INTRODUCTION
Company Background

SpaceAge Control, Inc.

Position Transducers **S021B(A)**

LEADING THE WAY IN POSITION MEASUREMENT

SpaceAge Control, Inc. 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.

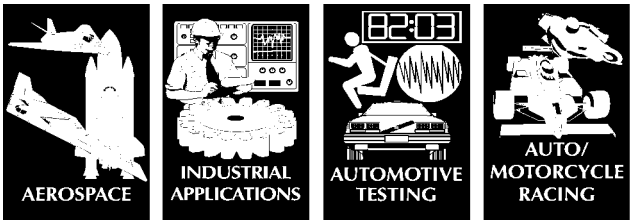
Through the 1970's and 1980's, virtually all U.S., Canadian, and European aerospace companies used the company's position transducers in their research, development, and test activities. Often, these products were designed and manufactured to custom specifications. As a result of these efforts, SpaceAge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

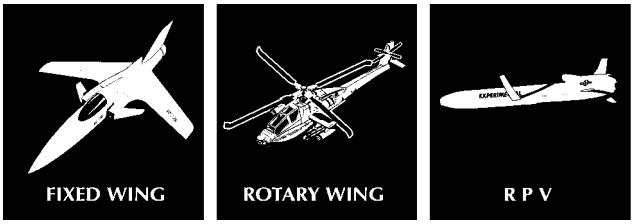
In 1989, a single auto racing team began using these position transducers to monitor throttle movement and suspension travel. This use resulted in the adoption of the products in a broad range of auto test and measurement projects including anthropomorphic dummy instrumentation, impact testing, and control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

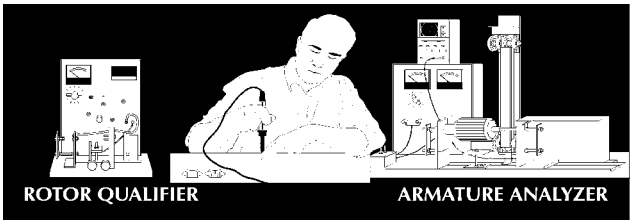
Today, SpaceAge Control, Inc. products benefit over 600 customers in 20 industries and in over 30 countries. Five of the world's seven largest auto manufacturing companies and the world's seven largest aerospace companies use SpaceAge Control, Inc. products. The products have been used on diverse applications such as off-road heavy equipment, manned space vehicles, and Formula 1/Indy race cars.

LINES OF BUSINESS

Product Line	Year
Position Transducers	1968
Air Data Products	1973
Automotive Electrical Test Equipment	1983







A Small, Flexible Alternative to LVDTs and Linear Potentiometers

SpaceAge Control, Inc. **661-273-3000** **email@spaceagecontrol.com**
38850 20th Street East, Palmdale, CA 93550 USA **Fax: 661-273-4240** **www.spaceagecontrol.com**

INTRODUCTION
About Position Transducers

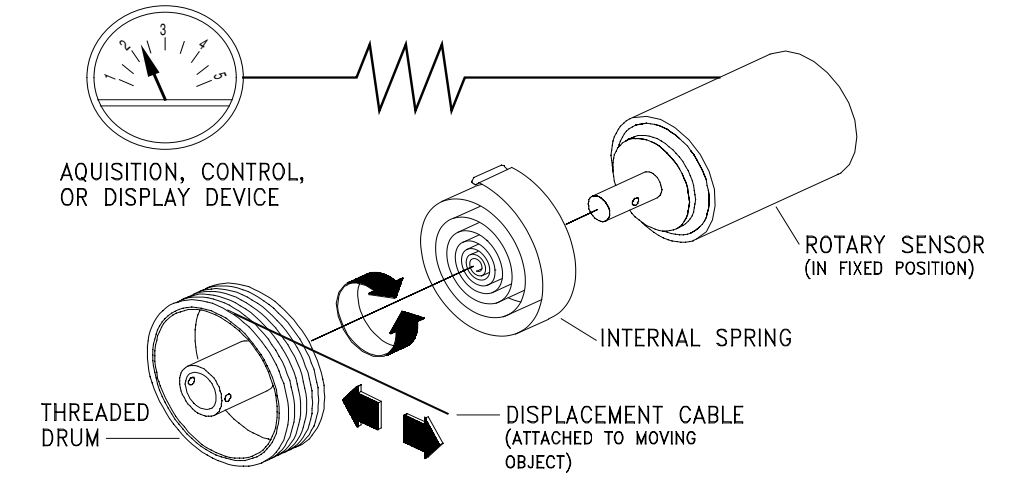
SpaceAge Control, Inc.

Position Transducers **S021C(A)**

HOW POSITION TRANSDUCERS WORK

Position transducers convert mechanical motion into an electrical signal that may be metered, recorded, or transmitted. SpaceAge Control, Inc. position transducers consist of a stainless steel extension cable wound on a threaded drum that is coupled to a precision 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 cable extracts and retracts. An internal spring maintains tension on the cable. The threaded drum rotates a precision sensor that produces an electrical output proportional to the cable travel. The output is measured to reflect the position, direction, or rate of motion of the moving object.



WHY USE SPACEAGE CONTROL POSITION TRANSDUCERS

There are many choices to make when selecting a position transducer for a specific application. Should the device be a contact or non-contact type? What accuracy is required? How durable should it be? What environmental specifications should it meet? What mounting requirements are there?

Without knowing all details about an application, it is difficult to make recommendations for what applications are best-suited for SpaceAge Control position transducers. Nevertheless, in general, SpaceAge Control position transducers should be used for applications requiring:

- small size
- light weight
- flexible mounting
- non-straightline motion monitoring
- up to 0.0001-inch (0.025-mm) resolution
- up to ±0.025% accuracy
- robust shock and vibration performance
- long-life

Keep in mind that nearly 20% of our products are produced to precise customer specifications.

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Application Examples

HOW POSITION TRANSDUCERS ARE USED IN INDUSTRY AND SCIENCE

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, magnitude of random cycle events
- monitor relative motion
- indicate events

TYPICAL APPLICATIONS

Auto/Truck & Bus/Off-Highway
- Suspension
- Vehicle Dynamics
- Engine
- Powertrain
- NV&H
- Ride and Handling
- Driver Behavior
- Safety Systems
- Crash Testing
- Motorsports
- Control Systems
- Durability

Aircraft
- Control Systems
- Flight Dynamics
- Linkages
- Engine
- Landing Gear
- Braking Systems

Aerospace
- Launch Systems
- Solar Panel Deployment
- Environmental Controls
- Docking and Capture
- Experiments
- Actuator Position

Rail
- Suspension
- Material Handling
- Vehicle Stability
- Passenger Comfort
- Control Systems
- Linkages
- Engine
- Braking Systems

Nautical
- 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

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INTRODUCTION
Product Line Overview

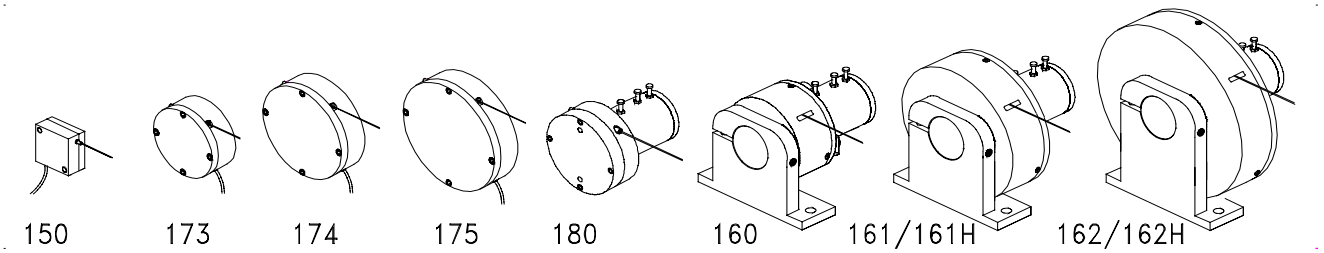
SpaceAge Control, Inc.

