

These notes relate to the modification of a Kobo Mini ebook reader by fitting a GPS or GPS/GLONASS module for navigation only. Modules are also available to make the Kobo work as an alti-vario as well as for navigation. The notes are my best shot at the time of writing. I cannot guarantee they are correct or represent ideal solutions but I will correct and update them when I can. Please inform me of any errors or better solutions you may find. The index for other Kobo/XCSoar notes can be found at:

http://www.50k-or-bust.com/Kobo_XCSoar/Kobo_XCSoar.htm

There is a thread on www.paraglidingforum.com which has a lot of information and many options and there are other web threads too. The notes below attempt to identify the best solutions.

Electrostatic Precautions

Modern electronics can be susceptible to damage from electrostatic electricity. When two materials are rubbed together they can become charged with electricity to hundreds of volts, and if this charge finds its' way to the connections of sensitive electronic devices it can damage or destroy them. Many electronic devices have protection against electrostatic discharge (ESD) built into them but in environments where people work on electronic equipment special precautions are often taken. I do not take specific precautions but I am reasonably careful and have had no problems with Kobos I have worked on myself. However I have had problems with Kobos which have been tinkered with by other pilots, notably the larger Touch and I am beginning to suspect that the Touch may be particularly sensitive to ESD. If you intend to work on a Kobo Touch I suggest you have a browse online about ESD precautions before you do.

GPS and GLONASS

GPS is a set of 32 satellites controlled by the USA distributed in a way intended to give coverage of the whole world. The accuracy and reliability of GPS is dependent on the position of satellites relative to the receiver and sometimes reception is poor. However there is another system of 24 Russian satellites called GLONASS which does a very similar job. Modules are available which make use of both GPS and GLONASS satellites together to give more reliable and accurate location than GPS alone. The GlobalTop GMS-G6 will do this and is electrically interchangeable with the externally mounted GlobalTop GPS only chips.

In the rest of this document statements about "GPS" generally refer to GPS and GLONASS. It is up to you whether you go for a GPS only module or a

GPS/GLONASS one. Some pilots seem prejudiced against GLONASS and I had no problems with a GPS only module through the one year I used it. However some pilots have had problems with GPS only. There is no point in fitting a GPS only module when a GPS/GLONASS one is available at trivial extra cost.

How Important Is GPS Reception Quality?

When we fit our GPS module into our Kobo we can choose to just do it so it works or we can try to get the best reception. Modern GPS modules are very clever pieces of kit. Not only can they receive very tiny signals buried in high levels of background noise, but they can also process them to get the best fix possible in a wide range of circumstances. For the purposes of locating ourselves in two dimensions accurately enough to keep out of controlled airspace we do not need particularly good signals. However, our XCSoar flight computer is capable of much more. Not only can it show us our ground speed and altitude, it can assess wind direction while we are circling in a thermal and it can assess our glide angle across the ground. If we are going to utilise these features we want our GPS reception to be as good as possible. Having said that, we must bear in mind that our installation is not one which has been carefully designed, tested and optimised in the way we hope a commercial instrument would be and we cannot expect it to be as sensitive. In poor GPS conditions the first thing to suffer is GPS altitude which should never be relied upon. If you are going to use the XCSoar glide computer in earnest I suggest you use a pressure module (Bluefly vario or similar) and set “Nav. by baro altitude” in the XCSoar Glide Computer settings.

Checking GPS Reception

When assessing GPS reception of a given setup we have to bear in mind that the available signal strength varies considerably with weather, location, time of day and even “space weather”. It can vary very quickly, almost from minute to minute. However, in general use the first symptom of poor reception is usually that it takes a long time to get a fix when the unit is switched on. Two other indicators in XCSoar which most easily show reception quality whilst the unit is stationary are ground speed and GPS altitude. The poorer our reception is, the more these values wander around.

The most objective check easily available is in the “System Status”.

Info 2 / Status / System or Gesture “S” and select “System”

The box “Satellites in view” shows the number of satellites the GPS is using for its fix. On the whole, more satellites corresponds to better reception and

quality of fix but not always.

If GPS Reception Seems Poor

If you are indoors try the GPS outdoors in a place where there is a good view of the sky. If this does not help check the visibility of the satellites using an online predictor program such as <http://satpredictor.navcomtech.com> . This tool is particularly good at showing the effect of high hills or buildings obstructing the horizon by entering different angles in the elevation mask.

Which GPS Module?

Externally Mounted Modules

The GlobalTop GMS-G6 (Titan 2) GPS/GLONASS module is best for use with the Kobo Mini. It will also work for the Kobo Touch but the physically larger GlobalTop GMS-G9 (Titan 3) works better and fits OK. The GMS-G9 is too large for the front of the Kobo Mini. Both perform well and are probably the best solutions for a straightforward setup.

