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CUSTOMER FOCUS

Flight Controls, Displacement Transducers, and Safety

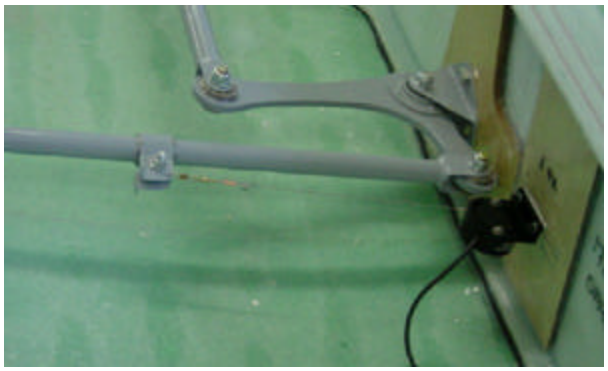
Sweden's Royal Institute of Technology Performs Swivel Connector Breaking Strength Testing

Editors Note: Thank you to Dr. Ulf Ringertz of the Royal Institute of Technology for performing the following testing and allowing this summary to be published.

SpaceAge Control position transducer have been safely used on a broad range of aircraft without incident for over 30 years. Recently, as a part of the KTH ASK-21 flight test program, the Department of Aeronautics at the Royal Institute of Technology in Stockholm, Sweden performed a breaking strength test of a SpaceAge Control cable assembly consisting of 7x7 0.018-inch (0.4572-mm) stainless steel cable (C40.0), copper sleeve (300292), and swivel (160026). Excerpts from the Institute's draft report are below. Later this year, the Institute will perform an additional test using a modified displacement cable assembly.

Summary of "Testing the Breaking Strength of a Position Transducer Cable"

All the control surfaces of the KTH ASK-21 flight test aircraft are measured using the position transducers manufactured by SpaceAge Control Inc. The transducer consists of a potentiometer which measures the movement of a spring loaded cable. The cable is attached to the moving object and the potentiometer provides an analog voltage that is proportional to the movement of the object. In the KTH ASK-21 case, the cable is attached to the push rods in the mechanical control system as shown in the photo below.



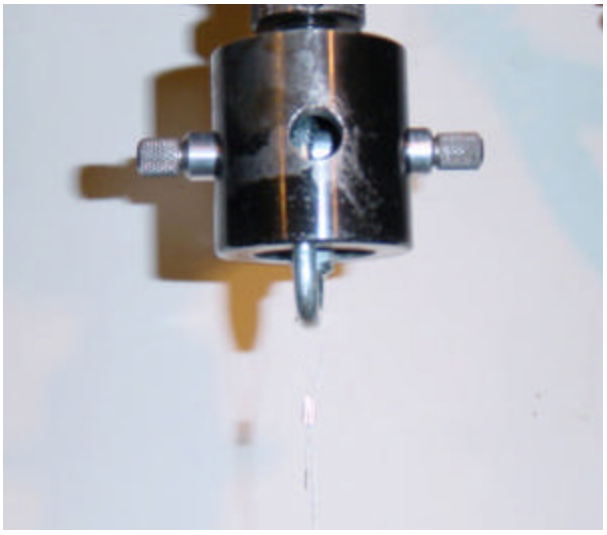
Series 173 position transducer installed to measure aileron movement.

Since the transducers are attached to the vital parts of the control system, it is essential to analyze the consequences of a possible failure of a transducer. Assuming that corrosion, wear and tear of the

transducer would start to affect the performance of the transducer, the most likely event is that the transducer would not retract the cable properly. This type of failure would not affect flight safety since a slack cable has no effect on the movement of the push rod. A more serious failure mode of the transducer would be if the cable would be locked inside the transducer in a retracted position. Although this situation appears were unlikely, if at all possible, the purpose of this investigation is to analyze the forces needed to brake either the cable or the connector that attaches the cable to each push rod.

