

Good Navigational Safety Sense!

Navigate On-Track Using GNSS



Development of Global Navigation Satellite Systems (GNSS - commonly known as GPS), and new equipment running sophisticated software, has given pilots the ability to navigate accurately, providing a helping hand to traditional dead reckoning skills. However, the vulnerability of GPS and the erosion of traditional skills can put the unwary in jeopardy.

This guide explains how you can safely integrate GPS into traditional navigation techniques. It will help you navigate with increased confidence, enabling you to better enjoy your flying.

There are lots of options for hardware and software, but the one feature you definitely need is NOTAM information updated at least in line with the 28-day AIRAC cycle for airspace.

Most software packages include a simulator mode which is very useful for familiarisation before going flying. However, beware the trap: flying in simulator mode will always show the aircraft on-track and will take you straight to the scene of the infringement!
Always check you are in the right mode before you fly.

GPS installation tips

- Ensure a good 'view' of the sky so your GPS receivers have enough satellites to operate effectively.
- Avoid glare and reflections.
- Use a secure mount that minimises vibration and does not interfere with controls. Check it won't jam the controls if it does fall off.
- Magnetic compasses may be affected if the GPS device is sited too close. Check before you fly!
- Ensure your cable will reach the power supply. If your device is battery-powered, take spares/a charger as appropriate.
- Confirm the device does not obscure your view of the instrument panel or the world outside the cockpit/lookout.
- Position the device so that its controls are easily accessible.
- Extremes of temperature can drain batteries or cause devices to shut down.

Setting up your device and software:

- Read the manual!
- Before you fly, set your preferences and practice using the program in simulator mode. Put it back on flight mode before you fly.



A leg-mount allows the unit to be shaded, is close enough to read and is ideal for a small cockpit.



A yoke-mount gives a good view of the device, but you may get glare and it can block controls.

Pre-flight planning

- Most GPS software has live NOTAM and weather information, but you will need a connection to the Internet.
- Use the software's flight planning tools to draft the route. Once completed, you should transfer the information to your paper chart in case the device fails.
- Choose a route that keeps you away from airspace boundaries. Try to stay at least **2 nm** from the edge of and **200 ft** above/below controlled airspace. Allow room for the unexpected.
- Anticipate your listening squawk requirements!
- Mark your chart with key information. Remember that many planning tools allow you to print a chart/log.

Proper pre-flight planning, using appropriate techniques and aids, remains vital to the safe conduct of any flight. The accuracy of GPS is no substitute for sound pre-flight planning.

Infringement of CTA (Class D)

The pilot stated that he was using an inappropriate flight information service and, with insufficient paper and pen flight planning, was over-reliant on GPS. His main GPS failed in flight. The secondary GPS was incorrectly set to a LARS designation code instead of his alternate airfield designation code. The chart he had placed on the passenger seat during flight fell between the seat and the door due to turbulence. A strong SE wind pushed the aircraft north of the planned route at higher than normal ground speed. Meanwhile, the pilot was distracted with the failed GPS unit and lost chart. There was poor decision-making throughout, from the planning stage up to the point when the flight was aborted.

Based on GASCo Flight Safety Extra June 2016

Route and turning point selection

- Start and end points should be close to, but not at, the departure and destination airfields (check the published airfield procedures to see if they stipulate locations).
- Remain away from the boundaries of airspace. Weather, other traffic and GPS failure could force you into infringement.
- Follow standard precautions around choke points, turning points or significant ground features.
- Include escape options in case there is bad weather.
- Choose features that are: **C**ontrasting; **U**nique; **L**arge; **T**all.
- Use 'handrail' features - eg a road junction with roads converging from either side of the planned track.
- Avoid 'electronic' waypoints (ie those only available using digital aids) in case of GPS failure.



