POSITION Measurement & Control

Fall 1999 — **Practical Information on SpaceAge Control, Inc. Position Transducers**

"Black Box" Position Transducers Increase Flight Safety

Integral to virtually every modern large aircraft accident investigation is the aircraft's "black box," formally known as a flight data recorder (FDR). The FDR is a data acquisition and storage device that collects information on key aircraft variables such as airspeed, altitude, temperature, and orientation.

Following two fatal Boeing 737 accidents (United Airlines Flight 585, Colorado Springs, Colorado, July 1989, and USAir Flight 427, Pittsburgh, Pennsylvania, September 1994), the U.S. National Transportation Safety Board (NTSB) reexamined FDR parameter requirements for commercial aircraft. As a result, the NTSB made safety recommendations to the U.S. Federal Aviation Administration (FAA) that called for, among other items, recording of additional parameters for most existing air transports that focused on recording crew flight control inputs and the resulting control surface movements.

The FAA responded with rulemaking action that issued a notice of proposed rulemaking in August 1996 and a final rule on August 18, 1997 requiring air transports record flight control crew inputs and control surface position. Other regulatory agencies and military aircraft organizations have likewise implemented similar requirements for their aircraft fleets.

Retrofitting efforts to existing aircraft to address the new data recording requirements include combinations of attaching existing signals to the FDR, modifying or replacing the FDR to allow for increased parameter recording, and adding transducers (sensors) to measure the new parameters.

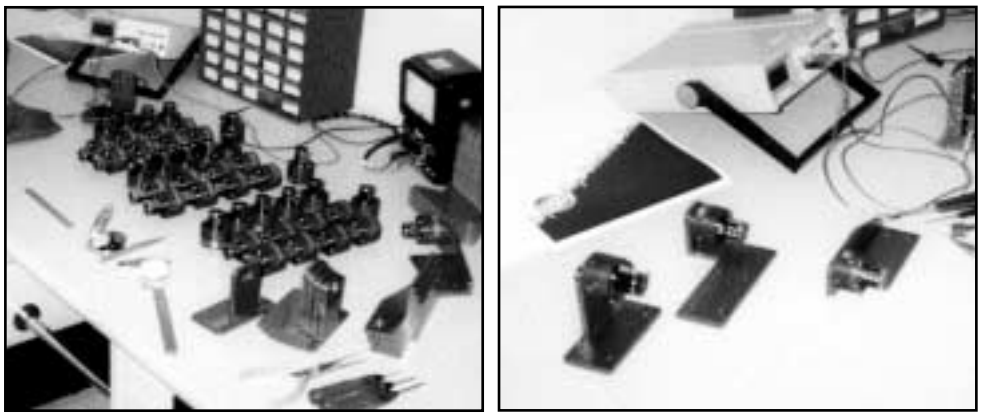
SpaceAge Control position transducers have been used extensively in these efforts to measure flight control inputs and control surface movements. This article highlights a few of the applications and customers using these products for FDR parameter measurement.

Regional Commuter Turboprop

Downey Corporation is an aircraft maintenance/structural repair firm focused on regional commuter aircraft and STC/developmental activities. They have developed a set of FDR upgrade solutions for the Beech, ATR, Saab, and Embraer regional turboprop aircraft. Their first implementation of SpaceAge Control position transducers involved the Beech 1900D twin-prop. Downey Corporation considered a broad range of sensors and transducers including magnetostrictive and linear potentiometer devices before specifying the SpaceAge Control solution based on the products' mounting flexibility, long travel range, and reliability. Jack Downey, Downey Corporation President, mentioned, "In addition, the position transducers can be mounted straight in line with the control mechanism eliminating any trigonometric corrections in software."

The products are used in the Beech 1900D to measure pitch trim input, roll control input, and yaw control input. A 5-V DC excitation (input) is used with the output going directly to the L3 Communications FDR with no intermediary signal conditioning required. The position transducers are mounted to the aircraft using bases designed by Downey Corporation. These bases make installation as simple as attaching 4 bolts and a cable clamp.

