eGuide to Setting and Using a Handheld GPS Applications in the UK ©by Paul Saunders

Quick-start If you're the kind of person that can't be bothered to read instructions, then simply do the following:

1. Set the datum to Ordnance Survey 1936 (OS36, OrdSrv, OSGB or similar)
2. Set the position format to British National Grid (BNG)
3. Set WAAS to Enabled or On.
4. Always carry spare batteries (and make sure they're fully charged)
5. Always carry a map and compass as well (and a torch!) Some of the grid references have been calculated from maps, not as a result of visiting the mountain summits. There also may be inaccuracies due to typing errors. You should take a good map and compass with you on all walking trips into the mountains. A GPS receiver is great fun, but a compass doesn't get flat batteries!

Introduction This is a guide to setting up and using a GPS in the UK. If you are unfamiliar with using a GPS it's well worth reading this information. If you are an experienced GPS user, it may still be helpful to skim through this guide on the off-chance that there's some information that you aren't already familiar with. **Setting Up Your GPS** The two most important settings in your GPS receiver are the datum and the position format. The default settings are the WGS84 datum and the latitude and longitude position format. These should be changed to Ordnance Survey GB 1936 and British National Grid (BNG) for use in the UK.

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To explain further, WGS84 is a world datum designed to approximate the Earth's surface as a whole, hence it is used as the default setting for GPS. However, the earth is not a perfect sphere, so while WGS84 is quite accurate in North America, it is inaccurate elsewhere. Therefore each country has its own particular datum that best fits that part of the world. If you use WGS84 in the UK it can be in error by up to 100m or more. For example in WGS84 the zero longitude meridian line is 102.5 metres east of the Greenwich Prime Meridian at the Royal Observatory.

Every map uses a specific datum. If you look closely at an Ordnance Survey map you'll notice that it states “Base map constructed on Transverse Mercator Projection, Airy Spheroid, OSGB (1936) Datum.” Therefore you need to set the datum in your GPS to OSGB (1936). Depending on the model you're using, this may be called Ordnance Survey, Ord Srvy GB, OS36 or something similar.

Likewise, the position format should correspond to that used by the map. If the map uses latitude and longitude, then that's what you should use. In the UK our maps use the British National Grid (BNG). This is much easier to use than lat/long, since each grid square represents 1km x 1km. In your GPS, set the position format to British Grid or BNG or similar.

If your GPS has the WAAS option, set it to Enable or On. Without going into details, WAAS refers to some extra satellites that basically make your position reading more accurate. WAAS refers to American satellites. In Europe we have a similar sytem called EGNOS. In practice they mean the same thing. Switch it on if you have the option. When WAAS is working, a small D will be shown on the satellite screen for each satellite. This indicates that your position is more accurate.

Reading the Position Format – 6 or 10 Figures Traditionally, the National Grid Reference System (as explained on Ordnance Survey maps) uses a two letter prefix with 6 numbers, for example SH 428373. The first three numbers represent the Eastings, the second three numbers represent the Northing. So the Easting is 428 (42 is the grid line, 8 is 8/10ths east of the grid line) and the Northing is 373 (37 is the grid line, 3 is 3/10ths north of the grid line).

The 6 figure grid ref is fine for manual use when reading a map, but it only has a precision of 100m. A GPS uses a 10 figure grid reference which has a precision of 1m (but it's not accurate to 1m, due to other errors which I'll mention later).

The above grid reference would be shown like this on a Garmin GPS: SH 42800 and BNG 37300

The top row shows the two letter prefix and the 5 figure easting. The bottom row shows the position format (BNG) and the 5 figure northing. As you can see, the first three numbers of each are the same, with two more figures for more precision. (Some people misunderstand this, thinking that the top row is a 6 figure grid ref, but wonder why 1 figure is missing.) So to convert a 6 figure grid ref to a 10 figure grid ref for use with a GPS, simply add two zeros to the northing and the easting, but this will still only be accurate to 100m.

Position Errors

GPS isn't perfect. The position it reports will always have some degree of error. Provided you've set your GPS correctly, this error is rarely more than 10 metres, so you don't need to worry about it much. Your GPS will show an EPE (Estimated Position Error) which is a rough guide to how accurate your position is. If the EPE is low, you can probably trust it, if it's high you probably can't (but you'll still know roughly where you are). If you want to know more about these errors, read on, otherwise you can skip this section.

