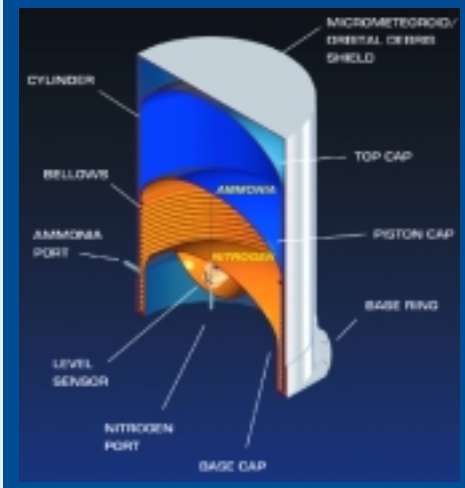
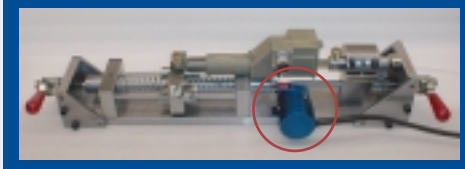
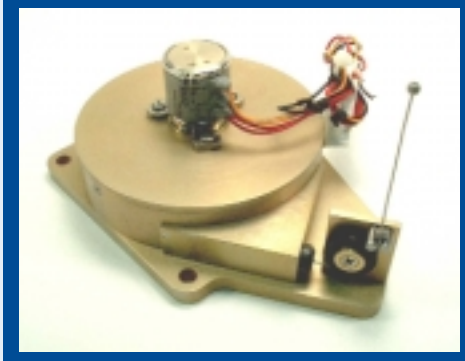