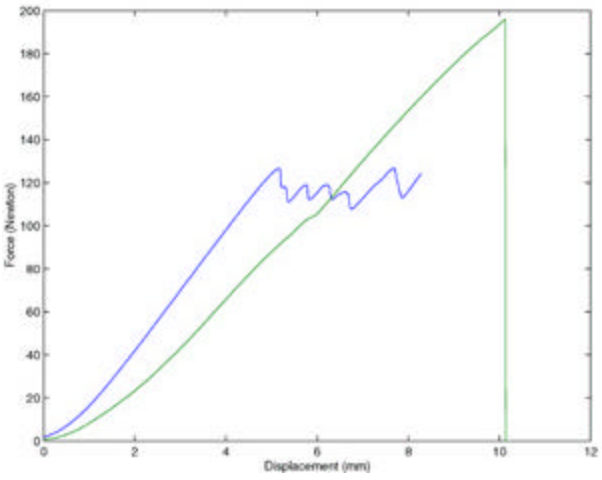
The breaking strength of the cable and the connector were tested independently.

The first test involved finding the breaking strength of the displacement cable itself. The cable was run around the load cell fitting in a loop as shown in the photo below.



Testing setup of the displacement cable by itself

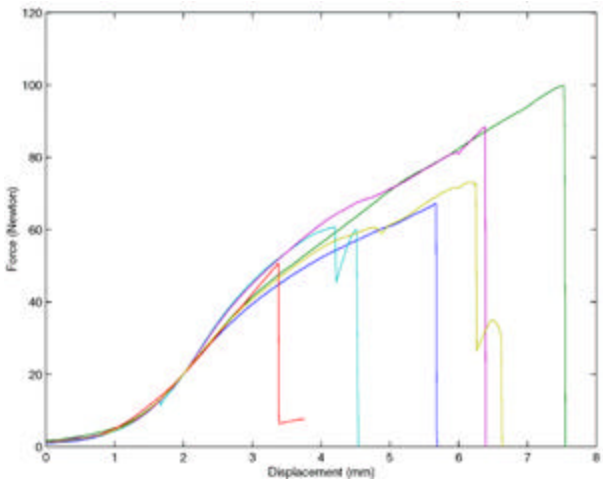
The loop was closed using the copper sleeve supplied with the transducers. Applying the force through displacement control of the testing machine produced the blue curve shown in below.



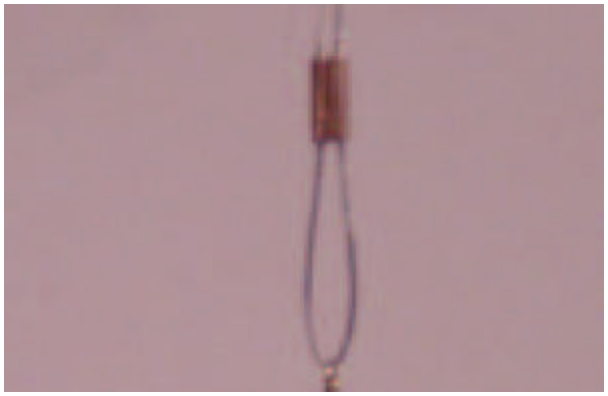
The load versus displacement for the two displacement cable tests.

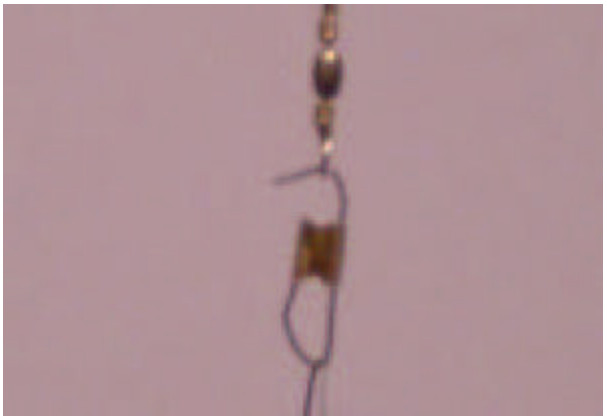
At roughly 120 N of force, the cable started to slip in the copper sleeve giving the varying displacement force relation shown below.

The swivel (connector) test setup



The load versus displacement for the six swivels (connectors)





Typical swivel failure mode

All the tested swivels.

Based on a conservative estimate of the breaking strength of the cable connector, the required pilot forces are well below what the average pilot can produce. For the elevator, the most critical control, the margin of safety is more than eight (8). However, for the aileron and air brake control the margin of safety is only about two (2).

If you would like a complete copy of the Insitute's test report, please contact us.

