Check for EC devices – FREE

PilotAware's **Keith Vinning** explains how to check your Electronic Conspicuity (EC) devices for FREE with PAW VECTOR

There have been many aviation magazine articles and forum posts on Electronic Conspicuity that have been written based on personal opinion, hearsay or otherwise. While these have been written with good intentions, most have been done without access to any meaningful data to back up their assumptions. This can lead, at best, to unsubstantiated and unhelpful conclusions, and misinformation at worst.

The principal difficulty has been that there has been no public, or private, method of checking the transmission fidelity of the various EC devices under discussion – *FLARM, PilotAware*, ADSB *(DF17), ADSB CAP1391 (DF18) and Mode-S*, either individually or collectively.

However, with the PilotAware ATOM GRID network now exceeding 200 sites in the UK and Europe, millions of data 'pings' are collected daily from all types of EC devices. This has allowed PilotAware to quickly analyse and compare all devices, individually by aircraft and collectively by device, using multiple sites and detecting multiple technologies on a continuous basis.

Powerful information

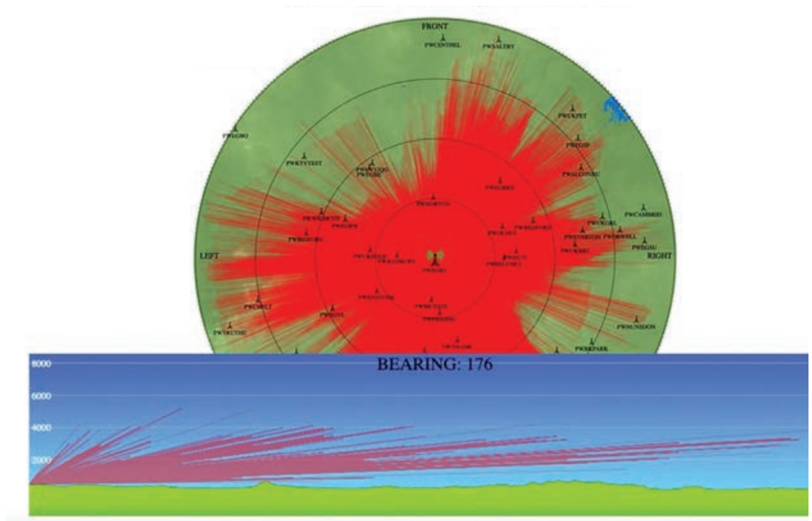
A detailed analysis of the collected data clearly shows that there is a very broad range of EC performance, from very good to very poor. This could lead to a dangerous situation where the users think that they are transmitting and receiving effectively, but they are not. To be clear, this can apply to ALL of the device types in use today.

Once this range was understood, it was agreed by the PilotAware Team that access to this valuable tool should be available to all, not just PilotAware users. However, to do this would require significant effort to develop and maintain.

Fortunately, this additional work requirement coincided with the DfT – CAA EC grant, which generated more than average revenue for PilotAware, and this has allowed us to maintain our altruistic business model. The result is PilotAware VECTOR, which has been made freely available to allow everyone to check and improve their EC performance. This article explains how VECTOR will help you.

PilotAware ATOM station coverage

All electronic conspicuity devices transmit and receive signals that require line-of-sight to operate correctly. PilotAware ATOM ground stations can detect all correctly working EC technologies at 60km+, if the line-of-sight signals are not obscured or attenuated (weakened). The signal strength used by the EC device is not a significant factor if the device is working and installed properly. For example, transponders transmitting 140W+ are required to see aircraft at far distances, but once they fly over the horizon and are out of line-of-sight of the receiver, the additional power is of no advantage.



Above An EC range and direction 'heatmap'.

The picture above demonstrates this, the range and direction heatmap shows PilotAware devices, transmitting 250mW, detected by the ATOM station at Turweston (EGBT). The diagram is built up using 230,000 data pings collected over 49 days during December and January 2020-2021. The heatmap shows the 360° coverage of the single site at Turweston. The apparent reduced range to the north-west is caused by the lack of GA aircraft flying in Birmingham controlled airspace.

