900 SERIES OPTICAL ENCODERS

FEATURES

- Compact, Robust, Economical
- Up to 256 Pulses Per Revolution (PPR) in a 1" Square Sealed Package
- Bearing Model for High Operating Speeds
- New Low Profile Housing Style and Tachometer Output Available

The 900 Series offers a full line of low cost, rugged optical encoders with incremental output. Well suited for industrial motion and position sensing, their low profile and high resolution also make them ideal for panel mounted applications. A two-channel quadrature code allows the encoder to detect the direction and magnitude of the input motion applied to its shaft.

Available in this family of encoders is a new low profile package with internal bearings and integrated mounting holes.

Also new to the 900 Series is a high resolution tachometer style with single channel output. This style is particularly appropriate for applications involving ticket dispensing, card reading, or any speed-sensing function.

Up to 256 pulses per revolution (PPR) are available in a 1" square package. Working with standard decoding logic provided by the user's application software, the device produces 1024 changes of state per revolution with full quadrature decoding. Output is completely compatible with TTL circuitry, permitting entry of digital data without the cost of A/D conversion. Onboard Schmitt trigger circuitry produces crisp square wave output.

A sealed metal housing along with available die cast or stainless steel shaft ensure strength and accuracy in harsh environments. The semi-conductor-based LED optical technology provides longer life and higher reliability than mechanical encoders or switches. Small in size, the encoder adapts well to new or retrofit applications. Output terminations available to match industry standard 4 or 5 pin configurations. This encoder may be directly coupled to a motor, gear, or axle. The threaded bushing allows easy system integration for these as well as panel mounted applications.

APPLICATIONS

MOBILE SENSING / CONTROL

Motion and direction are sensed through encoder's shaft and sent directly to microprocessor.

MOTOR CONTROL DEVICES

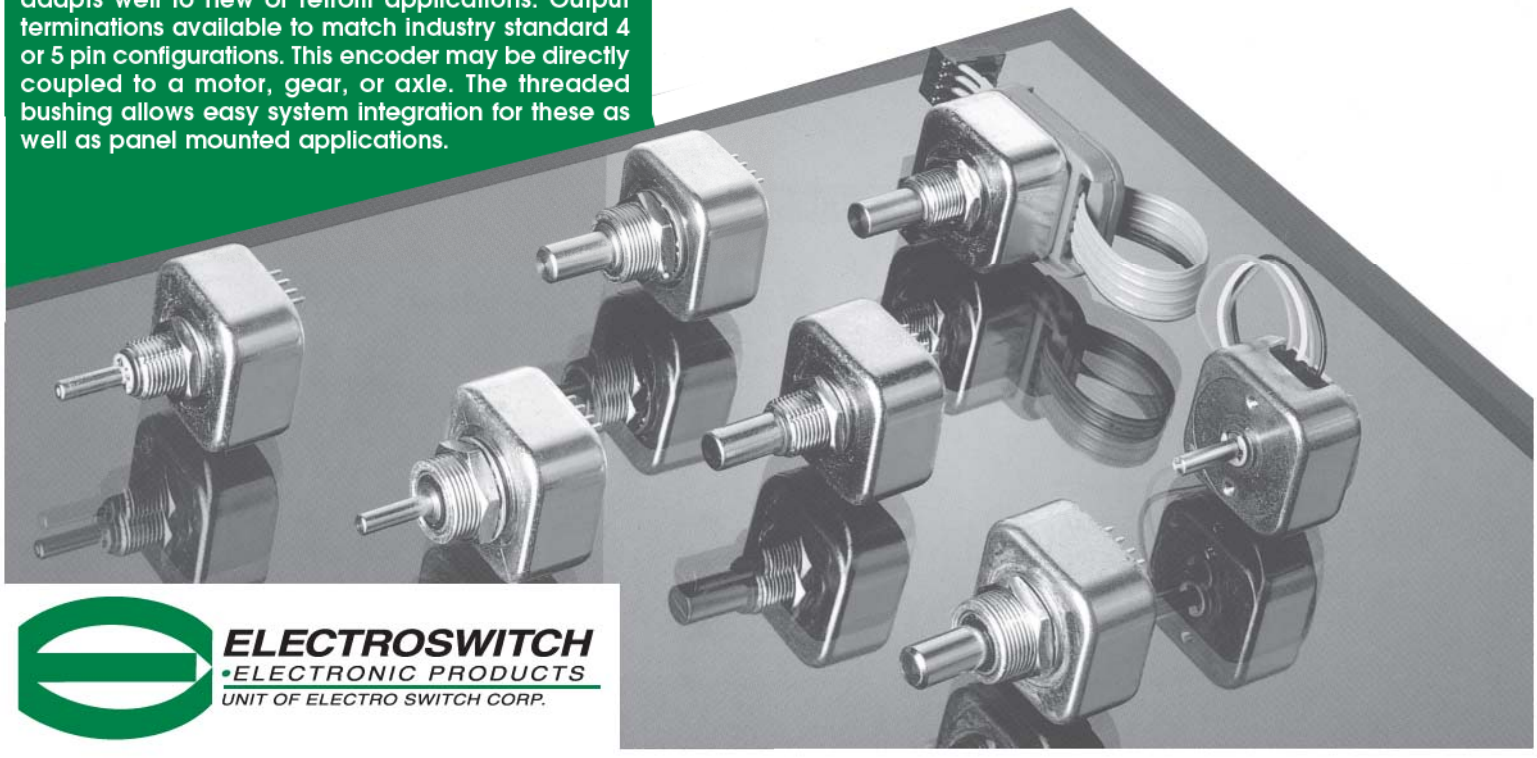
Control of motor circuits is accomplished by linking encoder to motor shaft.

FLOW CONTROL DEVICES

Fluid flow can be metered by the encoder, attached to displacement, turbine and other styles of meters and pumps.

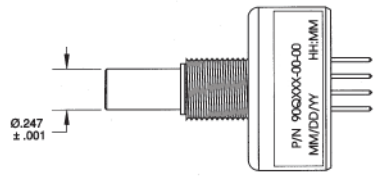
INPUT DEVICES

Panel mounted, the device is used as a low to high resolution input device for test and measurement, medical, and instrumentation of all varieties.



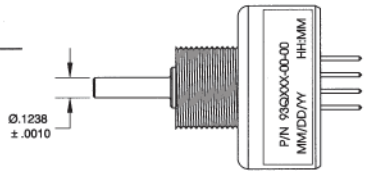
ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

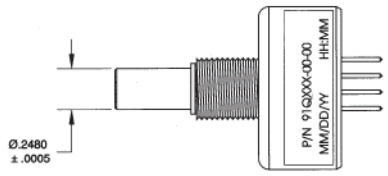
900 Series Encoder Configuration



90 Series
Die Cast Shaft
Sleeve Bearing

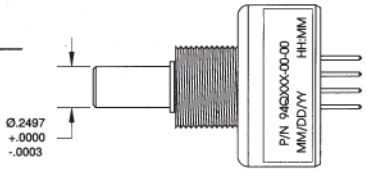
93 Series
Stainless Steel Shaft
Sealed Ball Bearing

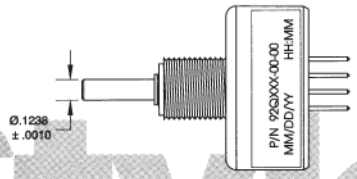




91 Series
Stainless Steel Shaft
Sealed Sleeve Bearing

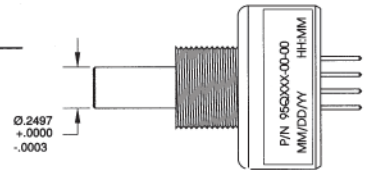
94 Series
Stainless Steel Shaft
Ball Bearing



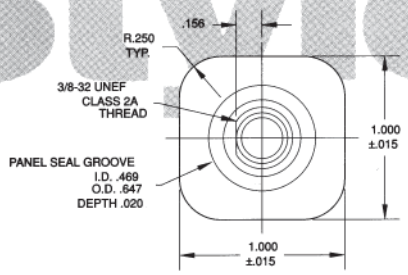


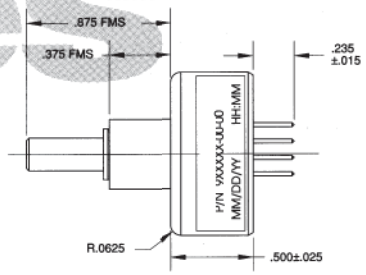
92 Series
Die Cast Shaft
Ball Bearing

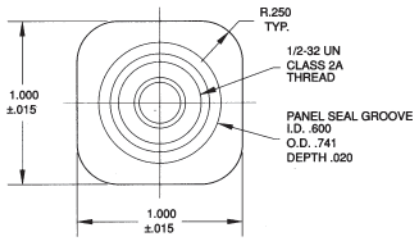
95 Series
Stainless Steel Shaft
Sealed Ball Bearing



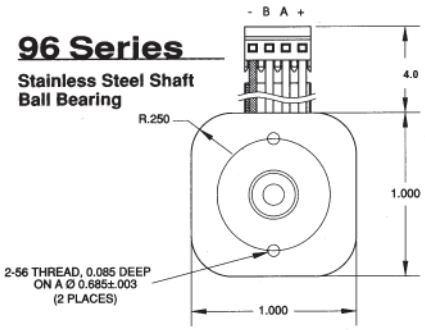
Styles

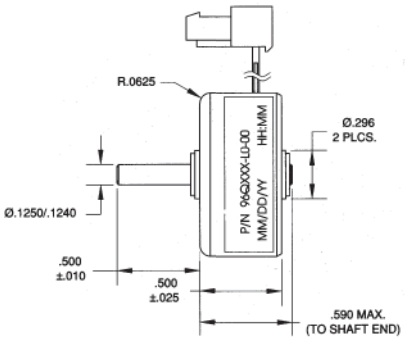






96 Series
Stainless Steel Shaft
Ball Bearing





Notes:

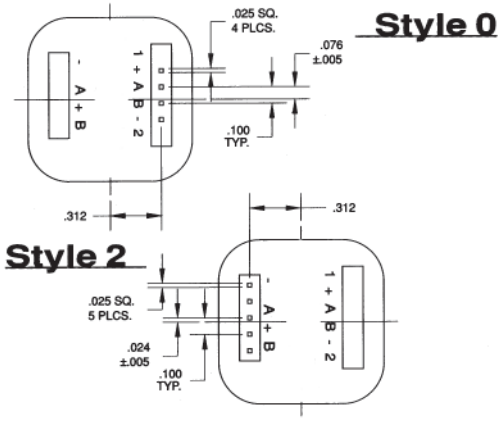
All dimensions in inches unless otherwise specified.

