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IS&S Avionics Update for the PC-12

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Pilatus PC-12 IS&S Avionics Upgrade

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Cleared for takeoff in IS&S's PC-12 demonstrator at San Diego Montgomery-Gibbs Executive Airport's (KMYF) Runway 28R, we engaged the autothrottle system, much the same as in most current-production FAR Part 25 transport category turbofan aircraft we've flown. The servo pushed up the throttle lever precisely to maximum takeoff power, freeing us to concentrate on looking outside the aircraft and controlling its trajectory. As the aircraft accelerated, the autothrottle made adjustments to keep the engine within limits.

After takeoff, the autothrottle automatically pulled back the lever from takeoff to climb power 30 sec. prior to the 5-min. limit and maintained the ap-

The IS&S integrated avionics packages for both the Eclipse 500/550 and PC-12 have custom features and non-standard color conventions that take a short time to learn.

propriate setting for altitude and OAT as we climbed to cruise altitude. At level-off, we used it to maintain a preset indicated airspeed.

Such a takeoff, climb and cruise scenario seems so normal and relaxed when flying a jet, but this is the first FAR Part 23 turboprop we've piloted with an autothrottle. It has two main operational modes: torque hold or speed hold. It also has maximum engine torque and temperature limiting protection, a minimum speed floor function to prevent stall and a turbulent air penetration speed-hold mode.

As such, the system marks a major step in reducing pilot workload, especially as these aircraft typically are flown by a single pilot. On approach, the speed-hold function is especially valuable. Imagine being alone in the cockpit, flying into a small general aviation airport, such as Steamboat Springs, at night in challenging weather conditions. Or imagine breaking out at minimums at Truckee-Tahoe Airport on

the approach to Runway 20 and then having to circle to land on Runway 29. An autothrottle can relieve a lot of the stress in such high workload situations.

The IS&S demonstrator, however, doesn't just have a new autothrottle. It has a complete $300,000 IS&S flight deck makeover that provides all the essentials for flying in NextGen airspace, including both ADS-B In and Out, VNAV for en route descents, RNP curved and segmented approach navigation, LPV precision approach guidance and electronic charts.

First-generation PC-12 aircraft were adequately equipped for flying in the 20th century airspace system. Typically, they had a five-tube Honeywell suite, including EFS40 or EFS50 electronic ADI/HSI stacks on the left and right sides, plus Bendix/King Silver Crown panel-mount radios, an MFD and engine instrument display package in the center. Three EFIS symbol generators and an air data computer were remotely mounted. But extensive modifications are needed to fly in 21st century NextGen airspace.

For the IS&S upgrade, the Honeywell gear is removed from the instrument panel and replaced with left and right 10.4-in. portrait configuration PFDs, with optional synthetic vision, and a central, 15.4-in., landscape

configuration MFD. Minimum surgery is required outside of the instrument panel. The old symbol generators (SG) and air data computer are removed. Wherever possible, the vacancies are used for IS&S replacement boxes to save installation expense.

System architecture essentially is hub-and-spoke. A data concentrator unit (DCU) that replaces one of the old SGs is the heart of the package. The DCU links to the displays, original KFC325 autopilot, weather radar and XM radio receiver, TAWS and traffic warning system, new IS&S redundant engine data concentrators and optional autothrottle, among other components.

The Silver Crown panel-mount radios are replaced with a pair of remote-mount Honeywell KTR-2280 multi-mode radios, an L3 NGT-9000R ADS-B Out Mode S ES transponder with both 978 MHz and 1090 MHz ADS-B In receivers, and dual digital

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air data computers. The original single or dual LITEF LCR-92 fiber-optic gyro AHRS boxes are retained, but IS&S is developing its own solid-state ADAHRS box as an upgrade to improve dispatch reliability.

The IS&S package doesn't include DME. For operators needing that capability, the system can be linked to an optional remote-mount Rockwell Collins DME4000 with distance displayed on the PFDs. However, the DME cannot be linked to the FMS as a backup for GPS. The new package shaves 60 lb. of empty weight from the aircraft.

The new cockpit looks a lot like the front office of the Eclipse 500/550 with AvioNG 1.7 equipment that IS&S developed about a decade ago. Display color conventions, basic functionality and the overall feature set are much the same.

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But the retrofit package for the PC-12 isn't fully integrated with aircraft systems and it retains the original annunciator light panel.

The aircraft we flew also had left- and right-side IS&S solid-state, integrated standby units (ISUs) that replace the original mechanical gyro standby attitude indicator. The $30,000 ISUs have considerably more functionality, as well as higher reliability, than the OEM spinning gyro, standby attitude indicators. They also have enough computing power to host the autothrottle functions for Pratt & Whitney Canada PT6A-powered aircraft that aren't equipped with the IS&S NextGen avionics package.