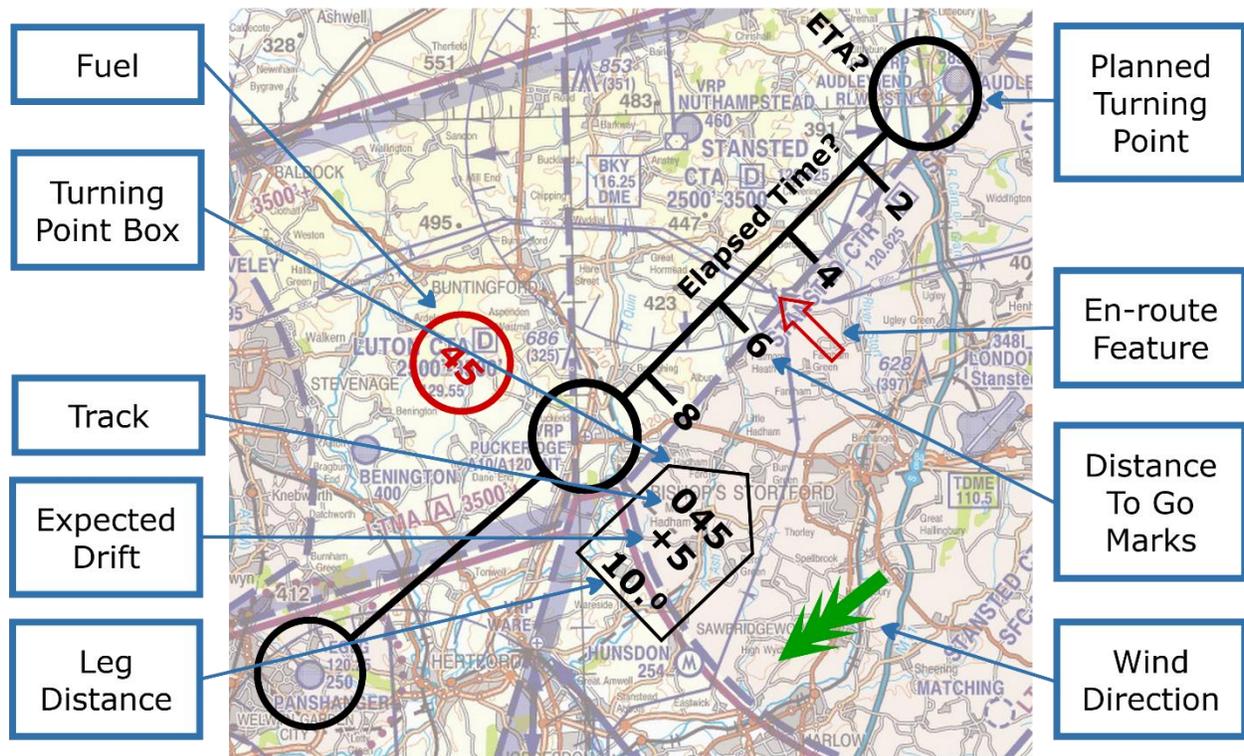
The Spinnaker Tower at Portsmouth Harbour:

Contrasting
Unique
Large
Tall

Image from Wikimedia Commons

Marking your chart

Traditional navigation planning has involved the production of a Pilot's Log, or PLOG. This is a useful tool for planning and in the air. While paper versions are still useful, most GPS software can also produce a PLOG - usually automatically and dynamically as the route is adjusted. However, it is good practise to transfer information from your PLOG to your chart - this reduces cockpit clutter and makes the data more accessible and easier to use.



- Turning point circles - wide enough not to obscure detail.
- Track lines - to avoid obscuring detail, these do not enter turning point circles.
- Wind arrow - good for situational awareness, as well as diversion/deviation planning.
- Turning point box - well away from track and containing:
 - Track - on-track navigation is the key to infringement avoidance!
 - Expected drift - calculated during planning.
 - Leg distance.
- Fuel circle - usually contains the expected fuel at that point.
- Distance-to-go marks.
- En-route features.
- ETA - pre-flight calculated ETA can be useful, particularly for ATC messages.

You could also add:

- Marks for radio calls - agency and frequency.
- Listening squawks - agency, frequency and transponder code.
- Sector safety altitudes and where to change pressure settings.

Before you fly

- Check your GPS device is in 'flight mode'.
- Ensure your GPS device is securely mounted and the display is visible.
- Connect your GPS device power supply and confirm that it is working.
- Stow the back-up batteries/alternate power source so that they are secure but easily accessible.
- Ensure that your paper chart is secure but easily accessible.
- If you use a stopwatch, and it is a good idea to do so, then confirm it is secure, visible and serviceable.
- Check the compass and DI are serviceable and synchronised; note deviation card.
- Check your GPS device is in the correct mode and set to 'Go Flying'.

Use of stopwatches is personal choice - some will find them invaluable, others stop using them after gaining their licence. However, they can be a useful tool when things go wrong, to help you maintain awareness of your position, or possible position.

Lined-up on the runway:

- Ensure that the moving map on your GPS device has followed onto the runway.
- Check that the compass and DI show the runway heading.

Before you fly, remember to:

- Confirm your route is downloaded to your GNSS device before going out of range of the Internet/cloud storage.
- Check the information on your chart matches your electronic PLOG.

Departure

- Remember that the start of the route should be a short distance away from the departure airfield (see 'Route selection').
- Use your GPS to confirm you have correctly identified the start point.
- Ensure that the moving map follows your climb out path.

On-track navigation

This technique uses turning points and other ground features chosen during the flight to create fixes at frequent intervals. It is a simple method for maintaining on-track navigation so is an aid to the avoidance of airspace infringements.

Remember to use the tips in 'Route and turning point selection' to help choose good markers.