Suppliers I know of are:

Comvergence M2M Ltd. Email: neil.dodson@comvergencem2m.co.uk

www.mirifica.de (Germany)

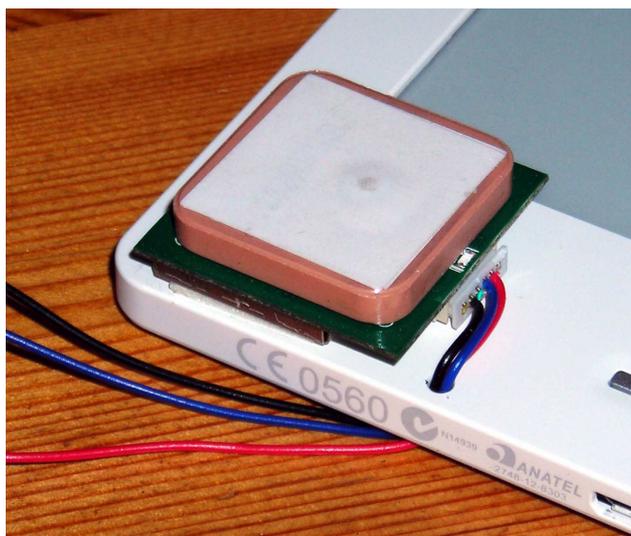
Shipping costs can be high so if you can collaborate with other pilots to buy a quantity it can reduce the cost considerably.

If you feel you must use GPS only the GlobalTop FGPMMPA6C is probably the optimum module. The GlobalTop FGPMMPA6H is similar but with unnecessary additional functions. It is slightly more expensive but usually more easily available.

Modules For The Kobo Touch

The GMS-G6 will also work for the Kobo Touch but the physically larger GlobalTop GMS-G9 (Titan 3) works better and fits OK. However there is now a different module available, the V.Kel VK2828U7G5LF which should work better. It is quite large (28mm square) but will just fit on the corner of the Touch and usually supplied with a connector and wires long enough to wire directly. Other components suggested below for the GlobalTop modules are not needed. The connector has six wires but only three (ground (Black), TX (Blue) and V+ (Red)) are necessary. The other three can be cut off close to the connector. This module does not have a backup connection but has some

kind of backup internally.



N.B. If using this module the covers detailed below will not fit and Sugru is not really suitable. A larger cover needs to be made. It is available from www.hobbyrc.co.uk .

Internally Mounted Modules For The Kobo Mini

I strongly recommend avoiding internally mounted GPS modules.

The GlobalTop Gms-u6b (GPS only) is almost the smallest available module which can be fitted inside the Kobo. To fit this a part of the structure of the Kobo has to be removed and module is very sensitive to adjacent metal parts and to electrical noise. It has to be fitted so that the patch antenna is as close to the edge of the casing as is reasonable to try and keep it clear of the printed circuit board and metal chassis. The performance of this setup is much poorer than with the larger chips mounted externally. One I made took a long time to lock up, had rather variable ground speed indication and the GPS altitude was very inaccurate. One made by another pilot appeared to operate OK until he found himself near cloudbase when it lost lock. My investigation showed that in similar conditions an internally mounted Gms-u6b received considerably fewer available satellites at poorer signal to noise ratios than externally mounted FGPMMPA6C or FGPMMPA6H chips. The only reason I can find to use an internally mounted module is that it looks a bit neater.

Opening Up The Kobo

- 1) Ensure the Kobo is powered off and not just in sleep mode by sliding the switch over and holding it until it says "Powered Off" on the screen.
- 2) Remove the outer back cover by sliding a small flat screwdriver blade under it in the slot in the corner adjacent to the slide switch. The outer back cover

will “unpop” in the corner. Carefully slide the blade around the edge of the cover to “unpop” it all the way round and remove the cover.