Black boxes, formally known as flight data recorders or FDRs, record data supplied by SpaceAge Control position transducers. Photo courtesy of Smiths Industries, Grand Rapids, Michigan USA.



Downey Corporation position transducers being readied for shipment at SpaceAge Control's manufacturing facility. Note the customer-designed bases for easy mounting.

Military Fixed and Rotary Wing

With a strong track record in systems integration, Raytheon Systems Company Australia (RSCA) is the premier system integration, weapons, flight test, and training specialists in Australia and the Pacific Rim. With a heritage in aircraft and aerospace, Raytheon is now capable of supporting systems integration needs for air, land, and sea vehicles.

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SpaceAge Control, Inc.

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Design Benefits

Avionics engineers have more than a few choices when selecting transducers for FDR flight control measurement. Why are they selecting SpaceAge Control position transducers for this task? Here are some benefits these transducers deliver:

Reliability With installations in the same aircraft for over 30 years, these products are reliable. Approved for man-rated space use, the products feature precision-machined components, Mil-Spec sensors, anodized surfaces, and bearing-mounted rotating components. These products have been performing in military FDR applications for over 3 years without failure.

Safety The stainless steel cable integral to the design of these position transducer will not bind in case of installation or product failure. In addition, cable connectors can be engineered to break free with less force than the 40-lb breaking strength of the displacement cable. The end result is a product that does not reduce the safety of the aircraft.

Size The hybrid rotational/linear measurement capability gives the most compact position transducer available per inch of maximum travel. These products can be mounted in a fraction of the space compared to rod-and-cylinder sensors such as linear potentiometers and LVDTs.

Weight With a stainless steel cable used to actuate the transducer mechanism, a tremendous weight advantage exists compared to other choices. This is especially true as the maximum distance to be measured increases.

Ease of Installation Rotatable mounting bases, re-directable displacement cables, and pulley options allows the product to integrate into the design of the aircraft. This flexibility eliminates complex fixtures and mounting hardware and does not require perfect alignment for operation.

Flexibility of Design The modularity of design with flexible mounting and cable exit options allows most installations to be performed with off-the-shelf products. However, custom design capability is available for installations having different requirements.

Choice of Electrical Outputs Electrical outputs can range from standard voltage divider (precision potentiometer) circuit output to synchro to signal conditioned outputs such as 0-5 VDC, 4-20 mA, ±5 VDC, or ±10 VDC.

Field-Repairable Design Product failure, while rare, can be addressed in the field with field repair kits. Should field repair not be an option, our standard shipping lead time is 1 week with next-day shipment available.

Cost of Ownership The combination of ease of installation, initial product cost, product reliability, and in-field repair capability results in an affordable cost of ownership.

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When RSCA was tasked with upgrading the FDR on fleets of Australia's military aircraft, RSCA began an extensive search for the appropriate sensors to measure aircraft control rods and pilot inputs. Their search ended with the selection of SpageAge Control position transducers. Paul Evans, Engineering Manager at RSCA, summarized their conclusion by saying, "We predicted that these products would be durable, reliable, and simple to install. We have had these units installed for over 3 years with no failures. We are happy with our decision."

RSCA supplied FDR upgrades using SpaceAge Control position transducers on a broad range of Royal Australian Air Force and regular Australian Army aircraft including 12 C-130H, 65 PC-9, 36 S-70A-9, and 6 CH-47. The number of position transducers installed per aircraft varied between 2 and 3, depending on the parameters being measured and the existing signals available. Series 160 position transducers were used to measure control rod inputs while the smaller Series 173 and 174 products were used to monitor flight control inputs. The products were mounted directly on the aircraft with no extra fixtures required.

Summarizing RSCA's experience with SpaceAge Control, Paul Evans noted, "The product is reliable, support is immediate, prices are stable, and delivery is fast."

