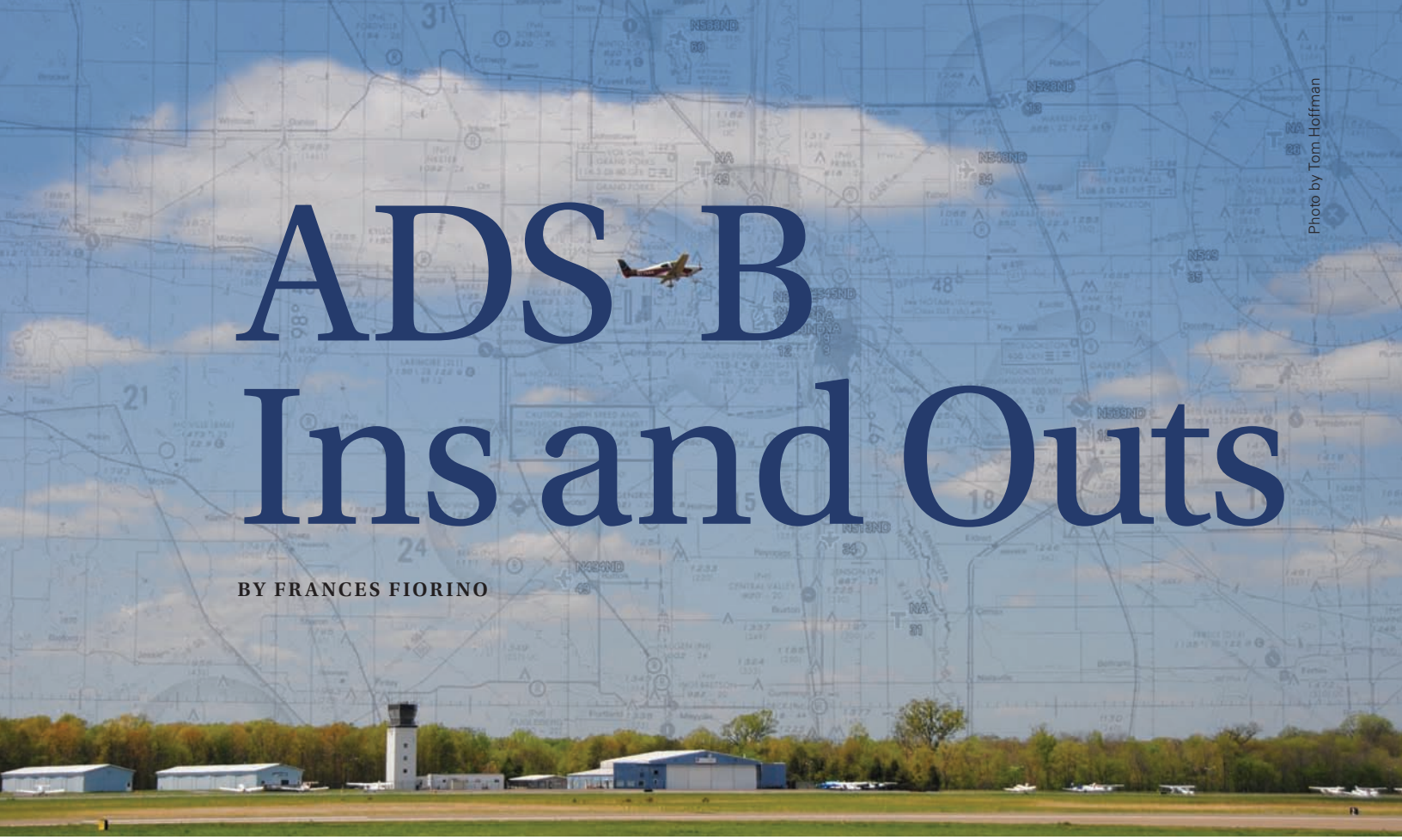


Photo by Tom Hoffman

ADS-B Ins and Outs

BY FRANCES FIORINO

You heard about the Automatic Dependent Surveillance–Broadcast mandate: By Jan. 1, 2020, as part of NextGen, aircraft operating in most U.S. controlled airspace must be equipped with ADS-B Out avionics.

How did you react? Pick up the nearest avionics catalog? Banish it from your mind until December 2019? Or ask, "What *is* ADS-B anyway, and what's in it for me?"