Hardware:

All standard product comes with the following mounting hardware:

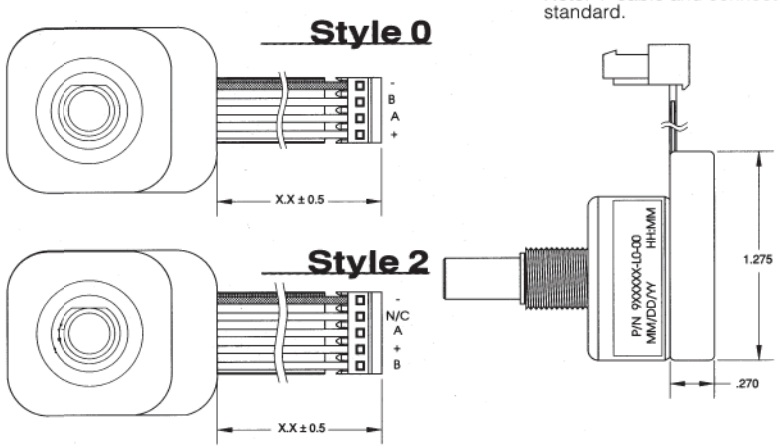
- Nut
  - Hexagon machine screw nut, UNEF thread
  - Thickness: .093 ± .006
- Lockwasher
  - Internal tooth
  - Thickness: .022

Pin Out Styles

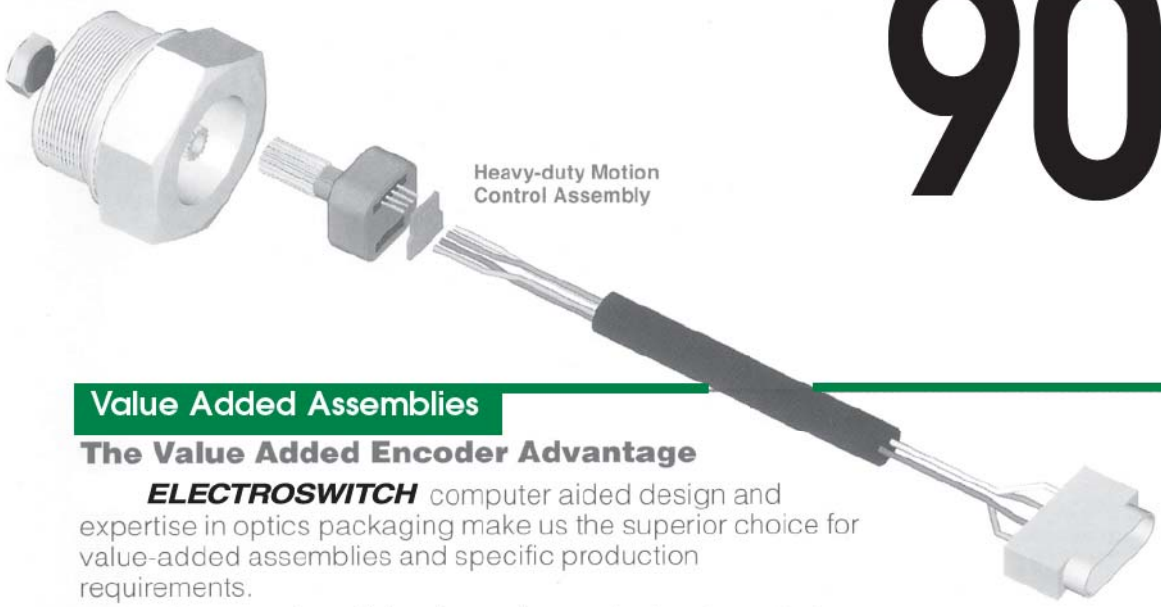


Cabin Styles

Note: 4" cable and connector standard.



900 SERIES OPTICAL ENCODERS



Heavy-duty Motion Control Assembly

Value Added Assemblies

The Value Added Encoder Advantage

ELECTROSWITCH computer aided design and expertise in optics packaging make us the superior choice for value-added assemblies and specific production requirements.

Manufacturers benefit by shortening cycle time from design to production, and lowering Bill of Material count and cost. Ideal for use in feedback or panel applications, these value-added assemblies are certified, pretested, and ready to "plug and play" on your assembly line. ***ELECTROSWITCH*** is capable of extensive preproduction testing of your assemblies and components to assure that electrical, mechanical, and environmental specifications are met.

Manufacturers seeking a cost-effective single source for encoder assemblies can depend on ***ELECTROSWITCH*** powerful design and production solutions.

Industrial Flow Control Assembly

Integrated Module Provides Built-in Connector And Additional Custom Signal Circuitry

Performance Plus

Propietary optical components allow ***ELECTROSWITCH*** to provide robust, compact, and economical encoders. The heart of these devices are monolithic Bi-Cell™ photo diodes with Schmitt Trigger circuitry.

Qualification of product using MIL-STD specifications sets SGI encoders apart from the competition.

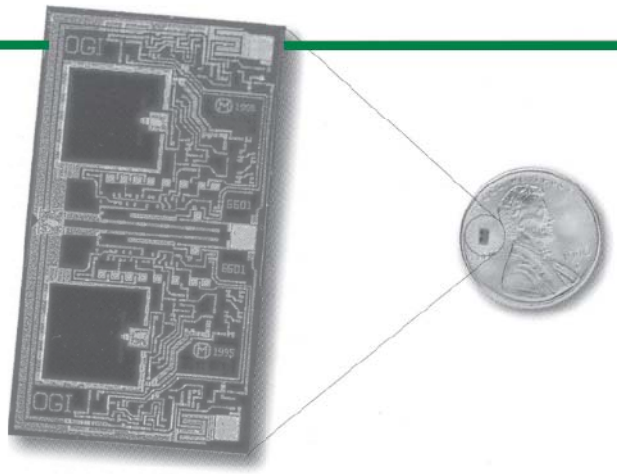


Photo IC shown at 30x actual size.

Specifications

Electrical Specifications

Parameter	Minimum	Typical	Maximum	Units
Vcc Range	4.75	5	5.25	V
For 200 & 256 ppr only	4.8	5	5.2	V
Supply Current @ 5V (Output Low) No Load		30	50	mA
VOH @ 100mA (Vcc = 5V)	3.0	4		V
VOL @ 16mA (Vcc = 4.75V)		290	700	mV
Pull-Up Resistor	7.5	10.5	13.5	KOhm
Output Rise Time (CL-15pF)		500		nS
Output Fall Time (CL-15pF)		14		nS
Output: 2-bit gray code, Channel A leads Channel B by 90° with clockwise rotation				
Power Consumption: 250mW max.				

Note: 1: Constant current source available for extended voltage ranges.
2: 12V and 15V input supply units available.

Environmental Specifications

Parameter	Minimum	Typical	Maximum	Units
Operating Temperature: Vcc = 5V	-40	25	85	°C
For 200 & 256 ppr only	0	20	50	°C
Storage Temperature Range: -55°C to +105°C, per MIL STD 202F Method 107G Test Condition A except 105°C max				
Humidity: MIL STD 202F Method 103B Condition A				
Solderability: 95% coverage				

Mechanical Specifications

Vibration: Harmonic motion with amplitude of 15g, varied from 10 to 2000 Hz for 12 hours, per MIL STD 202F Method 204D Condition B

Shock: 100g for 6 ms half sine wave with velocity change of 12.3 ft/s, per MIL STD 202F Method 213B Condition C

Rotational Torque: Sleeve bearing: < 1 in. oz. max., Ball bearing: < .25 in. oz. max., higher for sealed unit.

Operating Speed: Sleeve bearing: 200 RPM max., Ball bearing: 3,000 RPM max.

Shaft End Play: 0.005 max.

Shaft Radial Play: 0.010 max. @ .75 from mounting surface

Shaft Push In Force: 50 lbs. max.

Shaft Pull Out Force: 25 lbs. max.

Bushing Mounting Torque: 10 in. lb. max.

Weight: 1.1 oz. (90Q128-00-00)

Terminal Strength: 3 lbs. max. applied perpendicular to the terminals

Rotational Speed, Rotational Life and Shaft Side Load Rating:
(Load placed at end of standard shaft)

Series Number	Rotational Life	Rotational Speed Rating	Side Load Rating
90	5,000,000 +	200 rpm	0.25 lb.
91	10,000,000 +	300 rpm	0.50 lb.
92	100,000,000 +	3,000 rpm	0.25 lb.
93	100,000,000 +	3,000 rpm	5.0 lb.
94	100,000,000 +	3,000 rpm	5.0 lb.
95	100,000,000 +	3,000 rpm	5.0 lb.
96	100,000,000 +	3,000 rpm	3.0 lb.