Position Transducers S021E(A)

Product Line	Maximum Range	Maximum Cable Tension	Maximum Cable Acceleration	Temperature Range (Best)	Environmental Protection (Best)
Standard					
150	1.5 inches 38.1 mm	12 oz. 3 N	15 g	-85° to 257° F -65° to 125° C	NEMA 3S IP 54
173	3.0 inches 76.2 mm	12 oz. 3 N	12 g	-85° to 257° F -65° to 125° C	NEMA 3S IP 54
174	4.0 inches 101.6 mm	12 oz. 3 N	10 g	-85° to 257° F -65° to 125° C	NEMA 3S IP 54
175	5.0 inches 127 mm	10 oz. 3 N	8 g	-85° to 257° F -65° to 125° C	NEMA 3S IP 54
180	10.0 inches 254 mm	12 oz. 3 N	10 g	-67° to 257° F -55° to 125° C	NEMA 3S IP 54
160	21.25 inches 539.75 mm	70 oz. 19 N	50 g	-67° to 257° F -55° to 125° C	NEMA 4 IP 56
161	30.0 inches 762.0 mm	65 oz. 18 N	50 g	-67° to 257° F -55° to 125° C	NEMA 4 IP 56
162	42.5 inches 1079.5 mm	55 oz. 15 N	50 g	-67° to 257° F -55° to 125° C	NEMA 4 IP 56
161H	30.0 inches 762.0 mm	205 oz. 57 N	75+ g	-67° to 257° F -55° to 125° C	NEMA 4 IP 56
162H	42.5 inches 1079.5 mm	205 oz. 57 N	75+ g	-67° to 257° F -55° to 125° C	NEMA 4 IP 56

Specialty	
174-0321T	Series 174 design with high-torque spring for high-performance applications
150-0121VR/VL	Series 150 design with changes for Applied Safety Technologies crash dummy knee slider product
160-0321L	Series 160 design with changes for BioSID crash dummy (ribcage displacement)
160-0321VR/VL	Series 160 design with changes for Frontal Impact crash dummy (chest displacement)

Relative Size Comparison



A Small, Flexible Alternative to LVDTs and Linear Potentiometers

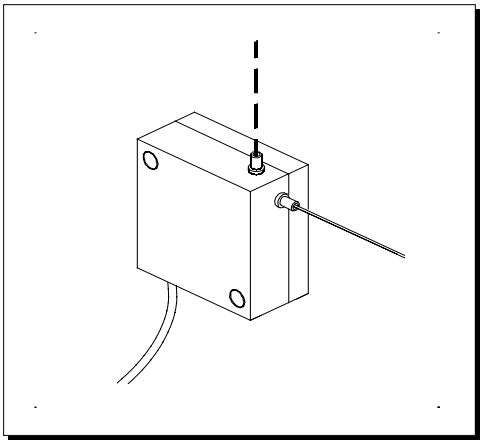
DATA SHEET
Series 150

Analog-Output Ultra-Small Subminiature Position Transducer

SpaceAge Control, Inc.

KEY FEATURES

- 1.50-Inch (38-mm) Maximum Travel
- Analog Signal Using Precision Conductive Plastic Potentiometer
- Grooved Drum for Enhanced Repeatability
- Small, Robust Design
- Choice of Displacement Cable Pull Direction



POTENTIOMETER SPECIFICATIONS

Potentiometer Type	1-turn, conductive plastic
Resistance: Value, Tolerance	5K ohms, ±10%
Travel: Electrical, Mechanical	340°, 340°
Mechanical Life	5 million shaft revolutions
Power Rating	0.75 watts at 158° F (70° C); maximum input voltage of 38 V
Max. Indep. Linearity Error	±1.0% per VRCI-P-100A
Output Smoothness	0.1%
Insulation Resistance	not applicable
Dielectric Strength	500 volts RMS
Resolution	infinite signal
Operating Temperature	-85° to +257° F (-65° to +125° C)
Electrical Connection	three-wire flying leads (red, white, and black)
Shock	100 g for 6 ms
Vibration	10 to 2000 Hz at 15 g per Mil-R-39023
Temperature Coefficient	±222 ppm/°F maximum (±400 ppm/°C maximum)

OTHER SPECIFICATIONS

Case Materials	precision-machined anodized 2024 aluminum
Displacement Cable	0.018-inch (0.46-mm) dia., 7-by-7 stranded stainless steel, 40-lb (177-N) min. breaking strength. A minimum of 12 inches (305 mm) of displacement cable is provided with an uncrimped eyelet and swivel for connection to the application. Swivel minimum breaking strength is 9 lbs (40 N). Other connecting solutions available on request.
Electrical Cable	A minimum of 18 inches (457 mm) of electrical cable is provided. Electrical cable is terminated with flying leads (no electrical connector). Cable is 30 gauge diameter with Teflon insulation.
Approximate Weight	0.5 oz. 15.0 g

Displacement Cable Tension

2 oz.	0.6 N	minimum	Opt. 107
5 oz.	1.4 N	maximum	(standard)
7 oz.	1.9 N	minumum	Opt. 108
13 oz.	3.6 N	maximum	(optional)

Environmental Sealing: NEMA 3S / IP 54

A Small, Flexible Alternative to LVDTs and Linear Potentiometers

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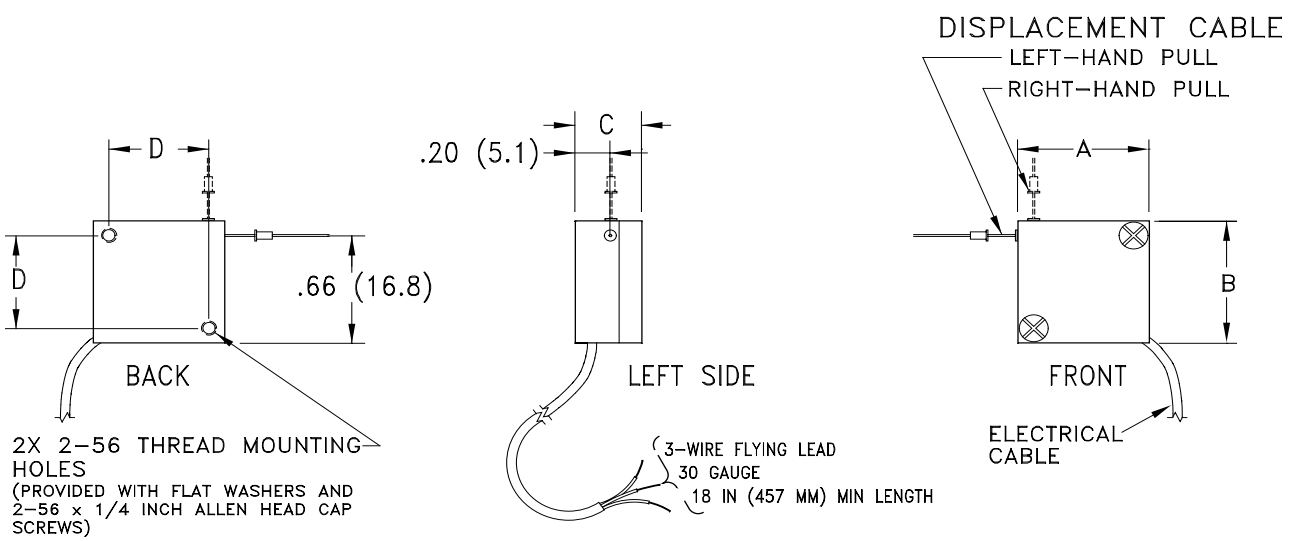
MODEL NUMBERS

150-0121	position transducer (1.50-inch (38-mm) range

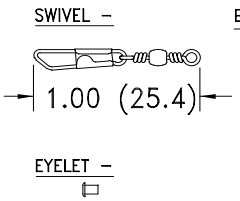
OPTIONS

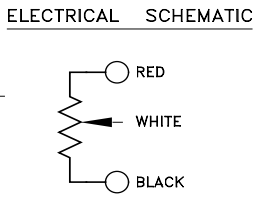
Opt. 101	left-hand displacement cable pull
Opt. 102	right-hand displacement cable pull
Opt. 107	cable tension: -010
Opt. 108	cable tension: -020
Opt. 9	SPECIAL = (describe special requirement or specification to be met)



SERIES	A	B	C	D
150	.75 (19.1)	.75 (19.1)	.38 (9.7)	.57 (14.5)

ALL DIMENSIONS ARE IN INCHES (MM)





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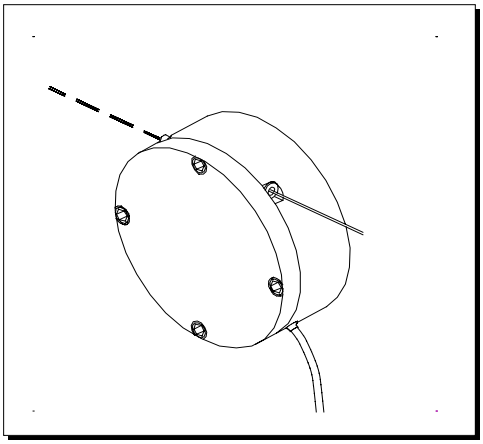
DATA SHEET
Series 173, 174 & 175

SpaceAge Control, Inc.

Analog-Output Subminiature Position Transducers

KEY FEATURES

- 5.00-Inch (133-mm) Maximum Travel (Series 175)
- Analog Signal Using Precision Conductive Plastic Potentiometer
- Grooved Drum for Enhanced Repeatability
- Bearing-Mounted Rotating Components
- Optional Flexible Mounting Bases



POTENTIOMETER SPECIFICATIONS

Potentiometer Type	1-turn, conductive plastic
Resistance: Value, Tolerance	5K ohms, ±10%
Travel: Electrical, Mechanical	340°, 340°
Mechanical Life	50 million shaft revolutions
Power Rating	0.75 watts at 158° F (70° C); maximum input voltage of 38 V
Max. Indep. Linearity Error	±0.5% per VRCI-P-100A
Output Smoothness	0.1%
Insulation Resistance	not applicable
Dielectric Strength	500 volts RMS
Resolution	infinite signal
Operating Temperature	-85° to +257° F (-65° to +125° C)
Electrical Connection	three-wire flying leads (red, white, and black)
Shock	100 g for 6 ms
Vibration	10 to 2000 Hz at 15 g per Mil-R-39023
Temperature Coefficient	±222 ppm/°F maximum (±400 ppm/°C maximum)

OTHER SPECIFICATIONS

Case Materials: precision-machined anodized 2024 aluminum

Displacement Cable: 0.018-inch (0.46-mm) dia., 7-by-7 stranded stainless steel, 40-lb (177-N) min. breaking strength. A minimum of 12 inches (305 mm) of displacement cable is provided with an uncrimped eyelet and swivel for connection to the application. Swivel minimum breaking strength is 9 lbs (40 N). Other connecting solutions available on request.

