

# The Shetland Attack Pony

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## Abstract

The Shetland Attack Pony (SAP) is an electronic compass and clinometer, designed for use in surveying caves. It is accurate to within a degree, and produces loop-closure errors that are usually slightly better than those obtained using traditional instruments (i.e. tape measure, sighting compass and clinometer). It is able to store information for some 2000 legs. It has an integral lithium polymer rechargeable battery, and is recharged through a mini-USB socket. It is also possible to retrieve data and adjust the settings via the USB cable. This article assumes that the reader is familiar with standard cave surveying techniques.

This manual is for use with SAPs running version 3 of the firmware.

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## 1 Safety Note

*This device contains a laser. While it is a low power device and is theoretically safe under normal usage conditions (exposure for less than 0.25s - human blink reflex time), it is strongly advised not to look directly into the beam. For this reason it is also recommended that, where possible, the person indicating the "to" station does so at arms length.*

## 2 Basic Usage

### 2.1 Turning it on and off

To turn on the SAP, press the button twice in quick succession (this is to prevent it turning on accidentally in transport). To turn it off, press the button briefly (holding it down will record a leg). Also the device will turn itself off after a minute of inaction. Note that the device will be unresponsive for 2 seconds after it has turned off.

### 2.2 General Use

You should see a bright red dot - this is your aiming point. The SAP measures the angle between the aiming point and the tip of the brass ring. The display will also light up, and will alternate between showing the compass bearing (e.g. 045, 210, 359), and the clino reading (e.g. +10, -05, +22); changing every 1/2 second or so. Note that the clino reading is always prefixed by a sign (+ or -), whereas the compass reading has no sign, and is always three digits long.

There is a slight delay to the measurements it takes a second for the device to fully catch up with any changes in direction. Unlike standard instruments, the SAP works equally well in all orientations, so there is no need to hold it level - if it is more comfortable to hold it with the display pointing down - that's fine.

### 2.3 Recording a leg

To record a leg, place the brass ring against your "from" station, and point the SAP so that the aiming point is on the "to" station. Hold down the button - the display will now read "SAVE". After 1 second the laser dot should briefly flick off and back on again - this indicates that the reading has been made. The reason why there is a delay is that the action of pressing down the button invariably moves the aiming point - the delay allows you time to correct this. Once the laser has "blipped", you can release the button. The display will now alternate between the compass and clino readings, and will no longer show the current bearing and inclination. It will also display a third number, prefixed by "L" - this is the leg number, and is used for retrieving the data later over the USB link. For leg numbers greater than 1000, the prefix is "M". To record a further leg, simply hold down the button again. To return to the "real-time" readings you would need to turn the SAP off and then on again.

## 3 Advanced Features

### 3.1 Battery power display

While turning the SAP on, continue to hold down the button on the second press. The display will show the estimated battery power left in the device. If the device's battery is so depleted that accurate readings cannot be guaranteed, it will simply display "BATT" and then turn itself off. All saved data will be preserved.

### 3.2 Temperature reading

If the button is held for longer while displaying the battery power, the display will change after a short time to show the temperature as measured by one of the internal chips. Please note that due to thermal heating from the battery, and also differences in external and internal temperatures, this reading may not reflect the temperature of the current environment.

### 3.3 Daylight mode

To save power the SAP normally runs the laser and display at less than maximum brightness. However, if using it on the surface or near large entrances, it can become difficult to read the display or see the aiming dot. While turning on the SAP, continue to hold down the button on the second press. This will cycle through the battery power and temperature displays. On returning to the battery power display, both the laser and the display will be set to maximum brightness. The device will revert to the preset laser and display brightness when it is next turned on.

## 4 Software usage

You can alter the settings for your SAP using a piece of software called PonyTrainer. All software is licensed using the Gnu Public License (<http://www.gnu.org/licenses/gpl.html>), and runs using python. The latest version of PonyTrainer is available from <http://www.shetlandattackpony.co.uk/>, as is the latest version of this manual.