Environmental Controls



Inspection System



Quantity/Level Sensoring

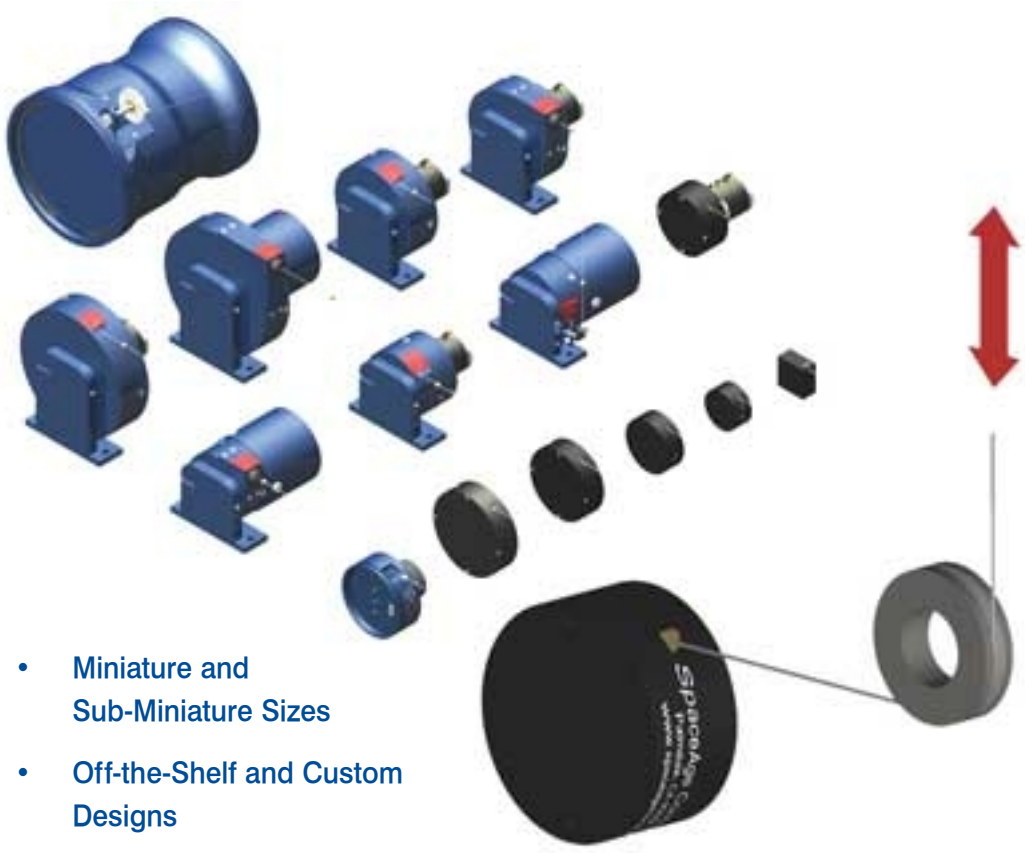
Vehicle and Crash Test

Flight Data Recorder

SpaceAge Control

Rugged, Miniature Position Transducers

Solution Guide



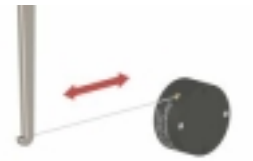
- Miniature and Sub-Miniature Sizes
- Off-the-Shelf and Custom Designs
- Operating Temperatures from -65° to +125° C
- Environmentally Tested to DO-160D, ED-14D, and MIL-STD-810E
- For Linear, Angular, Rotary, 2D, and 3D Motion
- Analog or Digital Electrical Output
- Qualified for Commercial/Military Aircraft and Manned Space Vehicle Use
- Vehicle, Aerospace, Industrial Control, OEM, Medical, and Test & Measurement Applications

"The Flexible Alternative to LVDTs and Linear Potentiometers"

Table Of Contents

Unparalleled Flexibility

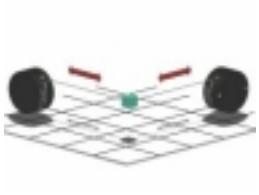
These all-environment miniature displacement transducers are also referred to as draw wire transducers, string pots, string encoders, cable extension transducers, and yo yo pots. Complementary to LVDTs, encoders, linear potentiometers, and related displacement sensors, SpaceAge Control position transducers are noted for their small size, rugged performance, accuracy, flexible mounting, and easy installation. Their inherent high-strength flexible cable allows linear, angular, rotary, two dimensional, and three dimensional motion to be monitored.



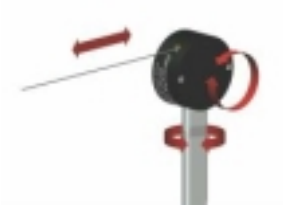
Linear

Angular

Rotary



2D

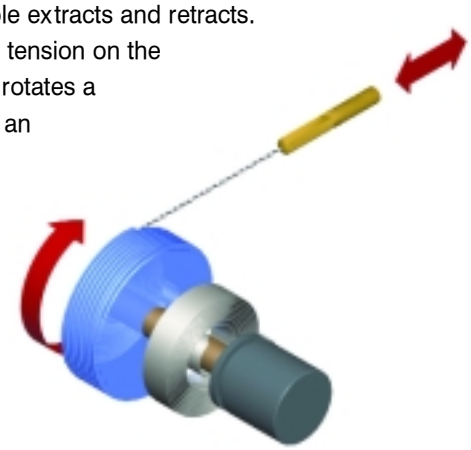


3D

Technology Overview

How Position Transducers Work

Position transducers convert mechanical motion into an electrical signal that may be metered, recorded, or transmitted. SpaceAge Control position transducers consist of a stainless steel displacement cable wound on a threaded drum that is directly coupled to a precision, long-life sensor. Operationally, the position transducer is mounted in a fixed position and the extension cable is attached to a moving object. The axes of movement for the extension cable and moving object are aligned with each other. As movement occurs, the displacement cable extracts and retracts. An internal, engineered spring maintains tension on the displacement cable. The threaded drum rotates a precision, long-life sensor that produces an electrical output proportional to the displacement cable travel. The output is measured to reflect the position, direction, or rate of motion of the moving object.



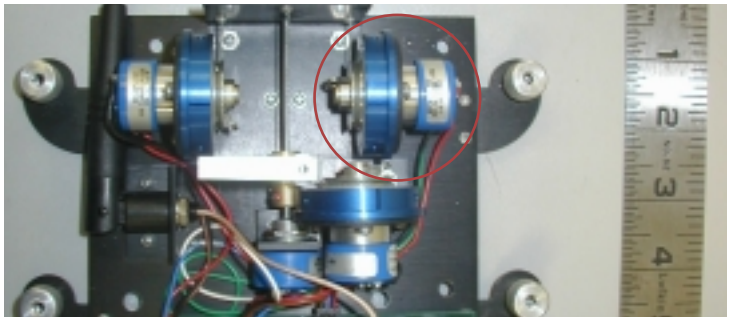
How They Are Used

Position transducers are used in a broad range of position, displacement, and velocity measurement applications to:

- ensure distance traveled
- continually sense location or relative position
- indicate levels
- act as limit sensors
- control actuators through position sensing
- act as a signal generator for recording position versus time, cycle rate and magnitude of random cycle events
- monitor relative motion
- indicate events

Train Suspension Monitoring

Vehicle Side Impact Testing



Medical Diagnostic Equipment

Typical Applications

Auto/Truck/Bus/ Off-Highway

- Suspension
- Vehicle Dynamics
- Powertrain
- NV&H
- Ride and Handling
- Driver Behavior
- Safety Systems
- Crash Testing
- Motorsports
- Controls Driver
- Durability
- Passenger Comfort
- Linkages
- Braking Systems

Aircraft

- Control Systems
- Flight Dynamics
- Linkages
- Engine
- Landing Gear
- Braking Systems
- Flight Data Recorder

Aerospace

- Launch Systems
- Solar Panel Deployment
- Environmental Controls
- Docking and Capture
- Bellows Level

Experiments

- Actuator Position
- Rail
- Suspension
- Material Handling
- Vehicle Stability

Nautical/Offshore

- Controls
- Actuators
- Engines

Industrial Machinery

- Material Handling
- Robotics
- Packaging
- Assembly Equipment
- Control Systems

Biomechanics

- Man-Machine Interface
- Entry and Egress
- Prosthetics
- Orthotics
- Ergonomics

Entertainment and Sports

- Bicycles/Motorcycles
- Amusement Park Rides
- Animation
- Sports Equipment
- Firearms
- Simulators
- Virtual Reality
- Stage Positioning

Product Matrix

Relative Size	Series	Data Sheet	Electrical Output (In (mm))	Maximum Measurement Range (inches (mm))	Best Lifetime (shaft revolutions)		Best Lifetime (full-stroke cycles)	Nominal Mass (oz (g))	Outline Dimensions (inches(mm))	Best Operating Temperature Range (°F (°C))	Best Frequency Response (g's)	Best Water/Dust Protection
	150	www.spaceagecontrol.com/s021f.htm	analog (voltage divider)	1.5 (38.1)	5 million		2.5 million	0.5 (15)	0.75 x 0.75 x 0.38 (19 x 19 x 10)	-85 to +257 (-65 to +125)	49	NEMA 3S / IP54
	170 173 174 175 176	www.spaceagecontrol.com/s021g.htm	analog (voltage divider)	6.5 (165)	100 million		50 million	1 (28) (Series 170)	.96 dia. x 0.45 (24 dia. x 11) (Series 170)	-85 to +257 (-65 to +125)	6 to 40	NEMA 3S / IP54
	160 161 162	www.spaceagecontrol.com/s021h.htm	analog (voltage divider)	42.5 (1080)	10 million		5 million	4 (113) (Series 160)	1.8 x 2.2 x 2.5 (46 x 56 x 64) (Series 160)	-67 to +257 (-55 to +125)	less than 50	NEMA 4X / IP66
	D60 D61 D62	www.spaceagecontrol.com/s021i.htm	digital (quadrature)	43.13 (1095)	100 million		10 million	6 (170) (Series D60)	1.8 x 2.2 x 2.5 (46 x 56 x 64) (Series D60)	-4 to +212 (-20 to +100)	less than 50	NEMA 4X / IP66
	161H 162H	www.spaceagecontrol.com/s021j.htm	analog (voltage divider)	42.5 (1080)	10 million		5 million	7 (198) (Series 161H)	2.4 x 3.0 x 2.87 62 x 76 x 73 (Series 161H)	-67 to +257 (-55 to +125)	greater than 50	NEMA 4X / IP66
	180-0803	www.spaceagecontrol.com/s021l.htm	analog (voltage divider)	10.0 (254)	5 million		800,000	2 (57)	1.5 dia. x 1.7 (38 x 43)	-67 to +257 (-55 to +125)	9	NEMA 3S / IP54
	C	www.spaceagecontrol.com/s021n.htm	analog or digital	100.0 (2540)	5 million		2.5 million	20 (567)	3.5 dia. x 3.95 (89 x 100)	-40 to +185 (-40 to +85)	10	NEMA 4X / IP66 (NEMA 61 / IP67 optional)
	L	www.spaceagecontrol.com/s021o.htm	analog or digital	21.25 (540)	5 million		2.5 million	3 (85)	1.7 dia. x 1.87 (43 x 47)	-40 to +185 (-40 to +85)	20	NEMA 12 / IP53 (NEMA 4 / IP66 optional)