Electrical Cable: A minimum of 18 inches (457 mm) of electrical cable is provided. Electrical cable is terminated with flying leads (no electrical connector). Cable is 30 gauge diameter with Teflon insulation.

	Series 173			Series 174		Series 175		
Approximate Weight	1 oz.	28 g		2 oz.	57 g	3 oz.	85 g	
Displacement Cable Tension	1.5 oz.	0.4 N	Opt. 107	6 oz.	1.7 N	5 oz.	1.4 N	minimum
	4 oz.	1.1 N	(standard)	10 oz.	2.8 N	9 oz.	2.5 N	maximum
	5 oz.	1.4 N	Opt. 108					minumum
	12 oz.	3.3 N	(optional)					maximum

Environmental Sealing: NEMA 3S / IP 54

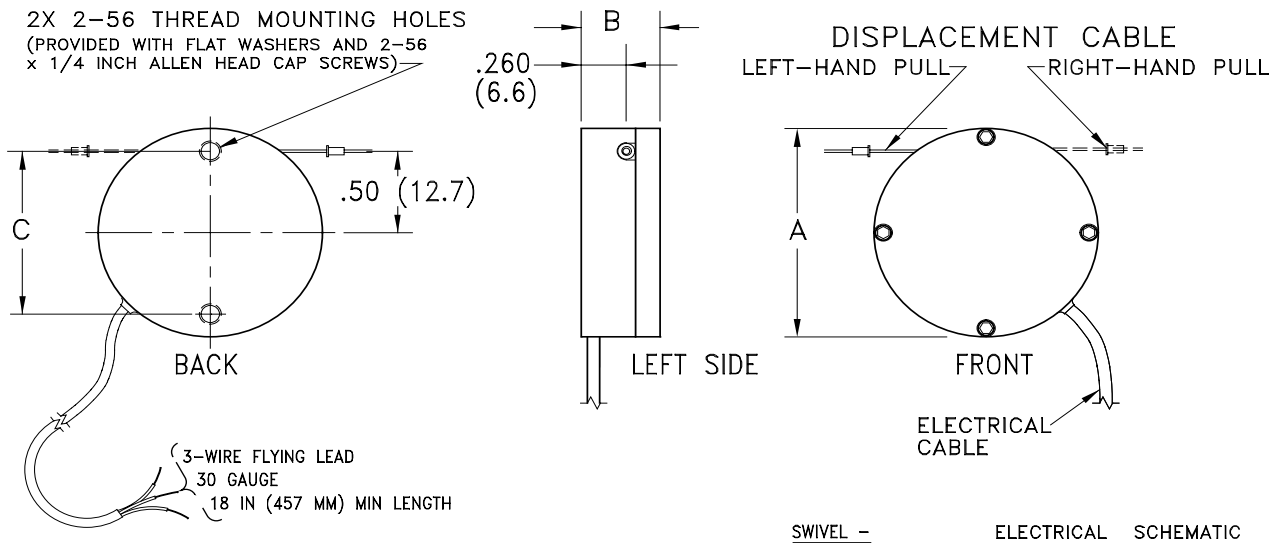
A Small, Flexible Alternative to LVDTs and Linear Potentiometers

MODEL NUMBERS

173-0161	position transducer (2.00-inch (51-mm) range)
173-0241	position transducer (3.00-inch (76-mm) range)
174-0321	position transducer (4.00-inch (102-mm) range)
175-0401	position transducer (5.00-inch (127-mm) range)

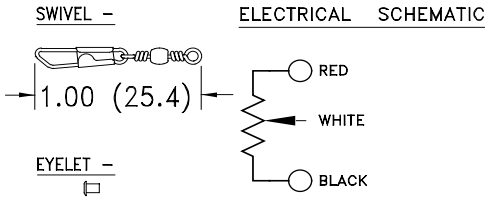
OPTIONS

Opt. 101	left-hand displacement cable pull
Opt. 102	right-hand displacement cable pull
Opt. 107	cable tension: -010 (173 only)
Opt. 108	cable tension: -020 (173 only)
Opt. B08	base: L (173 only); pn 173015
Opt. B09	base: L (174/175 only); pn 174015
Opt. 9	SPECIAL = (describe special requirement or specification to be met)



SERIES	A	B	C
173	1.28 (32.5)	.45 (11.4)	1.00 (25.4)
174	1.705 (43.3)	.49 (2.5)	1.425 (36.2)
175	1.99 (50.6)	.49 (12.5)	1.425 (36.2)

ALL DIMENSIONS ARE IN INCHES (MM)



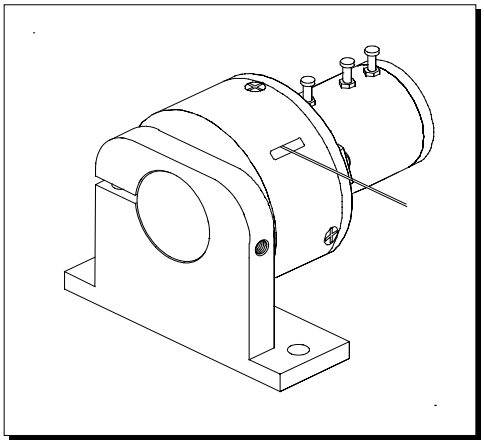
A Small, Flexible Alternative to LVDTs and Linear Potentiometers

DATA SHEET
Series 160, 161 & 162
Analog-Output Miniature Position Transducers

SpaceAge Control, Inc.

KEY FEATURES

- 42.50-inch (1080-mm) Maximum Travel (Series 162)
- Analog Signal Using Precision Conductive Plastic/Hybrid Potentiometers
- Threaded Drum for Enhanced Repeatability
- Bearing-Mounted Rotating Components
- Optional Flexible Mounting Bases



POTENTIOMETER SPECIFICATIONS

	1-turn	3-turn	5-turn
Potentiometer Type	1-turn, conductive plastic	3-turn, hybrid construction	5-turn, hybrid construction
Resistance: Value, Tolerance	5K ohms, ±20%	5K ohms, ±5%	5K ohms, ±5%
Travel: Electrical, Mechanical	340°, 360°	1080°, 1080° +10° -0°	1800°, 1800° +10° -0°
Mechanical Life	10 million shaft revolutions	5 million shaft revolutions	5 million shaft revolutions
Power Rating	1.0 watts at 158° F (70° C)	1.5 watts at 158° F (70° C)	2.0 watts at 158° F (70° C)
Max. Indep. Linearity Error	±1.0% per VRCI-P-100A	±0.5% per VRCI-P-100A	±0.35% per VRCI-P-100A
Output Smoothness	< 0.1%	0.5% max.	0.35% max.
Insulation Resistance	100 Mohms	1000 Mohms	1000 Mohms
Dielectric Strength	1000 volts RMS	1000 volts RMS	1000 volts RMS
Resolution	infinite signal	infinite signal	infinite signal
Operating Temperature	-40° to 257° F (-40° to 125° C)	-67° to 257° F (-55° to 125° C)	-67° to 257° F (-55° to 125° C)
Electrical Connection	3-terminal (1, 2, 3)	3-terminal (CW, CCW, S)	3-terminal (CW, CCW, S)
Shock	100 g for 6 ms	100 g for 6 ms	100 g for 6 ms
Vibration	10 to 2000 Hz at 15 g	10 to 2000 Hz at 15 g	10 to 2000 Hz at 15 g
Temperature Coefficient	±222 ppm/°F (±400 ppm/°C)	±389 ppm/°F (±700 ppm/°C)	±389 ppm/°F (±700 ppm/°C)

OTHER SPECIFICATIONS

Case Materials: precision-machined anodized 2024 aluminum

Displacement Cable: 0.018-inch (0.46-mm) dia., 7-by-7 stranded stainless steel, 40-lb (177-N) min. breaking strength. A minimum of 12 inches (305 mm) of displacement cable is provided with an uncrimped eyelet and swivel for connection to the application. Swivel minimum breaking strength is 9 lbs (40 N). Other connecting solutions available on request.

Electrical Connections: Three solder terminals. Customer-specified electrical cable and connectors available upon request.