Aircraft operating with ADS-B in controlled airspace ensure comprehensive traffic surveillance and, ultimately, an overall safer National Airspace System (NAS). Pilots may be concerned about ADS-B for a variety of reasons, such as cost, fear of a changing flight environment, and lack of knowledge about the technology.

We hear your concerns.

ABCs of ADS-B

ADS-B is more accurate than radar, reporting aircraft movements once every second. ADS-B avionics use GPS and other onboard systems to determine the aircraft's position, speed, and other data and broadcast this information directly to other ADS-B In-equipped aircraft and to the more than 600 ADS-B ground stations installed throughout the country. Ground stations relay the information to air traffic control (ATC) and aircraft equipped to receive the data.

ADS-B's Out function enables data to be transmitted. The In function enables an aircraft to receive data from ground stations and nearby Out-equipped aircraft, as well as traffic advisory, flight information, and weather service products.

- Basic avionics required: a GPS/WAAS (Wide Area Augmentation System) position source and transmitter
- For ADS-B In-equipped aircraft: the addition of a multi-function display and receiver

Being that ADS-B Out avionics transmit data approximately once every second, it enables more precise tracking of aircraft compared with the current radar sweep rates of 3-15 seconds. The smaller footprint of ground radios enables their placement in areas where a radar site would be unfeasible, such as mountainous terrain. The Highly precise GPS-based surveillance provided by ADS-B is also improving our ability to perform life-saving search and rescue operations. Air traffic controllers have better information about an airplane's last position, thus helping to take the "search" out of search and rescue.

With an expanded coverage area and with all aircraft transmitting Out data, controllers will have a highly accurate traffic picture. ATC, in turn, can better manage traffic flow and provide improved surveillance in a period of expanding traffic demand.

Pilots of ADS-B In-equipped aircraft, have the added advantage of seeing traffic and graphic weather on displays, which sharpens situational awareness and crucial see-and-avoid capability.

ADS-B Can Work for You

Early adopters of ADS-B technology are singing its praises. John Croft and his two co-owners of a 1997 Piper *Archer* fly in the traffic-congested Washington, D.C., area reaping the benefits of ADS-B In with a portable unit [Garmin GDL 39]. For instance, Traffic Information Services–Broadcast (TIS-B), transmits traffic information from ground stations to ADS-B In-equipped aircraft, providing pilots with enhanced situational awareness of aircraft operating in the area.

"Midair collisions are my biggest fear in flying," said Croft. "With the TIS-B, I'll see targets on my iPad display and on the portable, and then am better able to make visual contact."

Croft described a scenario he and his partners experience once about every two flights: On a December 2013 flight up the Hudson River Exclusion area, the display showed a target off the left wing and climbing towards the Piper. Remembering the fatal August 2009 midair collision of a tour helicopter and a single-engine aircraft, all three strained to make visual contact, but could not.

"It was tight, but we had enough room to turn away from the target along the river," Croft said. "Just as we turned, we picked up a helicopter visually. It was uncomfortably close. Getting an early alert to a possible conflict helped me avoid it, and certainly brought down my pulse rate."

How to Fly Safely with ADS-B

Trainers of tomorrow's pilots are enthusiastic about the benefits of ADS-B. They shared insights on how to fly safely with the NextGen technology. Certified flight instructors agree that task management skills, scanning techniques, and the ability to correctly interpret traffic data are imperative to safety.

"I feel almost naked if I fly an aircraft without ADS-B," said Chief Instructor Mark Lindquist of Freeway Aviation, a fixed-base operator at Freeway Airport in Bowie, Md.

Students are expected to know pilotage and dead reckoning skills, notes Lindquist. It is up to the instructor as to how early ADS-B technology is introduced in flight training, but it is usually by the time the student has their first solo progress check.

Like most of us, student pilots are taught from day one to keep their "heads-up" and "eyeballs outside" to spot traffic. Any pilot accustomed to analog dials who has switched to glass cockpit knows how mesmerizing the colorful displays can be. When using ADS-B, even on a handheld unit, Lindquist warns against "spending too much heads-down time looking at displays to the exclusion of the pilot's critical responsibility to see and avoid traffic." He also warns against "hyper-situational awareness," where pilots start fixating on targets, not realizing just how far away they are and how little chance of conflict actually exists.

According to Mike Hall, a former military and current general aviation pilot of a 1994 Mooney M20J, and early adopter of ADS-B In and Out, when learning to mine the rich data available from modern cockpit displays "You need to think carefully about task management and what is appropriate to be doing now."