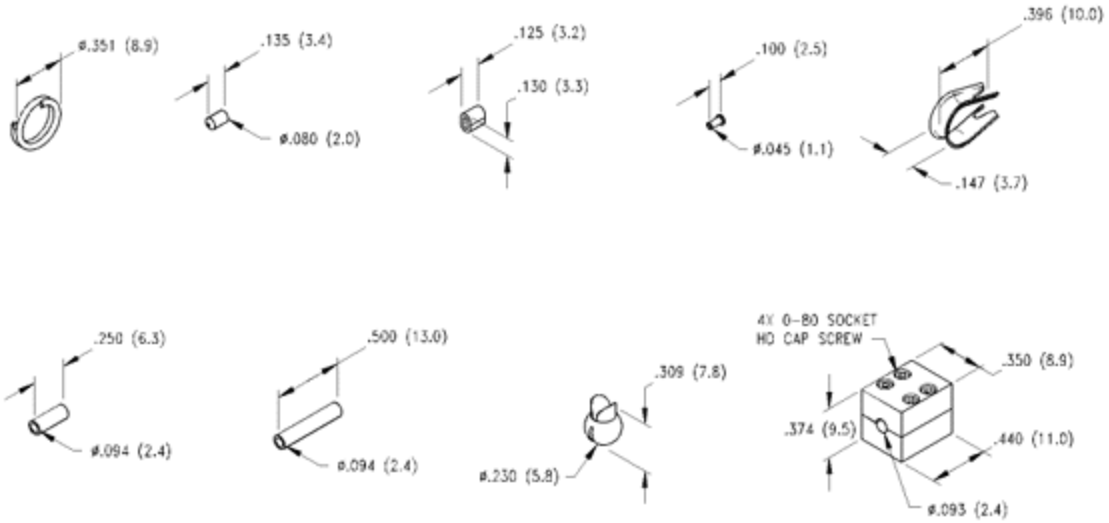
APPLICATION CORNER

The Application Corner answers your questions about using position transducers in specific applications. If you have an application question you would like answered, please contact us by phone, fax, e-mail, or Web form.

Displacement Cable Termination

Q. Your standard products are generally provided with the displacement cable unterminated. Can you terminate the cable for us to our specification?

A. Yes. If you have a specific length where you want the cable terminated, please specify this information on your purchase order as well as what type of displacement cable termination you would like. There is no charge for this service for most termination requirements. Note that our standard termination tolerance is ±0.01 inch (±0.254 mm).



Sampling of Displacement Cable Termination Components

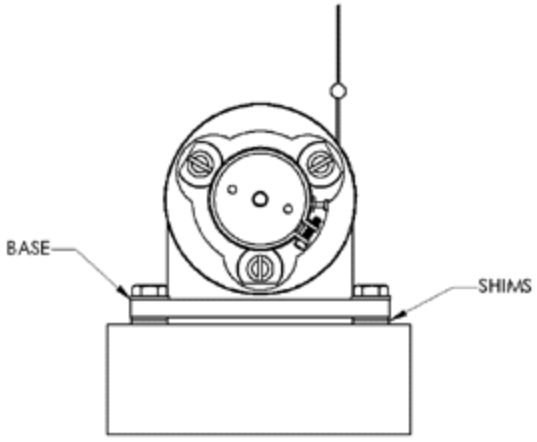
To terminate the displacement cable yourself, you may want to use the 160001-01 installation kit.

Zeroing of Electrical Output on Analog-Output Position Transducers

Q. How do I zero the output from unit to unit?

A. Below are a number of techniques you can use to zero the output on analog-output position transducer. If you have developed a technique not shown below, we would be interesting in hearing about it.

- adjustable displacement cable termination - a turnbuckle, threaded plug, or similar devices allow you to adjust the cable length
- precision displacement cable leader - leaders specific to the application can be fabricated
- shims - thin layers ("shims") can be added as required on the mounting base or displacement cable termination
- rotating the potentiometer - the cam locks can be loosened and the potentiometer rotated to achieve the desired output
- trimming potentiometer - trim potentiometers can be added to the voltage divider circuit to control the zero point



Examples of Shims Used To Zero the Electrical Output

RVDT-Based Position Transducer

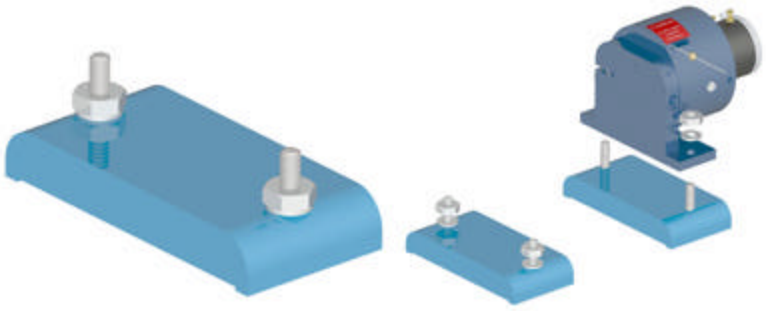
Q. We need to maintain backwards compatibility with our RVDT sensors. Do you offer a position transducer with an RVDT- or LVDT-type electrical output?