Approximate Weight:

Series 160		Series 161		Series 162	
4 oz.	113 g	6.1 oz.	170 g	9 oz.	255 g

Environmental Sealing: NEMA 4 / IP 56 (with optional sensor cover)

A Small, Flexible Alternative to LVDTs and Linear Potentiometers

MODEL NUMBERS AND CABLE TENSIONS: Series 160

Model	Range		Cable Tension Range (Full Retraction to Full Extraction)							
			Opt 111: -050 spring		Opt 112: -060 spring		Opt 113: -070 spring		Opt 114: -080 spring	
	inches	**mm**	**oz.**	**N**	**oz.**	**N**	**oz.**	**N**	**oz.**	**N**
160-0121	1.50	38	**10 to 17**	**3 to 5**	-	-	-	-	-	-
160-0151	1.88	48	**8 to 15**	**2 to 4**	-	-	-	-	-	-
160-0161	2.00	51	**8 to 14**	**2 to 4**	16 to 25	4 to 7	30 to 40	8 to 11	40 to 55	11 to 15
160-0181	2.25	57	**8 to 13**	**2 to 4**	16 to 25	4 to 7	30 to 40	8 to 11	40 to 55	11 to 15
160-0201	2.50	64	**8 to 12**	**2 to 3**	16 to 25	4 to 7	30 to 40	8 to 11	40 to 55	11 to 15
160-0231	2.88	73	**7 to 11**	**2 to 3**	16 to 25	4 to 7	30 to 40	8 to 11	40 to 55	11 to 15
160-0241	3.00	76	**7 to 10**	**2 to 3**	12 to 15	3 to 4	60 to 80	17 to 22	40 to 55	11 to 15
160-0261	3.25	83	**7 to 10**	**2 to 3**	16 to 25	4 to 7	25 to 35	7 to 10	40 to 55	11 to 15
160-0281	3.50	89	**6 to 10**	**2 to 3**	16 to 25	4 to 7	25 to 35	7 to 10	40 to 55	11 to 15
160-0311	3.88	98	**6 to 10**	**2 to 3**	16 to 25	4 to 7	25 to 35	7 to 10	40 to 55	11 to 15
160-0321	4.00	102	**5 to 9**	**1 to 3**	16 to 25	4 to 7	45 to 60	13 to 17	40 to 55	11 to 15
160-0403	5.00	127	**15 to 25**	**4 to 7**	20 to 35	6 to 10	45 to 60	13 to 17	112 to 192	31 to 53
160-0483	6.00	152	**10 to 20**	**3 to 6**	18 to 34	5 to 9	45 to 70	13 to 20	93 to 160	26 to 45
160-0523	6.50	165	**10 to 20**	**3 to 6**	16 to 32	4 to 9	45 to 60	13 to 17	86 to 147	24 to 41
160-0563	7.00	178	10 to 18	3 to 5	**15 to 30**	**4 to 8**	20 to 45	6 to 13	80 to 137	22 to 38
160-0643	8.00	203	9 to 15	3 to 4	**9 to 16**	**3 to 4**	24 to 37	7 to 10	70 to 120	19 to 33
160-0675	8.38	213	15 to 30	4 to 8	**16 to 35**	**4 to 10**	20 to 45	6 to 13	66 to 115	18 to 32
160-0723	9.00	229	-	-	**12 to 20**	**3 to 6**	20 to 40	6 to 11	62 to 110	17 to 31
160-0773	9.63	244	-	-	**16 to 29**	**4 to 8**	20 to 40	6 to 11	59 to 105	16 to 29
160-0803	10.00	254	6 to 12	2 to 3	**13 to 22**	**4 to 6**	19 to 32	5 to 9	57 to 100	16 to 28
160-0815	10.13	257	-	-	**16 to 30**	**4 to 8**	30 to 72	8 to 20	50 to 160	14 to 45
160-0875	10.88	276	10 to 20	3 to 6	**16 to 28**	**4 to 8**	24 to 55	7 to 15	51 to 92	14 to 26
160-0893	11.13	283	-	-	**16 to 27**	**4 to 8**	20 to 40	6 to 11	48 to 88	13 to 24
160-0945	11.75	298	-	-	**13 to 26**	**4 to 7**	20 to 40	6 to 11	45 to 84	13 to 23
160-0963	12.00	305	6 to 10	2 to 3	**10 to 15**	**3 to 4**	17 to 27	5 to 8	40 to 80	11 to 22
160-0993	12.38	314	6 to 10	2 to 3	**18 to 30**	**5 to 8**	16 to 25	4 to 7	38 to 77	11 to 21
160-1085	13.50	343	**10 to 20**	**3 to 6**	12 to 22	3 to 6	23 to 50	7 to 14	40 to 125	11 to 35
160-1215	15.13	384	**9 to 17**	**3 to 5**	10 to 19	3 to 5	21 to 45	6 to 13	27 to 108	8 to 30
160-1285	16.00	406	8 to 15	2 to 4	**9 to 17**	**3 to 5**	19 to 42	5 to 12	25 to 102	7 to 28
160-1345	16.75	425	7 to 15	2 to 4	**9 to 17**	**3 to 4**	17 to 40	5 to 11	24 to 96	7 to 27
160-1505	18.75	476	3 to 9	1 to 3	**9 to 17**	**3 to 5**	20 to 37	6 to 10	21 to 86	6 to 24
160-1615	20.13	511	6 to 14	2 to 4	**9 to 17**	**3 to 5**	16 to 35	4 to 10	25 to 85	6 to 24
160-1705	21.25	540	6 to 11	2 to 3	**8 to 16**	**2 to 4**	15 to 33	4 to 9	14 to 75	4 to 21

Bolded entries are standard cable tension and will be specified unless overridden on purchase order.

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MODEL NUMBERS AND CABLE TENSIONS: Series 161 and 162

Model	Range		Cable Tension Range (Full Retraction to Full Extraction)							
			Opt 111: -050 spring		Opt 112: -060 spring		Opt 113: -070 spring		Opt 114: -080 spring	
	inches	**mm**	**oz.**	**N**	**oz.**	**N**	**oz.**	**N**	**oz.**	**N**
161-0361	4.50	114	-	-	**18 to 30**	**5 to 8**	20 to 30	6 to 8	40 to 65	11 to 18
161-0411	5.13	130	-	-	**18 to 30**	**5 to 8**	20 to 30	6 to 8	35 to 50	10 to 14
161-0441	5.50	140	-	-	**18 to 30**	**5 to 8**	20 to 30	6 to 8	35 to 50	10 to 14
161-0461	5.75	146	-	-	**18 to 30**	**5 to 8**	20 to 30	6 to 8	35 to 50	10 to 14
161-1143	14.25	362	-	-	**6 to 12**	**2 to 3**	20 to 35	6 to 10	30 to 60	8 to 17
161-1283	16.00	406	-	-	**6 to 11**	**2 to 3**	12 to 25	3 to 7	30 to 65	8 to 18
161-1393	17.38	441	-	-	-	-	**10 to 16**	**3 to 4**	20 to 40	6 to 11
161-1443	18.00	457	-	-	-	-	**10 to 18**	**3 to 5**	20 to 55	6 to 15
161-1915	23.88	606	-	-	**7 to 14**	**2 to 4**	13 to 30	4 to 8	35 to 55	10 to 15
161-2145	26.75	679	-	-	-	-	**10 to 25**	**3 to 7**	30 to 56	8 to 16
161-2325	29.00	737	-	-	-	-	**10 to 16**	**3 to 4**	15 to 60	4 to 17
161-2405	30.00	762	-	-	-	-	**10 to 16**	**3 to 4**	15 to 60	4 to 17
162-0521	6.50	165	-	-	**10 to 16**	**3 to 4**	20 to 35	6 to 10	35 to 55	10 to 15
162-0561	7.00	178	-	-	**10 to 16**	**3 to 4**	20 to 30	6 to 8	35 to 55	10 to 15
162-0621	7.75	197	-	-	**10 to 16**	**3 to 4**	20 to 30	6 to 10	35 to 55	10 to 15
162-0651	8.13	206	-	-	**10 to 16**	**3 to 4**	20 to 30	6 to 10	35 to 55	10 to 15
162-1643	20.50	521	-	-	**10 to 16**	**3 to 4**	13 to 34	4 to 9	-	-
162-1763	22.00	559	-	-	**10 to 16**	**3 to 4**	13 to 32	4 to 9	-	-
162-1923	24.00	610	-	-	-	-	**12 to 30**	**3 to 8**	25 to 40	7 to 11
162-2043	25.50	648	-	-	-	-	**9 to 13**	**3 to 4**	25 to 40	7 to 11
162-2735	34.13	867	-	-	-	-	**9 to 21**	**3 to 6**	25 to 40	7 to 11
162-2945	36.75	933	-	-	-	-	**8 to 20**	**2 to 6**	20 to 35	6 to 10
162-3205	40.00	1016	-	-	-	-	**7 to 18**	**3 to 5**	12 to 41	3 to 11
162-3405	42.50	1080	-	-	4 to 8	1 to 2	**7 to 17**	**2 to 5**	10 to 40	3 to 11

Bolded entries are standard cable tension and will be specified unless overridden on purchase order.