ADS-B, the Multi-purpose Safety Tool

The challenge of instructing the use of ADS-B, and glass cockpit instrumentation in general, is learning how to properly interpret the data on the display, notes University of North Dakota (UND) Chief Pilot Jeremy Roesler.

UND, along with Embry-Riddle Aeronautical University (ERAU), were part of the FAA's original grant to test and operate ADS-B. Each school year, UND trains about 800 to 900 pilots, from private through advanced licenses and ratings, on about 114 aircraft, primarily Cessna 172s. The majority of the fleet is equipped with ADS-B Out. Training is staggered until a student is ready to take on additional instrumentation.

Roesler agrees ADS-B is enhancing safety in the UND flying environment. Grand Forks International Airport airspace is populated with a wide variety of military and commercial aircraft types, helicopters, and unmanned aircraft systems.

ADS-B is also a great tool in planning and managing lessons.

"Instructors can see all the traffic lining up for the instrument approach and can determine whether to request an instrument approach or opt to do something else. We are sold on it [ADS-B] and I don't ever see us going back," said Roesler.

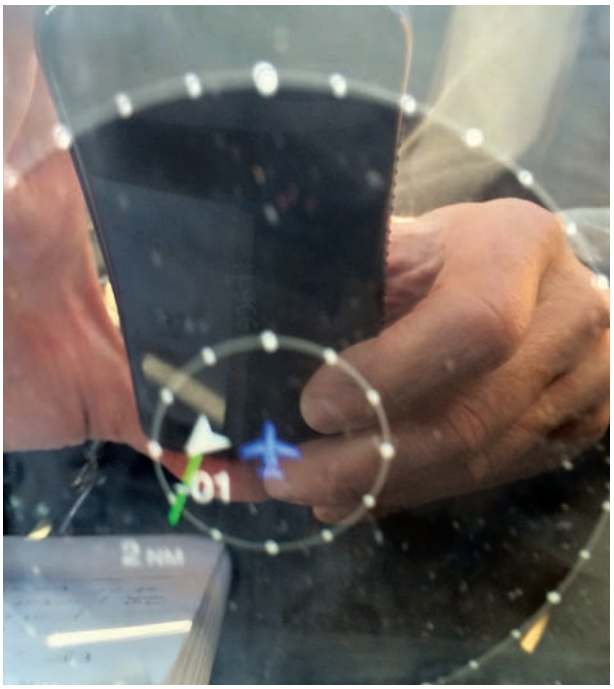
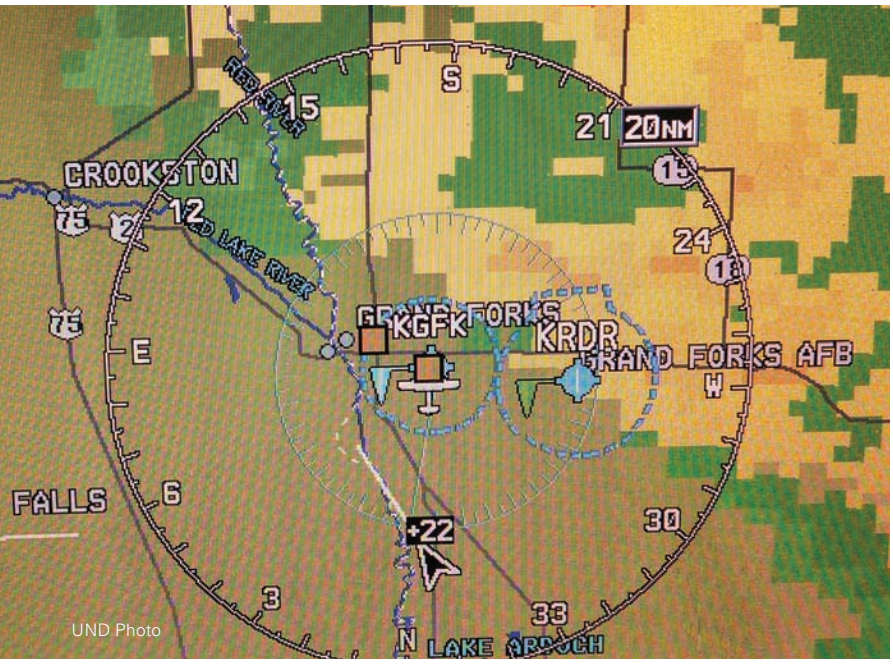


Photo by John Croft



UND Photo

Using commercial software that feeds off an ADS-B display, UND created a unique traffic management tool. A 30-inch screen depicting a sectional chart overlaid with all the traffic in the UND practice area enables the flight desk supervisor to determine how many aircraft to assign to the practice area.