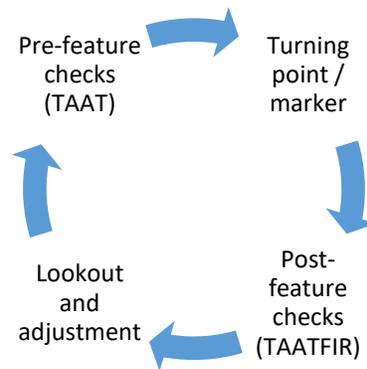
A paper chart should be used as your primary tool, with the GPS as support to enhance accuracy and provide confidence. If your device fails, using this technique will mean you are able to continue to navigate on-track and there is no need to panic.

The technique is designed to keep your workload low, leaving plenty of time to look out of the cockpit!

Application and en-route checks

- Around one minute before you reach it, identify the feature on your chart. Adjust your tracking.
- Carry out the pre-feature checks:
 - Track required after the feature - set on the HSI, if available;
 - Airspeed required after the feature;
 - Altitude required after the feature;
 - Timing - is the elapsed time as expected? Zero the leg-time stopwatch (if you use one).
- At the feature:
 - If at an on-track feature, continue to track towards your aiming point;
 - If at a turning point, turn onto the next track;
 - Look directly ahead and choose your next on-track aiming point. Check it correlates with the 'magenta line'!
 - Adjust heading to track towards aiming point;
 - Check balance.
- Carry out the post-feature checks:
 - Track;
 - Airspeed;
 - Altitude;
 - Timing - is the leg-time stopwatch running?
 - Fuel - compare to expected amount noted on chart. Change tanks if required;
 - Instruments - normal management checks;
 - Radio - check chart/PLOG for next call; check correct frequency and listening squawk are selected.
- Stow the chart. Continue to lookout and fly accurately. Adjust tracking towards the aiming point, selecting the next one as required.
- The GPS magenta line will confirm where you are going - enjoy the view and enjoy navigating on-track.
- At approximately one minute to go to the next feature, start the process again.

Using the structure above will naturally lead to the establishment of a work-cycle:



Choosing the next feature:

- Select your next aiming point before over-flying the present one;
- Approaching the present aiming point, sight ahead along the track line not the projected heading;
- When at an aiming point, the aircraft should be rolled out onto the compass track to allow the next aiming point to be picked before adjusting heading to track towards it.

Diversions

During your planning, you should give some thought to suitable diversions and contingency routes.

- Remember that diversions may not be foreseeable.
- A GPS device with appropriate software is an ideal tool for unpredicted situations.
- Zoom out or use a paper chart to get the big picture before changing heading.

'Lost' procedures

Yes, this can happen even when using GPS!

- Admit that all is not well.
- Talk to ATC or Distress and Diversion (D&D) and ask for help - that is what they are there for!
- Note the leg timer and heading.
- Establish a 'racetrack' pattern at a safe height - this gives time for lookout and for the compass to settle on the straights.
- Orientate the chart - using the compass and any unique landmarks.
- Plot a 'circle of uncertainty' - using the elapsed time to give a rough distance and the heading noted for direction.
- If your GPS device is working, this is your best navigation tool, but take care to check the surrounding airspace restrictions before using the GOTO button.

When you know where you are, check your endurance and decide what caused the 'lost' situation; decide whether to carry on, go back or divert.

It is a good idea to practise these procedures, including asking D&D for a training fix.

Landing away and flying back

- Remember to stop the GPS device navigating.
- If you can, put your device on charge whilst at your destination.
- Most software has a 'reverse route' facility. You could use this to redraw the route on your chart.

Equipment failure

Potential causes of failure:

- Batteries - old and cold batteries drain much faster;
- Your software may inadvertently be in simulator mode;
- Your device may switch itself off if it becomes over heated.

Should a failure occur:

- Aviate - fly the aircraft first and always;
- Navigate - revert to traditional methods;
- Communicate - if in doubt tell ATC and ask for help.

If you have passengers who are able to help ask them to:

- Check the power supply and, if necessary, go to back-up supplies;
- Check the GPS device aerial still has a clear view of the sky;
- If using an external aerial, check the connections;
- Check the satellite availability.

If all else fails:

- Reboot the system;
- Try using a substitute device.

Useful resources

infringements.caa.co.uk

airspace-safety.com

gasco.org.uk/flight-safety-information/take-two

Overviews of GNSS/GPS

en.wikipedia.org/wiki/satellite_navigation

trimble.com/gps_tutorial/whygps.aspx

youtu.be/NOJUSjYK7SY

garmin.com/aboutGPS

gnss.be/how_tutorial.php

GPS jamming in the UK

ofcom.org.uk/spectrum/information/gps-jamming-exercises