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OPTIONS: Series 160, 161 & 162

Opt. 111	cable tension: -050
Opt. 112	cable tension: -060
Opt. 113	cable tension: -070
Opt. 114	cable tension: -080
Opt. 9	SPECIAL = (describe special requirement or specification to be met)

OPTIONS: Series 160 (sensor cover, cable exit, bases)

Opt. C16	cable exit: slot (_60)
Opt. C17	cable exit: cable guide (_60); pn 160045-1
Opt. C18	cable exit: idler (_60); pn 160022; cannot be installed with cable guide
Opt. C24	base: mounting disk (_6_); 160040-1
Opt. C27	base: standard (_60); pn 160015-1
Opt. C30	base: universal (_60); pn 160030-1
Opt. C33	base: big foot (_60/_61); pn 160015-13
Opt. C35	base: h (_60); pn 160015-G1
Opt. C10	no sensor cover (_60)
Opt. C11	sensor cover (_60); pn 160060

OPTIONS: Series 161 (sensor cover, cable exit, bases)

Opt. C19	cable exit: slot (_61)
Opt. C20	cable exit: cable guide (_61); pn 160045-3
Opt. C21	cable exit: idler (_61/_62); pn 161022; cannot be installed with cable guide
Opt. C24	base: mounting disk (_6_); 160040-1
Opt. C28	base: standard (_61); pn 160015-3
Opt. C31	base: universal (_61); pn 160030-3
Opt. C33	base: big foot (_60/_61); pn 160015-13
Opt. C12	no sensor cover (_61)
Opt. C13	sensor cover (_61); pn 160060

OPTIONS: Series 162 (sensor cover, cable exit, bases)

Opt. C22	cable exit: slot (_62)
Opt. C23	cable exit: cable guide (_62); pn 160045-5
Opt. C37	cable exit: idler (_61/_62); pn 161022; cannot be installed with cable guide
Opt. C24	base: mounting disk (_6_); 160040-1
Opt. C29	base: standard (_65); pn 160015-5
Opt. C32	base: universal (_62); pn 160030-5
Opt. C34	base: big foot (_62); pn 160015-15
Opt. C14	no sensor cover (_62)
Opt. C15	sensor cover (_62); pn 160060

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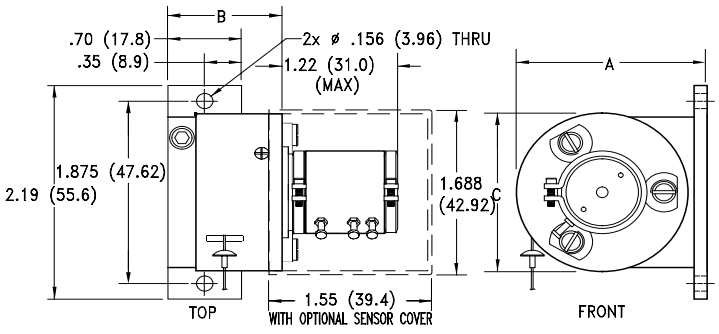
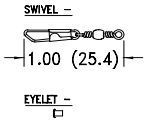
DIMENSIONS: shown with slot cable exit, standard base, and optional sensor cover.

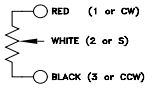


SERIES	A	B	C
160	1.81 (46.0)	1.07 (27.2)	1.62 (41.1)
161	2.43 (61.7)	1.07 (27.2)	2.24 (56.9)
162	3.185 (80.90)	1.07 (27.2)	2.99 (75.9)

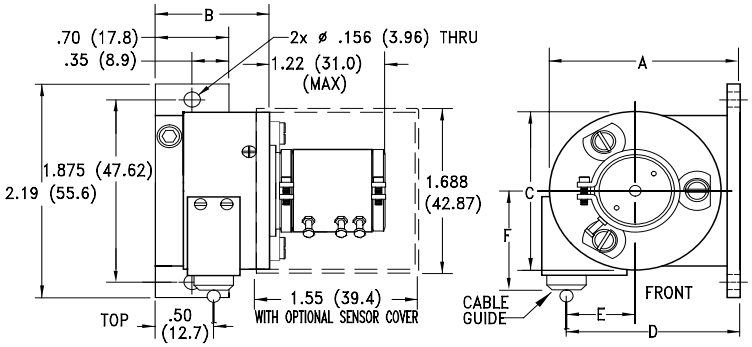
ALL DIMENSIONS ARE IN INCHES (MM)



ELECTRICAL SCHEMATIC

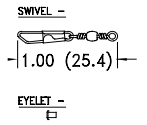


DIMENSIONS: shown with cable guide cable exit, standard base, and optional sensor cover.

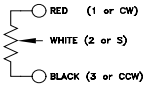


SERIES	A	B	C	D	E	F
160	1.81 (46.0)	1.07 (27.2)	1.62 (41.1)	1.64 (41.7)	.64 (16.3)	1.025 (26.04)
161	2.43 (61.7)	1.07 (27.2)	2.24 (56.9)	2.26 (57.4)	.95 (24.1)	1.335 (33.91)
162	3.185 (80.90)	1.07 (27.2)	2.99 (75.9)	3.015 (76.58)	1.325 (33.66)	1.71 (43.4)

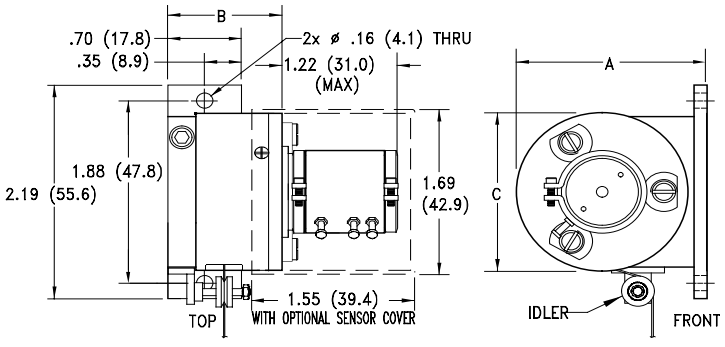
ALL DIMENSIONS ARE IN INCHES (MM)



ELECTRICAL SCHEMATIC

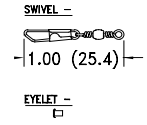


DIMENSIONS: shown with idler cable exit, standard base, and optional sensor cover.

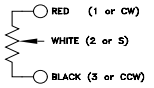


SERIES	A	B	C
160	1.81 (46.0)	1.07 (27.2)	1.62 (41.1)
161	2.43 (61.7)	1.07 (27.2)	2.24 (56.9)
162	3.185 (80.90)	1.07 (27.2)	2.99 (75.9)

ALL DIMENSIONS ARE IN INCHES (MM)



ELECTRICAL SCHEMATIC



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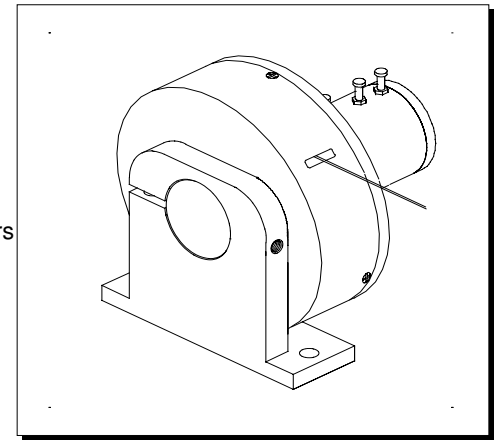
DATA SHEET
Series 161H & 162H

SpaceAge Control, Inc.

Analog-Output Miniature Position Transducers with High Cable Tension

KEY FEATURES

- High Cable Tension for Enhanced Frequency Response
- 42.50-inch (1080-mm) Maximum Travel (Series 162)
- Analog Signal Using Precision Conductive Plastic or Hybrid Potentiometers
- Threaded Drum for Enhanced Repeatability
- Bearing-Mounted Rotating Components
- Optional Flexible Mounting Bases



POTENTIOMETER SPECIFICATIONS

	1-turn	3-turn	5-turn
Potentiometer Type	1-turn, conductive plastic	3-turn, hybrid construction	5-turn, hybrid construction
Resistance: Value, Tolerance	5K ohms, ±20%	5K ohms, ±5%	5K ohms, ±5%
Travel: Electrical, Mechanical	340°, 360°	1080°, 1080° +10° -0°	1800°, 1800° +10° -0°
Mechanical Life	10 million shaft revolutions	5 million shaft revolutions	5 million shaft revolutions
Power Rating	1.0 watts at 158° F (70° C)	1.5 watts at 158° F (70° C)	2.0 watts at 158° F (70° C)
Max. Indep. Linearity Error	±1.0% per VRCI-P-100A	±0.5% per VRCI-P-100A	±0.35% per VRCI-P-100A
Output Smoothness	< 0.1%	0.5% max.	0.35% max.
Insulation Resistance	100 Mohms	1000 Mohms	1000 Mohms
Dielectric Strength	1000 volts RMS	1000 volts RMS	1000 volts RMS
Resolution	infinite signal	infinite signal	infinite signal
Operating Temperature	-40° to 257° F (-40° to 125° C)	-67° to 257° F (-55° to 125° C)	-67° to 257° F (-55° to 125° C)
Electrical Connection	3-terminal (1, 2, 3)	3-terminal (CW, CCW, S)	3-terminal (CW, CCW, S)
Shock	100 g for 6 ms	100 g for 6 ms	100 g for 6 ms
Vibration	10 to 2000 Hz at 15 g	10 to 2000 Hz at 15 g	10 to 2000 Hz at 15 g
Temperature Coefficient	±222 ppm/°F (±400 ppm/°C)	±389 ppm/°F (±700 ppm/°C)	±389 ppm/°F (±700 ppm/°C)

OTHER SPECIFICATIONS

Case Materials	precision-machined anodized 2024 aluminum
Displacement Cable	0.027-inch (0.69-mm) dia., 7-by-7 stranded stainless steel, 90-lb (400-N) min. breaking strength. A minimum of 12 inches (305 mm) of displacement cable is provided with an uncrimped copper sleeve and line connector for connection to the application. Line connector minimum breaking strength is greater than 90 lbs (400 N). Other connecting solutions available on request.
Electrical Connections	Three solder terminals. Customer-specified electrical cable and connectors available upon request.