The lower part of the diagram shows a vertical slice of the PilotAware equipped aircraft detected at 176° from Turweston. The Chiltern Ridge can be clearly seen, obscuring any aircraft in their shadow, to the south.

It is important to recognise that this is the heatmap from just one station. Other surrounding stations will have similar heatmaps (topographical obscuration permitting) that will overlap, providing redundancy and contributing to the full picture for all EC device types and altitudes. The data from each single site is shared among all local stations. Similar heatmaps are available for the other EC technologies detected.

PilotAware is grateful for the excellent work done by James Rose from Aircrew Ltd., in helping to provide the visualisation of this data.

Why do we need to check our EC devices?

The problem is airframe obscuration and attenuation, and it is more prevalent among carry-on devices.

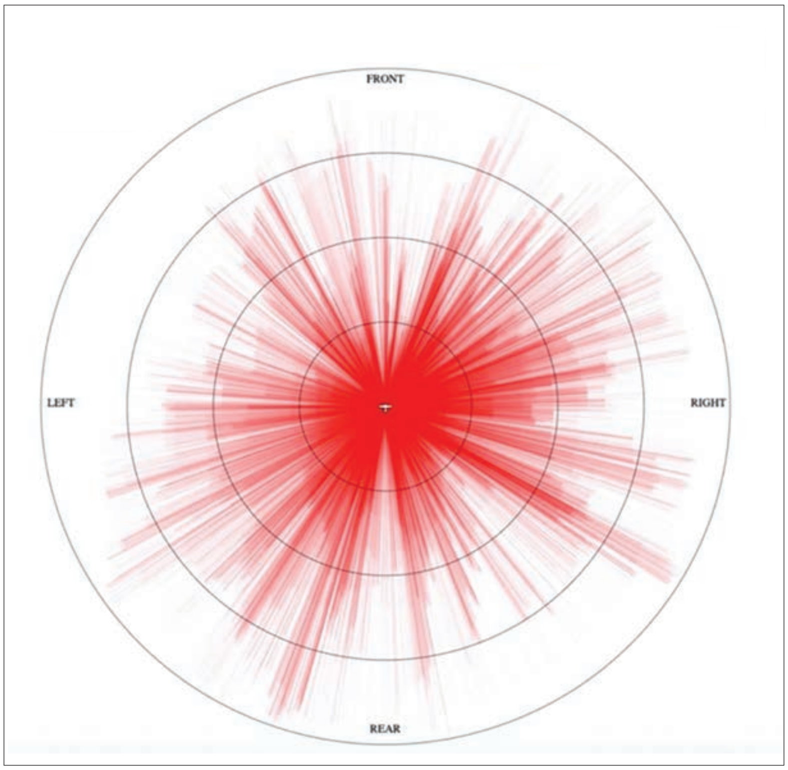
A performance reduction can be caused mainly by a combination of bad device location, incorrect antenna design or orientation, and poor GPS reception. The UHF radio signals used by all EC devices are obscured (completely shielded) by radio opaque objects such as metals or carbon fibre – the engine and airframe being the biggest culprits. The primary effect of airframe obscuration is to stop the radio waves transmitting in the direction of the obscuring object.

For example, if you put an EC device on the rear shelf of a metal or carbon fibre aircraft, it will be completely obscured to the rear as the signal fails to pass through the metal or carbon fuselage. And if the device is positioned low enough, it will also be blocked by the engine and firewall in the forwards direction. Fibreglass airframes and wood or tube and fabric aircraft will be less affected, but the engine and occupants will still block the signals in the forward direction. There is a PilotAware YouTube video that describes this further.

The signals are also attenuated by dense objects and liquids, such as the fuel in fibreglass or polypropylene fuel tanks and the water in the occupants' bodies – and we are 60% water, don't forget! The effect of this is to weaken the signals, and hence reduce the effective design range of the device. These effects are well understood, and performance is improved by placing remote internal antennas inside the aircraft at optimal positions or, better still, by using remote antennas outside of the aircraft. This is nearly always done with transponders and VHF radios and, therefore, is also the best option for EC performance improvement.