Ordering the 900 Series Encoder

Output Style
Q = Quadrature (two channel)
T = Tachometer (single channel)

Resolution
(Pulses Per Revolution)
032 125
064 128
100

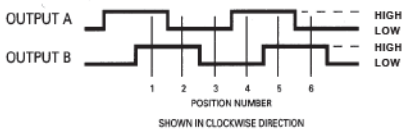
Pin Out Style
0 + A B -
2 - open A + B

9 [0] [Q] [0] [3] [2] - [0] [0] - 0 0

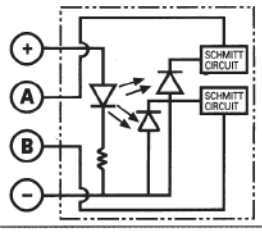
Shaft and Bearing Style
0: 1/4" dia. shaft, sleeve bearing, 3/8" dia. bushing
1: 1/4" dia. shaft, sealed sleeve bearing, 3/8" dia. bushing
2: 1/8" dia. shaft, ball bearing, 3/8" dia. bushing
3: 1/8" dia. shaft, sealed ball bearing, 1/2" dia. bushing
4: 1/4" dia. shaft, ball bearing, 1/2" dia. bushing
5: 1/4" dia. shaft, sealed ball bearing, 1/2" dia. bushing
6: 1/8" dia. shaft, internal ball bearing

Termination
0: Straight Pins (see drawing)
4: Standard 4" cable and connector
L: Custom cable length
Example: 8 = 8" cable length

Two Channel Waveform



Electrical Schematic



OE2 SERIES
OPTICAL ENCODERS

FEATURES

- Input device ideal for tuning, menu scrolling, and selecting functions
- Push-button feature allows dual function and reduced input panel part count
- Vibration and mechanical shock approved per MIL-STD 202
- Exceeds performance for humidity and thermal shock per MIL-STD 202

The OE2 Series Optical Encoder has been developed for customers who require switches that are more reliable and longer lasting than conventional rotary switches. Advanced optical technology uses no mechanical contacts, which reduces noise and eliminates contact bounce.

An important advantage of the OE2 Series is its complete compliance to MIL-STD 202 for humidity, vibration, thermal and mechanical shock and performance, which is unique for the switch industry. This provides a great fit for products involving critical functions, such as medical devices and industrial process controls.

The OE2 features rotary action, with or without a push-button option. This allows dual modes to be performed by a single switch. A popular application of the switch uses this dual mode feature to produce a "scroll and select" function for many different types of display screens, including LCD and CRT.

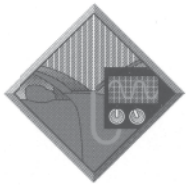
Numerous design options are available to meet individual specifications and application requirements. Standard output is incremental two-bit quadrature. Both straight pin out or a ribbon cable with connector are available as termination options.

In addition to extended life, the OE2 Series offers the advantages of low power consumption, pin or cable termination, small size, and digital output compatible with TTL and CMOS circuitry.

APPLICATIONS

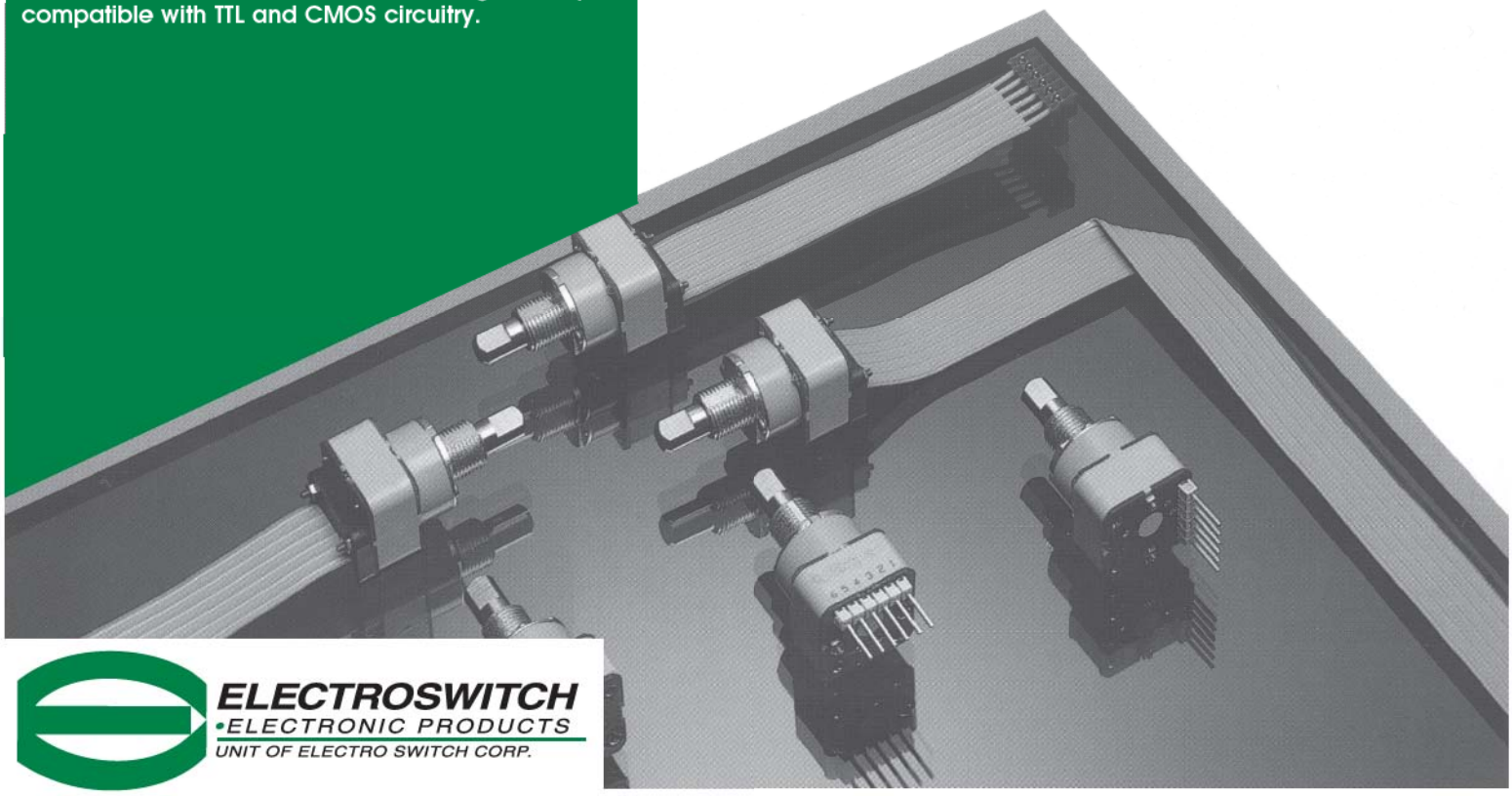
MEDICAL INSTRUMENT CONTROL PANEL
For critical care equipment such as defribrillators, ultrasound equipment, and analytical equipment.

TEST AND MEASUREMENT EQUIPMENT
Incremental coded models for all types of electrical measurement equipment.



AUTOMOTIVE DIAGNOSTIC EQUIPMENT
For tough service environments that require scrolling and selection.

INDUSTRIAL PROCESS / MACHINERY CONTROL
Encoder-driven capability for speed-tuning and mode selection.



ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

Specifications

Electrical Specifications

Parameter	Minimum	Typical	Maximum	Units
Vcc Range	4.5	5.0	5.5	V
Supply Current			25	mA
Vol @ (1mA)		150		mV
Suggested Pull-Up Resistor		4.7k		Ohm
Output Rise Time (measured at 90 rpm) C=16 pF	1.0		6.0	ms
Output Fall Time (measured at 90 rpm) C=16 pF	.5		6.0	ms
V_{CEO}			32	V
Push-button Contact Resistance (end of life)			.5	Ohm
Push-button Contact Bounce		4ms @ close / 10 ms @ open		ms

Environmental Specifications

Parameter	Minimum	Maximum	Units
Operating Temperature	-40	85	°C
Storage Temperature:	-55	105	°C
Humidity: 95% R.H. per MIL-STD 202, Method 103B, Test Condition B			

Mechanical Specifications

Parameter	Minimum	Typical	Maximum	Units
Rotational Life Rated with less than 8 oz. side load applied at end of shaft				
Detented		3,000,000 rotations		
Non-Detented		10,000,000 rotations		
Rotational Torque @ 20°C				
Detented	1.0	1.5	2.0	in.-oz.
Non-Detented	0.10	0.40	0.70	in.-oz.
Torque Test Speed		6 rpm		
Push-button Life		1,000,000 Actuations		
Push-button Actuation Force (Where Applicable)	375	500	625	gram
Push-button Travel		0.035 ± 0.015		in.
Bushing Mounting Torque		7.5		in.-lb.
Shaft end play		.015		in.
Shaft Push-In Force		50		lbs.
Shaft Pull-Out Force		25		lbs.
Shaft Radial Play		.010 max. T.I.R. (measured from the end of the bushing)		
Shock		100 (g) for 6 ms half sine wave		
Vibration		15 (g) Amplitude 10-2000 (Hz) for 12 (hr)		
Terminal Strength		3 lbs. (applied perpendicular to the terminals)		
Weight		0.04		lbs.

Ordering the OE2 Series Encoder

Detent 1 = Yes 0 = No

Push-button 1 = Yes 0 = No

Termination
0: Straight Pins (see drawing)
4: Standard 4" cable and connector
L: Custom cable length. Call factory for lengths over 9".

Hardware or Surface Mount Adaptor Bracket Available. Call Factory For Details.

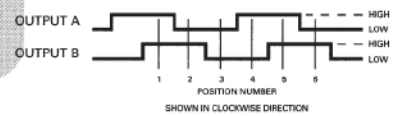
OE2 – 16 1 1 – Q O – 000

Postitions Per Rotation
16
24
32

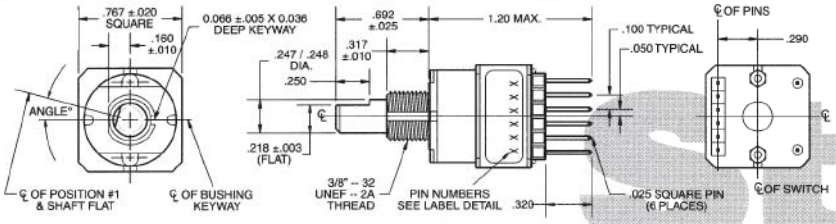
Code
Q = Quadrature

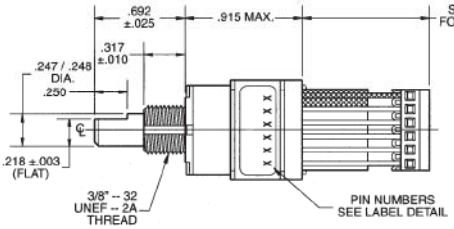
Output Truth Table available. Call factory for details.