"From a safety perspective, we keep an eye on weather rolling in, winds coming up, or ceilings coming down and can call back students if necessary," said Roesler (see photo).

ADS-B resolved a concern when controllers called UND's flight desk because a UND aircraft had disappeared below radar range and out of radio contact after the pilot told ATC the aircraft was low on fuel. But the UND supervisor was able to locate the aircraft in a traffic pattern at a local airport and confirm that the aircraft and occupants were safe.

"Radar didn't see them, but ADS-B did," notes Roesler.

ERAU uses ADS-B as a traffic awareness tool. The university first became involved with ADS-B in 2001 while exploring ways to mitigate the risk of midair collisions. In an agreement with the FAA, ERAU initiated the first two ADS-B sites and programs in the lower 48. By August 2004, ERAU equipped its fleet at Prescott, Ariz., and Daytona, Fla., campuses with ADS-B traffic displays, according to Prescott's Chief Pilot Brian Roggow.

Prescott flies four Diamond DA42NGs, 16 Cessna 172Ss, and one Cessna R182 with ADS-B In and Out capability. Daytona students operate 10 Diamond DA41 L3260s, 41 Cessna 172S, and a Piper PA284 Arrow with ADS-B In and Out.

Both campuses use airspace where high-density training operations are in play, so collision avoidance responsibilities are introduced early in training and revisited throughout the training syllabus. Roggow notes instructors are often challenged with minimizing student's use of cockpit instruments in an effort to develop their ability to fly using visual and kinesthetic cues.

"Visual scanning techniques to include use of the traffic display is a key part of building this skill," adds Roggow. "It is a delicate process to train a student to appropriately manage their attention resources."

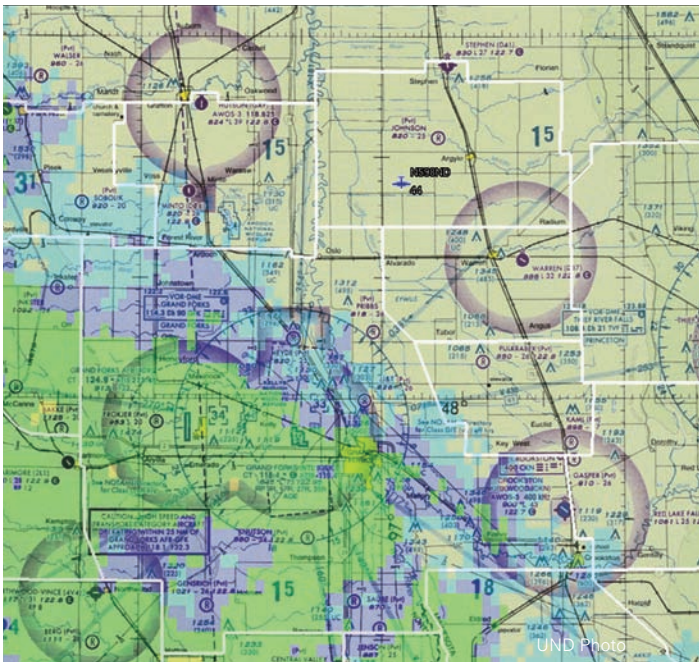
While displays can quickly identify an aircraft well before it becomes a potential conflict, the primary challenge is to prevent the student from overreliance on instruments — or in the case of instrument training, on the instructor — for collision avoidance, says Roggow.

"But students quickly learn to appreciate the value of the ADS-B information, especially after the first time it helps them avoid a close call," said Roggow.

A lesson for all of us.

"Considering the great safety enhancements it provides," Roggow encourages pilots, "Don't delay in getting ADS-B."

Frances Fiorino is Senior Technical Writer in support of FAA's NextGen Performance and Outreach Office. She is a private pilot who learned to fly in New York City skies and has had a 20-year career as an aviation journalist covering safety and training.


UND Photo

Already Equipped?