What 'good' looks like

Pictured below is the VECTOR Polar diagram for a Van's RV-7 using a PilotAware Rosetta EC device fitted with remote external antennas. Using data gathered from five flights and 11,416 detections, the VECTOR software shows an excellent polar pattern, with 360° of transmission with an air to ground range of over 60km to available distant ATOM stations. Each radial ring represents 20km. This is a good example and can be considered as the benchmark for a well-designed EC installation.



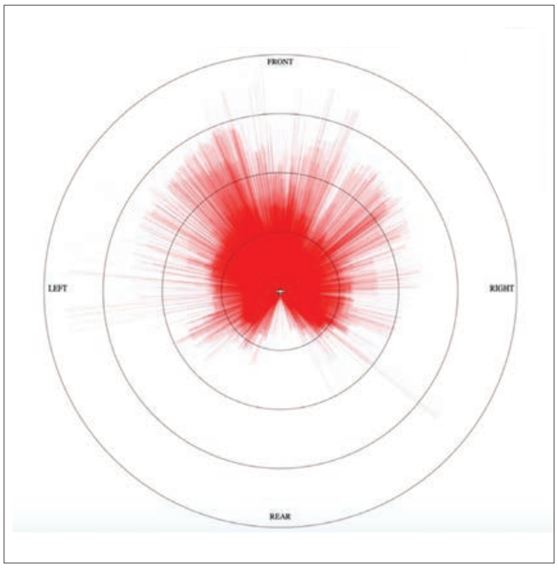
Below left VECTOR diagram showing a good transmission quality using external antennas in an RV.

Middle right VECTOR of Cabri helicopter showing obscured rearwood transmissions due to passengers, fuel and the engine.

Bottom right The very poor transmissions of a badly positioned 'carry-on' device in a PA28 with no supplementary antennas.

What 'average' looks like

This second plot, pictured below, is from a Cabri G2 helicopter with a carry-on PilotAware Rosetta EC device mounted in front of the binnacle. The air-to-ground range of the unit is 50km+ in all directions, except to the rear where there is significant obscuration. The fan shapes seen are produced as the aircraft passes abeam a local or distant ATOM ground station. The obscuration is caused by the passengers, fuel and the engine to the rear. This obscuration could be reduced by the use of remote internal antennas or better still, as shown in the previous example, by using remote external antennas.



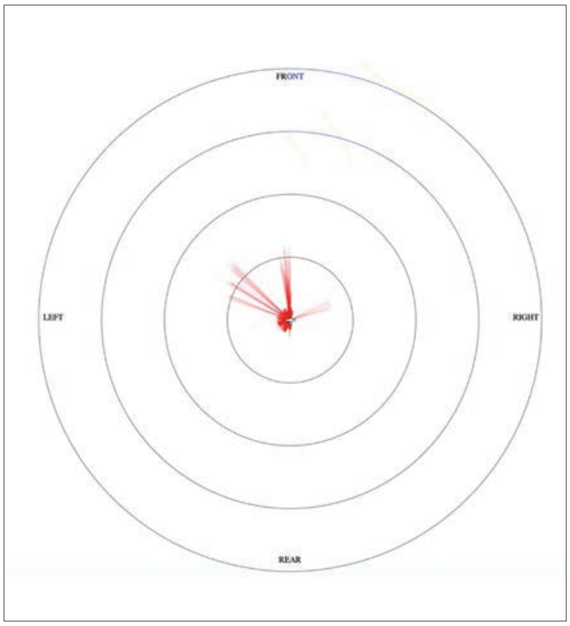
This is what 'poor' looks like

If an EC carry-on device is poorly installed and its signals are obscured and attenuated by the airframe, or by other reasons such as orientation or design, its polar diagram will look something like the picture below – or worse!

This polar diagram is taken from a carry-on device installed in a PA28, probably fixed to a port window. It can be seen that the EC device has been detected at 25km to the left, however, the majority of detections are received from much closer ATOM stations only.

There is also significant obscuration to the starboard side, most probably caused by airframe obscuration and occupant attenuation.

Using PilotAware VECTOR will allow the user to reposition the device or use remote internal or external antennas to get the best performance possible.



