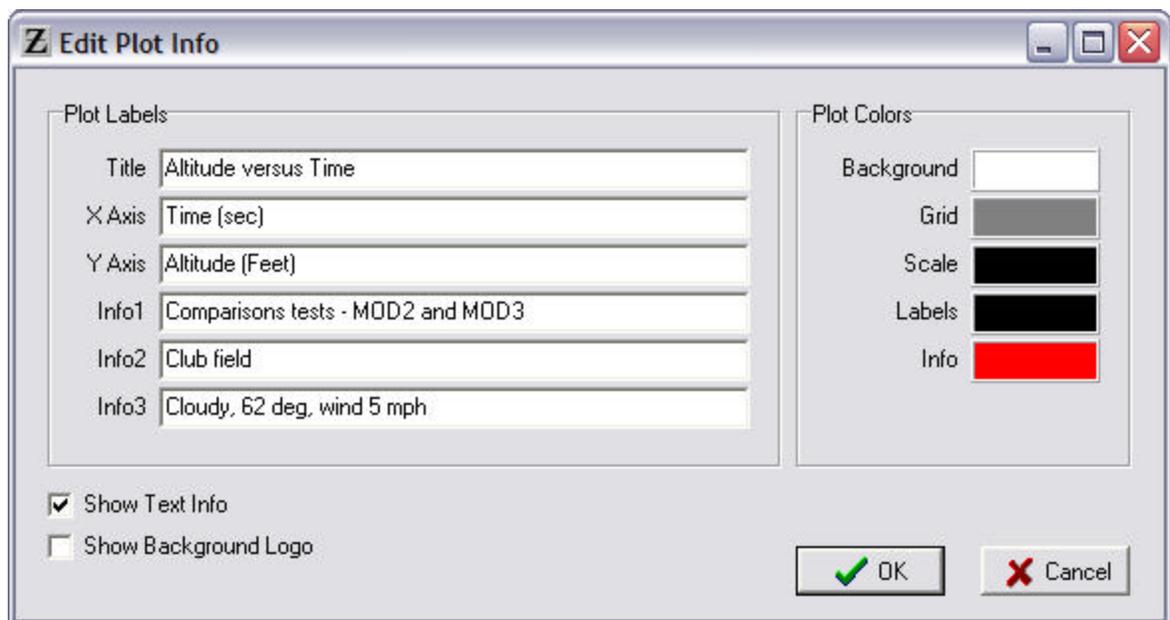


Figure 7. Plot Information Edit Dialog

The title, axis labels, info lines, and plot colors can all be customized as desired.

Show Text Info

When checked, this enables display of the text entered into the “Info” boxes on the plot, allowing you to add information to the plot.

Show Background Logo

When checked, this enables the ZLog logo displayed as a background on the plot.

Scale

Click scale to display a window for manually adjusting the plot axis ranges:

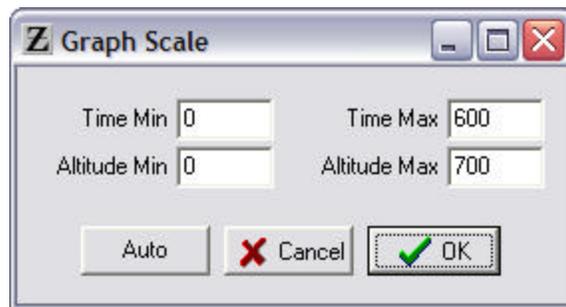


Figure 8. Graph Scale Dialog

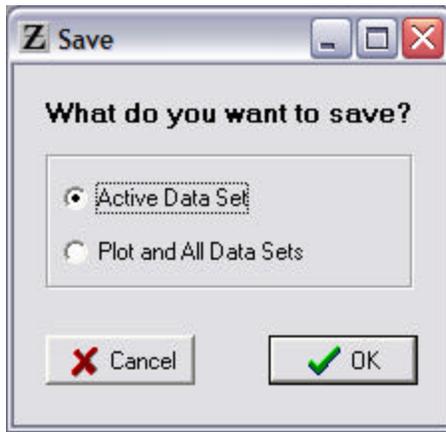
Click the Auto button to have the software automatically select a scale range to fit the data.

Load

Clicking “Load” will allow you to load a previously saved data set or plot.

Save

Clicking “Save” will allow you to save a data set. The data is saved in Comma Separated Value (.csv) format. Most spreadsheet programs can import this format if you need to do additional data analysis or formatting. A dialog window will appear allowing you save either the current data set or the entire plot and all data sets, including all display settings:



Export

This will allow the data to be exported in either JPEG (.jpg), GIF (.gif) or bitmap (.bmp) graphical formats. The GIF format is the most compact, usually looks best, and is ideal for web publishing of your altitude data.