If your aircraft is one of the approximately 4,200 already equipped with ADS-B Out, congratulations. But you may not be in full compliance, advises James Marks with the FAA's Aircraft Maintenance Division, Avionics Branch.

"Of those aircraft equipped with ADS-B, approximately 3,500 are operating with avionics performance or configuration issues that do not comply fully with the 14 CFR section 91.227 requirements," said Marks. Depending on the type aircraft and on-board equipment that feeds information to the ADS-B system for broadcast, the ADS-B rule can require up to 19 elements to be included with each message transmitted by the avionics.

"We see a high number of avionics systems transmitting information that indicate misconfiguration during initial system setup that are undetectable to the pilot following installation," said Marks.

Some misconfigurations can earn you a call from ATC. This typically occurs when a Mode S transponder and ADS-B Universal Access Transceiver system on the same aircraft are transmitting a 24-bit ICAO address (Mode S) or Mode 3/A code that do not match. ATC systems interpret this information as two aircraft in close proximity and cause traffic conflict alerts.

"Aircraft owners thinking about equipping with ADS-B should read the equipment requirements contained in §91.227 before undergoing an installation and have the install shop demonstrate the correct configuration before the work is accepted," advises Marks.

Those who are already equipped may request verification of their system performance and configuration through the FAA Compliance Monitor. Just send an email with your aircraft's tail number to: 9-AWA-AFS-300-ADSB-AvionicsCheck@faa.gov. The results will either confirm a good installation or provide information on how to correct an improper installation.

ADS-B Out Mandate and Equipment Requirements FAQs

What Pilots Want to Know

What are the rules?

The FAA published Federal Regulation 14 CFR 91.225 and 14 CFR 91.227 in May 2010. Entire text at www.ecfr.gov Final rule: http://edocket.access.gpo.gov/2010/pdf/2010-12645.pdf. The final rule dictates that effective January 1, 2010, aircraft operating in airspace defined in 91.225 are required to have an Automatic Dependent Surveillance – Broadcast (ADS-B) system that includes a certified position source capable of meeting requirements defined in 91.227. These regulations set a minimum performance standard for both ADS-B Transmitter and the position sources integrated with the ADS-B equipment your aircraft.

How many ADS-B avionics systems are there?

There are two ADS-B avionics systems available: 1. Mode S transponder based (1090MHz) ADS-B equipment certified to Technical Standard Order C166b TSO – C166B and 2. Universal Access Transceiver (UAT) equipment certified to Technical Standard Order TSO-C154c. UAT equipment provides ability to receive traffic and weather data provided by the FAA ADS-B network.

What system should I use?

For aircraft operating above FL180 (18,000 feet) or internationally, you must be equipped with a Mode S-Transponder based ADS-B transmitter.
For aircraft operating below 18,000 feet and within U.S. airspace, you must be equipped with either a Mode S transponder or with UAT equipment.

What position source should I use?

FAA recommends a Wide Area Augmentation System (WAAS) GPS that is compliant with TSO-C145 or TSO-C146. These units are readily available for general aviation and provide sufficient performance to meet the 14 CFR 91.227 requirements. GA vendors offer stand-alone receivers and packet them with a ADS-B transmitter or with GPS Navigator.

Can I mix and match ADS-B equipment with any GPS equipment?

No, a GPS receiver must be compatible with the installed ADS-B transmitter (reference list adjacent). Mixing and matching GPS systems with ADS-B units in the field (accomplished via field approval) is not permitted unless the equipment was shown to be compatible via a previous certification effort with the FAA (for example, a Supplemental Type Certificate). Be sure to contact your manufacturer if you are unsure which GPS systems are approved for your ADS-B system.

Some manufacturers are marketing uncertified ADS-B transmitters. Can I install these on my aircraft?

You may install an uncertified transmitter on amateur built aircraft and light-sport aircraft with experimental airworthiness certificates. However, you cannot install uncertified equipment, including uncertified transmitters on any aircraft with a standard airworthiness certificate. Also, uncertified ADS-B transmitters do not comply with 14 CFR Part 91.227 and will not be permitted to operate in §91.225 airspace requiring ADS-B after January 1, 2020, without prior approval from air traffic control (ATC).

ATC cannot use the data from uncertified transmitters — this means ATC cannot provide flight-following services or separation services to these aircraft. Data from the uncertified transmitters is not displayed on certified ADS-B-In displays. Therefore, your fellow pilots in aircraft with certified ADS-B equipment won't be able to "see" you. The FAA strongly discourages the use of uncertified ADS-B Out equipment even in experimental aircraft.