The IS&S integrated avionics packages for both the Eclipse 500/550 and PC-12 have custom features and nonstandard color conventions that take a short time to learn. We prefer the standard air transport color set: magenta for computer-generated targets, cyan for pilot-entered data, green for active, white for standby and yellow for cross-

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side. Most PC-12 pilots with whom we've spoken, though, say the IS&S package is easier to master than many of the other advanced avionics systems with which they've flown.

Virtual file folder tabs, for instance, are displayed at the bottom of the PFDs and MFD. Rotating left and right tab selection knobs provide easy access to subpage functions, such as com, nav, transponder, ADF, weather radar and autothrottle controls. The active folder tab is displayed in reverse video, so it's easy to see what function is being controlled.

Both the PFDs and MFD have dual concentric knob sets and line select keys on the left and right sides of the screens. The MFD also has mode select keys on the bottom bezel for map, FMS, checklist, system and audio control

pages. The outer knob typically moves the cursor from field to field while the inner knob changes data within a field. When data is entered, the numeric data momentarily zooms up in size to make it easier to see. Depressing the inner knob activates certain functions or swaps frequencies between standby and active.

Full-Range Flight Guidance

The package includes dual FMS, with twin Beta 3 satellite-based augmentation system receivers, which supports virtually all of the ARINC 424 procedure legs needed to navigate from takeoff to touchdown in the 21st century airspace system.

The day we flew the aircraft, for example, we planned a short flight from KMYF to Carlsbad McClellan-Palomar Airport (KCRQ), requesting the RNAV (RNP) Z Runway 24 approach as it has multiple waypoints with both straight and radius-to-fix legs.

We were cleared to climb to 3,000 ft. on a heading of 270 deg. after take- off, awaiting vectors from SOCAL to the Oceanside VOR (OCN). Passing through 2,500 ft., SOCAL cleared us to climb to 4,000 ft. We soon engaged the autopilot, as well as the autothrottle, and let the IS&S system play virtual copilot.

At level-off, we needed to switch the autothrottle from the torque-hold mode to the speed-hold mode. This isn't an automated transition as it is in most jets. It takes a few knob twists and button pushes. We had to momentarily disengage the autothrottle in the torque-hold mode and then re-engage it in the speed-hold mode, selecting 160 KIAS as the target airspeed. It would be handy if there were an automatic torque- to speed-hold transition feature.

Cleared direct OCN, we armed

approach and monitored the system as it flew us with RNP precision from waypoint to waypoint on the approach, making sure we complied with all vertical crossing restrictions.

We dialed down the speed to 120 KIAS and configured the aircraft for landing as we crossed JUBIM, the final approach fix inbound to Runway 24. Nearing minimums with the autopilot and autothrottle still engaged, we pressed the TOGA button on the throttle. This initiated go-around functions, including automatically advancing the autothrottle from speed-hold to takeoff torque-hold mode and activating FMS missed approach guidance. But the process isn't totally automated as the autopilot's approach navigation mode is terminated and the flight director and autopilot switch from approach navigation to go-around pitch mode. At that point, the autopilot nav mode must be re-engaged to provide coupled navigation guidance to the missed approach holding fix. This is a limitation of the legacy KFC325 flight guidance system. And the autothrottle must be manually switched from torque-hold to speed-hold mode at level-off.

After the missed approach at Palomar, we requested the VOR/GPS-A approach to San Diego Brown Field (KSDM). SOCAL was quite flexible, but we received extensive delay vectors to avoid traffic conflicts with jetliners arriving at Lindbergh Field.

When we finally were cleared for an abbreviated approach to Brown Field, we let the autopilot and autothrottle fly us down to 1,220 ft. at POGGI VOR (PGY), the missed approach point 2.3 nm north of the airport. At PGY, we disconnected the autopilot and flew the approach manually but used the autothrottle to maintain the desired approach speed.

We landed at Brown Field and taxied back for a VFR return to KMYF, again using both autothrottle torque- and speed-hold modes for takeoff, climb, cruise and approach.

In It for the Long Run

Innovative Solutions and Support's (IS&S) complete avionics upgrade and optional autothrottle system for the PC-12 are emblematic of the company's strengths. The Exton, Pennsylvania-based company is not as well-known as Garmin, Honeywell or Rockwell Collins. But, since its founding in 1988 by

Geoffrey Hedrick, it has created an impressive array of products and technologies for military, air transport and general aviation aircraft. It builds almost everything in house, including displays, SBAS GPS receivers, FMS computers, digital air data computers and AHRS.

Such strong vertical integration and lean staffing enables IS&S to respond quickly when opportunities surface. We first took note of IS&S in the early 1990s when it developed plug-and-play integrated digital air data altimeters for the Gulfstream GII, which enabled it to meet RVSM requirements. During the same time period, it developed RVSM altimeters for the KC-135, C-9 Nightingale and a variety of tactical jets.