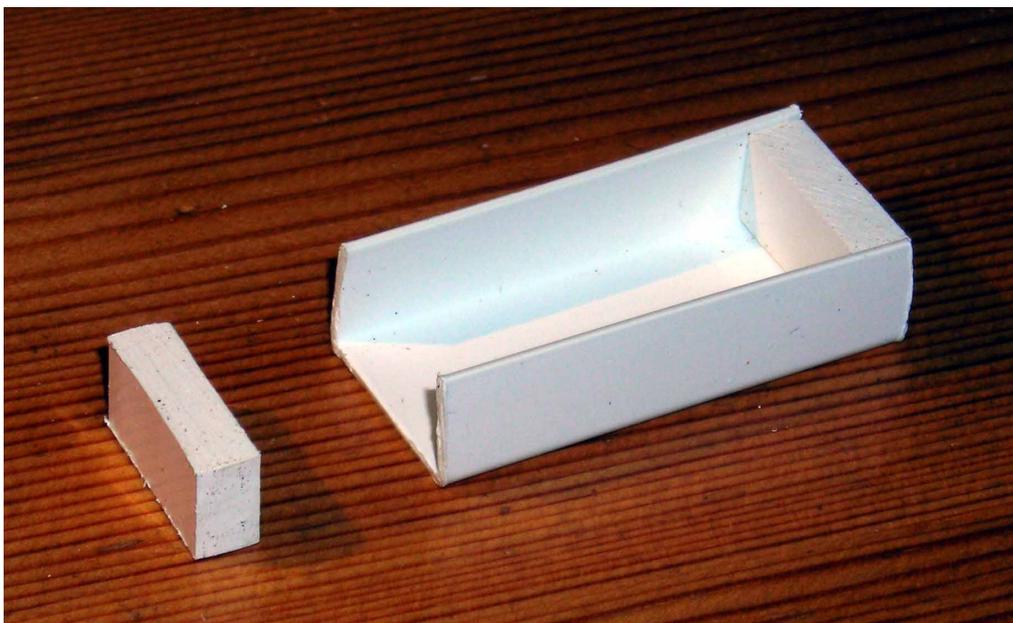
3) Remove the six small cross-head screws holding the inner back cover on. Make sure you use a screwdriver which fits well so they are not damaged.

4) Place the Kobo face down and use a very small flat bladed screwdriver to prise up the edge of the inner back cover to your left. (The right edge viewed from the front of the Kobo.) The inner back cover will “hinge” open and can be “unhooked” from the “hinges” at your right hand side.

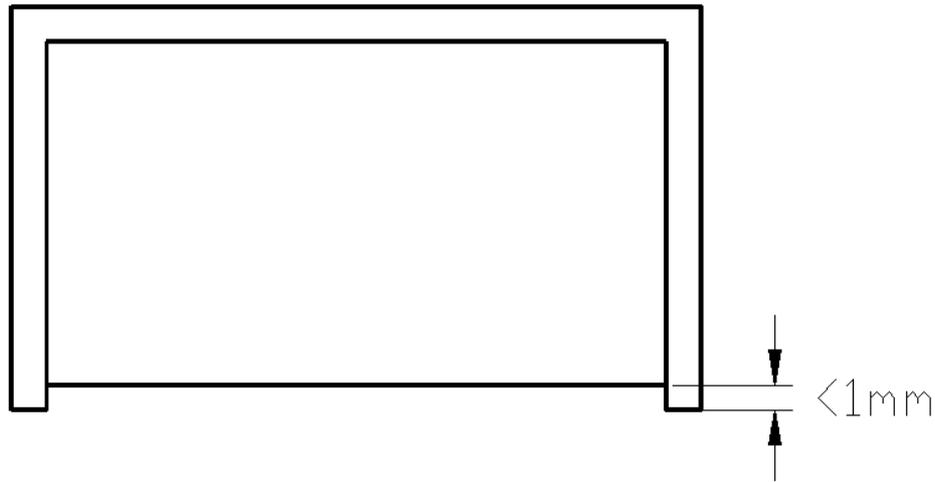
Closing up the Kobo is the reverse of the above. Make sure the inner back cover is “popped in” properly all the way round before screwing it down.

How Should The GPS Module Be Mounted

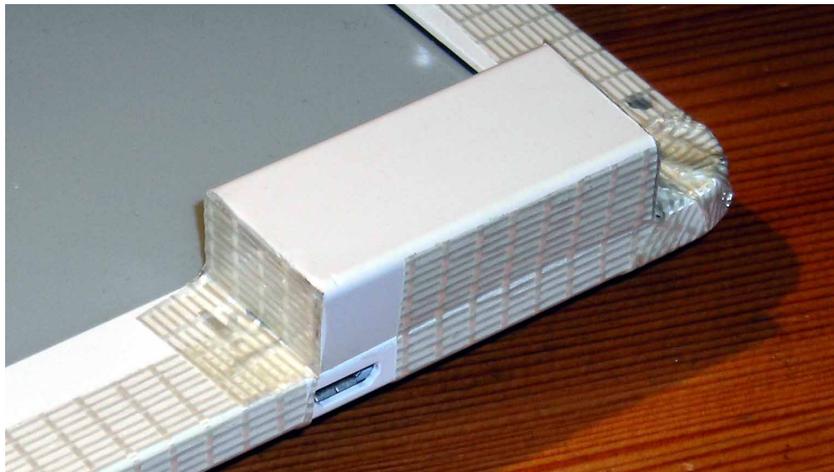
There are lots of ways of mounting the module. One is to fix it to the front of the Kobo using double sided foam tape (Sometimes called servo tape, Sellotape Sticky Fixer Strip). A cover can be made from a piece of PVC channel approximately 18mm x 10mm from a DIY store with end pieces made from 5mm thick PVC.



The end pieces can be glued into the channel with PVC pipe weld cement and trimmed back so there is a gap just less than 1mm under each piece.