Approximate Weight	Series 161H		Series 162H	
	7 oz.	198 g	10 oz.	284 g

Environmental Sealing	NEMA 4 / IP 56 (with optional sensor cover)

A Small, Flexible Alternative to LVDTs and Linear Potentiometers

MODEL NUMBERS AND CABLE TENSIONS: Series 161H and 162H

Model	Range		Cable Tension Range (Full Retraction to Full Extraction)					
			Opt 115: -090 spring		Opt 116: -100 spring		Opt 117: -110 spring	
	inches	**mm**	**oz.**	**N**	**oz.**	**N**	**oz.**	**N**
161-0361H	4.50	114	**65 to 95**	**18 to 26**	120 to 150	33 to 42	170 to 200	47 to 56
161-0411H	5.13	130	**65 to 95**	**18 to 26**	120 to 150	33 to 42	170 to 200	47 to 56
161-0441H	5.50	140	**65 to 95**	**18 to 26**	120 to 150	33 to 42	170 to 200	47 to 56
161-0461H	5.75	146	**65 to 95**	**18 to 26**	120 to 150	33 to 42	170 to 200	47 to 56
161-1143H	14.25	362	**55 to 85**	**15 to 24**	115 to 145	32 to 40	100 to 320	28 to 89
161-1283H	16.00	406	**55 to 85**	**15 to 24**	115 to 145	32 to 40	150 to 300	42 to 83
161-1393H	17.38	441	**55 to 85**	**15 to 24**	115 to 145	32 to 40	170 to 200	47 to 56
161-1443H	18.00	457	**65 to 130**	**18 to 39**	70 to 130	19 to 36	170 to 200	47 to 56
161-1915H	23.88	606	**25 to 170**	**7 to 47**	50 to 245	14 to 68	175 to 205	49 to 57
161-2145H	26.75	679	**40 to 90**	**11 to 25**	135 to 165	38 to 46	175 to 205	49 to 57
161-2325H	29.00	737	**65 to 95**	**18 to 26**	135 to 165	38 to 46	175 to 205	49 to 57
161-2405H	30.00	762	**65 to 95**	**18 to 26**	135 to 165	38 to 46	175 to 205	49 to 57
162-0521H	6.50	165	**55 to 85**	**15 to 24**	105 to 135	29 to 38	155 to 185	43 to 51
162-0561H	7.00	178	**55 to 85**	**15 to 24**	105 to 135	29 to 38	155 to 185	43 to 51
162-0621H	7.75	197	**55 to 85**	**15 to 24**	105 to 135	29 to 38	155 to 185	43 to 51
162-0651H	8.13	206	**80 to 120**	**22 to 33**	105 to 135	29 to 38	155 to 185	43 to 51
162-1643H	20.50	521	**50 to 90**	**14 to 25**	95 to 125	26 to 35	60 to 165	17 to 46
162-1763H	22.00	559	**50 to 80**	**14 to 20**	95 to 125	26 to 35	120 to 230	33 to 64
162-1923H	24.00	610	**50 to 80**	**14 to 20**	95 to 125	26 to 35	145 to 175	40 to 49
162-2043H	25.50	648	**50 to 80**	**14 to 20**	95 to 125	26 to 35	145 to 175	40 to 49
162-2735H	34.13	867	**65 to 95**	**18 to 26**	115 to 145	32 to 40	175 to 205	49 to 57
162-2945H	36.75	933	**65 to 95**	**18 to 26**	115 to 145	32 to 40	175 to 205	49 to 57
162-3205H	40.00	1016	**65 to 95**	**18 to 26**	115 to 145	32 to 40	175 to 205	49 to 57
162-3405H	42.50	1080	**11 to 80**	**3 to 22**	40 to 145	11 to 40	175 to 205	49 to 57

Bolded entries are standard cable tension and will be specified unless overridden on purchase order.

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OPTIONS: Series 161H & 162H

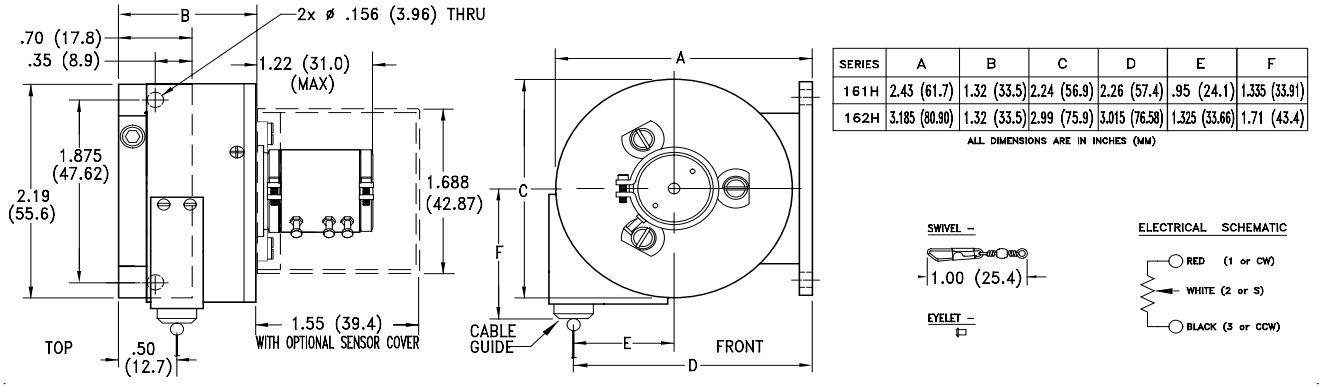
Opt. 115	cable tension: -090
Opt. 116	cable tension: -100
Opt. 117	cable tension: -110
Opt. 9	SPECIAL = (describe special requirement or specification to be met)

OPTIONS: Series 161H (sensor cover and bases)

Opt. C24	base: mounting disk (_6_); 160040-1
Opt. C28	base: standard (_61); pn 160015-3
Opt. C31	base: universal (_61); pn 160030-3
Opt. C33	base: big foot (_60/_61); pn 160015-13
Opt. 12H	no sensor cover (_61)
Opt. 13H	sensor cover (_61); pn 160060

OPTIONS: Series 162H (sensor cover and bases)

Opt. C24	base: mounting disk (_6_); 160040-1
Opt. C29	base: standard (_65); pn 160015-5
Opt. C32	base: universal (_62); pn 160030-5
Opt. C34	base: big foot (_62); pn 160015-15
Opt. 14H	no sensor cover (_62)
Opt. 15H	sensor cover (_62); pn 160060



SERIES	A	B	C	D	E	F
161H	2.43 (61.7)	1.32 (33.5)	2.24 (56.9)	2.26 (57.4)	.95 (24.1)	1.335 (33.91)
162H	3.185 (80.90)	1.32 (33.5)	2.99 (75.9)	3.015 (76.58)	1.325 (33.66)	1.71 (43.4)

ALL DIMENSIONS ARE IN INCHES (MM)

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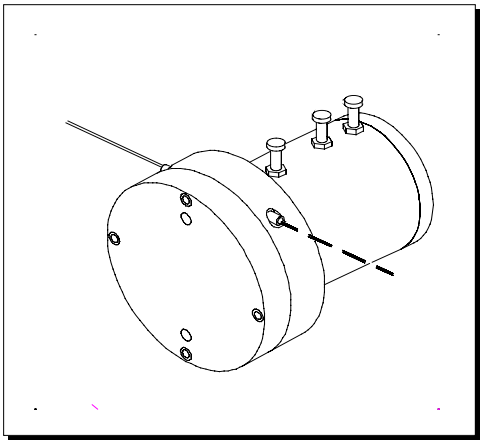
DATA SHEET
Model 180-0803

SpaceAge Control, Inc.