Click the “Export” button. Select the filename and path when prompted and click “Ok”. A window will display allowing you to specify the size of the output, and also to select whether it is displayed in color or black and white:

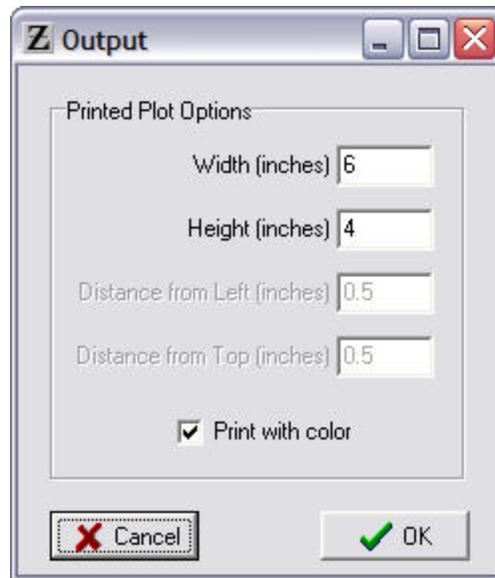


Figure 9. Export Output Settings Dialog

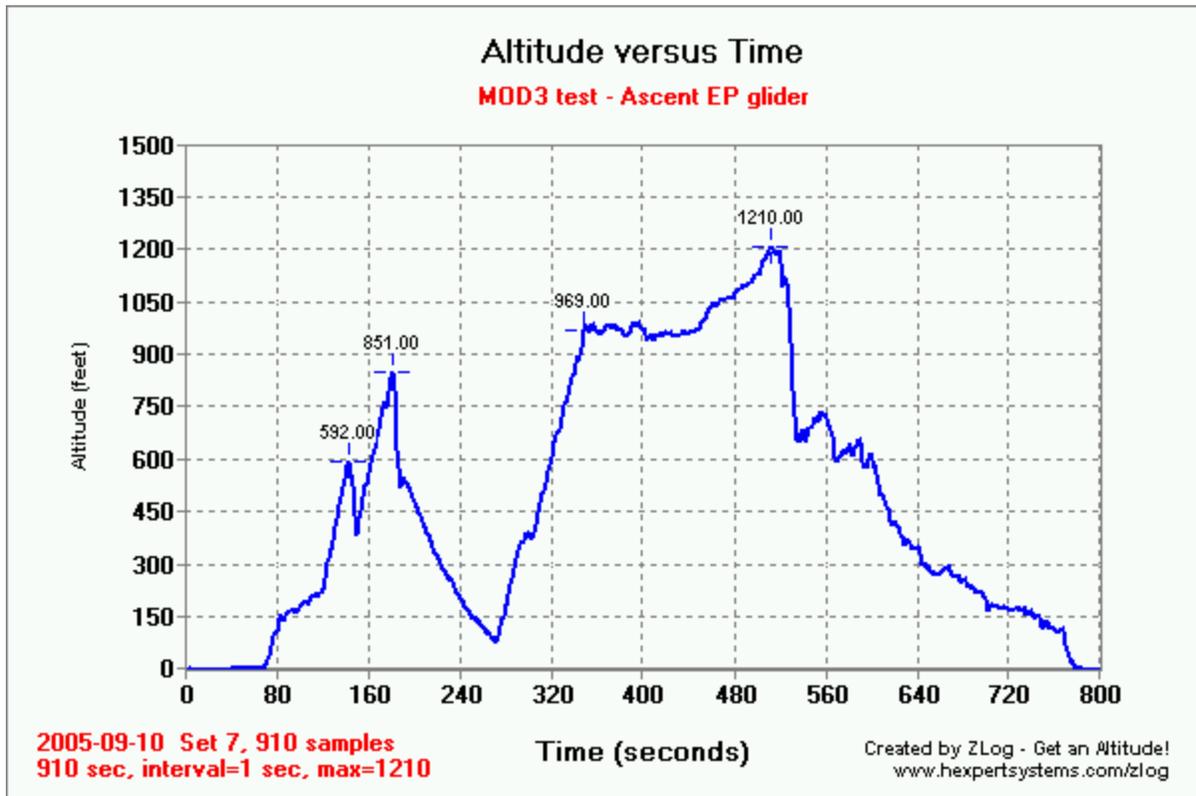


Figure 10. Sample GIF Formatted Output

Print

Select "Print" to send the plot to a printer. A dialog will be displayed, allowing you to specify the print location on the page, the plot's size, and whether to print color or black and white. Next, select the print device.