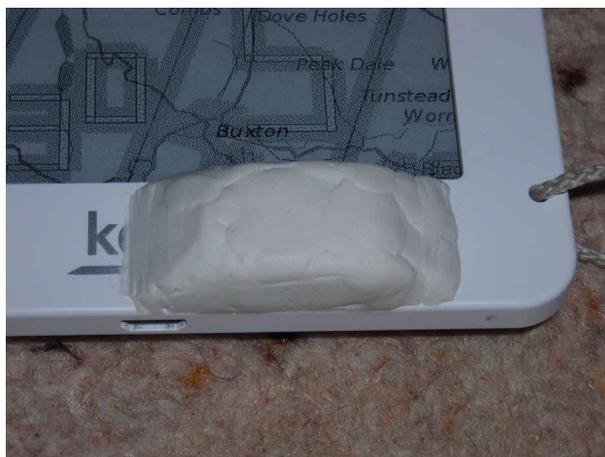


A piece of double sided foam tape is fitted to the 5mm end piece so it sits in the gap. These pieces of tape stick the cover to the front of the Kobo along with pieces of crossweave tape. This works fine for white Kobos but unfortunately this tape may not stick very well to black Kobo's which appear to have a coating of silicone rubber. The only solution to this problem I have at this time is to scrape the silicone rubber coating off the Kobo. Rather messy! Fixing with Sugru (described later) works fine with black Kobos.



This arrangement is a bit bulky but has the advantage that the chip can be easily accessed if necessary. It can be made long enough to accommodate additional components or even a Bluefly module.

The best permanent solution is to mount the chip on the front of the Kobo by embedding it in Sugru which sticks well and does not appear to degrade GPS or GLONASS reception at all. This may seem a bit drastic but where I have had problems with the functioning of Kobos I have sliced off the module together with its' lump of Sugru and wires and installed the whole lot into another Kobo without difficulty. However it is a good idea to make sure you are happy with the performance of the module before you embed it in Sugru.



Sugru costs about £7 for three 5g sachets and is available in a number of colours. It can be moulded rather like plasticine and sets like a hardish rubber overnight. One sachet is more than enough for the job. I put a layer about 1mm thick under the chip and press the chip gently into it. I then mould most of the rest around the chip with a layer about 2mm thick over the top with sloping sides like a little flat topped pyramid. Note that Sugru does not store very well and has a use by date on the packet.

Is The GPS Module RX Connection Necessary?

In basic operation no data is sent from the Kobo to the GPS module so a wire from the Kobo TX pin to the GPS chip RX pin is not necessary.

Is It Necessary To Program The GPS Module?

No. By default GlobalTop GPS modules produce standard NMEA data sentences from the TX pin at 9600 baud which XCSoar is able to interpret. Most GPS modules are similar.

Is the GPS Module Backup Supply Necessary?

The GPS module has to acquire a certain amount of information in order to locate its position. From “cold” it can sometimes take several minutes to locate. If powered up intermittently the GlobalTop GPS modules can store information from day to day over three days which usually help them to locate faster. However to enable them to store this data when the power is off the modules need a backup supply all the time. With the backup supply available the GPS will sometimes locate much more quickly if the power is switched off for a short while and then switched on again so it may be of particular benefit in difficult reception conditions.

This backup uses an insignificant amount of power which can be taken from a test point TP2 inside the Kobo near the battery connector. However if this supply is accidentally shorted there is likely to be some damage. An 8K2

resistor fitted as described earlier will limit the current to about 0.5mA if the backup supply is accidentally shorted.

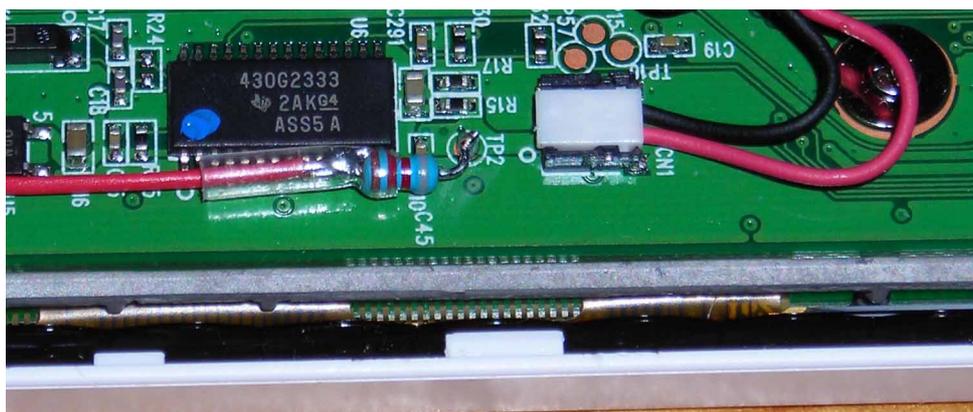
It is up to you whether you fit the backup wire. It is a bit fiddly. You will probably not notice the difference in normal flying from a hill or airfield but it may help if you are using your Kobo on a retrieve, in a city or in a vehicle.