### 4.1 Installation

#### 4.1.1 Windows

Simply download <http://www.shetlandattackpony.co.uk/downloads/ponytrainer3.exe>, and run it. This should install the relevant device driver, and also the PonyTrainer application will be placed in the Start Menu.

#### 4.1.2 Linux

**Dependencies** You need to have a few packages installed before you can install PonyTrainer

- Python (this will almost certainly be installed already)
- wxPython
- gcc (on ubuntu, install the build-essentials package)

You should be able to obtain these using your distributions package manager.

**Installation** Download <http://www.shetlandattackpony.co.uk/downloads/ponytrainer3.tar.gz>, and unpack it. In the shetland directory, run:

```
$ sudo ./install
```

The installation prevents the cdc-acm kernel module being loaded; this may cause problems if you use a usb modem. If you have any problems, please contact me at [phil@furbrain.org](mailto:phil@furbrain.org) <mailto:phil@furbrain.org> [furbrain.org.uk](http://furbrain.org.uk)

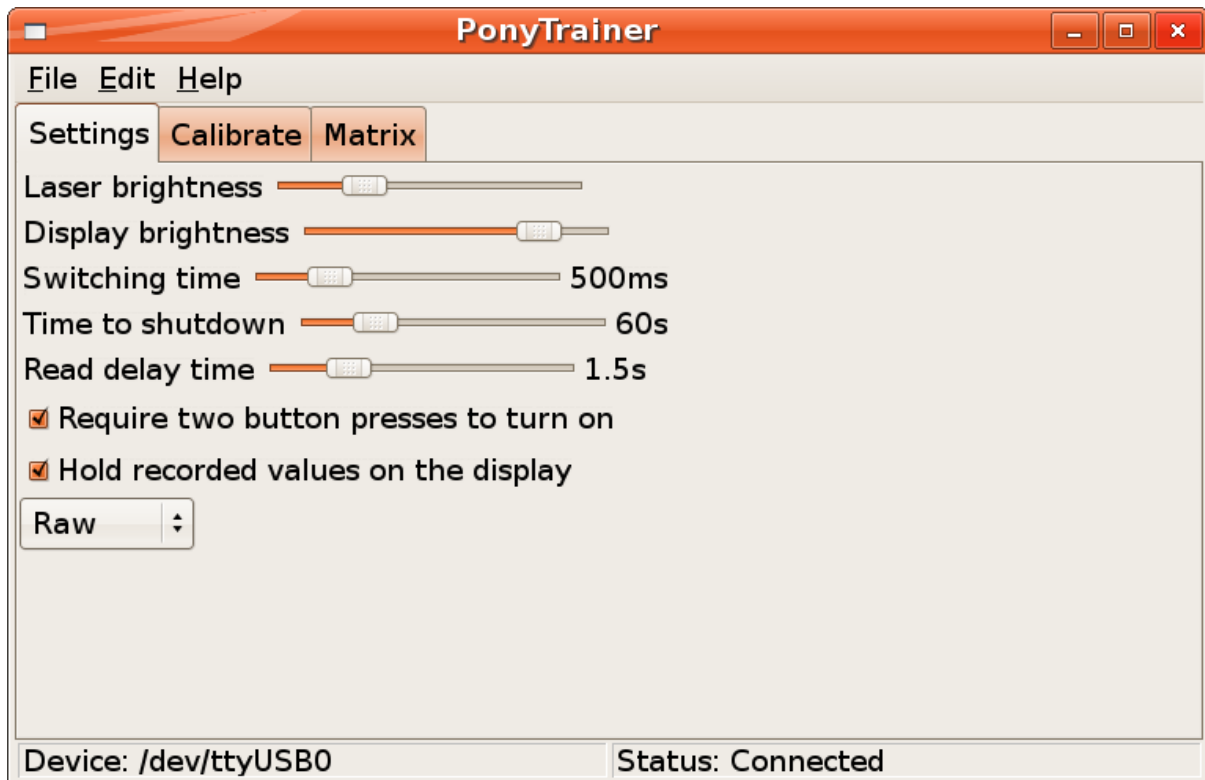
To run PonyTrainer, make sure the SAP is attached to your computer, and run