There are three main causes of position errors – datum errors, conversion errors and reception errors.

Datum errors. These are caused by setting the wrong datum (or not changing the default datum) in your GPS. Apparently many people don't bother to change the defaults. As already explained, if you don't set the correct datum your position can be in error by up to a hundred metres or more.

Datum conversion errors. This error is more subtle, but most of the time you don't need to worry about it. Your GPS receiver always uses WGS84 internally, so when you change the datum, it has to convert it to your local datum to display

your position. Because datum conversion can be quite complex, it uses a simple conversion instead (a GPS isn't powerful enough to make complex conversions in real time). This results in a small error, typically of around 7 metres in the UK. In normal use you wouldn't notice this, since 7m is only ¼ of a millimetre on a 1:25,000 scale walkers' map. In a computer program like Memory Map, this error is only 3 pixels.

The Ordnance Survey does provide an online tool to convert WGS84 grid refs to OSGB with high accuracy. However, this is only necessary when working with very large scale maps. It makes the grid refs more accurate when used with a MAP, but not when used with a GPS (since the GPS uses a simple internal conversion). For GPS use, although it seems paradoxical, you shouldn't use the accurate online tool. GPS software uses the same simple conversion that is used in the GPS, so the results are consistent. So if you've recorded a waypoint in WGS84 lat/long format and you want to convert it to OSGB BNG, use a program like GPS Utility, NOT the accurate OS conversion tool. Even though the conversion will be less accurate compared to a map, it will be more accurate when used with a GPS.

I recommend the use of GPS Utility to manage waypoints, routes and tracks. The free version is usable for up to 100 waypoints, 500 track-points and 5 routes. You have to register it to load more than that. One of its best features is that it has the ability to import and export practically any GPS file format you can think of. So for example, you could convert files from Memory Map to use in Google Earth, or you could download waypoint files from the internet in any format and convert them to use in your favourite GPS software.

You can download GPS Utility here: http://www.gpsu.co.uk/

Normally you'll find it difficult to get hold of truly accurate OSGB coordinates, but there is a list of such coordinates for all the UK Trig Points available on the web, in both WGS84 and OSGB formats. If you want to use these coordinates, DON'T use the OSGB file (this is for use with maps), instead download and use the WGS84 file (which is for use with GPS). The file is in GPS Utility format so you'd need the registered version to be able to load the whole file, but it's also readable with any text file editor.

You can download these trig point files here: http://www.haroldstreet.org.uk/trigpoints/

Satellite Reception Errors. This is the most common cause of error that you'll encounter. Usually the error is less than 10m, particularly when out walking in open terrain, so it's not something you normally have to worry about, but it can sometimes be much worse, so it's useful to know when the reception is bad and what you can do about it.

EPE. This stands for "estimated position error". It's a good idea to keep an eye on this when checking your position. If the EPE is low you can usually trust it to be accurate, but if it's high, then treat your position as a rough indication only. I think the average error is supposed to be around 15m most of the time, but that includes use in cities where there are many buildings blocking the signal. When out walking in the open the error is usually very low, often 5m or better.

Constellation. This refers to the arrangement of satellites in the sky. It's similar to a constellation of stars but is constantly changing since most of the satellites are moving. Sometimes there's a good spread of satellites around the sky, sometimes there's not. You can see the constellation on the satellite screen. If your GPS is picking up 12 satellites spread evenly over the sky, you'll have a very accurate position, but sometimes it may only pick up 5 or 6 satellites and they aren't spread evenly, so your position can be much less accurate, even if you're out in the open. On high mountain summits I've often had an EPE as good as 2m (occasionally even 1m), but once I had a very poor constellation on a mountain top and only had an EPE of 7m, in spite of having perfect reception.