Checking your device using PilotAware VECTOR

PilotAware VECTOR is very easy to use and works in the following way. As you fly, your EC transmissions will be picked up by several ATOM GRID stations at various bearings and distances. The picture below shows a long flight in the Midlands and East Anglia, but you don't have to fly this far for VECTOR to work.

If you don't have time for such a long flight don't worry. Data is collected from all flights automatically, so the more you fly the more data that is collected. If you fly a few lazy, flat, five-minute orbits for 30 minutes or so, this will provide enough data to produce the initial polar diagram for analysis.

There is absolutely no need to fly any elaborate, accurate or complicated shapes in the sky. The GPS in your EC device and the ATOM station software will do all that work for you. The picture (below, opposite) shows the current ATOM station locations in the UK, so just randomly fly around and let the network do the rest. Each ATOM station will receive signals on all EC frequencies transmitted at a distance of 60km+, if there is line of sight and if there is no airframe or topographical obscuration and attenuation. We still have more work to do to bring stations into service in the South West of England, South Wales, the Borders and Highlands of Scotland and Cumbria, but the main flying areas are well supported as shown.

Plotting your results

Once you have flown sufficiently, visit the VECTOR site at *www.pilotaware.com/analysis/vector*, and follow Steps 1 to 5.

Step 1

Enter the HEX-ID (ICAO) of your Aircraft or Electronic Conspicuity device into the 'ICAO' field.

Step 2

Select the Electronic Conspicuity type to be plotted in the 'Type' field or select 'All'.
Vector analysis PilotAware, FLARM, ADS-B Transponders, Mode-S and CAP1391 devices.
Note that using 'All' will overlay all EC types, so will not show the individual genres.

Step 3

Choose the 'Diagram' type of interest. We currently offer a Polar Diagram or a 'Quadrant Matrix' diagram. The latter tabulates the quantity of data by quadrant.

Step 4

Use the calendar feature ' ' to select and deselect data from individual flying days. This can be used as a way of measuring your EC improvement or degradation over a period of time.

Step 5

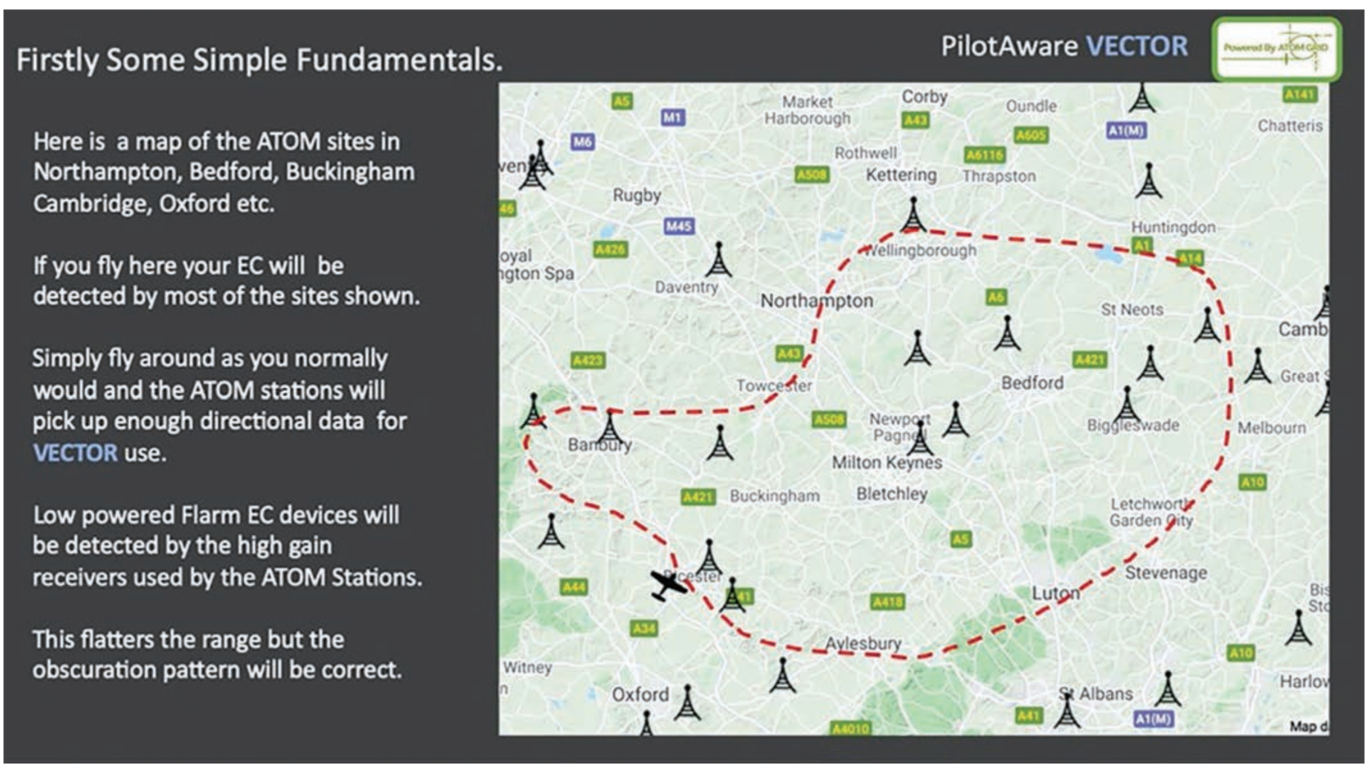
Select 'Go' to produce your chosen diagram.
There is also a youtube video which explains how to use VECTOR which is available at *www.youtube.com/watch?v=VOoZPhzFNDY&t=0s*