Output Waveforms Quadrature Versions

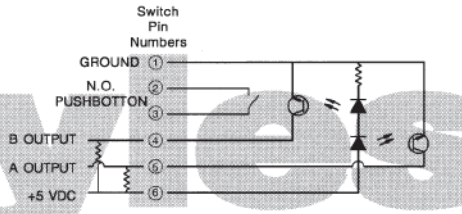


OE2 Series Encoder Confiigurations





Electrical Schematic



SUGGESTED EXTERNAL RESISTORS ARE 4.7K

Note: all dimensions in inches.

Connector P/N AMP 640443-6

ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

OE2 SERIES
OPTICAL ENCODERS

700 SERIES MECHANICAL ENCODERS

FEATURES

- Digital Codes Available:
  Incremental: A/B or Quadrature
  Absolute: Binary or Gray
- Up to 98 pulses per revolution (PPR)
- Analog resistive output for use as a potentiometer
- High temperature materials meet 85° requirements
- Push button feature allows dual function with single shaft input

The 700 Series is the economical solution to virtually any digital encoder or potentiometer requirement. As the latest version in our new generation of rotary encoder products, the 700 Series has been freshly tooled to include resistive analog output for potentiometer applications, as well as the standard digital code for direct interface with a microprocessor. The .890" package enhances the original design concept, delivering high performance and quality levels in the triple digit PPMs.

Electroswitch leads the market in rotational torque management for encoders. Our process includes digital maps to ensure repeatable and quantitative measurement.

Newly introduced in the 700 Series in an integrated push-button, which permits two functions in a single shaft. This feature provides system cost savings and user-friendly interface for input selection. The push-button feature is offered in the same package size as the standard 700, with a complete interface for scrolling through a menu and making a selection.

The 700 Series features a wide range of standard configurations to fulfill most needs. As with standard product, customized versions for volume applications also benefit from Electroswitch's cost-effective, automated production processes to build in quality performance.

APPLICATIONS

TIMER AND TEMPERATURE SELECTION

Incremental output codes are ideal for scroll functions required for input devices. Resistive output for temperature input selection.

HVAC TEMPERATURE AND FAN CONTROL

Digital or analog output for temperature with direct drive to display and fan control for automotive use.

ELECTRONIC RANGE CONTROL

Control of bake time, temperature and duration in residential and commercial applications.

PANEL INPUT DEVICE

Used to scroll through menu via shaft rotation; for selecting menu item via push-button.

AUDIO INPUT

Volume control for all amplifier applications; automotive, musical, home, and professional.

ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

700 Series Application Notes

With the introduction of the 700 Series Mechanical Encoder and Potentiometer, Electroswitch delivers a low cost, multifunctional rotary interface with repeatable torque and 'feel' to match the user's needs.

New to the 700 Series is the addition of resistive (analog) output. Therefore, users have the unprecedented option of choosing between two types of outputs; digital or resistive. The digital outputs are available in absolute or incremental code, and reflect Electroswitch's many years of technological expertise in this area. The resistive outputs are available in 5K or 10K linear tapers; custom outputs can be developed upon request. All of these variations are offered in the same package size and may be used in any combination. The typical absolute code is either gray or binary. The four or five bit output gray code provides the benefit of only one bit change per change of state.

The incremental output code is known as an A/B counting code. As the shaft is rotated, two wave forms are generated and the A/B code 'counts' these pulses, sending them to the microprocessor to determine a 'relative' position. The counts or pulses continue with the rotation of the shaft, which allows the position to change infinitely, or as the microprocessor allows. Direction may be determined by analyzing the phase difference between the two channels.

The A/B code is also known as a quadrature. In full quadrature, each change of state in the two waveforms is counted, providing the highest form of resolution at 4 counts per cycle. In half quadrature, only the changes of state in one wave form are counted, providing 2 counts per cycle. While in quarter quadrature, only the rise in one wave form is counted, providing 1 count per cycle.

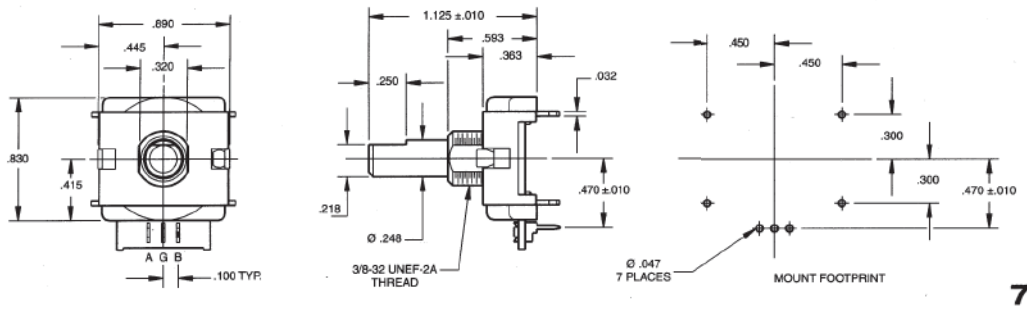
The 700 Series features 12, 16, 24, 32 or 36 mechanical detent positions that provide up to 36 electrical outputs per revolution in standard offering. Without mechanical detents, the resolution per rotation can be much higher. Electroswitch offers up to 96 electrical outputs per revolution in this non-detented method in custom applications.

Several options within the 700 Series make it unique and a valuable choice for any user. Our push-button feature allows two functions to be controlled by one shaft. By integrating the push-button function into its standard design, Electroswitch has been able to keep the package size the same for all of the 700 Series products. This push-button feature is ideal for scrolling and select functions, or to incorporate an on-off option in one rotary package size.

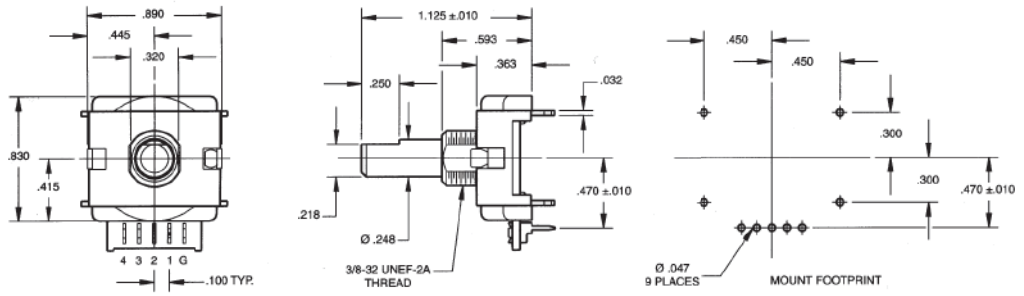
Standard mounting configuration is shaft perpendicular to the mounting board, with a bracket for additional mounting strength.

Applications

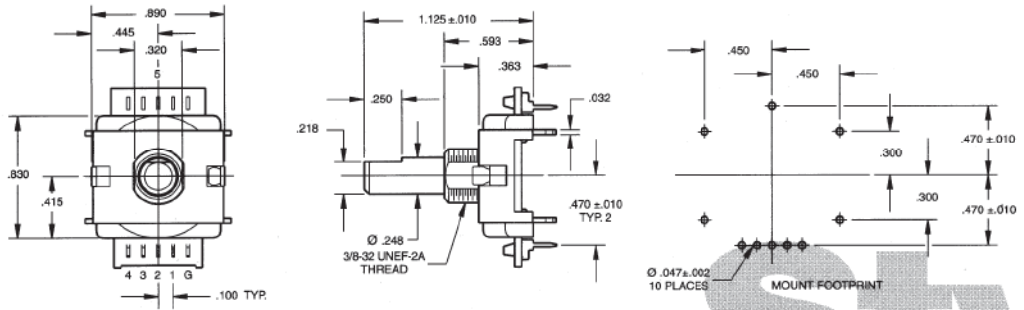
700 Series Encoder Configurations



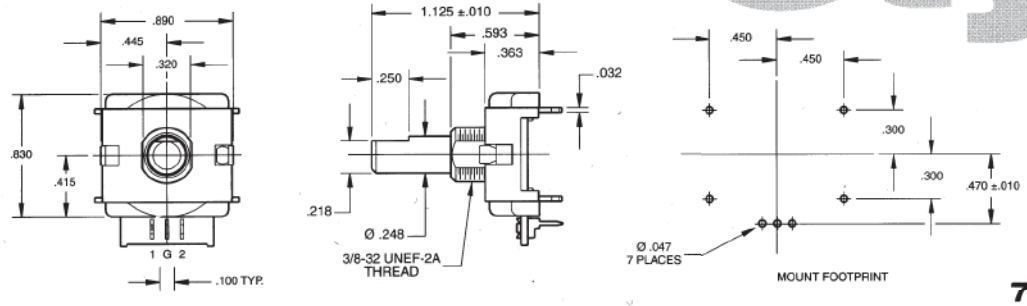
700 Series



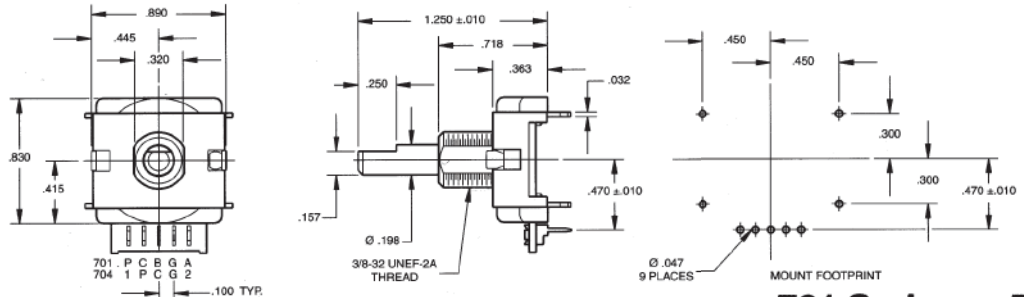
12 or 16 position **702 Series**



24 or 32 position **702 Series**



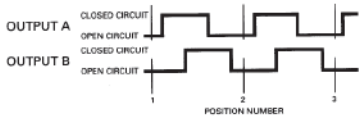
703 Series



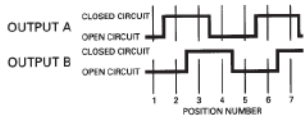
701 Series or 704 Series

Truth and Output Tables

QUADRATURE CODE FULL CYCLE PER DETENT
(12, 16, 24 POSITION)