\$ PonyTrainer.py

## 4.2 Using PonyTrainer

To use PonyTrainer, first plug in the SAP using a mini-usb cable (obtainable at all electrical stores, but you probably already have one if you have a digital camera). The port is accessed by removing the “battery cover” on the back of the SAP; the port is a little recessed, but will be obvious if you look closely. You also need to do this to recharge the battery.

### 4.2.1 Settings



As you can see there are several options which you can use to adjust the function of the SAP. None of these are made permanent unless you agree when closing the program.

- Adjusting the Laser Brightness and Display Brightness changes the brightness of the SAP in its usual mode (daylight mode is unaffected).
- The switching time adjusts the underlying “clock” of the SAP - this is the time taken to switch between the compass and clino readings. It also affects a couple of other time related phenomena - the first two button presses to turn the device on must be within two “clock ticks” of each other.
- “Time to shutdown” - is the button is not pressed within this period, the unit will turn itself off
- “Read delay time” - this is the time between pressing the button and getting a reading. I recommend at least 1s as pressing the button will throw your aim off slightly; the 1s delay gives you a chance to correct it.
- “Require two button presses to turn on” - if this is unchecked, then a single button press will turn the SAP on. Battery power, temperature, and daylight mode are all available by pressing the button for differing lengths of time on the first press.
- “Hold recorded values on the display” - If this is turned on, once you have taken a reading it will continue to be displayed until you take another reading. If turned off, the SAP will display the current compass and clino readings as soon as you stop pressing the button.
- The choice at the bottom selects the recording mode for the pony:

- Hold: This mode will not record any data into the memory
- Save: Data is stored to the nearest degree. 2000 legs available
- Raw: The raw sensor readings are stored. This can be useful if you are worried that the pony is not accurately calibrated, as it is possible to adjust the readings after the calibration has been done. Contact me for more details. 166 legs available
- Hi-res: Data is stored (And displayed) to the nearest 0.1 degrees. Be aware that the pony is not accurate to a tenth of a degree, so this data may be a little misleading. 1000 legs available
- 400g: Data is stored and displayed in 400g format (400 "grads" in a circle, 100 in a right angle).
- Program: If you select Program as the recording mode, the device will be put into Program Mode (for upgrading the firmware; see Section 6)

#### 4.2.2 Data

This tab shows the data currently stored within the Pony.

#### 4.2.3 Matrix

This tab shows the current calibration matrix for the device. This can be saved by File | Save Calibration Data, and loaded by File | Apply Saved Calibration Data

## 5 Calibration

Your SAP should arrive already calibrated. There are a few things that can invalidate the calibration. These are:

- Shaking loose the battery or laser within the device
- Removing the circuit board from the device
- Leaving the SAP next to something with a strong magnetic field.

### 5.1 Testing the calibration

To test the calibration of the device, take some readings between two fixed points, with the display facing upwards. Record the readings. Repeat with the display facing left, right and down. The readings should not vary by more than two degrees in total. Repeat with two more fixed points

### 5.2 Field calibration

It is possible to recalibrate the SAP in the field. It does not require a compass or clino. It is actually easier to do underground than on the surface; it is important that there are no ferrous objects nearby. This includes your watch.