Additional Resources

For additional background information on displacement measurement and sensors, review these publications:

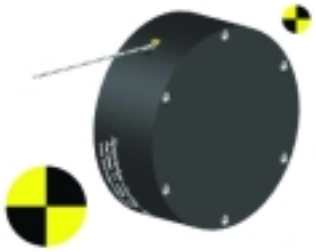
Publication	www.spaceagecontrol.com/
• Selecting Position Transducers	selpt.htm
• Sensor Total Cost of Ownership	s054a.htm
• Application Note for Aircraft/Aerospace	s004a.pdf
• Application Note for Ground Vehicles/Transportation	s005a.pdf
• Application Note for Industrial Control/OEM Uses	s054f.htm
• Thermal Effect Calculator	calctemp.htm
• Catenary Curve (Cable Sag) Calculator	calccabl.htm
• Sinusoidal Motion Calculator	calcsinm.htm
• Linearity Calculator	calclin.htm
• Cable Stretch Calculator	calcstre.htm
• Cost of Ownership Calculator	calctco.htm
• Installation Guide	s023a.htm

Key Innovations

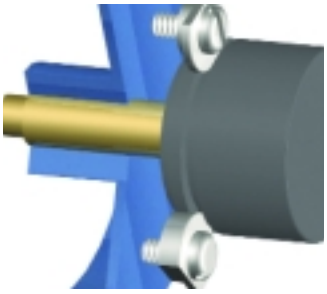
SpaceAge Control has pioneered a broad range of techniques and designs to improve displacement sensing ease of use, accuracy, and miniaturization. A few of these innovations are shown below.

Patented (1974) universal mounting base provides 2-axis rotational capability in a compact form factor.

Integrated and separate idler pulleys allow the displacement cable to be re-routed or to track movement along an angle (geometric plane).

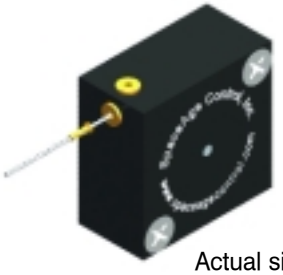


High cable-tension, ultra-low-inertia Model 174-0321T position transducer has the highest frequency response for all subminiature position transducers.



Direct Connect™ sensor-to-drum technology eliminates the use of backlash-causing torsion springs, clutches, gears, and other devices.

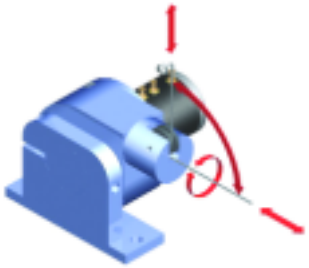
AccuTrak™ threaded drum are offered only by SpaceAge Control and enhance repeatability performance by not allowing cable overlap nor cable spread.



Actual size

Ultra-small designs fit where others won't. Series 150 products are the world's smallest.

FastInstall™ mounting is secure, fast, flexible, and low-profile.



MultiExit™ cable guide allows cable extraction direction to change "on the fly" without re-orienting the position transducer.

String Potentiometer and String Encoder Engineering Guide

Would you like to qualify for a 12-page, full-color copy of the "String Potentiometer and String Encoder Engineering Guide"?

If so, complete a web form at www.spaceagecontrol.com/req054b.htm and you will be qualified for a FREE downloadable (electronic) copy. This publication will get you up and running on cable-actuated displacement-sensing technology, uses, designs, benefits, and limitations.

More Information

For complete information including data sheets, fully-dimensioned installation drawings, and CAD solid models, visit www.spaceagecontrol.com/ptmain.htm. Or, contact us by phone (661-273-3000), fax (661-273-4240), or e-mail (email@spaceagecontrol.com).

