

How to Choose a Reliable UAV Autopilot Vendor

MicroPilot provides its customers with stability, cutting edge development technology and a seamless upgrade path for long-lasting growth.

Selecting the right autopilot for an unmanned aerial vehicle (UAVs) is not a simple task. Many factors affect this decision, the most important being the autopilot's manufacturer. After all, the UAV autopilot is a critical component in the manufacturing of a UAV. Not only is the UAV manufacturer buying a solution, they also enter into a relationship with their chosen vendor. This relationship directly impacts the UAV manufacturer's success. This white paper discusses what to look for when selecting a UAV autopilot.

Typically, vendor selection involves three factors. First, an assessment of the autopilot vendor's reliability. Second, the production processes and technology used during autopilot production. Third, the capabilities of a vendor's product offering. Looking ahead, the autopilot vendor's product offering affects the UAV manufacturer's ability to fill the needs of their end users and also their ability to differentiate their product from competing UAVs. An autopilot vendor should fulfill its customers' present requirements, anticipate future needs, provide sufficient flexibility to differentiate the UAV manufacturer's system and satisfy the UAV operator's critical needs.

If the UAV autopilot vendor falls short on any of these criteria, the UAV manufacturer may be forced to switch suppliers. The cost of switching autopilot suppliers is high; time is lost while searching for a new vendor. Going through the learning curve of a new autopilot, and integrating a new autopilot into your UAV all will cause delay and additional expense. For these reasons it is preferable to choose the most suitable autopilot supplier at the start of a project.

Company Stability

With enough research, UAV manufacturers can learn how accessible vendors are, what standards they are held to, and how long they have been in business. UAV manufacturers can also fully understand these vendors' stability. It is important to realize that UAV autopilot manufactures do disappear.

Examples of UAV autopilot manufacturers either out of business or no longer producing autopilots include:

- Advanced Subsonics
- Carvec Remote System Control
- Crossbow
- Dynon Avionics
- Geneva Aerospace
- Mavionics
- Neural Robotics
- O-NAVI
- Pico Pilot
- Rotomotion LLC
- UAV Flight Systems Inc.
- U-Nav

Accessibility

Some UAV autopilot suppliers sell their products through dealers rather than establishing a relationship directly with their customers. Although, working with a local dealer may sound reassuring and convenient, dealers can interfere with the relationship between a UAV manufacturer and its autopilot supplier.

A direct relationship with your autopilot supplier offers many advantages, including clear communication. When the only contact is through a dealer, important information does not always make it from the UAV autopilot vendor to the buyer and vice versa. Additionally, resolving technical issues can be difficult without a direct relationship with a vendor. Moreover, in the end dealers are often helpless, since the power to manage repairs, resolve technical problems and implement improvements falls entirely in the hands of the autopilot manufacturer and not the dealer. Do not rely completely on dealers; make sure that the autopilot manufacturer is still willing to have a relationship with you.

With the accessibility of the internet, finding subsystems to integrate into your UAV seems quick and easy; however, even the smallest company can create a web presence. It is easy to hide inexperience and lack of capability behind an attractive web page. Selecting such an autopilot supplier leaves UAV manufacturers who did not do their homework with potentially orphaned or inadequate solutions.

It is possible to launch a web store without establishing the necessary personnel, equipment and processes to properly manufacture UAV autopilots. It is easy to appear professional with a virtual web presence; ultimately though, only a real company can provide real products. Ideally, the UAV manufacturer should visit their UAV autopilot manufacturer. The cost of an on-site visit is money well spent if it saves you from choosing the wrong vendor. However, if visiting your vendor is not possible, there are other indications that a vendor is a real company and not just an attractive web store.

One important indicator is sales effort. Real companies spend money to reach their customers, trade shows and advertising being the two most common. Also consider the history of sales effort. It is easy to place one or two advertisements or show up at a tradeshow once. Real companies know that both trade shows and advertising are ineffective unless they are sustained for the long run.

All of this effort is more than simple advertising; it shows the passion and drive of the company to succeed and its desire to interact and create relationships with customers.