1. Turn the device on, putting it in "Daylight Mode" (see ??)
2. Press the button twice in quick succession.
3. The display should now read C000 - you are now in field calibration mode.
4. Choose two fixed points, lets call them A and B.
5. Take four readings from A to B, with the display facing up, left, down and right respectively.
6. The display should now read C004
7. Repeat from B to A, the display should now read C008
8. Choose a further two fixed points, C and D so that C->D is about 90 degrees from A->B

9. Take four readings from C to D and four from D to C.
10. The display should now read C008
11. We now need to collect a further 48 legs of random data. Imagine A,B,C,D being in the middle of four sides of a cube. Take a set of four readings from each of the corners of the cube, and one set straight up and one set straight down.
12. The display should start slowly counting up from CLX1 to CL99 - it will take about 5-10 minutes.
13. Once complete, turn the device off by pressing the button briefly.
14. The calibration process is now complete. It can be cancelled at any point up to step 12 by turning the device off

### 5.3 Formal calibration

For a formal calibration, you will need a sighting compass and clino. The whole process will take about 40-60 minutes. To recalibrate it, you will need a sighting compass and clino. The whole process will take about 40-60 minutes. These are the steps you need to take:

1. Connect the SAP to your computer, save any data you want to keep, and set the mode to "Raw". Note that this will wipe any data legs currently stored on the device. Save your changes to the SAP, and disconnect it.
2. Find a largish space away from large metal objects (a decent sized living room would be large enough)
3. Create a fixed point - a wooden stake hammered into the ground, or a candle on a wooden table would be fine. It is important that there is no ferrous material nearby. This probably includes your watch.
4. Pick a target point at least 1.5m away, between +30 and -30 inclination.
5. Measure the compass and clino readings from your fixed point to the target point. Write it down.
6. Record a leg from the fixed point to the target point using the SAP (see Section 2.3). Do this with the display facing upwards. Do this again three more times, but with the display facing left, down and right. Write down the leg numbers you have just recorded (there should be four in total).
7. Repeat steps 4-6 another 11 times. Try to get a good spread of compass readings and clino readings
8. You should now have 48 separate readings. You need to enter these into a text file (Windows users use Notepad, Linux users use your favourite text editor). Each line should represent one of the legs. Enter the leg number, compass reading, and clino reading, in that order, separated by tabs. See Figure 1 on page 7 for an example.
9. Connect the SAP to your computer, and start PonyTrainer. You should now have a "Calibration" tab - select that.
10. Choose File | Load Raw Calibration Data, and select the file you have just created. The Columns labelled "Reading", "RCompass", and "RClino", should be filled with the data you have just created.
11. Press "Calculate Errors"
12. Go and have a cup of tea.
13. And maybe some toast, if your computer is slow...
14. All of the columns should now be filled with data. Look down the Errors column. Less than 1 is excellent, more than 3 suggests you've stuffed it up somehow. You can then go back and remeasure these if you want. Alternatively, you can exclude bad readings from the final calibration by unchecking the check-box in the "Include" column for particularly duff readings.