EGNOS (and WAAS). These are systems of geo-stationary satellites that sit over the equator. Since they stay where they are relative to the Earth, their positions are known with much greater accuracy. Signals from these satellites are used to correct your position and make it more accurate. When this happens, the satellite screen will show the letter D over each satellite signal to show that it's being corrected. When this happens you can get a very accurate position, often with an EPE of just 2 or 3m in very open terrain. Since these satellites have to be over the equator, they appear quite low in the sky from northern latitudes. As a result you need a clear view to the south to pick them up. Consequently, when walking on the northern sides of hills and mountains you often can't pick them up.

Signal Blockages. The most likely problems occur when walking in forests, where trees block the satellite signals, or in deep valleys or near cliffs, when the land itself blocks the signals. Even your body can block the signals from the satellites, so it's a good idea to wear your GPS high up. Many people attach it to a rucksack strap so that it lays on top of their shoulder, or close to it. When wearing it on a belt, it's likely to be less accurate. When marking a position, hold it above your head for the best reception.

Signal Reflections. Sometimes you may have a clear view of most of the sky, but have part of it blocked by a nearby cliff. Satellite signals may bounce off the cliff, giving your GPS false readings. So your GPS may report a low EPE, but it may not be as accurate as it thinks. Walking below cliffs often produces an error which can clearly be seen when you check your track on a map later. High buildings cause the same effect. If you're walking near a cliff and your GPS is on the same side of your body as the cliff, your body can block the signals from the other direction resulting in a very poor signal. So if possible, move your GPS to the other side of your body. It's a good practice to do this whenever you're walking close to a cliff or steep hillside.

Lost Reception. Sometimes you'll lose the signal completely and there's not much you can do about that if you're in a deep valley. But if you're in woods, the signal blockage tends to be intermittent. If this happens, it's best to move to a clearing or an area where the trees are less dense, then stop and hold the GPS high up until it regains the signal lock. It's more likely to regain the signal if you're stationary rather than if you keep walking (because the signals keep getting interrupted when you move). Once you've regained a lock on the satellites, you can continue moving. Once your GPS "knows where it is", it's more likely to keep the signal lock.

Straight Path. When your GPS loses signal lock, it doesn't stop working immediately instead it assumes that you are still walking in the same direction at the same speed while it tries to regain the lock. It does this for about 30 seconds, so even if you stop or change direction, the GPS will "keep moving" in the same direction. This can happen a lot in forests. There's

also a slight delay when you change direction. Watch your GPS map screen when you change direction suddenly, you may notice that it doesn't turn straight away.

If you're having reception problems, don't use battery saver mode. Especially near or in a forest, try to wear your GPS as high as you can, facing the largest amount of clear sky (away from hillsides). If you lose reception, stop until you regain it.

How to make an accurate waypoint: Usually a rough waypoint will be fine, but if you want to mark your position as accurately as possible do the following: First stop and let your GPS settle down. Face south to try to pick up the EGNOS satellites. If you can pick them up, then wait until you see a D over every satellite signal. Hold your GPS above your head so that your body doesn't block any signals. Use the averaging mode and let your GPS average the position for at least a minute (you can watch the EPE getting lower as it averages).Many people recommend averaging for at least 10 minutes or even half an hour if you want a really accurate position, but I think that 1 minute is enough to average out any minor errors. I've tried averaging for longer times, but I don't find that 10 minutes gives much more accuracy than 1 minute. If you need super accuracy, you need to use professional GPS equipment. Consumer grade GPS receivers aren't good enough for that, but you can sometimes get 2-3m accuracy in optimum conditions. I've tested this at a local trig point several times and had an average accuracy of 2m. (Remember that the EPE is an "estimated" error, not the actual error – to know the actual error you have to know what the true grid reference is, for example with the list of trig points mentioned previously).

Basic Guide to GPS Models: If you're unfamiliar with GPS, here's a quick breakdown of the basics:

- Basic. The cheapest and simplest models have no internal map. They do have a map screen, but that only shows waypoints, routes and tracks. Even this basic information can still be very helpful though.
- Map. More expensive units can usually load maps. They come with a default base-map (showing only major roads and rivers), and in the UK they're very inaccurate and almost worse than useless. Decent maps have to be bought and are quite expensive. There are topographic maps available which are well worth the investment for hill walking, if you can justify the expense. Otherwise, there are some free contour maps available on the internet. They're not so

accurate but are still very useful.