Remote internal and external antennas

As the data shows, the best way to improve the performance of your EC device is to use remote antennas, either internal or externally mounted. However, what you can and can't do to modify an aircraft depends on the classification of its registration. All aircraft both C of A and Permit aircraft can fit internal antennas as a modification to the airframe or avionics is not required. In addition, external antennas can be readily fitted to Permit aircraft and signed off by your inspector. This is very good news for LAA and BMAA Permit aircraft, providing lots of options to improve performance.

However, for aircraft on the CAA or EASA registers it has not been so easy. It is possible to install antennas on EASA aircraft using the standard change CS-SC004a in CS STAN issue three, or the minor change route could be used instead. However, I am told by those helpful people in Cologne that help is at hand.

Over the last nine months EASA has been working to extend the 'light touch' regulation currently available for the installation of remote external antennas for FLARM devices, it is soon to include other EC devices operating on a non-aviation frequency.



Below Example of a flight to test the performance of your EC set up.

EASA states that the intention is that, "*This template could be drastically simplified for the installation of an electronic conspicuity device. No flight test (no flight conditions, no Permit to fly) is needed. A flight check is sufficient.*" This will of course include PilotAware and other EC devices operating on a non-aviation frequency only.

With the UK leaving the EU and EASA, the application of this for aircraft on the CAA register will, presumably, depend on whether this change is harmonised by the UK authorities.

Still more work to do

PilotAware VECTOR provides a step change in the availability of data to help you get the most out of your EC installation, but there is still more to do. The air-to-ground range available to the ATOM GRID network does not directly correlate to direct air to air EC performance. Air-to-air ranges will always be less than air to ground ranges – for all EC devices. This is because the receiving antennas used by the ATOM stations are of a higher gain than those that are transmitting from the aircraft, significantly so for FLARM and 190MHz. The result of this is that the achievable air-to-air range distances of all EC devices are flattered to a lesser or greater extent.