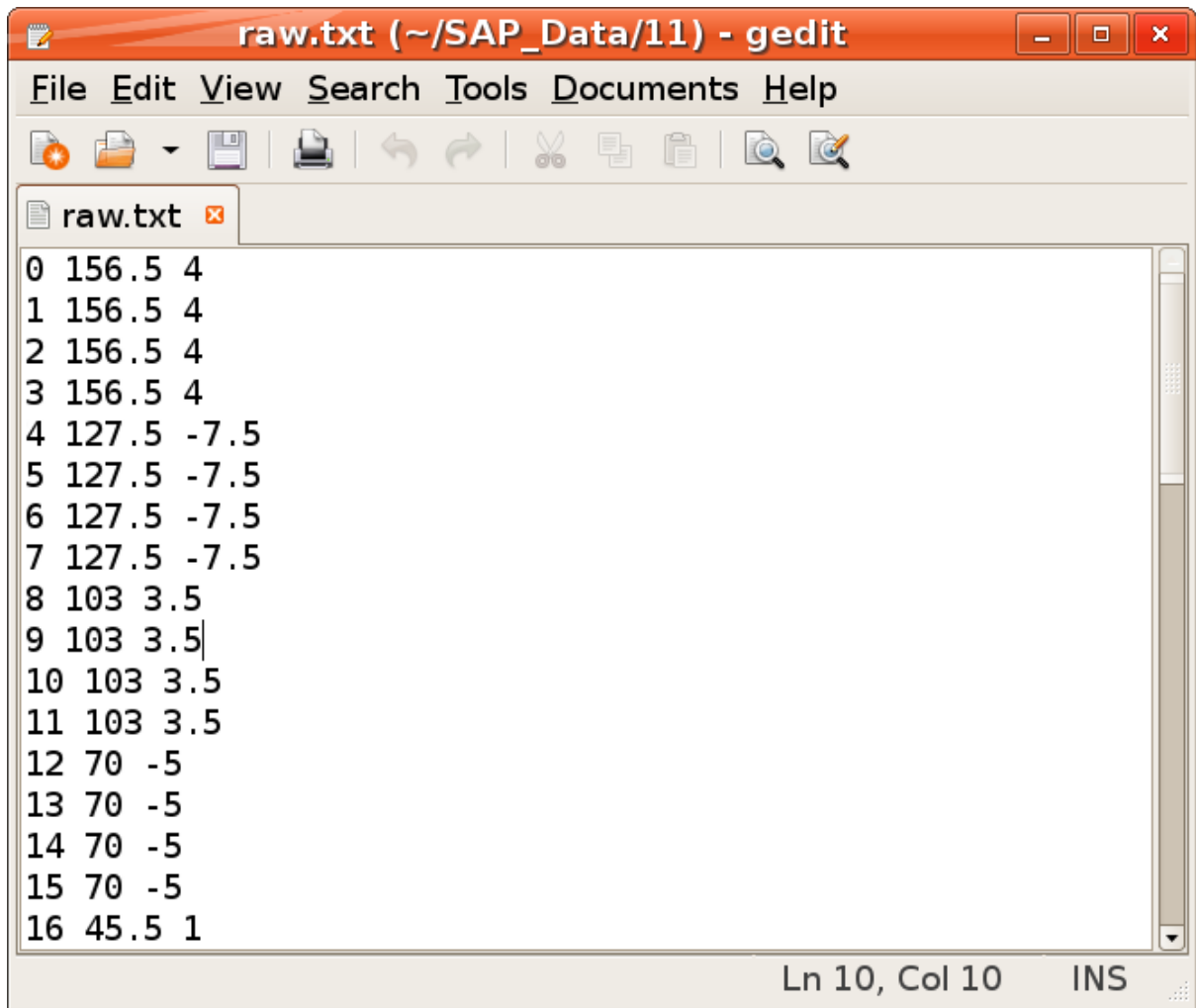


Figure 1: How to enter the calibration data. Note that the compass and clino readings come in groups of four

15. Press "Calibrate Pony" - this process shouldn't take too long. The average error should be less than 1.5 degrees.
16. Choose File | Save Calibration Data - it's worth keeping a record of your calibration matrices.
17. Change the mode to "Save" on the Settings page
18. Choose File | Exit and Save Changes
19. Your SAP is now ready to run again.

## 6 Upgrading the Firmware

Every so often, I may release upgrades to the firmware (the program that runs inside the pony). To save you posting them back to me to be reprogrammed, it is now possible to do this in the comfort of your own home. A word of warning - you will be using hex files which are a standard format for firmware (you may get a hex file for your mp3 player for example). These hex files will download quite happily onto the pony, but if they are not written specifically for your version of the pony, they will not work, **and could potentially damage it**. I therefore recommend only using hex files that I have emailed to you, or that you have downloaded directly from the <http://www.shetlandattackpony.co.uk/>

## 6.1 Saving your calibration

From the PonyTrainer main menu select `File | Save Calibration Data`; then save the calibration file to a safe place

## 6.2 Put your device in Program Mode

- The simplest way to do this is to change the mode from the Settings tab of PonyTrainer, then `File | Exit and Save Changes`.
- Alternatively you can remove and then replace the battery connector from the pcb inside the Pony, while it is turned on (but not connected via USB).
- Emergency reset: If neither of these methods work, unplug the battery connector from the pony. Wait 5 seconds. Short out the pins marked on Figure 2 on page 9 or Figure 3 on page 10, depending on which style of PCB you have, and then plug the battery back in. This should force the device into Program Mode.
- Either way, you can tell that the device is in Program Mode because the display is blank, and the laser slowly flashes on and off.