Long-Range Commercial

Aircraft Systems and Manufacturing Inc. (ASM) is an aircraft systems integrator with a broad range of FDR upgrade kits flying today on mid- and long-range commericial jet aircraft. Started in 1987, ASM has a 28,000 square foot facility located in Georgetown, Texas, a suburb of Austin. ASM is an FAA PMA approved facility and an approved FAA Repair Station.

When looking for measurement solutions for the new mandated parameters, ASM looked at synchros, linear potentiometers, control transformers, and other sensing mechanisms. After careful study, ASM chose SpaceAge Control's products due to their simple installation and high reliability. Notes Dan Googin, Program Manager at ASM, "Other solutions involved complex linkages with high development costs and with higher probability of failure."

To date, ASM has used five-inch and three-inch SpaceAge Control products on 727 and DC-10 aircraft to measure lateral

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SpaceAge Control position transducer shown mounted near 727 flight control cable as part of ASM FDR upgrade kit. Photo courtesy of Aircraft Systems & Manufacturing Inc.

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control input (727) and pitch control input (DC-10). Depending on the aircraft and the FDR, the position transducer output is either fed directly into the FDR or to the flight data acquisition unit (FDAU) for processing. The transducers are mounted directly to the structure (DC-10) using the products' flexible Universal Base or via a spanning plate (727). The displacement cable is attached using a loop attached to the control mechanism.

Business Jet

Started in 1971, Midcoast Aviation is an aircraft maintenance and modification house with a focus on corporate jet aircraft. With over 600,000 square feet of facility and 600 employees, Midcoast Aviation provides a comprehensive range of services to virtually every type of corporate jet. These services include FDR upgrades. To date, Midcoast Aviation has used SpaceAge Control position transducers on Canadair Challenger, Gulfstream II, and Gulfstream III upgrade programs. Generally used to measure the pilot's pitch control input (yoke movement), the position transducers are mounted directly to the aircraft structure using standard mounting bases. The displacement cable is connected to control cables or push rods using an in-house fabricated clamping mechanism.

Joe Barteau, Director of Engineering at Midcoast Aviation, noted, "Most installations can be done in as little as 4 weeks." This schedule includes all engineering work and is compressed due to the flexible installation features of the position transducers.

For more information on companies mentioned in this article, please contact:

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Downey Corporation
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Midcoast Aviation
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Raytheon Systems Company Australia
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Installations to date: C-130H, S-70A-9 (Blackhawk), CH-47D (Chinook), PC-9S, P-3C
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sydney@raytheon.com.au
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Series 170 and 176 Subminiature Position Transducers Announced

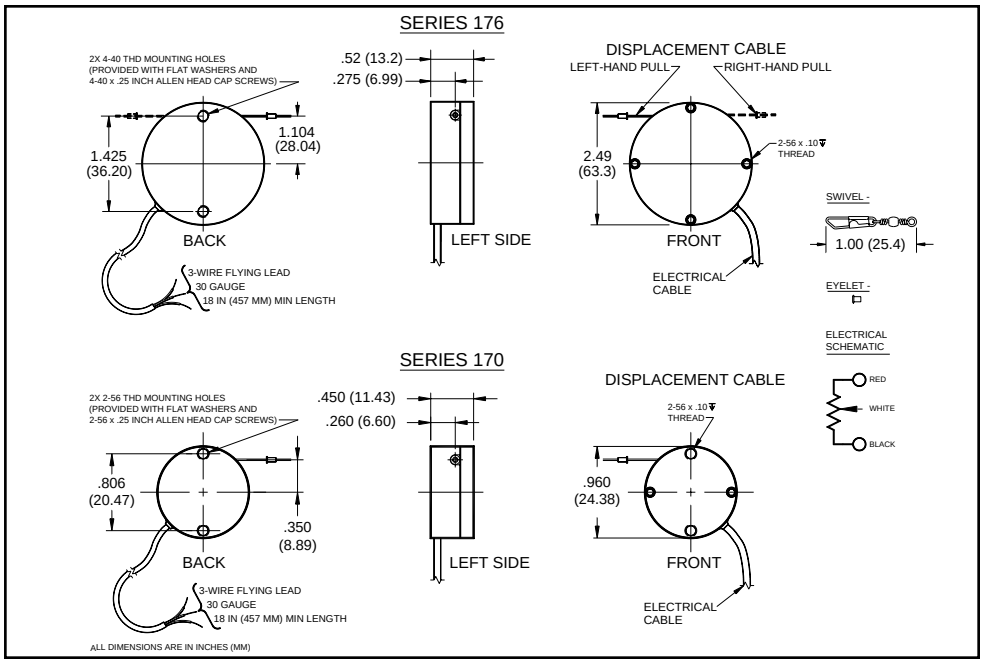
Extending the capabilities of the Series 173, 174, and 175 product lines, SpaceAge Control has announced the availability of the Series 170 and 176 position transducers. Developed from customer requests for longer ranges and smaller sizes, the Series 170 and 176 products share the same high-performance characteristics of the Series 173, 174, and 175 while offering smaller size (Series 170) and longer range (Series 176).