Are Additional Components Necessary?

There is a recommended application circuit for the GPS chips which can be found in their datasheets online in which a few external components are added to minimise electrical noise in the vicinity of the chip. In theory this should improve the performance and I incorporated them in my earlier unit. Most pilots seem to be just soldering their chips in directly which seems to work OK.

Resistors and capacitors are cheap so eventually after a number of tests I decided on the following compromise:

- a) Connecting the ground and +ve wires directly from the Kobo port to the GPS chip with a 0.1uF ceramic capacitor across the GPS module terminals.
- b) Soldering a 330 ohm (330R) 1/8th watt resistor to the TX connection of the GPS chip with a wire to the RX connection of the Kobo port.
- c) For the backup supply I fit an 8.2 kohm (8K2) 1/8th watt resistor at TP2 near the battery connector of the Kobo.



The soldered connection between the wire and the resistor should be covered with insulating sleeving. It is necessary to cut a small piece of the webbing of the back case away as seen in the following picture to the left of the circular pillar so that the wire does not get crushed. (More on this later.)



I also fit a second 8.2 kohm 1/8th watt resistor at the backup connection to the GPS module. The first resistor provides some protection if the backup supply wire is accidentally shorted and the second should help reduce any interference picked up by the backup supply wire as it passes across the Kobo circuit board.

Resistor Types

1/8th or 1/10th watt (0.125 or 0.1 watt) resistors are best. More easily available 1/4 watt (0.25 watt) resistors will work fine electrically but are bigger and more difficult to fit. Relatively small quantities of resistors are most easily purchased on ebay.

Connections And Soldering

Before doing any soldering make sure the Kobo is powered off and disconnect the battery. Using a small screwdriver lift the white connector vertically from the socket on the PCB.

I strongly suspect that most problems pilots have with their units is to do with soldering so if you have no experience it is probably best to get some help from someone who has. However, here are a few tips for if you want to just do it:

1) The soldered connections on the GPS chip are very small and a soldering iron around 15 watts with a small bit is best. The Silverline 264572 iron is available very cheaply. However the ground connection on the Kobo is attached to a large area of copper and requires a larger bit on a more powerful soldering iron, I would say at least 25 watts. I use the corner of a fairly large wedge shaped bit for this.

2) You are not going to do a large amount of soldering so avoid lead free solder. It has a higher melting point than normal solder and is a little trickier to use. Just make sure you wash your hands afterwards and don't lick your fingers.

3) Use wire whose outside (insulation) diameter is no more than 1mm as larger sizes will be difficult to route. Obsolete computer cables stripped open are often a good source of small wires. However wires vary considerably in their construction, flexibility, how easily stripped, resistant to crushing and to melting when soldered, and some can be very awkward. Unless you can inspect wires before you buy or otherwise obtain them it can be pot luck.

4) Always leave some slack in the wires. It reduces the chances of them getting pulled or stretched and you have some spare if you need to re-make a joint.

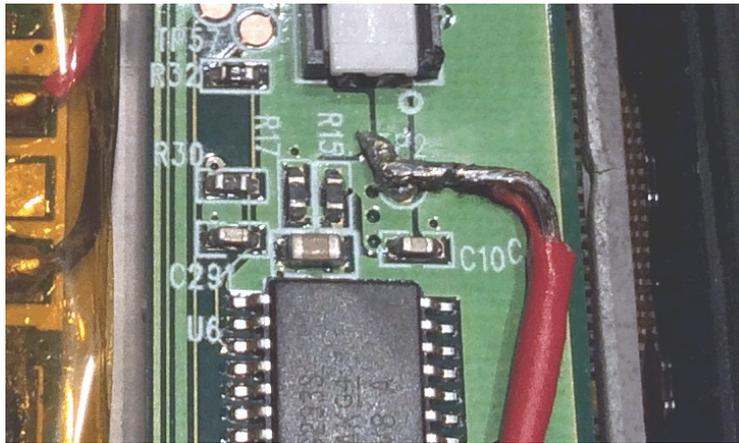
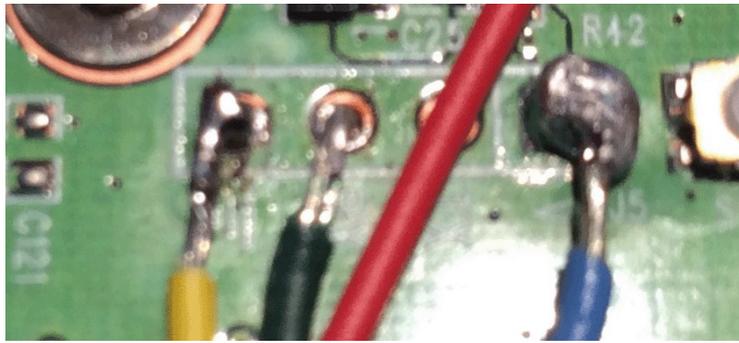
5) If you don't have a soldering sponge make a pad by folding a paper kitchen towel up into a square of about 4cm sides. Soak this in water, squeeze most out, and place it on an old tin lid or similar. Use it to wipe the soldering iron bit after each joint. It will hiss and spit a bit but it will remove burnt flux from the iron. The pad and the tin lid will become contaminated with lead so dispose of them carefully afterwards.