Analog-Output Subminiature Position Transducer with Extended Range

KEY FEATURES

- 10.00-inch (254-mm) Maximum Travel
- Analog Signal Using Precision Hybrid Potentiometer
- Threaded Drum for Enhanced Repeatability
- Bearing-Mounted Rotating Components
- Optional Flexible Mounting Base



POTENTIOMETER SPECIFICATIONS

Potentiometer Type	3-turn, hybrid construction
Resistance: Value, Tolerance	5K ohms, ±5%
Travel: Electrical, Mechanical	1080°, 1080° +10° -0°
Mechanical Life	5 million shaft revolutions
Power Rating	1.5 watts at 122° F (50° C)
Max. Indep. Linearity Error	±0.5% per VRCI-P-100A
Output Smoothness	0.5%
Insulation Resistance	1000 Mohms
Dielectric Strength	1000 volts RMS
Resolution	infinite signal
Operating Temperature	-67° to 257° F (-55° to +125° C)
Electrical Connection	3 potentiometer terminals
Shock	100 g for 6 ms
Vibration	10 to 2000 Hz at 15 g per Mil-R-39023
Temperature Coefficient	±389 ppm/°F (±700 ppm/°C)

OTHER SPECIFICATIONS

Case Materials	precision-machined anodized 2024 aluminum		
Displacement Cable	0.018-inch (0.46-mm) dia., 7-by-7 stranded stainless steel, 40-lb (177-N) min. breaking strength. A minimum of 12 inches (305 mm) of displacement cable is provided with an uncrimped eyelet and swivel for connection to the application. Swivel minimum breaking strength is 9 lbs (40 N). Other connecting solutions available on request.		
Electrical Connections	Three solder terminals. Customer-specified electrical cable and connectors available upon request.		
Approximate Weight	2 oz.	57 g	
Displacement Cable Tension	6 oz.	1.7 N	minimum
	13 oz.	3.6 N	maximum
Environmental Sealing	NEMA 3S / IP 54		

A Small, Flexible Alternative to LVDTs and Linear Potentiometers

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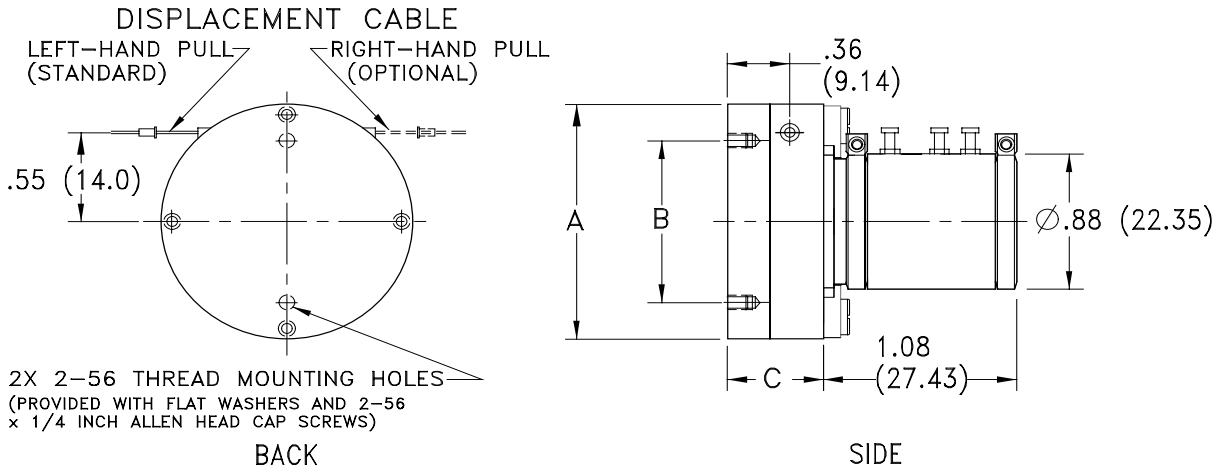
MODEL NUMBERS

180-0803	position transducer (10.00-inch (254-mm) range)

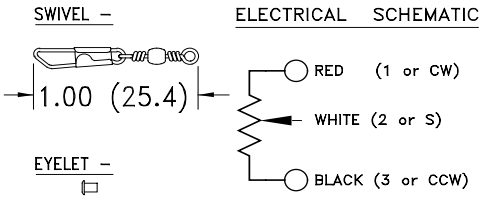
OPTIONS

Opt. 101	left-hand displacement cable pull
Opt. 102	right-hand displacement cable pull
Opt. B08	base: L; pn 173015
Opt. 9	SPECIAL = (describe special requirement or specification to be met)



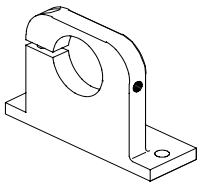
SERIES	A	B	C
180	1.49 (37.8)	1.00 (25.4)	.625 (15.9)

ALL DIMENSIONS ARE IN INCHES (MM)

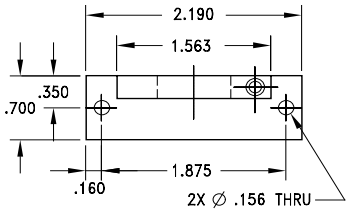


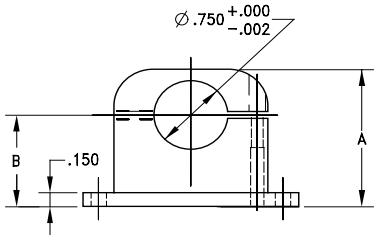
A Small, Flexible Alternative to LVDTs and Linear Potentiometers

base: standard (_6_); pn 160015-_ (upright mounting; allows 360° rotation about one axis)

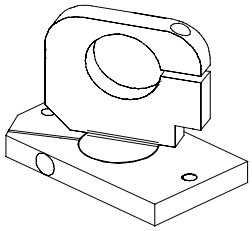


DASH #	A	B
-1	1.50	1.00
-3	1.81	1.31
-5	2.19	1.69

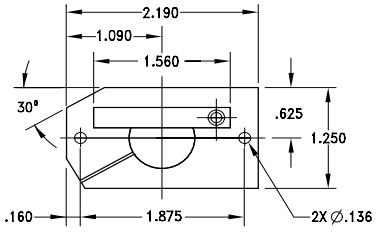


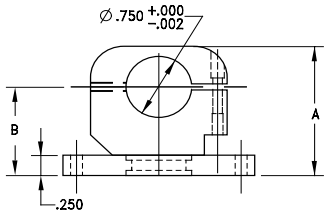


base: universal (_6_); pn 160030-_ (upright mounting; allows 360° rotation about two axes)

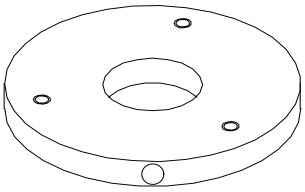


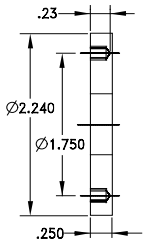
DASH #	A	B
-1	1.64	1.13
-3	1.90	1.39
-5	2.28	1.77

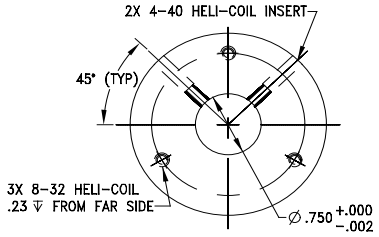




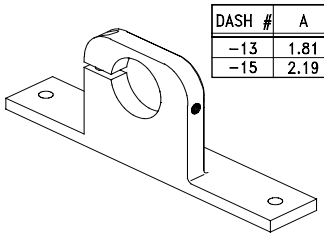
base: mounting disk (_6_); pn 160040-1 (for prone mounting with 360° rotation about one axis)



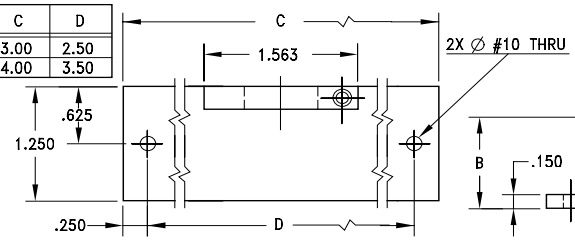


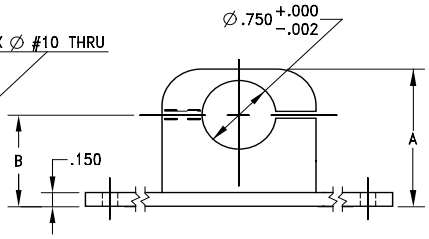


base: big foot (_6_); pn 160015-__ (similar to base: standard with broader base for easier mounting screw access)

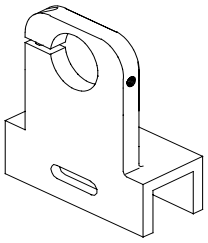


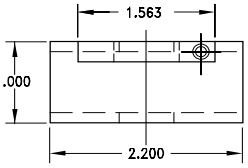
DASH #	A	B	C	D
-13	1.81	1.31	3.00	2.50
-15	2.19	1.69	4.00	3.50

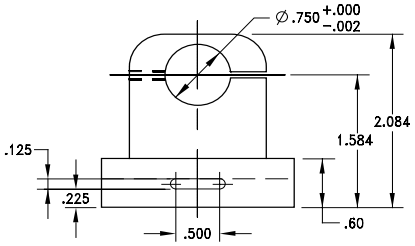




base: h (_60); pn 160015-G1 (similar to base: standard with slot for strap clamp attachment)







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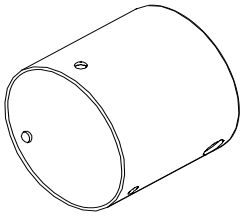
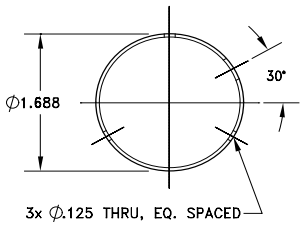
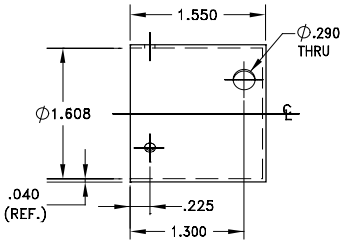
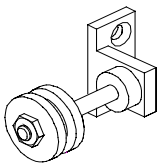
sensor cover (_6_); pn 160060 (protects sensor from adverse elements)

