Altitude Encoder Calibration by Kevin Stewart CEng

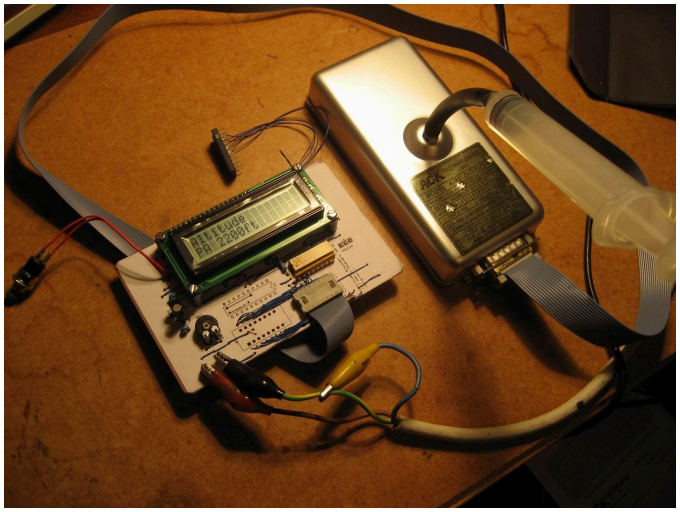
The problem faced by a fellow Strut member set my engineering brain going. His problem, probably faced by many aircraft owners was simple: how do you calibrate your altitude encoder without access to some very expensive test equipment?

The standard method of calibration uses an RF test set to 'ping' the transponder and display the altitude returned in the transmission. A vacuum pump arrangement connected to the static system then simulates different altitudes.

Modern transponders such as the Microair, Funkwerk, Trig & Garmin all have an altitude display feature which allows an owner to carry out his own calibration. Older generation units were not fitted with a display and so there is no mechanism to show the altitude value coming from the encoder. There are still plenty of old Narco and King transponders fitted to the GA fleet that are fully serviceable.

My initial research showed that altitude encoders use a standardised binary pattern called a Gillham code. This is used to pass height information to the transponder where it is added to the ground station reply message. The first thing I discovered was that there was a complete lack of information about the Gillham code and how it worked. All I could find on the Internet was that it appeared to be a modified form of Gray code. I was familiar with the Gray code, a special form of binary with the property that only a singe bit (binary digit) changes between each value. This dates back to when mechanical encoders were used in sensors and by only allowing a single bit change, ambiguous messages could be avoided. It seems that many engineers just use a look up table to carry out the conversion from Gillham code to altitude. This did not seem very satisfactory or very tidy. This led me to search for an algorithmic approach (a series of equations or calculations).

After much trawling of patents, technical articles and forum postings I was able to piece together how the Gillham code worked. As a great believer in the sharing of knowledge there was only one thing to do, publish my findings on Wikipedia http://en.wikipedia.org/wiki/Gillham_Code.



Now that I could decode the Gillham code all I had to do was to develop some method of displaying the altitude in a human readable format. I decided to use a simple 8 bit microprocessor (Microchip PIC) in conjunction with a liquid crystal character display. The circuit would sit in between the transponder and the encoder reading the Gillham code as it was generated. I programmed the micro with an algorithm I developed from what I had learnt about how the Gillham code worked. I decided that it would be useful if the circuit could display various other pieces of useful diagnostic information. My current prototype can display: the pressure altitude, the raw Gillham code in binary and the supply voltage. A single push button switch allows the operating mode to be changed. The raw binary display is useful for finding wiring faults as it shows the status of each of the lines from the encoder. The pressure altitude display allows the encoder to be calibrated with reference to the aircraft's altimeter. There are normally a couple of adjustment potentiometers on the side of the encoder. Each encoder normally has a published set up procedure.

It is worth noting that most older encoders can take up to 10 minutes from power up before they output any height information. This is to allow the internal pressure sensor to be heated to operating temperature. Changing altitude can be simulated by connecting a 75ml syringe to the static system. So long as there are no leaks this will happily take you to beyond 30000ft!

Here is a photo of the finished unit boxed up and connected to a Microair transponder which also has an altitude display. At present the software in the test unit is able to display the binary code on the data cable from the encoder, the decoded pressure altitude and the battery voltage. There is a serial port on the unit capable of sending the messages on the display to a PC should one wish to do so.