QUADRATURE CODE 1/4 CYCLE PER DETENT
(12,16, 24, 32, OR 36 POSITION)



QUADRATURE CODE
FULL CYCLE
12, 16, 24 POSITION

SWITCH POSITIONS	OUTPUT A	OUTPUT B
1	•	
	•	•
		•
2		
	•	
	•	•
		•
3		
	•	
	•	•
		•
4		
	≈	≈
24		•

QUADRATURE CODE
1/4 CYCLE
ALL POSITION

SWITCH POSITIONS	OUTPUT A	OUTPUT B
1		
2	•	
3	•	•
4		•
5		
6	•	
7	•	•
8		•
9		
10	•	
11	•	•
12		•
13		
	≈	≈
XX	•	•
36		•

• INDICATES LOGIC LOW

GRAY CODE
16 POSITION (*)

SWITCH POSITIONS	OUTPUT 1	2	4	8	16
1					
2	•				
3	•	•			
4		•			
5		•	•		
6	•	•	•		
7	•		•		
8			•		
9			•	•	
10	•		•	•	
11	•	•	•	•	
12		•	•	•	
13		•		•	
14	•	•		•	
15	•			•	
16				•	

* - 12 position gray code is the same as a 16 position without positions 11 through 14.

GRAY CODE
32 POSITION (**)

SWITCH POSITIONS	OUTPUT 1	2	4	8	16
17				•	•
18	•			•	•
19	•	•		•	•
20		•		•	•
21		•	•	•	•
22	•	•	•	•	•
23	•		•	•	•
24			•	•	•
25			•		•
26	•		•		•
27	•	•	•		•
28		•	•		•
29		•			•
30	•	•			•
31	•				•
32					•

** - 24 position gray code is the same as a 32 position without positions 21 through 28.

Ordering the 700 Series Encoder

Code
700: Quadrature
701: Quadrature with Push-button
702: Absolute
703: Resistive
704: Resistive with Push-button

Electrical Cycles or Resistive Value
700: 06, 08, 09, 12, 16, 24, 32 or 36
701: 06, 08, 09, 12, 16, 24, 32 or 36
702: 01
703: 05K or 10K
704: 05K or 10K

Number of Detent Positions
700: 12, 16, 24, 32, 36 or 00: No Detents
701: 12, 16, 24, 32, 36 or 00: No Detents
702: 12, 16, 24, or 32
703: 00: No Detents
704: 00: No Detents

701 — **08** — **32**

700 Series Standard Offerings

700-09-36	701-08-32	702-01-12	703-05-00	704-05-00
700-16-16	701-04-16	702-01-16	703-10-00	704-10-00
700-24-24	701-06-24	702-01-24		

Specifications

Current Carrying Capacity	Resistive 0.5 watt
Switching Load	1mA at 115 VAC, 15mA at 14 VDC
Shock Humidity	MIL-STD 202E
Dielectric Strength	750 volts
Contact Resistance	1 ohm typical
Contact Bounce	5 ms @ 15 RPM
Contacts	Phosphor-bronze gold interface with program board
Codes	Resistive, Quadrature, A/B, Binary, Gray
Code Program	Non-shorting typical
Operating Forces	16 position = 7.5 in.-oz. ±20%, 36 position = 4.5 in.-oz. ±20%
Life	50,000 cycles (50% loss in torque over life. High temperature operation will reduce detent life.)
Operating Temperature	-40°C to +85°C
Shaft Material	Molded plastic
Anti-Rotation Device	Flatted mounting bushing .375" dia. x .320", double "D"

Detent Angles	36°, 30°, 22.5°, 15°, 11.25°, 10°; others upon request
Molded Construction	Valox plastic rated 94 V-0 or better
Board Material	FR-4 with 1 oz. copper clad, plated
Push-Button Characteristics	Stroke: .065 ±.015
	Push-Button Force: 15 oz. max.
	Push-Button Resistance: 80 ohms max.
	Torque: 12, 24 position = 1.6 ±.3 in.-oz.
	Torque: 16 position = 2 ±.3 in.-oz.
	Torque: 32, 36 position = 1.2 ±.3 in.-oz.
	Contact Resistance: 5 ohms max.
	Contact Bounces: 5 ms max. @ 15 RPM
	Push-Button Life: minimum 250,000 operations

700 SERIES
MECHANICAL ENCODERS

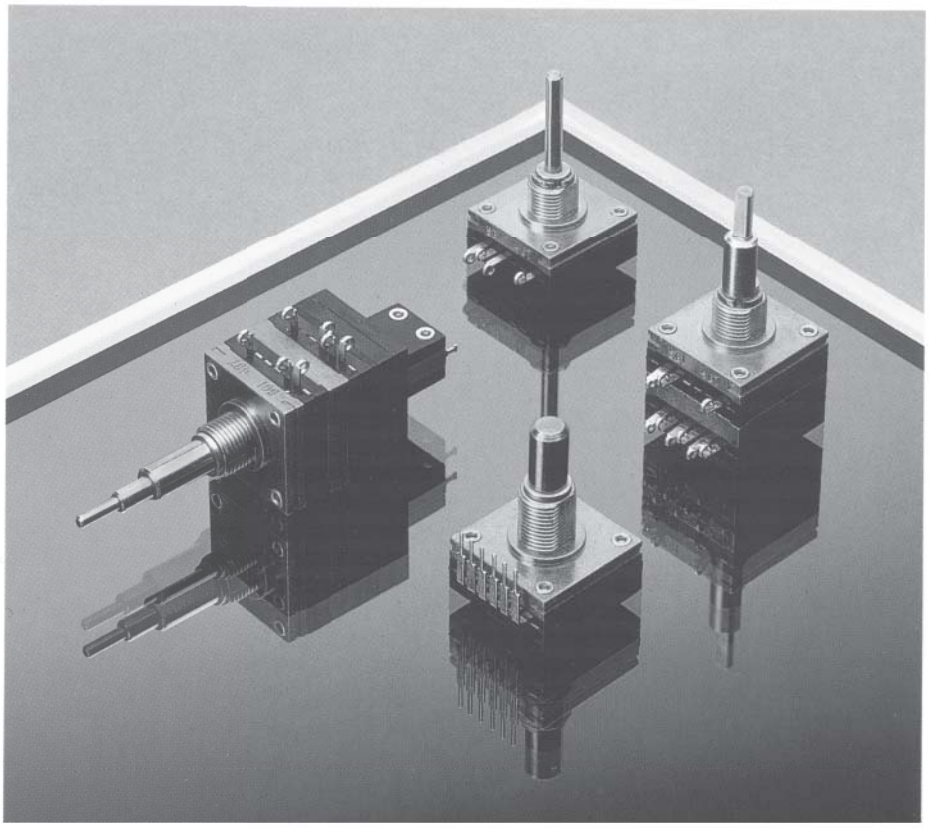
ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

MM P/Rel ROTARY SWITCHES

The MM P/Rel Series represents the best in contemporary rotary technology, and reflects the high standards of reliability which have made ELECTROSWITCH rotary devices known worldwide. At only .865" square, these compact switches have up to 36 positions and adapt to numerous design requirements. Strong, electron-welded PC terminations permit easy insertion into printed circuit boards.

Stainless steel detents provide long term performance and increased stop strength. Durable construction and an enclosed, high-temperature-resistant design make the MM P/Rel Series ideal for wave solder applications. Contacts are insert molded in place for lifetime registration and switching accuracy.

Precious metal contacts ensure a long service life of over 50,000 cycles. Available options include concentric shafts and metric shafts and bushings. Highly versatile and economically customized, the MM P/Rel Series is the cost-effective solution for a wide range of applications.



Applications

Defibrillators
Voltage control

Oscilloscopes
Scale input control

Avionics
Radio channel select, Auto pilot select

GPS (Global Position System)
Co-ordinates input

Commercial & Military Radio
Channel select

Voltage Regulators
Limit set device

Agricultural
Combine platform height select

Postage Meter
Selectors input

X Ray
Intensity input

General Specifications

Electrical/Mechanical Characteristics

Current Carrying Capacity
Resistive load
250 MA at 28 VDC

Shock Humidity
MIL-STD 202E

Code Program
Shorting or non-shorting (non-shorting versions, up to 16 positions only)

Dielectric Strength
From pole to shaft 1,000 volts minimum

Contact Resistance
75 milliohms maximum, over lifetime

Contacts
Phosphor-bronze with silver inlay at interface with program disc. Gold inlays available upon request. External terminals are solder (60-40) plated except on die cut edges.

Codes
Hexadecimal, B.C.D., Gray and others on special order

Switching Loads
1.5 MA at 115 VAC
150 MA at 14 VDC

Operating Forces
(torque over detents): 7 to 20 in./oz. ±25%

Life
50,000 minimum cycles at rated load

Stop Strength
15 in./lb. minimum

Operating Temperature Range
-55°C to +85°C (105°C optional)

Sealing
Terminals are insert molded into housing. Front and rear molded sections of module are interlock construction. Ideally suited for wave soldering.

Shafts and Hardware
Shafts and hardware are steel, cadmium plated and chromate treated. Detent parts, including stops, are stainless steel.