Standards and Coverage

MicroPilot, like all ISO 9001 certified manufacturers, must have robust business processes and maintain proper records. When a buyer forms a relationship with an ISO 9001 certified supplier, they know for certain their vendor:

- Checks their production equipment's calibration
- Maintains adequate backups and properly documents their procedures
- Verifies that only the correct procedures are used
- Seeks customer feedback and has a process of continuous improvement

An ISO 9001 certification assures UAV manufacturers that all of these systems are in place. In order to maintain ISO 9001 certification a manufacturer must perform

internal audits and submit to an extensive annual audit performed by a certified outside auditor once each year.

It is also important that your chosen UAV autopilot supplier has adequate insurance. The last thing a UAV manufacturer needs is for their autopilot vendor to close up shop because they could not afford to defend themselves against a lawsuit. Without proper insurance it is also difficult to recover from a fire, major theft, or other unforeseen event that interrupts business operation.

Expensive insurance is often passed over by companies at the cost of their customers; therefore, adequate coverage is one criterion UAV manufacturers should consider when selecting a supplier.

Company Stability

UAV manufacturers know how much time is needed to integrate an autopilot into a UAV airframe. This integration involves developing wiring harnesses, qualifying settings, flight testing, developing product manuals, and configuring the autopilot to work with other systems in their UAV. UAV manufacturers experience a considerable learning curve from day-one installation to final acceptance test. If a manufacturer's autopilot vendor goes under, they will be forced to switch autopilots – a major endeavor.

To minimize the risk of ending up with an orphaned autopilot, UAV manufacturers should look for red flags. For example, since most businesses fail within the first few years, the length of time a vendor has been in business reveals how stable they are. A safe approach is to consider only vendors who have been in business for at least four years.

Country of Origin

The country in which the vendor is headquartered should also be considered. Although the ISO standards mentioned earlier are monitored by an international organization and theoretically should be the same globally, it is doubtful that their implementation is the same throughout the world. For example, it is unlikely that Chinese companies are held to the same standards as North American or European companies.

The political stability and corruption within a supplier's country also determines the degree of reliability a company is likely to offer its customers. For example, a Russian autopilot manufacturer risks being corrupted by organized crime. Where

does that leave the UAV manufacturer?

Furthermore, complications arise for autopilot vendors that are controlled by International Traffic in Arms Regulations (ITAR), a set of US regulations that control the export and import of defense-related articles and services. If a UAV incorporates one single ITAR component, the entire UAV becomes ITAR controlled, regardless of which country manufactures the product. Therefore, UAVs with ITAR controlled autopilots are difficult to export outside the US. If your UAV incorporates such an autopilot, any time you wish to export your UAV, you will need the approval of the US government. Although most US autopilots are ITAR controlled, MicroPilot's Canadian autopilots are not controlled by ITAR.

Level of Production Technology

In addition to vendor stability, good technology advancement and development processes help assure successful installation and deployment of UAV autopilots.

State-of-the-Art Software Development Tools

Since software is at the heart of all UAV autopilots it is important to consider the vendor's software development processes. A *revision control system* is a minimum requirement and allows revisions to be compared, restored, and merged during the software development process. Issue tracking software is also important and must include detailed reporting tools. This software should link to the revision control system so changes to the code base can be identified from an individual ticket. Issue tracking software can provide all of this functionality.

Overnight processes ensure errors from the previous day are caught quickly. In addition, a static code analysis tool can look for specific types of errors.

Other important applications include numerical computation programs, a 3D CAD/CAM/CAE solution, and a professional PCB layout tool.

Robust Simulation Tools

The simulation tools a UAV autopilot vendor uses to test their products also indicate the vendor's maturity and have a direct effect on product dependability. Software in the loop (SIL), quasi hardware in the loop (qHWIL), and true hardware in the loop (trueHWIL) simulators are invaluable tools that autopilot companies use to develop reliable and safe products at reasonable costs. Buyers should

consider the company's use of these tools as criteria when choosing an autopilot vendor, especially if they can be used as a training tool for customers.

trueHWIL simulators offer larger companies a more complete and higher fidelity simulation. Unlike existing qHWIL simulators that use a serial communications port to transmit sensor information to the autopilot, the trueHWIL uses analog-to-digital converters and FPGAs to electrically simulate sensor signals. This tool provides the highest possible simulation fidelity, since the exact same code executes in the simulated autopilot as in the real autopilot. The trueHWIL allows systems and software to be validated to a degree not possible with an SIL or qHWIL.