### 6.2.1 To return to normal mode

If you change your mind, you again have two options to return your device to normal mode.

1. Run `PonyUpgrade`, but cancel when asked for a file
2. Remove and then replace the power plug (without USB connected)

## 6.3 Perform the upgrade

First ensure the pony is connected to the computer, and in Program Mode.

### 6.3.1 Windows

From the start menu, choose `PonyUpgrade`. You will be asked for a hex file. Select this, and you will see a progress bar. When this has completed, the program has exited, and your pony should be back in normal mode

### 6.3.2 Linux

From the command line, run `PonyUpgrade.py`. You will be asked for a hex file. Select this, and you will see a progress bar. When this has completed, the program has exited, and your pony should be back in normal mode

## 6.4 Restore your calibration

1. Start PonyTrainer again. From the Settings tab, choose "Save" (or "Hi-Res" if you prefer).
2. `File | Apply saved calibration data`, and choose the calibration file you saved earlier.
3. `File | Exit and Save Changes`; don't worry about the warnings.

## 7 Troubleshooting

There are currently four circuit designs that support v3 of the firmware - check which is yours by comparing the insides of your pony against the two photos below. Be careful when opening your box - the buzzer is connected to the underside of the lid, and is only attached by fragile wires.

If you have one of the newer styles of pony (with a blue case) look for the speaker. This is a circular disc that is glued to the inside of the case (you should be able to see it through the case). If the speaker is on the opposite side to the display, then it is PCB Version C. If it is on the same side, it is PCB version D