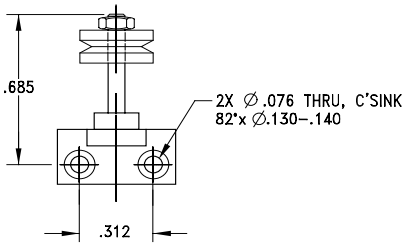


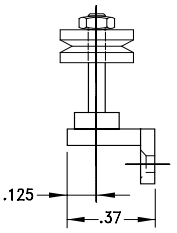




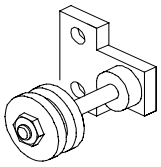
idler (_60); pn 160022 (compensates for off-center cable travel)

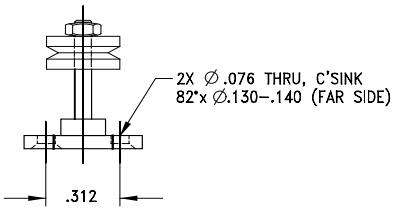


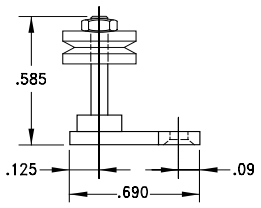




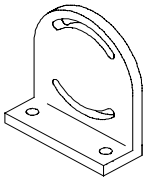
idler (_61/_62); pn 161022 (compensates for off-center cable travel)

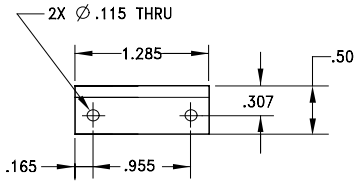


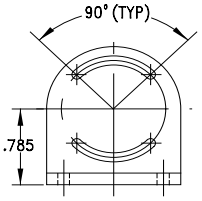




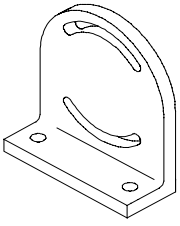
base: L (173); pn 173015 (upright mounting; allows for 90° rotation in one axis)

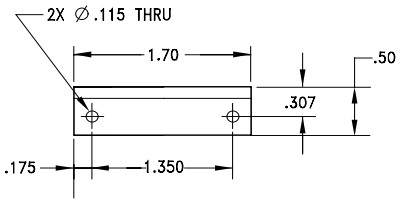


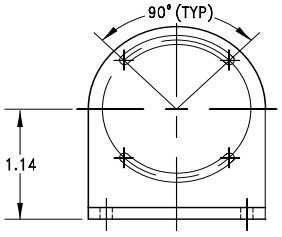




base: L (174/175); pn 174015 (upright mounting; allows for 90° rotation in one axis)







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How to Order

Product Selection Guidelines SpaceAge Control, Inc. position transducers provide flexibility to meet your precise measurement requirements. The following information will assist you in selecting and ordering the model number that is best for your application. Before ordering, please review these guidelines.

To determine what model best meets your requirements, specify your requirements in the order shown below.

Range
Maximum Cable Acceleration
Size
Environmental Protection
Mounting Method

Then, using the *Product Line Overview* and the appropriate *Data Sheets*, choose the position transducer model number and options that best meet your requirements. To specify the part number for your purchase order, simply specify the model number and the options. For example, to order a model 173-0241 position transducer with default cable tension, left-hand cable pull, 5K ohms potentiometer resistance, and L base, specify the following part number and options on your purchase order:

173-0241, Opts. 101, 107, B06, B08

Feel free to contact our Application Engineers if you have questions on position measurement in general or specifically about our products. If we cannot meet your requirements, we will be happy to refer you to someone who can.

Ordering You may order by:

fax 805-273-4240

phone 805-273-3000

e-mail email@spaceagecontrol.com

mail SpaceAge Control, Inc., Attn: Sales Administration, 38850 20th Street East, Palmdale, CA 93550 USA

Net 30 terms are offered on approved credit. Visa, MasterCard, American Express, and COD payment methods are also available.

Warranty SpaceAge Control, Inc. position transducers are warranted for 90 days from date of shipment against defects in materials or workmanship, excluding cable breakage and related damage. During the warranty period, SpaceAge Control, Inc., at its option, will repair or replace defective products at no charge to the purchaser if the product is returned to SpaceAge Control, Inc. freight pre-paid. This warranty covers products operated under normal working conditions. This warranty does not apply to products that have been misused, abused, damaged by accident, or disassembled.

SpaceAge Control, Inc. makes no other warranties, either expressed or implied, other than those above. SpaceAge Control, Inc. assumes no liability for consequential or special damages under any circumstances.

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ADDITIONAL INFORMATION
Position Measurement Worksheet

SpaceAge Control, Inc.

Position Transducers **S021P(NC)**

Please complete this worksheet and fax it back to us at 805-273-4240. We will respond quickly with our assessment.
If we cannot meet your requirements, we will refer you to someone who can.

Date		Phone	
Name		Fax	
Position		E-Mail	
Company		Web	
Address			
City		Province/State	
Postal/Zipcode		Country	

Application _____
Description _____

General Information
Measurement Range:_____ Lifetime (total cycles):_____
Maximum Velocity:_____ Maximum Acceleration:_____
Target Price:_____ Estimated Quantity:_____

Accuracy ❑ resolution:_____ ❑ repeatability:_____ ❑ linearity:_____

Operating Environment
❑ road vehicle ❑ aircraft ❑ lab/office ❑ marine
❑ offroad vehicle ❑ space vehicle ❑ industrial ❑ other:_____

Operating Conditions
❑ high temperature:_____ ❑ severe shock:_____
❑ low temperature:_____ ❑ severe vibration:_____
❑ small size:_____ ❑ corrosive chemical:_____
❑ high humidity:_____ ❑ moisture/condensation:_____
❑ dust/debris ❑ salt water exposure

Output ❑ analog: voltage ❑ analog: current ❑ digital: absolute ❑ digital: incremental

Sketch position measurement application here. Indicate rough dimensions.

A Small, Flexible Alternative to LVDTs and Linear Potentiometers

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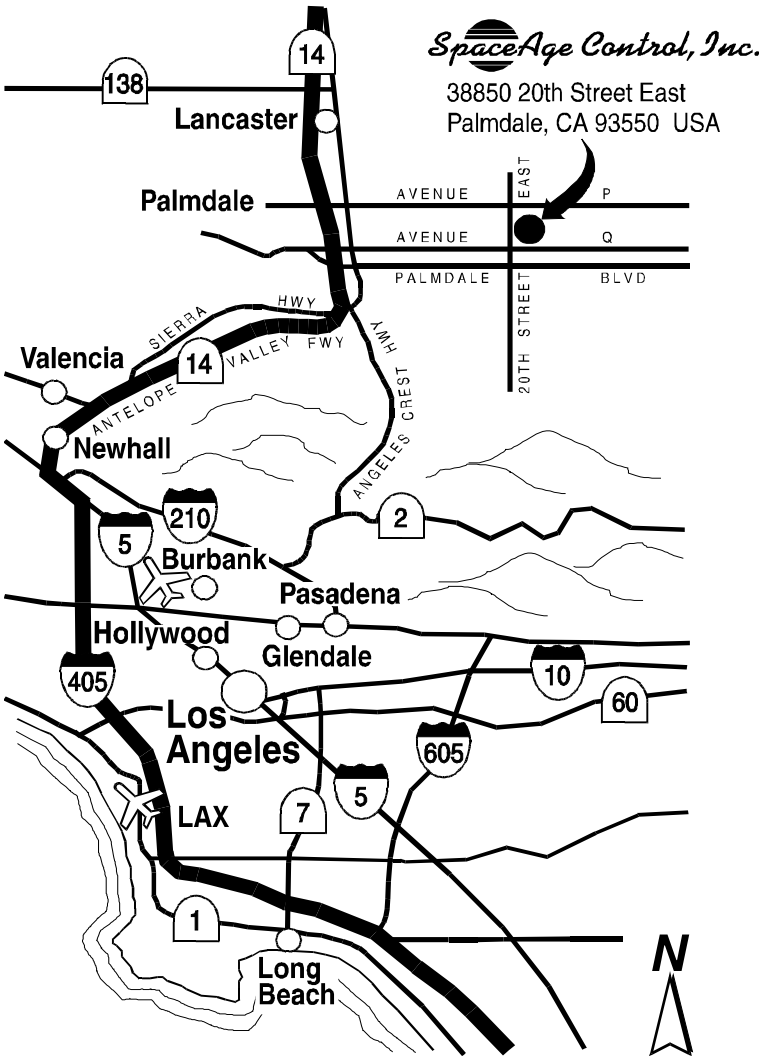
38850 20th Street East, Palmdale, CA 93550 USA **Fax: 661-273-4240** **www.spaceagecontrol.com**

ADDITIONAL INFORMATION
Visitor's Map

SpaceAge Control, Inc.

S021Q(NC)

DIRECTIONS: SpaceAge Control, Inc. is approximately 70 minutes by car from Los Angeles International Airport (LAX). From LAX, take the 405 North (San Diego Freeway) to the 5 North (Golden State Freeway) to the 14 North (Antelope Valley Freeway). In Palmdale, exit east (right) at Avenue P and continue east 2.5 miles (4 km) to 20th Street East. Turn south (right) and continue approximately 1 mile (1.6 km) to 38850 20th Street East.



A Small, Flexible Alternative to LVDTs and Linear Potentiometers