- Altimeter. Some models include an altimeter. Strictly speaking these aren't necessary since the GPS gives you height data anyway, but such data can be unreliable if you don't have a good signal. The advantage of using an altimeter model is that it makes the height data more reliable and consistent and keeps working even if you lose the signal. You need to remember to calibrate the altimeter before each walk, but there is an auto-calibration feature built in so it will reach the correct altitude after a while even if you forget to calibrate it.
- Compass. Some models include an electronic compass. Like the altimeter, this isn't really necessary since the GPS compass will work fine without it, but ONLY when you're moving. The electronic compass is therefore useful to check your direction when stationary (or moving very slowly, below 1mph) or when you can't get a GPS signal, such as in a dense forest or deep valley. Be warned though, the compass eats battery power at a frightening rate, so only switch it on when you really need it (on my Garmin GPS60 you hold the PAGE button to turn it on and off). If your GPS regularly runs out of battery power quickly, it may be because you've left it permanently switched on.
  GPS Features Waypoints. This is a stored grid reference with an icon attached to it. You can input waypoints manually (or with software) before your trip, and you can mark your position as a waypoint when you're out on a walk.

- Routes. A route is a collection of waypoints linked together to form a route, so each pair of waypoints is connected by a line. When you activate a route on your GPS, the compass screen will lead you to each waypoint, switching automatically to the next waypoint as you reach each one. You need to create a route in advance of your trip. It's much easier to do this using software rather than doing it manually.

- Tracks. A track is created automatically when you're out walking. You need to switch track recording on and leave the GPS on the whole time. This track is a record of your walk, like leaving a trail of breadcrumbs. If you should get lost during your walk, you can use it to retrace your steps. There is a backtracking feature which effectively turns your track into a route so that you can follow it back with the compass screen. Also, it's handy to save tracks of your walks on your computer for future reference.

Methods of using a GPS: First of all, the usual precautionary advice must be stated that GPS is not a replacement for a map and compass. It can replace a map and compass if you've input sufficient waypoints and/or a route in advance, or if you're using a map model, but you should always carry a map and compass as well, just in case. For that matter, it's advisable to always carry a torch too, in case your walk takes longer than you expect. Here's a few different methods of using a GPS.

The Worst Method - Take the GPS with you but leave it switched off inside your rucksack. This is typically done by people navigating with map and compass, keeping the GPS simply as a backup in case they get lost. If this happens, simply switch the GPS on to determine your position (wait a few minutes to get a good satellite lock first) then locate where you are on the map. To be honest, there's not much point in having a GPS if you use it this way, since you are wasting most of its potential, but it can be a lifesaver if you get completely lost in mist or at night. Of course, it must be set up properly in advance otherwise it cannot tell you your position.

Some reckless people may go walking without a map, trusting simply that they can see where they are going. Unfortunately, if the visibility gets bad, the GPS position won't help (unless it's a map model). Knowing your position is of no use if you don't know where you started from. So if you choose to use this method, you should at least switch it on before you start your walk and record a waypoint at your start point. You can later use this to help guide you back if necessary (but it won't help you to avoid obstacles like cliffs or lakes).

A Better Method – Mark your start point and keep the GPS switched on to record a track. This is the minimum level of use that I'd recommend. In fact I usually do this myself when walking in familiar areas. Since I know where I'm going, I don't need to plot waypoints or a route in advance, but it's always handy to record a track (I save all my tracks for future reference). Sometimes I may wander away from my intended route, sometimes into unfamiliar territory, but I always have the track to guide me back if necessary. By the way, I use a map model, so I virtually never have to look at my paper map, but I always carry one just in case.

The Best Method – Plot waypoints and plan a route in advance. This is best done using software like Memory Map, Anquet Maps or similar. Doing it by hand is a real pain, and can be prone to error. The extra expense of buying the software is well worth it for anyone who walks regularly, and is essential to use a GPS to its full potential. As I said, GPS is not a replacement for a map, but in this case do all your map reading and planning is done BEFORE you walk. http://www.landscape-guides.co.uk/googlemaps4.asp As you study the map you place waypoints to mark key locations, like car parks, summits, important path junctions and other features of interest (like cairns or viewpoints). Then you'd use these waypoints plus others to create a route (or more than one if you'd like alternative routes).