A. We can provide our position transducers with an RVDT as the rotary sensor to meet the electrical output requirements of your application. Alternately, we can work with you to simulate RVDT/LVDT output using an appropriate electrical circuit.

Mounting with Magnets

Q. Do you have a source of magnets for mounting your product to our application?

A. For our Series 160, 161, 162, D60, D61, D62, 161H, and 162H style products, we now offer the 160005 magnet base that interfaces to both the standard base and the universal base. For more information on this product, please view our Mounting Bases and Accessories datasheet.



160005 magnet base (left) and shown mounted with Series 160 position transducer

A supplier of magnets you may want to consider is http://www.bunting-magnetics.com.

IN ACTION

Every month we see numerous fascinating applications of our position transducers. Here are a few recent ones:

SSSSSHHHHHHH! Business aircraft will soon be quieter with the use of engine quieting technology that

use a custom-engineered SpaceAge Control displacement transducer that acts as a limit switch. These "hush kits" shroud aircraft jet engines during takeoffs and landings to lower the sound levels ("hush") emanating from them. The SpaceAge Control displacement transducer provides input to cockpit displays indicating if the hush kit is in a retracted or extended position.

Hush kits quiet aircraft jet engines and reduce noise pollution.
Photo credit: McGraw Hill

Automotive Components Manufacturer Finds "Less Is More" An automotive component was using 4 different types of non-SpaceAge Control displacement sensors for factory automation and testing purposes. These displacement sensors did not offer mounting flexibility and required the company to purchase a different sensor model for each orientation that needed to be measured. The manufacturer's manufacturing engineering group were referred to SpaceAge Control position transducers from a sister division and found that a single SpaceAge Control position transducer offered the installation flexibility to allow 1 model to replace 4 models of the previous device. The use of SpaceAge Control position transducers reduced the manufacturer's sensor inventory, fixturing requirements, and installation time.

The flexibility of the universal mounting base combined with the cable guide or idler eliminates custom fixturing and allows one part to to take the place of multiple instances of other sensors.

SpaceAge Control Gets the Checkered Flag (with the Help of Penske) On May 26, 2002, Helio Castroneves of Penske Racing won his second straight Indianapolis 500. In his cockpit during the race, SpaceAge Control miniature position transducers were monitoring driver controls for performance improvement analysis.

Photo credit: Penske Racing (http://www.penskeracing.com/)

NEWS YOU CAN USE

What Is Your Vote? New Poll Implemented On Web Site

If you haven't visited our Web site in a while, you may notice there is now a poll on the left sidebar of every page. We encourage you to give us your opinions on the questions we pose. Doing so will allow us to better meet your requirements for displacement measurement solutions.

NEW *Air Data Products* Solution Guide Now Available

After 6 months of development, design, and production, our 12-page *Air Data Products* solution is now available. The solution guide gives engineers, researchers, technicians, and students background on how to measure the fundamental variables that are use to calculate airspeed and altitude. Included is information on measurement of angle of attack, angle of sideslip, total pressure, static pressure, outside air temperature, and total air temperature. Additionally, an entire range of product offerings is described including the new 100900 4-vane, heated air data boom and the 100800 trailing bomb. To obtain the *Air Data Products* solution guide, please complete a literature request form.

Air Data Products solution guide

You may also view or download this document in pdf format.

Web Site Features Announced: Refer A Colleague and Printable Page

Our Web site now features the ability to easily refer colleagues to specific pages. If you find material on our Web site that could be of interest to a colleague, simply complete a few fields on the bottom of each Web page on our Web site. Your colleague will be notified of the page by e-mail with your e-mail address referenced.

Each page on our Web site now also offers a "Format for Printing" link at the bottom of each page that optimizes the page layout for printing.

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