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TWIN & TURBINE

FOR THE PILOTS OF OWNER-FLOWN, CABIN-CLASS AIRCRAFT

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ELECTRIC FUTURE

CLEAN & QUIET PROPULSION IS CLOSER THAN YOU THINK

IS&S Autothrottle System for PC-12s and King Airs

by **Dale Smith**

Okay, so you've lined your twin up for takeoff, advance the throttles, V_1, V_2, rotate, and just after you've stowed the gear, the left engine gives up. As you try to "rub your head and pat your tummy," you reactively do your best to control the airplane and keep it flying. But, in your attempt to maintain altitude, the airspeed drops off and suddenly you're on the wrong side of right-side-up.

Of course, this is the classic VMCa stall situation. As you'll recall from your training days, VMCa stands for Velocity-Minimum Control (airspeed). That happens when a multi-engine aircraft suffers the failure of one engine. While trying to maintain altitude, the pilot pulls back on the yoke, dropping the airspeed to the point where they lose control of the aircraft.

In fact, when it comes to VMCa situations, it can be easier to keep a piston twin right side up than a twin turboprop. Why? When you lose an engine on a piston twin, you pretty much are committed to an emergency landing.

But, with the turboprop's added power is a temptation to keep flying. So, when you lose power on one side and still have all that added horsepower lifting the opposing side, the asymmetric thrust makes the airplane that much more unstable in the roll axis. Even the best of us can easily get way behind the airplane in that situation.

Less Power to You

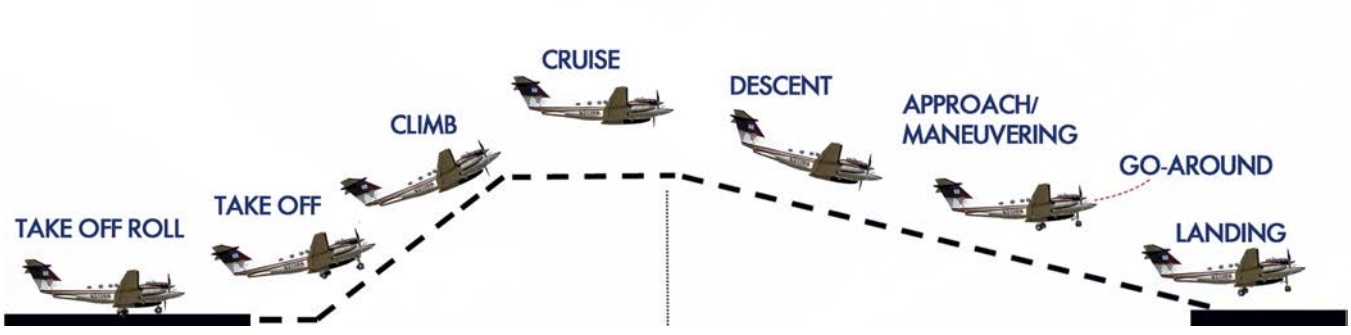
And if it's a problem with a pair of 650 shp turboprops, it must be a huge issue with much more powerful aircraft. And it would be if not for dynamic engine control technologies.

"I was an aerodynamicist on the F-14 Tomcat program for Grumman, which was one of the first aircraft to have dynamic VMCa protection," explained Tom Grunbeck, director of autothrottle programs for Innovative Solutions & Support (IS&S). "If you lose an engine on takeoff, the 'good' engine will maintain a fixed limited power of approximately 25 percent of thrust so the pilot can maintain directional control."

"Our new ThrustSense Autothrottle system is the only full-regime system available with dynamic VMCa protection," he continued. "ThrustSense for the King Air features our patented LifeGuard Protection system that dynamically adjusts the power settings on the 'good' engine based on the aircraft's airspeed to help the pilot maintain directional control."

As Grunbeck explained it, the ThrustSense Autothrottle controller collects all the aircraft's current flight data, then automatically calculates airspeed, engine power and rudder-effectiveness during single-engine operations, and it can make its throttle adjustments. And it does it at up to five-knots-per-second intervals.

"Our real-time analysis of loss of control due to asymmetric thrust and sudden loss of airspeed showed that by modulating the remaining engine's available thrust, all the pilot has to do is put their foot on the rudder on the side of the failed engine and the airplane will stay straight," added IS&S Chairman and CEO, Geoffrey Hedrick. "No matter how slow you go, the airplane will go straight and level to the stall. Of course, our ThrustSense Autothrottle will sense the loss of airspeed and



IS&S ThrustSense Autothrottle – modes of operation.

automatically advance power on the good engine to help prevent the stall. It keeps the pilot in control and the airplane right side up."

Easier Said Than Done

As you may well expect, developing a system as sophisticated as ThrustSense didn't come easy. Even to a company with "Innovative Solutions" in its name.

"Right after we got a Pilatus, I decided then to develop the autothrottle system, but it was a lot easier said than done," Hedrick said. "For the next 15 years, we worked on it until we came up with a very simple, retrofittable actuator that is truly failsafe. We put it on our airplane, and it works perfectly."