Use **The Photographer's Ephemeris** to plan your shoot. You can search for your chosen location or navigate using the map. Scroll through the year or use the calendar to select a date, to see sunrise/sunset and moonrise/moonset information for that location displayed instantly. Click on Details view to see Twilight times or click to view the day's celestial events. **TPE** also allows you to spot potential obstructions to the light hitting your intended photographic target by using the handy horizon tool. Whether you are photographing a wild, windswept mountain top, the sun setting between a city's high towers or the moon rising over an island at sea, you can plan the best date and time to photograph any location on earth using **The Photographer's Ephemeris**.

Download the free desktop version or get the iPhone app at **http://photoephemeris.com**

If you do this work in advance, you rarely ever need to look at your map during the walk your GPS will guide you all the way. But it's up to you to plan a sensible route. You don't have to use too many waypoints, but you do need to use enough to guide you around features like lakes and cliffs. Even with a basic non-map model you can still load enough information so that you don't need to check the map during your walk. If you do have a map model with a detailed topographic map loaded, you don't need many waypoints or even a route. But it's still a good idea to plot a few key waypoints and plan a route so that you don't have even to think about the navigation while you're walking, which can be a big timesaver, for OSGB and GPS-GB go to: http://www.hill-bagging.co.uk/ Of course, even the best GPS can stop working, so you should always carry a map and compass as a backup. There are many websites that list the mountain summits and hills of England and Wales,

and many of these give the 6 figure (100 metre) Ordnance Survey grid references of the summits. Most hand-held GPS receiver's like a Garmin GPSMAP 60Cx, which can record 10 figure grid references (theoretically accurate to 1 metre), you can get grid references taken from the Database of British Hills, which benefits from having many people contributing their GPS readings to the database, and many hills having several readings thus improving accuracy and reliability.

I know that for many summits, such precision is unnecessary - but in mist, or when the top could be one of several rocky outcrops, or a flat plateau with a tiny cairn, or even completely unmarked. Such accuracy would, of course, have been useless before "Selective Availability" was switched off.

What Could Go Wrong?

GPS receivers are very reliable devices and rarely go wrong when used properly, so the usual advice about always carrying a map and compass is a little paranoid in my opinion. However, it's still worth following that advice (your GPS *can* sometimes fail, and a map can often come in handy since it shows details that your GPS doesn't have). So what could go wrong and what can you do to avoid these potential problems?

Wrong Datum. A common mistake is not to set the datum properly, but if you've followed the advice at the beginning of this guide, this won't happen to you. This is a one-time mistake, so it usually happens to GPS novices. Once you've set the correct datum, you won't need to worry about it again, unless you travel to another country of course, in which case you'll need to change the datum to match the maps you'll be using.

Latitude/Longitude differences. If for some reason you decide to use the lat/long position. Format in the UK, you need to be aware that the your position will be different depending on the datum you use. Some people assume that you should use WGS84 with lat/long, but you should still use OSGB when in the UK. Although UK maps use the British National Grid, they do indicate latitude on longitude on the edges of the map (although this isn't much use since the lat/long lines curve as

they cross the map, and these curved lines aren't shown). If you use lat/long with WGS84, your position won't match the UK lat/long coordinates. As mentioned previously, the zero longitude line in WGS84 is 102.5 metres east of the Greenwich Royal Observatory, which is where it should be!

Flat Batteries. The most common GPS failure by far is due to batteries running out. Many claim that you shouldn't rely on GPS for this very reason. But how many people say that you shouldn't rely on cars because they might run out of petrol? They could, but generally speaking they don't, because you make sure you put enough petrol in the tank. It's the same with GPS. If you make sure you carry enough batteries (and that rechargeable batteries are always freshly charged), this should never happen to you. If it does, that's just carelessness. It can happen of course. You may sometimes forget to charge your batteries before going out, or think they have enough charge left but they don't (because you charged them after your last trip but you haven't used them for a while). But if you always carry spares this shouldn't matter. I use Ni-MH rechargeable batteries in my GPS, and always carry spares. Additionally I always carry a set of heavy duty alkaline batteries as an emergency backup (which I never use, unless I really have to). The advantage of always carrying normal batteries is that they lose very little charge over time like re-chargeable do. It's like carrying a first aid kit, you should always take it, but most of the time you will never need to use it. Since rechargeable batteries lose their charge over time, you should recharge them regularly if you don't use them, perhaps every few weeks. If you don't use your batteries regularly, it's worth charging them again just before each trip. You should also recharge flat batteries straight after a trip, it's best to store them fully charged. Rechargeable batteries don't last forever, so as they start to wear out, buy new ones to replace them.