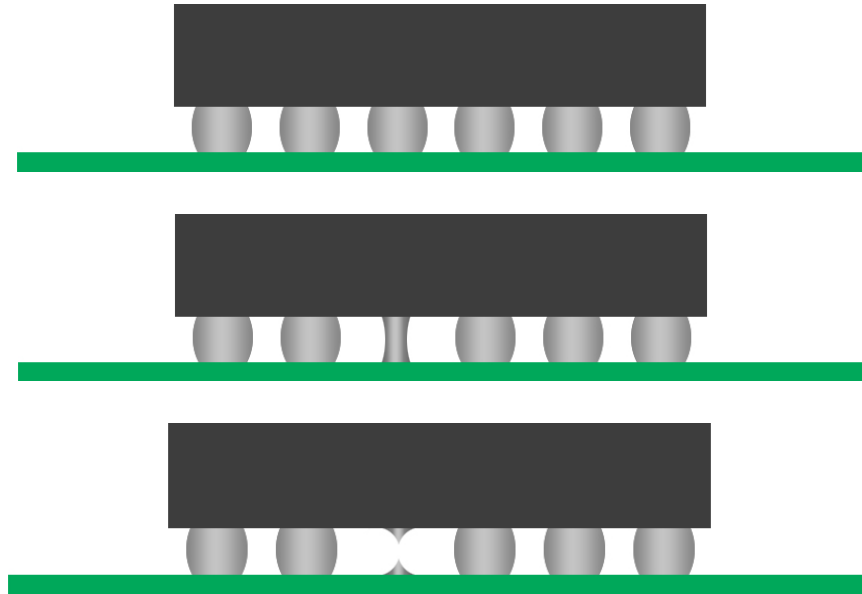
Hardware Quality Standards

UAV manufacturers should also research the hardware the UAV autopilot vendor uses in its products. Autopilot vendors should meticulously choose their hardware, including the circuit boards installed in its autopilots, which involves checking on its vendors' IPC standards. There are three categories, *IPC I* being the lowest and *IPC III* being the highest.

Ideally, autopilot vendors will only purchase circuit boards designed and manufactured to *IPC III*. These boards are produced with state of the art equipment by production staff trained to IPC standards. Many of the boards coming out of Asia do not meet these criteria.

Environmental Stress Screening

Environmental stress screening is an important tool for maintaining hardware quality standards. It involves submitting circuit boards to a wide range of temperature and vibration to break any weak solder joints or components before they reach the customer. Sometimes, due to imperfections in the electronic manufacturing process, solder joints may be sufficient to conduct electricity but may be mechanically compromised. These compromised solder joints will pass electrical production tests but will fail in the field. This is a major contributor to infant mortality in hardware. In the figure below, the top chip has good solder joints while the middle chip has a solder joint that is electrically fine but mechanically compromised. The purpose of environmental stress screening is to subject the circuit board to enough stress to break any weak solder joints. Environmental stress screening is expensive but is cheap when compared to the cost of a failed autopilot.



Single – Channel GPS Simulator

Single channel GPS simulators are useful to ensure that the autopilot's GPS receiver is working properly. This is important because simply turning on the GPS and measuring the signal strength received from the actual satellites is unreliable. This is because the signal strength depends upon the position of the GPS satellites and this changes day by day and hour by hour. Without a constant strength signal it is impossible to determine if the GPS receiver is working properly. A single – channel GPS simulator provides a known signal strength and allows the proper testing of the GPS receiver.