Anti-Rotation Device
Flatted mounting bushing
.375" dia. x .320", double "D"

Concentric Shafts
Available

Detent Angles
90°, 60°, 45°, 36°, 30°, 22.5°, 20°, 18°, 15°, 12.8°, 11.25°, 10°

Molded Construction
Molded parts are Ryton R4 and Polyester PBT, chosen for heat resistance and electrical characteristics. Rated 94 V-O or better.

Disc Construction
Program disc is glass epoxy, copper clad with silver plating standard. Gold upon request.

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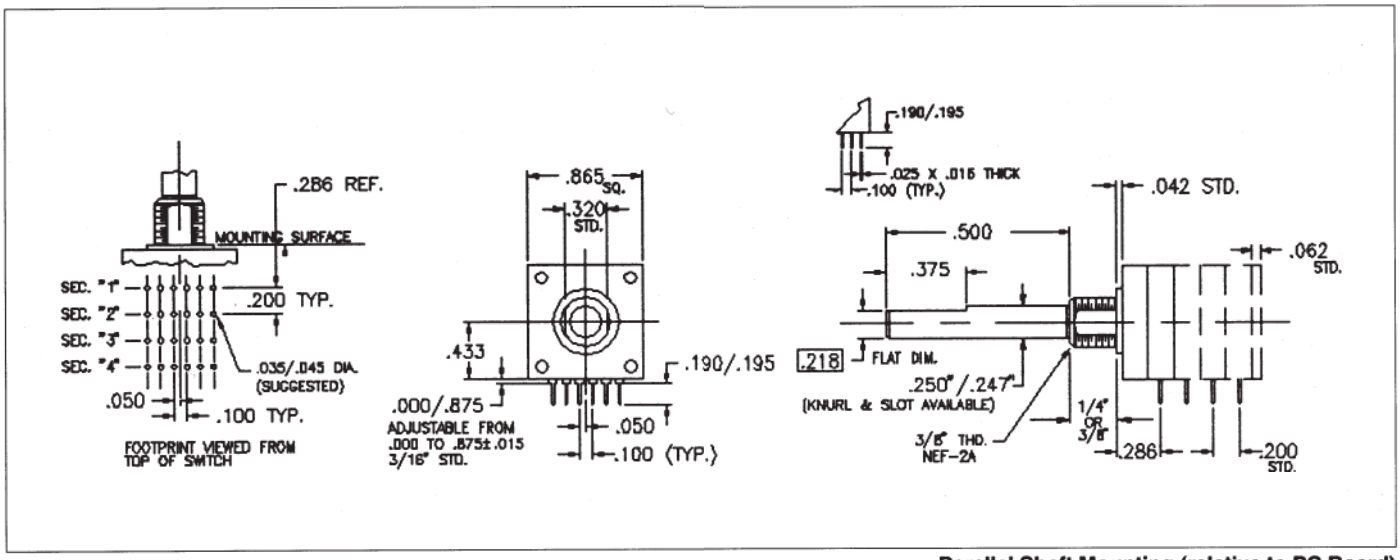
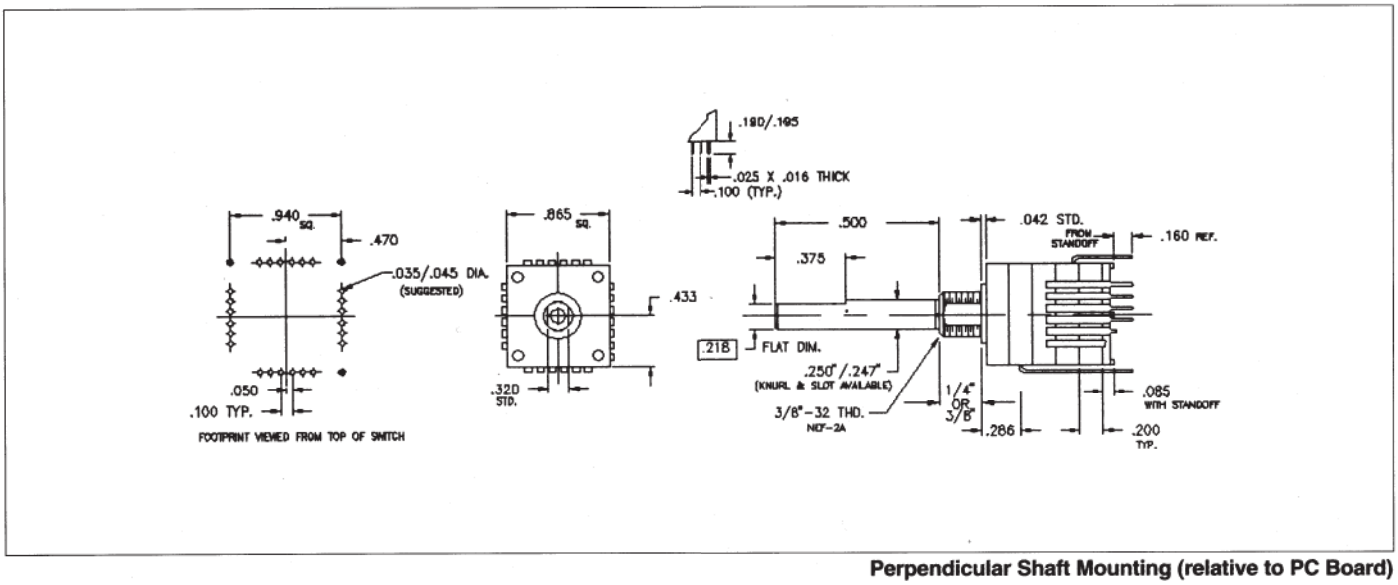
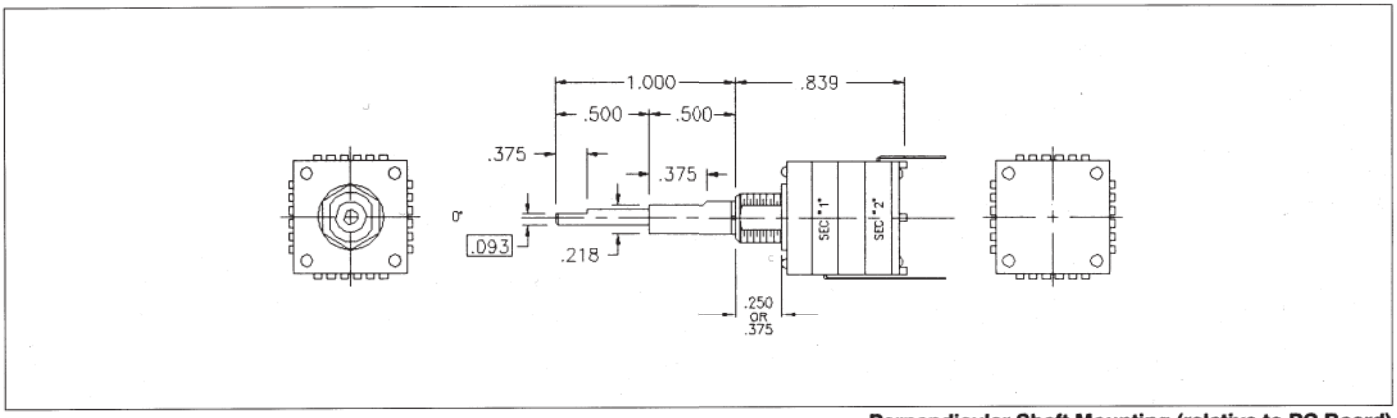


Parallel Shaft Mounting (relative to PC Board)



Perpendicular Shaft Mounting (relative to PC Board)



Perpendicular Shaft Mounting (relative to PC Board)

ELECTROSWITCH
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UNIT OF ELECTRO SWITCH CORP.

MM P/Rel
ROTARY
SWITCHES

SOLENOID ASSEMBLIES

PROFILES OF SUCCESS

Affordable, Application-specific Solenoid Solutions

Our creative engineering process is Electroswitch's unique ability to work one on one with customers to develop the industry's only truly affordable application-specific solenoid assembly. To illustrate this process, we've featured several case studies describing the challenges and innovative solutions we have achieved for four very different types of solenoids.

In each case study, starting with a standard solenoid, we designed a solution integrating the customer's solenoid requirements into an application-specific assembly. Then - and this is the remarkable part - we provided the entire assembled package for less than the combined cost of the ready-made parts.

Yes, Custom for Less than Off-The-Shelf

How do we do it? Electroswitch has fifty years of solenoid engineering expertise, and a tradition of focusing that expertise on each individual customer's solenoid problem. With our advanced engineering software capabilities and long-term experience in developing application-specific solenoid assemblies, we already have the immediate expertise to meet your design needs.

Let Us Achieve Success for Your Company

For each of the companies featured in these case studies, our "perfect fit" assembly increased performance efficiency, decreased the number of components and reduced the manufacturing costs. Let us design a solution for you. Call us for a free no obligation consultation.

HOUSING STYLES

BALL RACE ROTARY

Uses angled ball traces to convert a linear force into a rotary force. High starting torque, high speed and long life.