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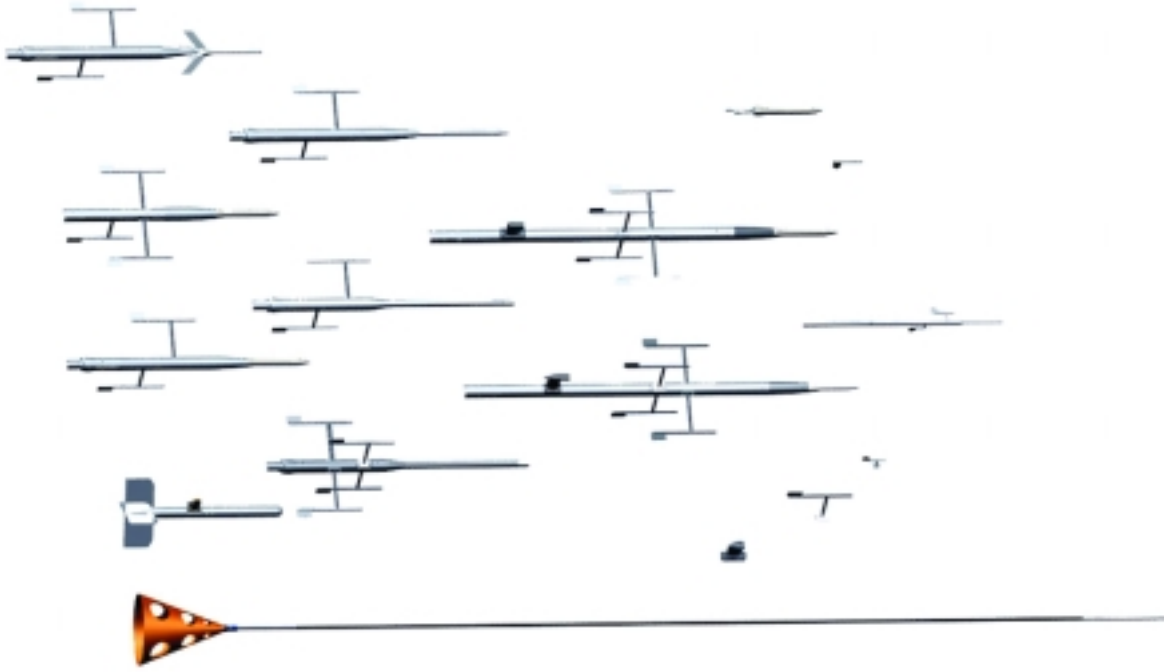


Company Background

Leading The Way In Position Measurement

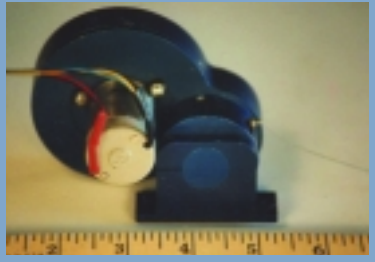
SpaceAge Control was established in 1968 to design, develop, and manufacture pilot protection devices in support of space-based and high-performance test aircraft programs. In 1970, the company was awarded a NASA contract to produce precision, small-format position transducers for aircraft flight control testing. The successful completion of this contract led to the development and production of a complete line of innovative, small-size position transducers.

Through the 1970's, 1980's, and 1990's, virtually all U.S., Canadian, and European aerospace companies used SpaceAge Control's position transducers in their research, development, and test activities. Often, these products were designed and manufactured to custom specifications. As a result of these efforts, SpaceAge Control's quality system met the Mil-Q-9858A quality system requirement. Today, the SpaceAge Control quality system meets the ISO 9001 and AS9000 quality standards.

In 1989, a single auto racing team began using these position transducers to monitor throttle movement and suspension travel. This use resulted in the adoption of the products in a broad range of vehicle test and measurement projects including anthropomorphic dummy instrumentation, impact testing, and control verification. SpaceAge Control has also leveraged its electro-mechanical core technologies to air data products and automotive electrical test equipment.

Today, SpaceAge Control products benefit over 600 customers in 20 industries and in over 40 countries. The seven largest auto manufacturing companies and seven largest aerospace companies use SpaceAge Control products. The products are used on diverse applications such as off-road heavy equipment, manned space vehicles, and Formula 1/IRL/CART/NASCAR race cars. Environmentally tested to commercial aircraft and military standards, SpaceAge Control position transducers and air data products are the products of choice for demanding applications.

Early position transducer use: YF-12 aircraft dynamic testing in 1970.



Initial designs set the standard for position transducer small size, ruggedness, and accuracy.

SpaceAge Control

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