In the 2000s, IS&S developed upgraded original equipment avionics for the Eclipse 500, as well as retrofit flat-panel displays for the Boeing 757/767 and a large number of RVSM retrofit kits for business aircraft. Later, it created plug-and-play retrofit LCDs for classic B737s and Delta Air Lines' MD-88/MD-90 jetliners. It has now delivered more than 300 shipsets of replacement LCDs for Boeing 757/767 aircraft.

A FADEC for the PT6A

The Pratt & Whitney Canada PT6A turboprop, one of the longest-running product lines in business, general, and military aviation, is finally getting an electronic engine control. The powerplant entered service in the early 1960s and until now has always been managed with a hydromechanical engine control.

Not that this has been a handicap for the PT6A, more than 47,000 units of which have been produced in 71 models in power ratings ranging from 500 to 1,900 shaft horsepower for 128 applications fielded by more than 6,700 operators in 180 countries. Oh, and the total fleet has chalked up more than 387 million flight hours.

The reliability of the reverse-flow engine has earned it a reputation of being "bullet proof" among pilots who've flown between, behind, or in front of PT6As

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in twin- or single-engine airplanes and has gone a long way toward convincing civil aviation authorities in North American and Europe to allow commercial single-engine IFR operations in aircraft like the Cessna Caravan and Pilatus PC-12 turboprops.
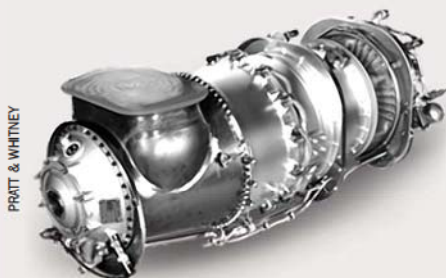
The watershed event conferring a FADEC, or full-authority digital electronic control, to at least one version of the PT6A was selection by Textron Aviation's Cessna Aircraft to supply engines for the airframer's new SkyCourier twin turboprop small freighter and commuter passenger plane. The variant is the 1,100-shp PT6A-65SC, which will be equipped with a digital engine- and propeller-management system operated with a single lever designed to reduce pilot workload.

"The PT6A has always been easy to start in all conditions, so our advanced control system will offer much more than 'start and limit' for the engine," a PWC spokesperson told BCA. Conceived specifically for commercial applications, the Dash 65SC will be equipped with PWC's FAST (full-flight data acquisition, storage, and transmission) diagnostic and prognostic system for operational optimization, operating cost reduction, and enhanced dispatch reliability.

The engine is designed to remain on-wing longer with a 6,000-hr. TBO and claimed to have been engineered to support high payloads in the small freighter class. Late last year PWC was engaged in the demonstration phase of the digital engine/propeller control. On the SkyCourier, the PT6A-65SC will drive a McCauley aluminum four-blade Blackmac prop. PWC has not indicted whether it will adapt the electronic control system to other PT6A variants in the product line.

Launch customer for the SkyCourier is Federal Express, which has placed an order for 50 of the freighter-configured aircraft for use in its feeder network. In the freighter role, the aircraft is projected to carry a 6,000-lb. payload, or three LD3 standard containers. As a commuter aircraft, the SkyCourier will accommodate 19 passenger seats and be placarded for a 5,000-lb. payload. Maximum cruise speed will 200 kt. and service ceiling 25,000 ft. Freighter and passenger configuration max ranges are predicted to be, respectively, 400 nm and 900 nm. **David Esler**

IS&S also developed a retrofit flight deck for C-130 Hercules aircraft, an integrated standby instrument unit for helicopters, the autothrottle system for the Eclipse 500/550 and a retrofit RNP-capable navigation system for air transport aircraft.

Now, the firm is in the final stages of certifying a stand-alone autothrottle system for other PT6A applications. One of the first offshoots will be an autothrottle system for other models of the PC-12, including the newer NG series aircraft that have integrated Honeywell Apex avionics packages, -67P engines and upgraded airframe systems. Only two main components are needed: IS&S's smart integrated standby instrument unit (ISU) and a single throttle servo in the center console. The ISU provides all autothrottle control and display functions, along with hosting the autothrottle computer. The ISU-based AT system is priced at $60,000.

Next, IS&S plans a twin autothrottle system for Beech King Airs that includes a pair of throttle servo actuators. The system will be priced close to $75,000.

IS&S is a relatively small firm but one with impressive creativity, engineering expertise and agility that enables it to develop and certify avionics solutions more quickly and less expensively than many larger companies. The rapid development of the autothrottle system for the PC-12 and Beech King Air takes full advantage of those strong points. Look for this firm to provide creative, cost-effective upgrades for a wide variety of business aircraft in the future. **BCA**