Provided you follow the above advice, you should never run out of battery power, unless you go on a particularly long trip in the wilds. But you are rarely away from a power socket or a car battery for very long in the UK. If you do go on a long trip in the wilds, carry plenty of spare batteries as you think you'll need, plus a few more (plus your emergency alkalines).

If the worst does happen and you find yourself running low on power, there are two things you can do. Firstly, if you're only running slightly low, you can switch your GPS to “Battery Saver” or “Low Power” mode (you can do this in advance if

you're on a very long trip and expect to run low). This will save power by only accessing the satellites intermittently. This is fine when you're in open terrain and don't need a highly accurate position, but it works terribly when in woods or deep valleys, so always use normal mode in those situations.

If your power situation is desperate, simply switch your GPS off. Don't wait until it goes completely flat. Then turn it on occasionally to check your position and mark key points that you might need later if you want to return the same way. If you have to navigate in bad visibility, switch your GPS on to check the compass direction to your next waypoint, then turn it off and use your real compass to get there. Provided you don't let the batteries go completely flat, your GPS, can still be useful to navigate with. You just won't be able to record a complete track of your walk.

One more point about batteries. It's always a good idea when walking in the hills to carry a torch, just in case your plans go wrong and you find yourself walking at night. But if so, make sure you have extra batteries for the torch too! If your torch and GPS use the same type of batteries then you can use them interchangeably, but if they all get used up in your GPS you may find yourself without a torch! So make sure you have enough for each.

Bad Reception. Technically this isn't a problem with your GPS, it just happens in certain circumstances like when you're in a forest or a deep valley, or when close to a cliff or when your body is blocking the signals. This was covered earlier in the section on Position Errors.

Broken GPS. Yes, in spite of their reliability, you may actually drop and break your GPS. I've seen it happen to a friend of mine. To my surprise he took another GPS out of his rucksack and carried on using that instead! Now that's what I call going prepared! In fact, he found out later that his broken GPS carried on working and recording a track, it was just the screen that was broken!

So yes, a GPS can break, but so can a compass, and your map could blow away in a gale, so nothing is 100% reliable. But so long as you take care this is unlikely to happen. By the way, my friend's GPS fell out of his pocket when he bent over,

and it hit a rock. That's one reason why I always attach the lanyard to the end of a zip or to my rucksack or something, so that I can't drop it.

A Final Word To sum up, if you set your datum and position format correctly, plan your trips with waypoints and plot routes in advance, carry your GPS high up so that it gets a good signal, always carry spare batteries and take care not to drop and break it, your GPS will be a reliable accurate device that you can rely on. But always carry a map, compass and torch as well, just in case!

Addendum

It's been pointed out to me that some people prefer to keep their GPS set to WGS84 with lat/long coordinates. I don't recommend this since it's not possible to cross reference your position with an Ordnance Survey map. However if you are using a GPS with an internal map then the datum and display format don't affect your position on that map (they only affect the coordinates reported by the GPS), so arguably you don't need to change the datum. This is fine so long as your GPS continues to function properly, but carrying a paper map as a backup is still a good idea. Many people use TomToms and similar navigation devices in their cars these days. I believe these are set to WGS84 and lat/long, and I don't think those settings can be changed. But that doesn't matter because these devices are only intended for in-car use. They are not suitable for hillwalking, although some people apparently use them that way. They can be used for locating the start points of the walks in this book, but are not recommended for navigating to the viewpoints in this book. **©Paul Saunders**

OSGB and GPS-GB

We recommend this UK-GB Map web site for all ten figure OSGB and GPS-GB references: http://www.hill-bagging.co.uk/contact.php

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