6) Unless you are fairly experienced at soldering or happen to have three hands do not try and apply the solder to both parts of the joint at the same time. Apply some solder to the wire so it's coated and shiny and then apply a blob to the pad you wish to solder it to. If there is now a big blob on the iron wipe it off on your soldering sponge or wet pad. Now apply a small amount of solder to the iron, place the wire on the pad, and then apply the iron. The solder on the bit should have been enough to make the joint and you only needed two hands.

7) When soldering wires to the serial port on the Kobo circuit board do not feed the wires through and solder them on the bottom side which requires the removal of the circuit board and creates lumps on the underside of the board. Just solder them to pads on the top of the board. The holes through the board are "plated through" and connect the pads on the top of the board to the pads on the bottom. Solder will probably fill the hole but is unlikely to fall out of the bottom.

8) Try to keep the blobs of solder on the pads of the Kobo reasonably small. The pads are surrounded by a copper area (ground plane) which is coated with an insulating laquer. If the solder breaks or burns this laquer there is a risk of a short circuit. This is not an issue with the ground connection which is connected to the ground plane.

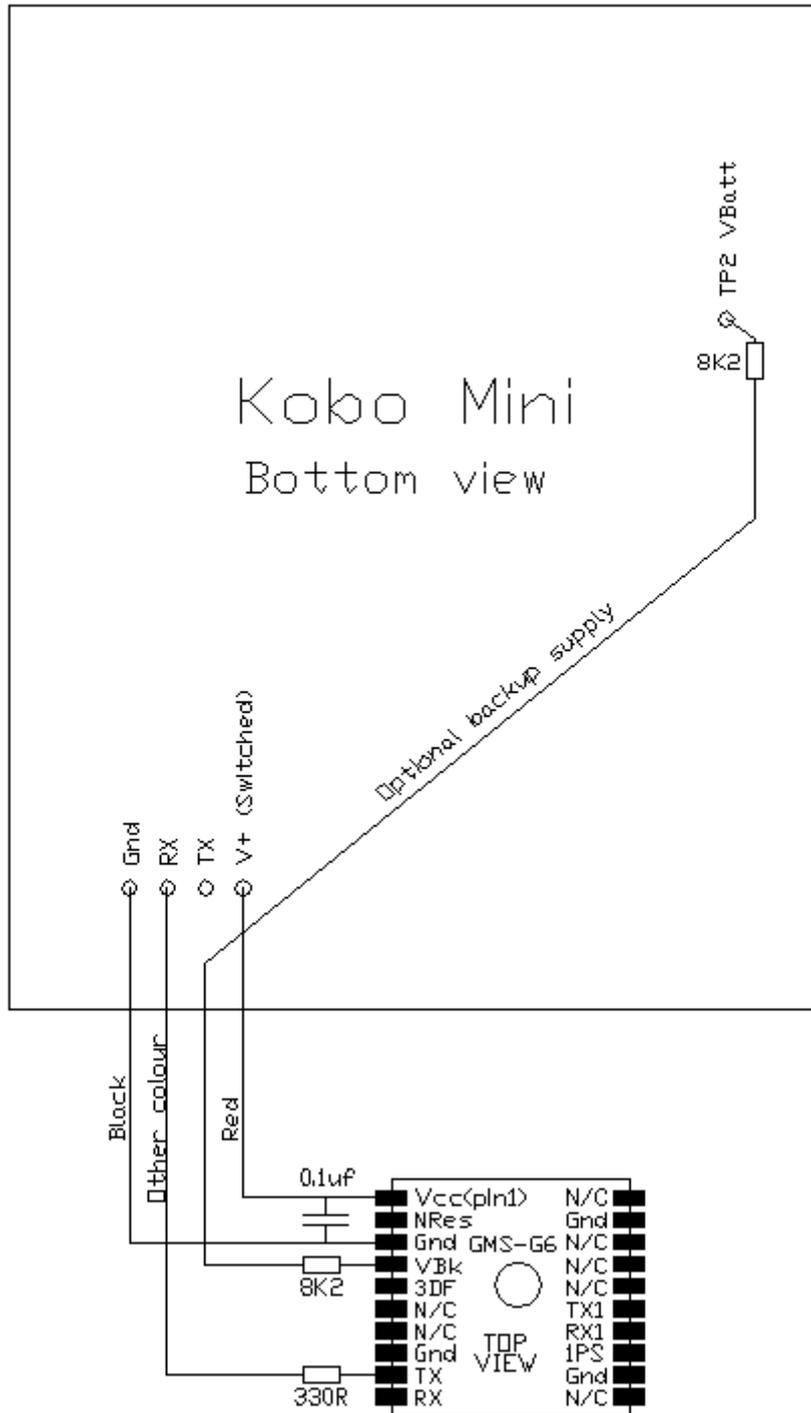
The two pictures below show solder overlying the ground plane area.