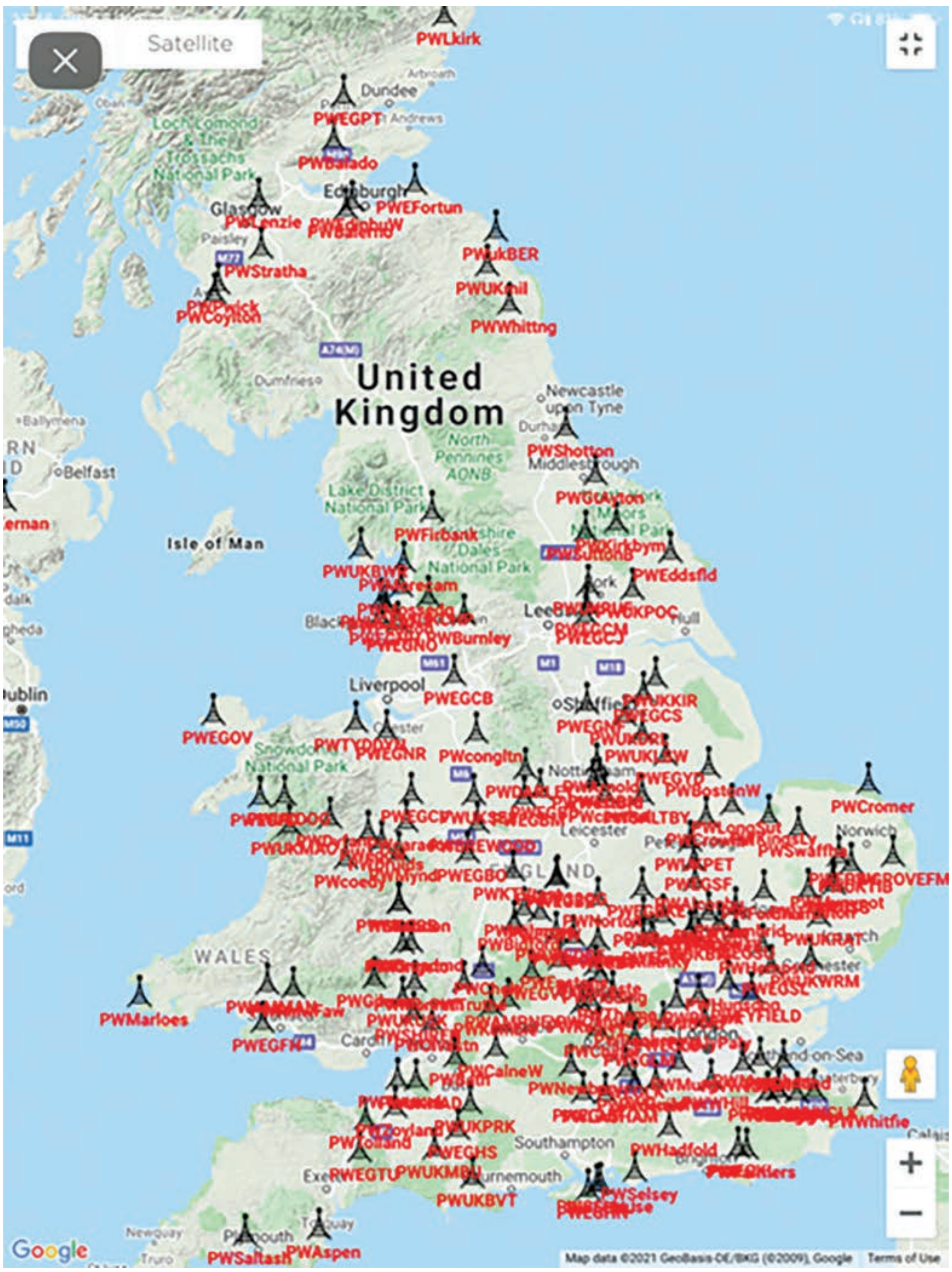
For example, users of FLARM will recognise that the air to air design specification is about 10-12kms, and possibly double that for Power FLARM. However, no one should expect to get a direct air to air range for FLARM that is comparable with the 60km+ air to ground performance of the ATOM GRID or OGN receivers.

So, one of the next developments on the PilotAware roadmap is to plot similar polar diagrams showing the air-to-air performance where possible. This will then provide everyone with real data on which to further understand the performance of their situational awareness and fly accordingly.

Summary

Using VECTOR will freely give everyone significant data to allow them to get the best out of their chosen EC devices, not just PilotAware. It should be regularly used as much as required. Also, please encourage your flying companions to do the same, as it says in the VECTOR video – it takes two to tango. In optimising your EC installation, everybody wins.

If you want to help aviation safety and improve situational awareness by installing an ATOM GRID station at your flying club or local site with the help of the PilotAware subsidy, please email *atom@pilotaware.com* ■



Left The location of Atom Grid sites around the UK. Can you help by hosting an antenna?