"We developed our first ThrustSense Autothrottle system for our PC-12, but the team saw more potential, so IS&S purchased a King Air to use for the twin-engine program," Grunbeck said. "With the King Air, we had two main hurdles from the retrofit standpoint: system size and cost. There were already autothrottle systems available, but they are very expensive and add too much weight."

"We overcame both hurdles through a combination of developing our own proprietary actuators and doing something I think is incredibly innovative: Our engineers built the autothrottle's controlling computer into our integrated standby unit (ISU)," he continued. "So, the retrofit installation requires replacing the legacy standby unit with our ISU and adding the actuators into the existing throttle quadrant. That greatly simplifies the installation."

Grunbeck said that the new IS&S actuators are very light, small, and extremely reliable. And the entire system weighs in at only 5 pounds – about one-sixth of other autothrottle systems.

"Our actuators are extremely sensitive and accurate. They can actually move the power levers the width of a human hair," he said. "There's no hunting power at cruise to maintain airspeed. The system does it all."

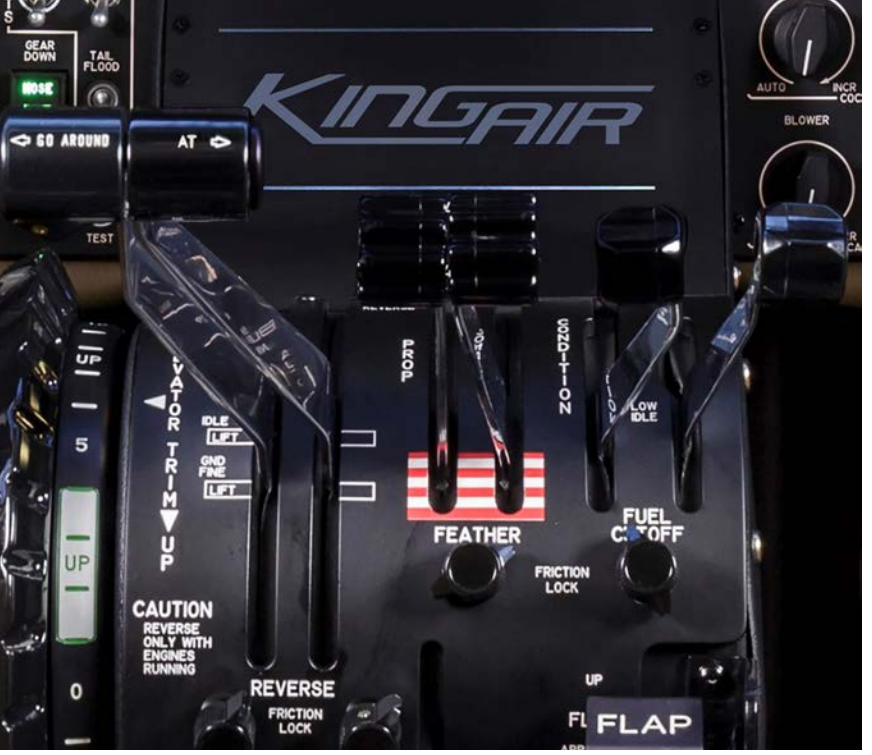
Full-Regime Benefits

"ThrustSense is the only full-regime autothrottle available for retrofit on the PC-12 and Collins Pro Line 21 and Fusion-equipped King Air family," Grunbeck said. "Some other production autothrottles are engaged in climb and not on takeoff. The benefits of full-regime operation are an extremely important differentiator for us."

According to Grunbeck, the patented ThrustSense full-regime autothrottle provides automatic power management from takeoff to touchdown, including go-arounds. In addition, the system protects the engine against operator-induced speed exceedances, engine over-torque, and under-temp – all of which greatly enhance the safety and operational value of the aircraft.

"We pride ourselves in delivering truly innovative and unique solutions to problems. For example, the autothrottles feature our patented







▲ Installation in Pilatus PC-12 legacy and NG.

◀ Existing King Air throttle quadrant with IS&S actuator installed.

"Guard Mode" that lets you manage the power manually, but the system will automatically keep the engine where it needs to be for that phase of flight," Hedrick added. "If you advance the throttle to a point where it will over-temp or over-torque, the system will automatically push the power to a safe zone."

"It gives you feedback in the throttle's feel. If you are approaching the engine's limits, it will actually push back on the power so you don't overstress the engines. A lot of pilots are asking for that feature," he said. "It's the same if you're on approach and slow the airplane down too much. It will automatically sense the loss of airspeed and advance the throttles to maintain a safe maneuvering speed."

While the IS&S ThrustSense Autothrottle system is extremely capable, as Grunbeck explained, it's simple to use.