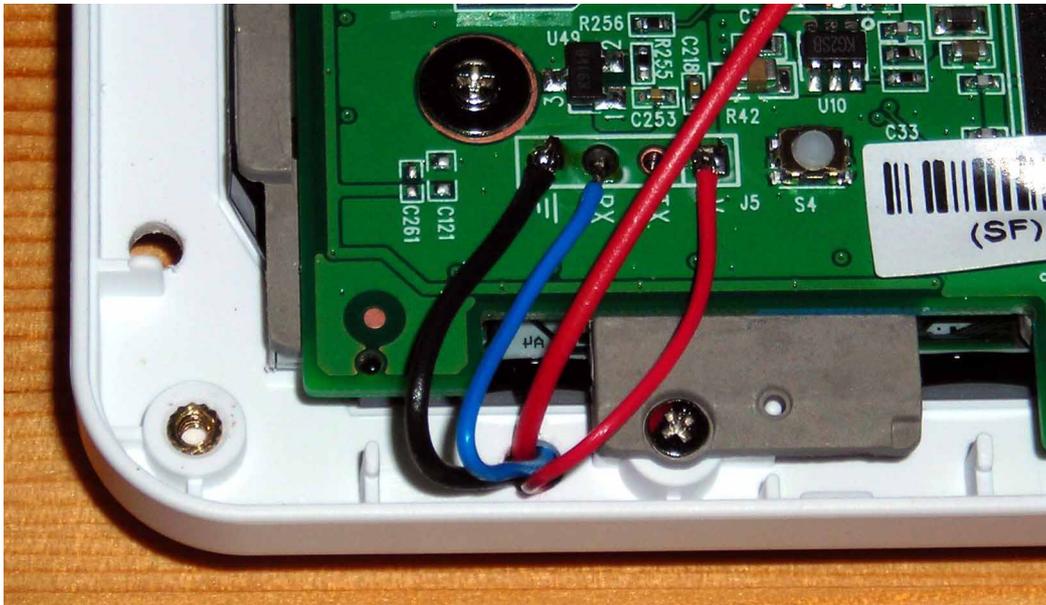
This unit failed to work and the pilot who built it had to purchase another Kobo.

9) Large blobs of solder are most easily removed with a solder sucker, a sort of pump, available for less than £2 on ebay. Alternatively “desoldering wick” is a sort of copper braid which will soak up solder when heated.

10) If you have a scrap PCB from a computer or other electronic junk then practice your soldering on that first.



Schematic



Kobo Port Connections



GPS Module Connections

Note the resistors and capacitor will be embedded in the Sugru along with the GPS chip. The Sugru will insulate their connections so no sleeving is required.

Wire Routing and Back Case Web Trimming

The webbing on the inside of the back case is designed to press on the surface of the printed circuit board and will crush the wires we have fitted.

Arrows on the left part of the image below show where wires will be pinched. Arrows on the right show where webbing needs to be trimmed to stop pinching.



The backup wire running across the circuit board can be fixed with blobs of glue or small pieces of double sided foam tape. I fix it where it goes through the notch in the webbing next to the screw pillar and where it crosses areas of board with no components.

Does It Need A Bigger Battery?

As the battery drains its voltage falls. Eventually the unit shuts itself down and the screen freezes. Units using a GlobalTop PA6C and PA6H chips run for about 12 hours in tests with the standard 1000 mAh battery whilst the

unit is stationary. However in flight the screen is refreshing more frequently and the unit uses more power. Although there has been one recorded flight of 9.5 hours with a Kobo unit some pilots have only obtained about 7 hours with tests on car journeys. This may be enough for some pilots, but others would really like a longer run time, or to be able to fly over several days without recharging. One solution to this is to use an external “powerbank” plugged into the micro USB socket.

In theory it is possible to fit a higher capacity battery inside the Kobo and some pilots have fitted a battery intended for the Samsung Galaxy W / S5820 mobile phone with a claimed capacity of 1700 mAh. However mobile phone batteries I have tested have been disappointing and no better than the standard Kobo battery.

The other solution is to fit a physically larger battery. The “Large Battery Notes” (separate file) describes how one with three times the capacity of the standard cell can be fitted.