Can I install an uncertified GPS as my ADS-B position source?

You may install an uncertified GPS on amateur-built and light-sport aircraft with experimental airworthiness certificates. As stated above, you cannot install uncertified equipment, including an uncertified GPS on aircraft with standard airworthiness certificates. Additionally, these position sources do not comply with 14 CFR 91.227 and will not be permitted to operate in airspace requiring ADS-B in 2020 without prior approval from ATC.

What are the risks of using an uncertified position source?

The risk for any GPS receiver, when used to support separation services, is how far the position measurement can be in error without detection. If the position error gets large enough, air traffic control would not be able to provide safe separation between your aircraft and other traffic in your vicinity. FAA and our international peers conducted a safety analysis prior to publishing the final ADS-B rule to determine what this error detection boundary should be and the ADS-B performance requirements are based on the results of this safety analysis.

Certified GPS sensors compare GPS satellite measurements against each other. When a satellite signal error becomes large enough to detect, the receiver will reject that signal. The integrity performance specified in the ADS-B rule depends on the proper operation of this error detection feature. It ensures the safety of using ADS-B positioning based on GPS measurements.

By comparison, uncertified commercial grade GPS sensors assume the system is working properly and do

not attempt to detect errors in the satellite measurements. When presented with an erroneous measurement, they will calculate an erroneous position. This was proven to be an unsafe condition by the FAA's safety analysis. Therefore, ADS-B position based on these sensors was prohibited from being used to support air traffic separation and ADS-B air-to-air operations.

What can I buy today?

Several manufacturers are selling approved avionics. Several other manufacturers have products in development that will be available in time to meet the 2020, mandate for ADS-B Out. Some of the approved GPS receivers are certified GPS navigators as well. They may be installed to support precision approaches in addition to providing a position source for your ADS-B system. In some cases the GPS receiver may also be integrated with a Multi-Function Display providing a moving map, an ADS-B Traffic Display, access to the Flight Information Services–Broadcast information, and more.

The FAA does not endorse any particular item or manufacturer. The following list, current as of May 1, 2014, contains items that have met FAA certification requirements. Check the FAA ADS-B site for updates to the list.

Manufacturer	ADS-B Model Number	Approved Position Source
ACSS	XS-950	RCI GLU-920 , RCI GLU-925
Honeywell	XS-852	CMC CMA-4024-1 SBAS
Trig-Avionics	TT-31	FreeFlight WAAS 1201 Accord Technology NexNav™ Mini GPS unit
FreeFlight	FDL-978-TX	FreeFlight WAAS 1201
ACSS	XS-950	RCI GLU-920 (A320), Thales TLS8755-01-0101A/0102B (A330)
Honeywell	ISP-80A.1	Honeywell ADIRU Part#'s HG2030BE02, BE03 or BE04
Trig-Avionics	TT-22	FreeFlight WAAS 1201
Garmin	GDL-88 GTX-23 GTX-33x w/ES GTX-330x GTX-3000 (GTX models require appropriate S/W rev)	Garmin GTN 625/635/650, GTN 725/750, GPS 400W, GNC 420W/420AW, GNS 430W/430AW, GPS 500W/530W (w/ or w/o TAWS) (all require appropriate S/W rev)
Honeywell	MRC XPDR w/ADS-B Out	CMC CMA-3024 SBAS GNSSU MK II and CMA-4024 SBAS GNSSU
Honeywell	XS-858B Transponder, P/N 7517402-970	Honeywell GPS module (made by CMC), P/N 245-604067-100
Honeywell	XS-858B P/N:7017401-970	Honeywell GNSS/MMR VIDL-G, P/N: 7026208-804
NavWorx	ADS600-B	Accord Technology NexNav™ Mini GPS unit
FreeFlight	FDL-978-XVR	FreeFlight WAAS 1201 (either external or integrated in FDL-978-XVR)
Rockwell	TDR-94D-550	Universal UNS-1Fw
Avidyne	AXP340	Avidyne GPS (including R9) Garmin GNS430W/530W Garmin GTN650/750 FreeFlight Model 1201/1204 NexNav™ mini-T (external)
BendixKing	KT-74	Accord NexNav™ Mini GPS unit FreeFlight WAAS 1201