Competency of Developers

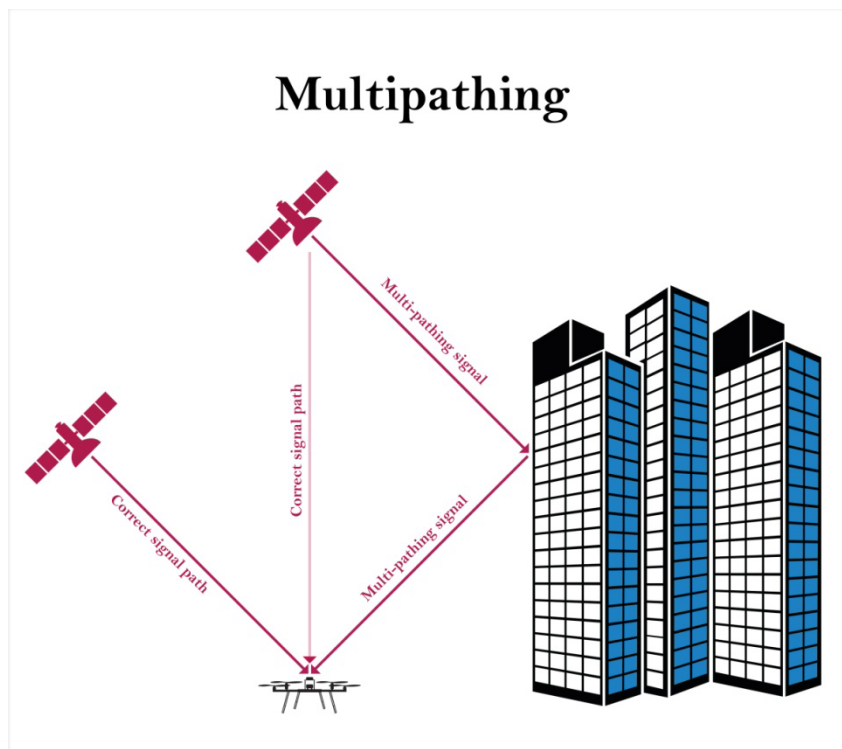
A UAV vendors' engineering excellence is critical. The people behind a UAV autopilot system need a solid background in their respective fields. For example, autopilots do not operate in a vacuum; they are constantly interacting with other systems such as ground control stations, which enable a range of other processes. Moreover, synchronizing three autopilots can only be achieved by qualified professionals.

GNSS Simulation

Quality control is just as important for software as it is for hardware when it comes to autopilots. Arguably the most important part of that software is the part that interprets the signals from the sensors telling an autopilot, and thus the UAV, where it is, where it is going and how it is going to get there. Among the most important of these signals are those from the GPS receiver.

A multi-channel GPS simulator is an important tool for developing software for autopilots that relies on GPS for position information. GPS receivers can sometimes behave oddly. There are many situations where a GPS receiver will output erroneous position and velocity information. A good example of a situation that results in GPS errors is multipathing.

Multipathing, is a phenomenon that occurs when signals from a GPS satellite, instead of traveling straight from satellite to receiver, bounce off of the ground or a building before being received by the GPS receiver. This can cause a sudden jump in position of hundreds of meters or more. It is very difficult to create multipathing during a flight test; however, with a GPS simulator an autopilot manufacturer can create multipathing at will and ensure that their software minimizes the adverse impact of this, and other GPS errors.



Ability to Serve Customers' Long-Term Needs

To determine if vendors can fulfill needs over time, UAV manufacturers should learn about a vendor's:

- Technical support offering
- Level of open architecture
- Full array of products
- Pricing history
- Ability to fill large orders

Level of Technical Support

It is crucial that UAV manufacturers ask potential vendors questions about the technical support they offer:

1. Does the vendor use an issue tracking system?
If not, much time can be wasted updating staff each time customers contact them about a problem.
2. Is their technical support and product development one in the same?
A support staff that specializes is more effective and is more likely to be available.
3. Is their technical support anonymous?
Public forums are less than ideal for getting questions answered. Autopilot manufacturers risk exposing critical details and privileged secrets to competition when they are forced to use internet forums for technical support.
4. Are enough people on staff to handle support calls?
A separate, well trained support staff, with issue tracking, that supports customers without divulging critical information is a good indicator that a vendor has good technical support. There should also be options to receive on-site technicians for integration and troubleshooting assistance. Full training programs on and off-site are also a positive indicator of good technical support.