XCSoar has a battery gauge which reads as “percent”. This helps, but like many battery monitors, is not very linear. With the standard battery the Kobo shuts down very quickly after the gauge reading drops below about 45%.

When shutdown occurs the image freezes and the touchscreen does not respond. Plugging in the micro usb charging lead re-boots the system.

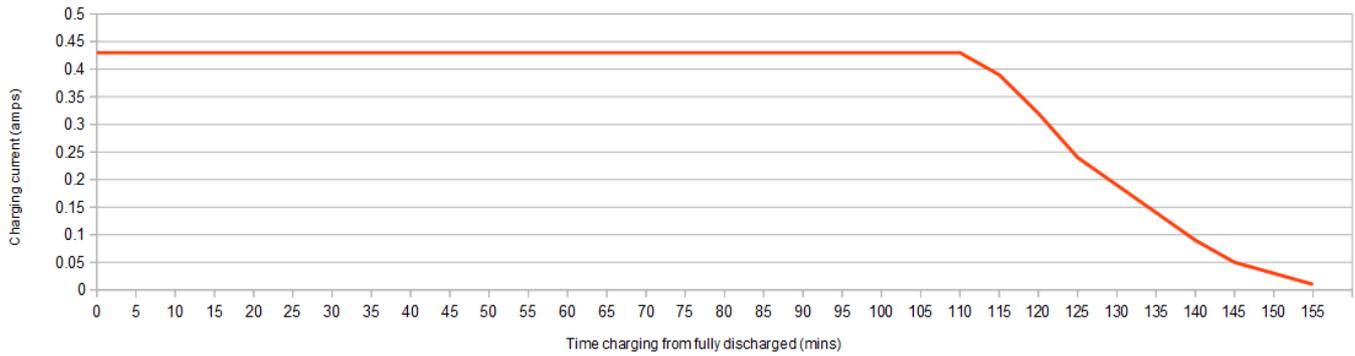
Battery Life With The Bluefly Vario Module

Fitting the Bluefly vario will increase power consumption and reduce the above run times somewhat. From the reported power consumption of the Bluefly and without having done tests I would expect run times around 75% of the run times with a GPS module only. This figure could be very dependent on the vario settings and the characteristics of the flight.

Battery Charging

The Kobo incorporates a system to control the charging. This graph shows charging current plotted against time.

Kobo/XCSoar Battery Charging

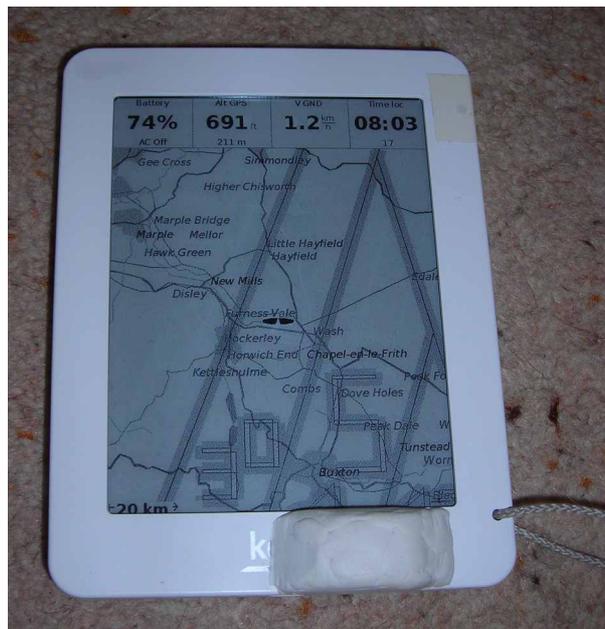


However not all Kobo units appear to charge at the same rate. Some charge at about 0.3 amps and some at about 0.43 amps. A fully discharged unit should be connected for about 4 hours to ensure full charge with a 500mA USB supply. The charging circuit should protect the battery against overcharging.

Be aware that plugging in the charger may boot the device into the start screen which may interfere with proper charging. If this happens select "Power Off" .

Drop Protection Cord

I fix the unit to my flight deck with velcro in the normal way but to protect against accidentally dropping it I drilled a 2.5 mm hole right through the unit and threaded a 2mm cord through it as in the picture below.



To avert potential disaster I drilled the hole first through front from inside the case, put the inner back on and then drilled through that from the front. Finally I put the outer back on and drilled that from the front. Make sure you

remove all swarf from inside the unit.

At the top right of the picture you can see another hole covered with tape. I can assure you that this is an alternate tie on point. NOT a mistake!

Device Driver Settings In XCSoar

Before the GPS chip will work the device driver Port A in the Kobo/XCSoar unit has to be set as follows:

Port: ttymxc0
Baud rate: 9600
Driver: generic

The “Setup And Operation Notes” contain detailed instructions for this.

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