"Once you're lined-up for takeoff, you just push the go-around (GA) button, and that engages the autothrottle system. In takeoff mode it lets the engines spool up and deliver maximum torque and temperature limits for that density altitude. It also automatically corrects for any engine surges that may occur as the power is advanced," he said. "After takeoff, there are modes to optimize every phase of flight."

- **Takeoff Mode:** ThrustSense compensates for environmental conditions and mitigates engine surges during power-up. Takeoff Mode is active until the system transitions into Climb Mode.
- **Climb Mode:** The throttles are automatically reduced to maximum continuous climb or torque schedule as a function of the altitude.
- **Airspeed Mode:** Controls airspeed to a command value through a manually-selected speed change. The autothrottles maintain a constant mach airspeed, as commanded by the FMS or, pilot's IS&S Integrated Standby Unit (ISU).
- **Protection Modes:** Continually monitor the aircraft and engine performance. The engines are kept within safe torque and temperature limits, per the aircraft's POH.
- **VMCa Mitigation:** ThrustSense A utothrottle will apply appropriate maximum safe power that precludes any adverse yaw and catastrophic upset. The autothrottle's One Engine Inoperative (OEI) mode is active during engine loss when ThrustSense is engaged for takeoff, climb, or go-around.
- **Go-Around Mode:** ThrustSense automatically sets maximum safe power while providing full engine protection.

No matter what mode you are in, automatic engine management and protection is a key benefit that ThrustSense brings to both the Pilatus PC-12 and King Air series. But, while it provides "automatic" protection, it still permits pilots to hand fly the throttles if they want.

"In some systems, we can also integrate our new ThrustSense Autothrottle to have full 4D navigation capabilities," Hedrick added. "Vertical and lateral navigation, RNP (required navigation performance), LPV (localizer performance with vertical guidance), as well as the required time-of-arrival. It's quite a valuable and safety-enhancing upgrade for these aircraft."

While that's certainly an impressive array of workload-reducing features, the company recently announced some significant additions, including Torque Matching, Power Lever Detents and an Electronically Controlled Throttle Handle Brake. As you may guess, the King Air ThrustSense will offer all those with the addition of the new Asymmetrical Beta Mode Protection capability.

Affordability of Autothrottle Enhancements

"Sure, I want one," you say. "But what's it cost?"

As of this writing, Grunbeck said that if you're flying a Pilatus PC-12

(legacy or NG-series), the system MSRP is just under $55,000. For a Collins Pro Line 21-equipped 200- and 300-series King Airs, the system lists for $68,000. If your King Air has Collins Fusion integrated avionics, the ThrustSense kit retails for $76,550. The higher cost is due to the Fusion system requiring a second remote unit. And, yes, prices are subject to change.

The MSRP is for the complete installation kit including the STC and a new IS&S Integrated Standby Unit (ISU), but does not cover the labor for the installation. As you can guess, that depends on the particular aircraft's equipage and panel configuration.

As for who can do the installation, Grunbeck said that any authorized Pilatus Service Center can install the IS&S system. On the King Air side, along with the Textron Aviation Service Centers, IS&S has established relationships with a number of leading MROs to do the work.

Of course, if you're fortunate enough to be taking delivery of a factory-new King Air 260 or 360, IS&S's ThrustSense Autothrottle with LifeGuard protection and dynamic VMCa mitigation is standard equipment.

"Textron Aviation has shown great initiative and trust by certifying our ThrustSense Autothrottle with LifeGuard protection on the new-generation King Air 260 and 360," Hedrick concluded. "They are currently the only factory-new turboprop airplanes in the world with VMCa mitigation. That says a lot about their commitment to safety." T&T

Dale Smith *has been a commercial, private and business aviation marketing and media communications specialist for nearly 40 years. He is an award-wining aviation journalist and aviation artist. Dale has been a licensed pilot since 1974 and has flown more than 40 different types of aircraft. Contact Dale at* **dalesmith206@comcast.net.**





ThrustSense® full authority auto-throttle with dynamic VMCa protection down to stall warning



Dynamically programmable PCL detents



In single and twin engine turboprops

ThrustSense®
Autothrottle with LifeGuard™ Protection
Making Safer Flying Simple

Optional features continue to grow and are now available for order.

- LifeGuard™ VMCa protection down to stall warning employing maximum safe power on operating engine
- Airspeed, Mach and Torque control
- LifeGuard™ FADEC functionality and protection of aircraft & engine in both MANUAL and AUTOMATIC modes including hot start
- Electronically adjustable detents covering entire flight envelope can be programmed to emulate NextGen aircraft operation
- Electronically adjustable throttle brake
- Easy installation with short downtime with no structural modifications

Available on Beechcraft® King Air® 260 and 360 aircraft and for retrofit on all certified 200/300 cockpits through Textron Aviation Service Centers or your preferred Service Center.

Available for retrofit on Pilatus PC-12 Legacy and NG through authorized Service Centers.

Innovative Solutions & Support
www.innovative-ss.com

Scan here for more information and sales contact

Scan here to view the VMCa protection demonstration video