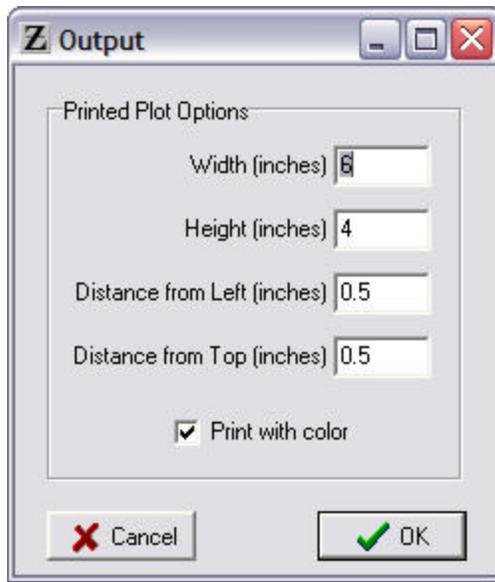


Figure 11. Print Output Settings Dialog

Appendix A. Troubleshooting Firmware Upgrade.

Should the first attempt fail, try the following steps to troubleshoot the problem and recover:

If you get a “Cannot open Comm port” error, check that you are setting the correct Comm port in the connect screen. If it is correct, make sure there are no other programs using the Comm port. Programs such as PDA hot syncs use the port to continually monitor for a hot sync request.

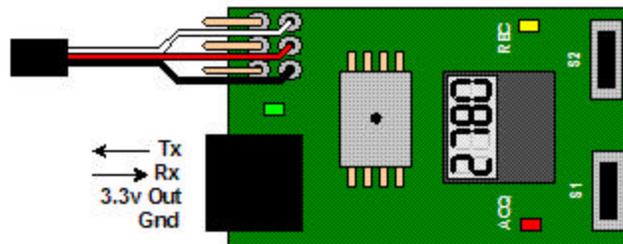
Once the Comm port conflict is resolved, try the normal firmware upgrade procedure again.

Any other failure will probably result in the ZLog module no longer working. This is evident when you power the ZLog and the display remains blank. To recover from this, follow these steps:

- Power off ZLog.
- Run PC application.
- Go directly to the Config screen.
- Verify "Part is Blank" is checked.
- Click "Upgrade Firmware" button.
- Click "OK".
- Select "zlog-v?.?.hex" file.
- Click "Open".
- Turn on zlog power - don't press any buttons.
- Click "OK".
- If it fails, repeat.

Appendix B. Zlog Interface

You may want to interface the Zlog module with your own aircraft monitoring, control, or telemetry system. Zlog provides a continuous serial output of the altitude data through its interface connector. The connector has 4 signals as shown below. The 3.3v power is an output and should be limited to a load of 50 mA or less.



The serial interface operates at 115200 baud, 8 data bits, 1 stop bit, and no parity. The output can be toggled on or off by sending Zlog a lower-case 'L' character (hex 0x6C). Data is output as a 16-bit binary value, most significant byte first. The value represents the current altitude in the units as currently configured in Zlog. The value will be output at the configured rate.

Appendix C. Specifications

Board Dimensions	1.57" x 0.92" x 0.37". 40 mm x 23.4 mm x 9.4 mm.
Weight	8 grams.
Temperature Range ¹	0°C – 60°C (pressure sensor ± 1.5% accuracy) -10°C – 60°C (pressure sensor ± 3.0% accuracy)
Input Voltage Range.	4.0 – 30.0 volts DC.
Input Current	16 milliamps (backlight on). 13 milliamps (backlight off).
Maximum altitude ¹	Measured: 52000 feet (15849 meters). Displayed: 9999 feet/yards/meters. Recorded: 32767 feet (9987 meters).
Minimum altitude ¹	Measured (absolute): -2000 feet (-656 meters). Displayed (relative or absolute): -999 feet/yards/meters. Recorded (relative or absolute): -32512 feet (-9909 meters).
Memory capacity	16378 samples.
Acquisition sampling rates	100 milliseconds/sample up to 1 hour/sample in 100 millisecond increments.
Timing Accuracy	± 2.5%
Altitude Resolution	1 foot (1 meter).

¹ Specifications taken from component ratings and system limits and may not have been tested to the full extent of the specified ranges.