Initial applications of the products include UAV flight control position monitoring, medical diagnostics equipment, and vehicle testing.

The products are available immediately. For more information, please contact us or visit our Web site at :

http://www.spaceagecontrol.com/litroom.com

Series 176 (far left) and Series 170 (far right) shown with the Series 175, 174, and 173 subminiature position transducers.



Product Specifications - Summary

Model	170-0161	176-0521
Maximum Range	2 inches (51 mm)	6.5 inches (165 mm)
Resistance Value	5K ohms	5K ohms
Linearity	±0.5%	±0.5%
Power Rating	0.75 W	0.75 W
Operating Temperature Range	-65° to +125° C	-65° to +125° C
Weight (approximate)	1 oz. (28 g)	4 oz. (113 g)
Operating Life	50 million cycles min.	50 million cycles min.
Potentiometer Specifications	per Mil-R-39023	per Mil-R-39023

ISO 9001 Compliance Achieved

11-Month Process

After 11 months of intensive implementation efforts, SpaceAge Control's quality system is now compliant with the requirements of the ISO 9001 quality standard. The company's quality system was previously compliant with Mil-Q-9858A, an obsolete quality standard developed by the U.S. military and upon which ISO 9001 is based.

The implementation effort required development of 4 levels of quality documents: quality manual, operational procedures, work instructions, and forms. Reviews of the documentation and self-audits resulted in several documentation revisions and process changes.

To verify compliance, SpaceAge Control underwent two management reviews (most recently in September 1999), two complete internal audits, and three reviews of its quality system documentation.

Jeff Kempton, QA Manager/Mechanical Engineer at SpaceAge Control and ASQ-certified Lead Auditor mentioned, "Seeing a company go from brand-new quality documents to full compliance in 11 months is nothing short of amazing."

The motivation to achieve ISO 9001 compliance was due to a number of factors including changing quality standards, an antiquated paper-based quality system, and customer demand. Noting the benefits of the implementation effort, Thomas Anderson III, CEO at SpaceAge Control stated, "We began the process in response to a number of customer quality surveys inquiring about our ISO 9001 status. In the end, however, we were most successful due to our focus on achieving product consistency and continuous improvement."

SpaceAge Control Quality Policy

SpaceAge Control, Inc. will continuously improve its products to better satisfy the needs of its customers and will deliver to them, on time and every time, defect-free products and services.

Source: QM-00-001 (SpaceAge Control Quality Manual)

For an uncontrolled copy of SpaceAge Control's Quality Manual, please contact Jeff Kempton at SpaceAge Control by phone (661-273-3000), fax (661-273-4240), or e-mail (email@spaceagecontrol.com). ❑

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Miniature and Subminiature Position Transducers

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