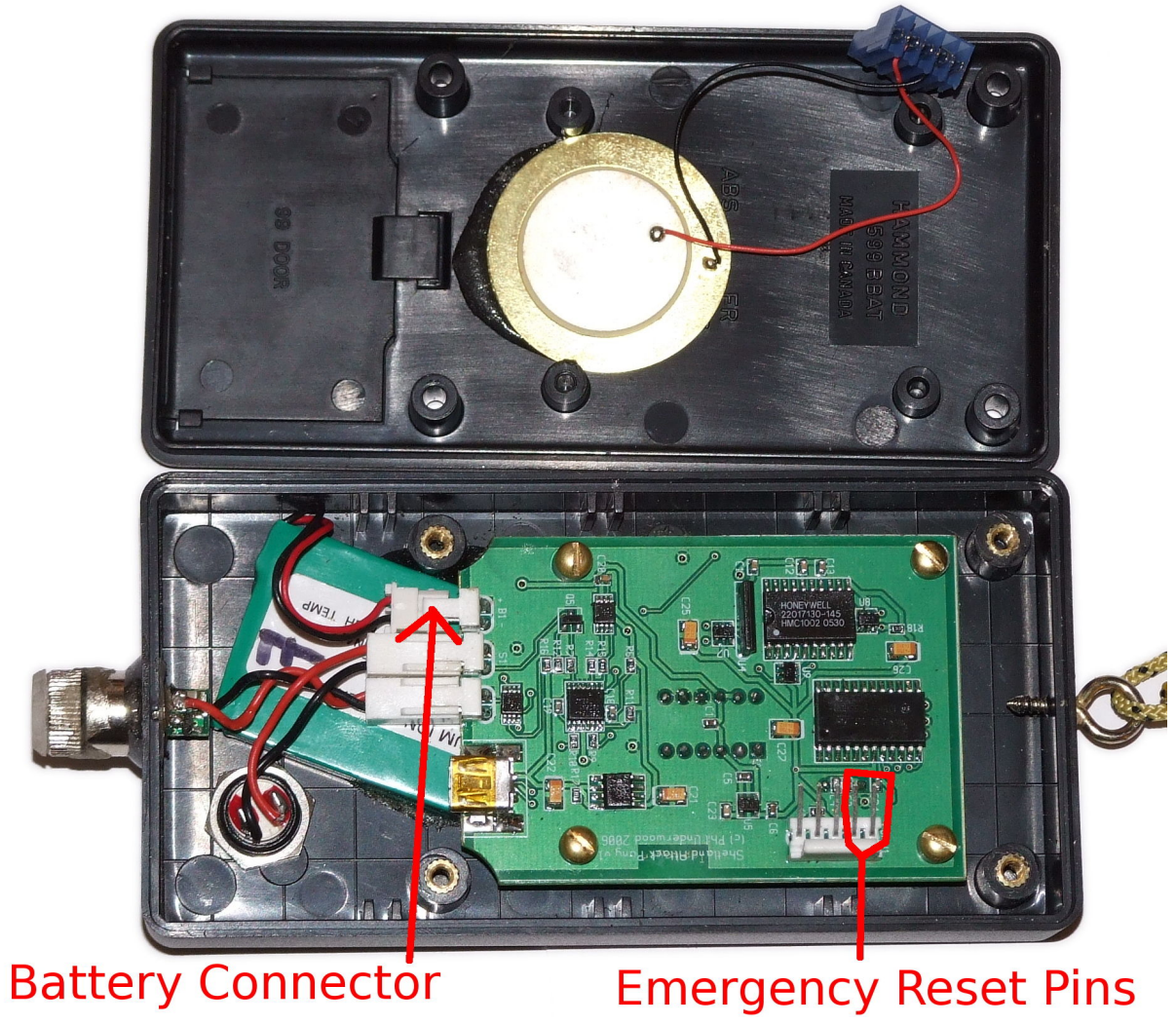


Figure 2: PCB Version A

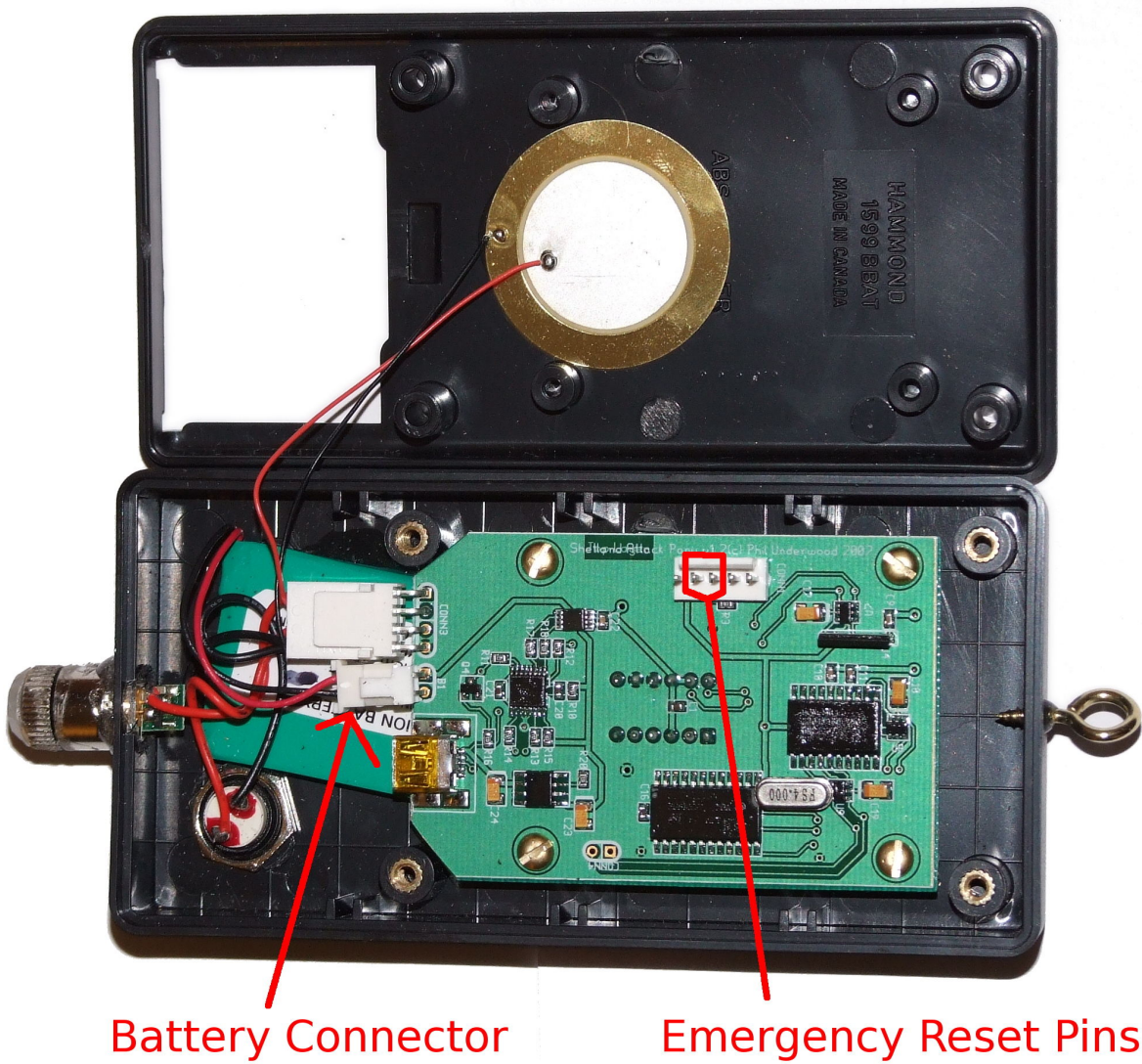


Figure 3: PCB Version B

### **7.1 Pressing the button does nothing, laser does not light, LED display does not illuminate**

- The battery could be dead; try attaching the pony to a computer via a USB lead (the laser should then light and the display show the percentage battery remaining)
- The battery could have come loose - check the connections on the PCB - see Figure 2 on page 9 and Figure 3 on page 10
- It may be worth trying a hard reboot (see Section 7.4)

### **7.2 Pressing the button does nothing, laser flashes slowly, LED display does not illuminate**

- This means that the pony is in Program Mode. Unplug and replace the battery connector (while the USB lead is not connected). This should restore normal operations. If it does not, your firmware may be corrupted, and you will need to reinstall it - see Section 6.3

### **7.3 Pressing the button turns the unit on and off as usual, and even takes readings, the laser is on, but the LED display displays garbage or is blank**

- It is likely that the PCB has come loose from the display. Pressing firmly over the display may help. If this is not effective, post the unit back to me, and I will repair it.

### **7.4 Pressing the button does nothing, laser is on, LED display is displaying garbage or is not changing**

- This means the firmware has crashed. It may be worth trying a hard reboot. Unplug the battery connector while the USB lead is not connected, and then replace it. This should put you into Program Mode. Remove and replace the battery connector once more, and normal service should be resumed. If not, you may need to reinstall the firmware - go to Section 6

### **7.5 The SAP has got wet inside**

- The SAP has a conformal coating, and so will withstand small amounts of condensation without problem. If there is a lot of water, disconnect the battery connector, and carefully empty the unit. In either case, once the trip is finished, leave the unit to dry by leaving in the open with the access panel removed.
- For the later blue models, they should not get wet as they are fully sealed. If there is water, you will need to open the device, then reseal it - please contact me first.

### **7.6 The laser, battery, or PCB is loose.**

- The SAP relies on all of these components having a fixed relationship to each other for its calibration. You will need to securely reattach whatever is loose, and then re-calibrate the device (see Section 5)

### **7.7 The SAP is in several pieces, and nothing works**

- You have dropped the SAP down a pitch. You may need to buy a new unit. It may be possible to scavenge some components; send me them and I may be able to refurbish the unit for less than the cost of a new one.