BRUSHLESS ROTARY

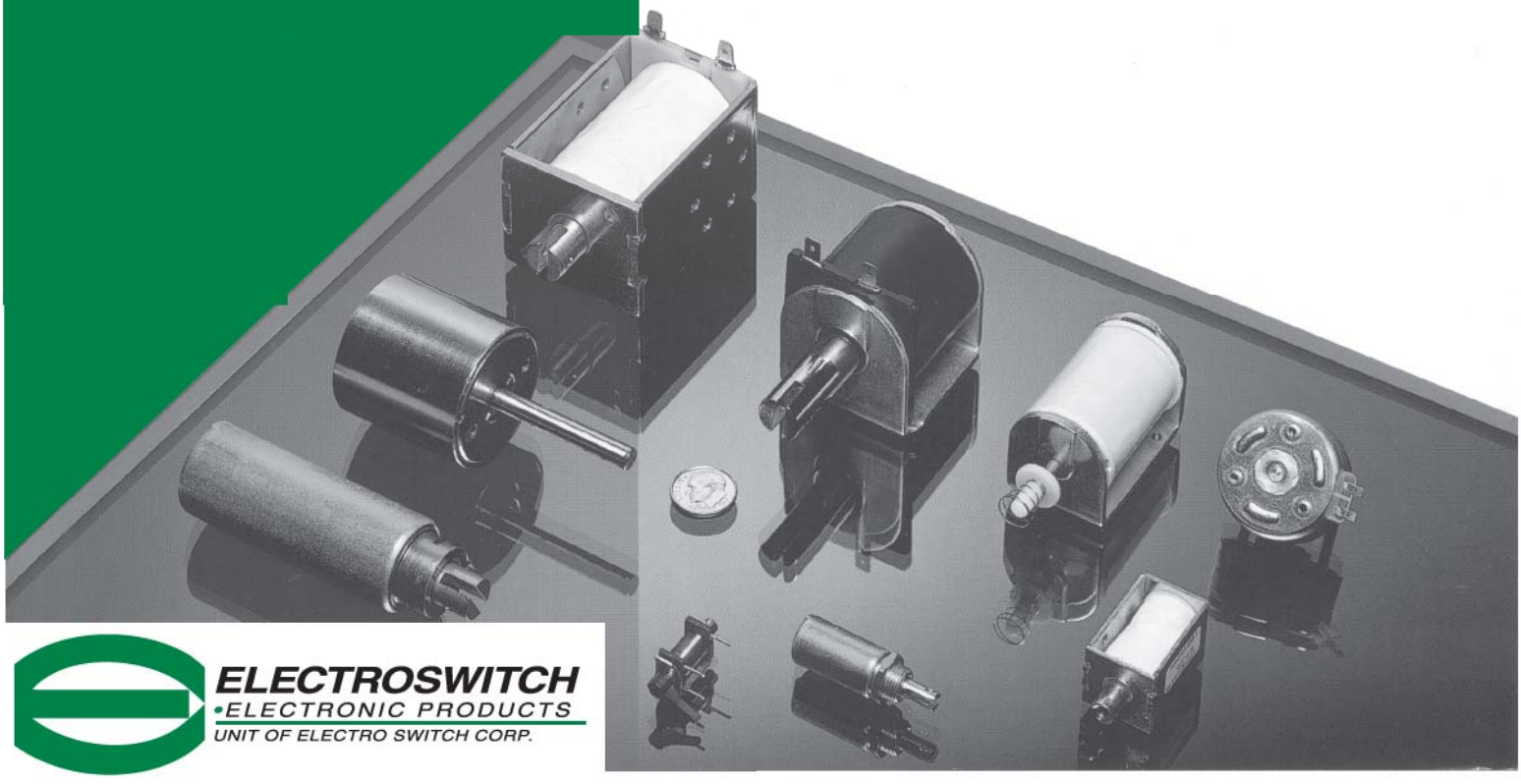
Converts a linear force directly into a rotary force without any contacting parts. Medium starting torque, high speed, and long life.

C & D BOX FRAME

Low-cost linear solenoid can be customized to specific applications. Multiple sizes, DC or AC, with terminals or lead wires.

TUBULAR

DC solenoid constructed to maximize linear force. Available with bushing mount, good heat dissipation and long life.



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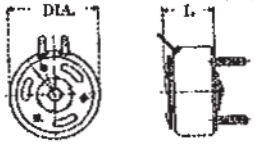
UNIT OF ELECTRO SWITCH CORP.

ROTARY SOLENOIDS

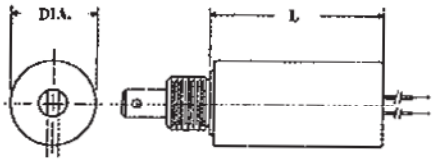
Voltage (DC)	Type	Size (D x L)	Stroke/Motion (Right/Left Hand Strokes)	Starting Torque
6, 12, 24	2NE	1.125" x .716"	25°, 35°, 45°	up to 1.4 lb in
	3NB	1.312" x .718"	25°, 35°, 45°, 67.5°	up to 2.7 lb in
Duty Cycles	5NB	1.875" x 1.265"	25°, 35°, 45°, 67.5°, 95°	up to 8.3 lb in
Int., Cont.				



Note: Standard rotary solenoid uses needle bearing for increased life and performance.

TUBULAR SOLENOIDS - PUSH/PULL TYPE

Voltage (DC)	Type	Size (D x L)	Type	Size (D x L)
6, 12, 18, 24, 48	C7-18	7/16" x 1 1/8"	C12-24	3/4" x 1 1/2"
	C8-14	1/2" x 7/8"	C16-18	1" x 1 1/8"
Duty Cycles	C8-24	1/2" x 1 1/2"	C16-32	1" x 2"
Int., Cont.	C8-32	1/2" x 2"	C24-26	1 1/2" x 1 5/8"
			C24-38	1 1/2" x 2 3/8"



Force Range
up to 7.5 lbs @ 1/4" stroke

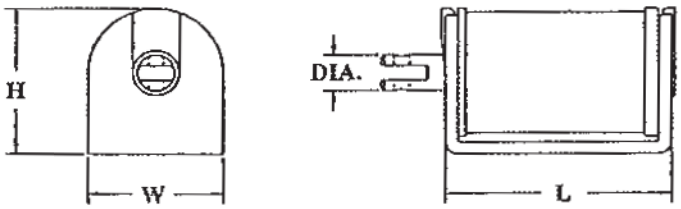
D FRAME SOLENOIDS - PULL TYPE

Voltage (DC)	Type	Size (W x H x L)
6, 12, 24, 48	34	.750" x .750" x .765"
	35	.750" x .750" x 1.187"
Duty Cycles	37	.937" x .812" x 1.625"
Int., Cont.	40	1.828" x 1.562" x 2.625"
	42	1.218" x 1" x 2"

Force Range
up to 10 lbs @ 1/4" stroke

C FRAME SOLENOIDS - PUSH/PULL TYPE

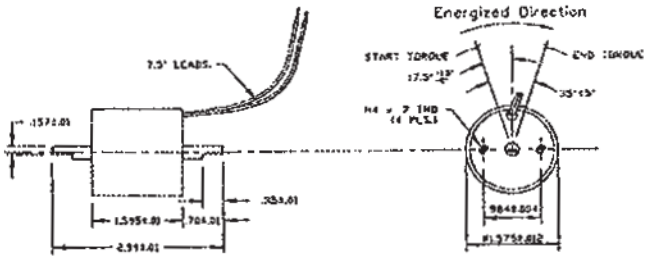
Voltage (DC)	Size (W x H x L)
12, 24, 36	1.13" x 1.28" x 1.84"
	1.56" x 1.70" x 1.70"
Duty Cycles	**Force Range**
Int., Cont.	up to 6 lbs @ 1/4" stroke



ELECTROMECHANICAL TORQUE ACTUATORS

Voltage (DC)	Size (D x L)
6, 12, 24, 48, 120	1.575" x 1.595"
Duty Cycles	**Starting Torque**
Int., Cont.	up to 5 lb in

Note: Various shaft dimensions available upon request.



APPLICATION-SPECIFIC SOLENOIDS

Electroswitch has the unique ability in developing application-specific solenoid assemblies. With our advanced engineering software capabilities and long-term experience in developing application-specific solenoid assemblies, we already have the immediate expertise to meet your design needs. Electroswitch provides a custom cost-saving solution for your application.

We begin with a standard solenoid, and design an assembly which will integrate the specific solenoid function. Our "perfect fit" assembly increases performance efficiency, decreases the number of components and reduces manufacturing costs. Let us design a solution for you.

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•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

SOLENOID ASSEMBLIES

If you have a solenoid challenge,

Diverters

The Challenge

A manufacturer of automated industrial equipment came to Electroswitch with a new concept for a diverting device. This customer was adamant that the diverter be produced with the performance characteristics defined by their development team. In the past, they experienced frustration with other solenoid suppliers who were only successful in building prototypes. When these prototypes went into volume production, the product consistently failed to meet specifications.

The Solution

Among the several suppliers evaluated, only Electroswitch was able to build to the customer's design specifications, and produce a low cost solenoid at high volume production. Our key to success was incorporating computer aided manufacturing (CAM), which guaranteed the accuracy of precision tolerances within the rotary solenoid.

Electroswitch's long-term commitment to cell manufacturing - including computer aided auditing of production - paid off for everyone. Due to the device's high degree of accuracy required, it was critical that the production process utilize the computer controlled test equipment developed exclusively by Electroswitch engineers. This guaranteed that the product coming off the process would meet the customer's specifications each and every time.

In this application, Electroswitch's special expertise in CAM ensured that the quality went beyond the prototype stage to stay consistent in high volume production.

Locking Mechanism

The Challenge

A manufacturer of point-of-service equipment faced several dilemmas in the design of their cash register drawer locking mechanism. Electroswitch was informed that the solenoid needed to be extremely compact due to size constraints in the design. We were also charged with keeping costs low at a medium-volume production level, and we had to overcome the security flaws of the original design which intensified the challenge.

The Solution

In this type of application, when a signal is received by the solenoid, a plunger pushes the lever to unlock and open the drawer. In the previous design, the solenoid's plunger had a fixed linkage to the lever. A physical impact to the outside of the drawer would override the solenoid and push the lever into motion, opening the drawer. Electroswitch addressed this security design flaw by developing a soft linkage, which prevented a physical impact from unexpectedly tripping the lever. This improvement meant that the drawer could only be activated by energizing the solenoid to push the lever, releasing the drawer.

Through creative reengineering, Electroswitch successfully met this customer's unique security, design and budget requirements. Let us do the same for you!

we have a solenoid solution.

Flow Control

The Challenge

A leading manufacturer of medical equipment needed a solenoid to control a valve which in turn controlled two lines. The solution had to be low cost with minimum tooling. The value manifold system must also withstand very high pressure with little maintenance. Although the valve normally remained open, low power consumption on the solenoid coil was critical to ensure continuous energized operation when the valve was closed. Further, this customer sought a solution that was compatible with their installation process, and had to retrofit existing products in the field.