Open Architecture

Some UAV autopilot vendors sell autopilots that are a *black box*. These vendors do not reveal details regarding the inner workings of their systems to their buyers. UAV manufacturers who work with these vendors must have a vendor technician onsite each time a modification needs to be made to the autopilot

settings. This not only adds to the cost and time required to integrate their autopilots, it also imposes an unnecessary level of dependence on the autopilot manufacturer. For example, the vendor might not be able to accommodate a UAV manufacturer's timeframe, slowing new product development and jeopardizing projects.

Ideally, autopilot vendors should provide open architecture, which offers customers several advantages. Consequently, UAV manufacturers can make intelligent decisions about how they design their airframes, which results in better products for their customers. In addition, UAV manufacturers should not be dependent on the autopilot vendor to integrate an autopilot into their unmanned vehicle. Nor should they need to pay for a technician or be at the mercy of a technician's time schedule. An autopilot vendor's customer's ability to understand the inner workings of the autopilots is invaluable when supporting their customers.

Moreover, UAV manufacturers do not need to reveal proprietary information to their autopilot vendors. In fact, they do not have to ever see their customers' vehicles. Lastly, the flexibility provided by an open architecture approach gives UAV manufacturers more ability to differentiate their product. Good autopilots offer a wealth of features, which UAV manufacturers can combine in innovative ways to extend value to their end users.

Products for Future Needs

Quality UAV autopilot vendors provide a range of hardware, software and accessories. Moreover, buying autopilots from a vendor that offers both an upgrade and downgrade path allows UAV manufacturers to easily expand their product line to span multiple price points.

Even the most flexible autopilot cannot accommodate all of a UAV manufacturers must have features. UAV manufacturers often need to implement features that tailor the autopilot to their requirements. For this reason, MicroPilot provides products that fill the gap between standard autopilot functionality and their customers' specific requirements. MicroPilot's XTENDER^{mp} is a software development kit that gives UAV manufacturers the ability to:

- Customize control laws
- Write custom ground control station software

- Control custom payloads
- Collect data from custom sensors

Another advantage of the XTENDER^{mp} product is it allows UAV manufacturers to protect their critical intellectual property. If a UAV manufacturer has some feature that they wish to add to the autopilot they may not want MicroPilot to add this to their autopilot as they would then share this IP with MicroPilot's customer base. By using XTENDER^{mp} to incorporate this IP into the autopilot they preserve what could be an important competitive advantage.

MicroPilot also offers a board level autopilot and an enclosed autopilot. Board level autopilots can be plugged into a carrier board, allowing UAV manufacturers to customize their input/output to suit their needs.

Pricing and Discounts

Not only is the price of the autopilot an issue when choosing a vendor, additional costs need to be factored in. For example, what is the pricing for the autopilot vendor's ground control station? All UAV manufacturers expect their product to enter serial production. The quantity one price is much less important than the price the manufacturer will pay when purchasing greater quantities. UAV manufacturers should also find out how much prices have increased or decreased within the last few years.

Capacity to Fill Large Orders

UAV manufacturers must know if products are available when needed. Manufacturers evaluate this by asking if vendors ship from stock, what their inventory levels are, and if they rely on automated production processes to cope with peak demands. Small companies can develop and sell autopilots at a steady pace; however, if these companies are flooded with large orders, the delivery time might become unacceptable. A larger company can give manufacturers the support and supply stream they require today and for years to come.

About MicroPilot

Started in 1994, with 850 clients in over 70 countries, MicroPilot is the world leader in professional autopilots for UAVs and MAVs, and the first autopilot manufacturer to bring an ISO 9001 sub 30 gram autopilot, triple redundant autopilot, and full-function general purpose autopilot. MicroPilot offers a family of lightweight UAV autopilots that can fly fixed-wing, transitional, helicopter, and multirotor UAVs. MicroPilot also provides complementary products such as the XTENDER^{mp} SDK and the trueHWIL2.

MicroPilot's low cost MP2128^{HELI2} flies helicopters, VTOL and fixed wing. For triple redundancy, the MP2128^{3x} for helicopters and fixed wing UAVs. The trueHWIL² MATLAB-based hardware in the loop electrically simulates all sensors, providing the highest fidelity autopilot simulation available.

For more information contact info@micropilot.com or go to their website www.micropilot.com.