The Solution

We proposed a very simple approach that eliminated couplings at the manifold, as well as the potential leaks and contamination issues of other designs. This approach made installation as easy a spiacing the solenoid's body into a holder, snapping the hose lines into a manifold and plugging in the connector. Because only the manifold required tooling, costs were kept low. We utilized a tubular solenoid for the solenoid valve, which minimized power consumption and maximized valve strength. The power consumption required to hold the valve closed during operation was lowered to eliminate heat rise problems.

By carefully analyzing the problem and providing a simple, low cost solution, Electroswitch gained another satisfied customer.

Pusher

The Challenge

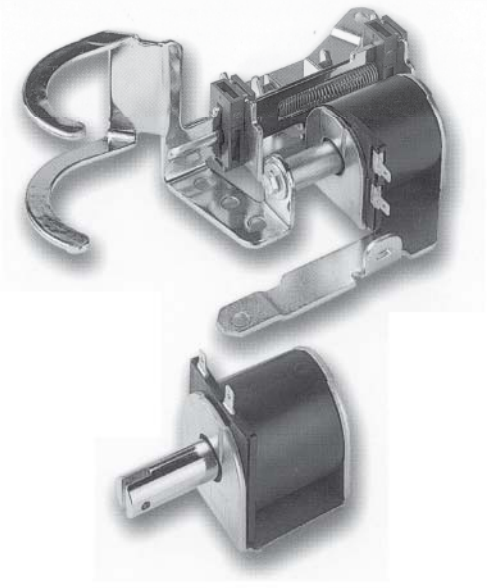
A major manufacturer of automated industrial sorting equipment needed a solenoid to retrofit into their existing equipment. This equipment required life specifications at 10 million cycles, which is ten times the industry standard. The customer was also under a very tight time constraint. Normally, the life cycling of plastics takes months to test at normal operating speeds because of the heat rise within the solenoid coil.

The Solution

To retrofit into the existing equipment and space, Electroswitch's engineers designed a very compact, linear solenoid. By combingin multiple stampings into one, we incorporated a C-Frame solenoid onto the main bracket of the assembly without welding or using rivets. This reduced the piece part count and improved both quality and manufacturability.

Electroswitch then experimented with different plastics and metal platings to increase life expectancy. Finally, we developed a low temperature testing method which decreased the overall testing time from months to days to help the customer meet their delivery time frames.

Thanks to flexible, innovative engineering approaches and early quality involvement, Electroswitch economically increased the life of the solenoid, reduced part count and assembly time, improved quality, and delivered the product on time.



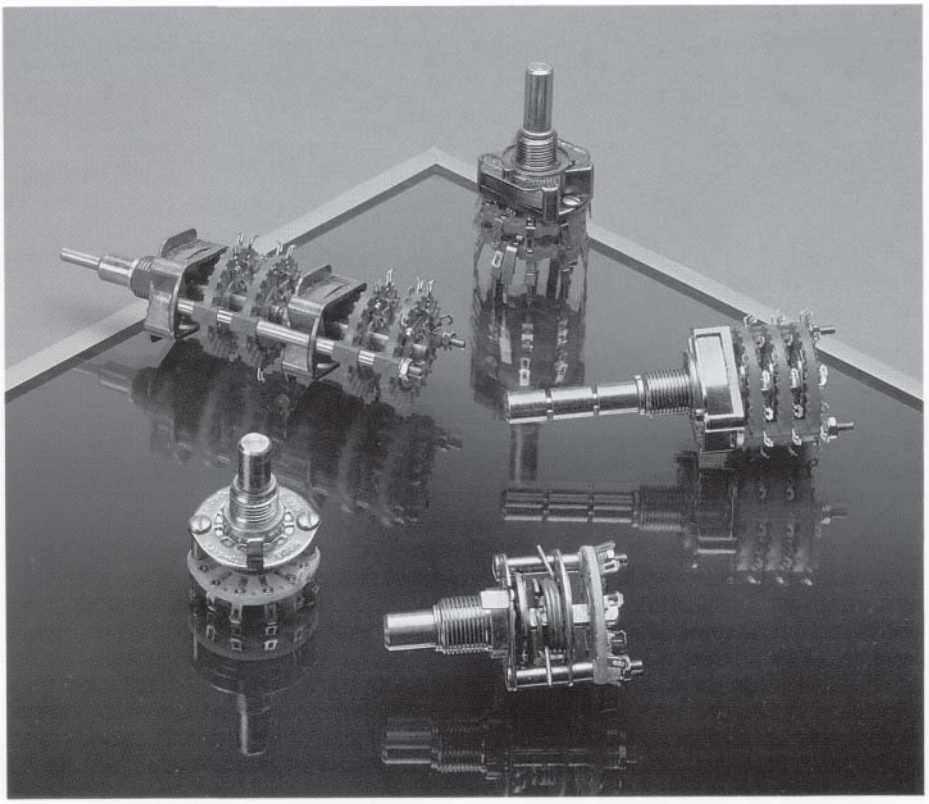
OPEN FRAME
SWITCHES

As the leading manufacturer of Open Frame Switches, ***ELECTROSWITCH*** is well known throughout the electronics industry. These versatile switches incorporate their patented double wiping contacts which are self-cleaning and require no maintenance during life under normal operating conditions. The self-cleaning action assures a clean, positive contact capable of wiping through accumulated particles or dust, oxides, and other contaminants.

Both unidex and ball bearing indexing are available. Unidex, a major improvement in indexing switches, is a dual ball detent indexing on a starwheel. This detent offers 100,000 cycles of mechanical life, with the torque remaining constant and crisp throughout the life of the switch.

Ball bearing indexing is offered in single, dual, or tri-ball indexing over a hill and valley or punched hole plate. This index is common to ***ELECTROSWITCH***'s Type L and Type MF switches.

ELECTROSWITCH's Open Frame Switches have been used successfully for decades in the areospace industry, test and measurement equipment, and demanding military applications.



General Specifications

Stop Strength
One fixed stop, 15 inch-pounds; one adjustable stop, 10 inch-pounds

Life
10,000 cycles minimum. Room temperature, rated load

Ambient Temperature
-65°C to +85°C

Hardware
Includes .375" -32 mounting nut, lockwasher, and adjustable stopwasher

Finish
Suitable to withstand 50 hour salt spray per MIL-S-3786

Note
Mechanical and electrical specifications through rated life after break-in.

Feature Summary

	A	F/FC	JC	K	L	MF
Strut Size	.812	1.032	1.250	1.250	2.000	2.000
Envelope Size	1.180	1.312	1.531	1.531	2.312	2.312
Maximum Positions	12	12	12	12	18	24
MIL-S-3786 Style	SR05	SR03	SR02	SR02	SR10	SR09
Index Mechanism	Unidex	H+V	H+V	H+V	H+V	H+V
Insulation Material	Diallyl	Phenolic/ Ceramic	Ceramic	Phenolic	Phenolic	Phenolic
Electrical Carrying @ 28VDC	.5 amp	1 amp	1 amp	1 amp	1 amp	1 amp

Open Frame Rotary Switch Design Chart

Basic Switch Type		A	F	JC/K	L	MF
MIL-S-3786 Style		SR05	SR03	SR02	SR10	SR09
Envelope Area Over Standard Terminal Bend		1.06" 26.9mm	1.47" 37.3mm	1.50" 38.1mm	2.31" 58.6mm	2.31" 58.6mm
Maximum Positions	**Index Angle**					
4	90°	A	F			
6	60°	A, AM	F			
8	45°	AA	AF	AK		
10	36°	BA	BF	BK		
12	30°	A, AM	F	JC/K		MF, MFE
14	25.7°			CK		
16	22.5°			EK		
18	20°				L, DL	
24	15°					MF, MFE
Insulation Material Available						
Phenolic			F, AF, BF	AK, BK, K, CK,EK	L, DL	MF
Silicone Glass		A, AA, BA	FE	CK, KE		MFE
Ceramic			FC	JC		
Diallyl Phthalate		AM	FJ			
Thermoplastic Polyester			FG			
Index Mechanism	Unidex	X	X			
Shafts Available	Single	X	X	X	X	X
	Concentric	x	x	x	x	x

Optional features available are adjustable stops, momentary positions, pull or push to turn, and unidirectional operations.

Switch and Current Voltage Ratings

Switch Type	Material	Make/Break Current	Make/Break Voltage	Carry Continuous	Applications	Breakdown Voltage
A	Silver	1 amp .5 amp	28 VDC 110 VAC	5	Commercial	750
F, K, JC	Silver	2 amp 1 amp	28 VDC 110 VAC	5	Commercial	1,000
L, MF	Silver	2 amp 1 amp	28 VDC 110 VAC	5	Military	1,000

Note: 500V RMS maximum between the contacts mounted on opposite sides of stator in a common position.

Contact Materials and Definitions

To provide economical switches without sacrificing reliability, ELECTROSWITCH has developed contact materials with precious metal inlays and overlays. These are being used in many applications, replacing solid precious metals which were the industry standard. In keeping with our philosophy, new contact materials must meet or exceed all existing standards and must not adversely affect switch performance.

Contact materials that are not gold plated have a protective anti-tarnish coating applied after plating to inhibit oxidation during assembly, shipping, and storage.

The contact materials described provide for a full range of switching applications, from dry circuitry to 1 amp at 110 VAC. Current and voltage ratings on resistive loads at room ambient operating temperatures should not exceed those shown.

ELECTROSWITCH developed double wiping contacts for their rotary switches which are self-cleaning and require no maintenance during life under normal operating conditions. The self-cleaning action assures a clean, positive contact capable of wiping through accumulated particles or dust, oxides, and other contaminants.

Non Shorting Type Switch—also called "break before make." When switching from one position to the next, the first contact fully breaks before the second contact is made.

Shorting Type Switch—also called "make before break." When switching from one position to the next, the second contact is closed before the first is opened.

Cycle—is defined as a rotation from one stop to the other and return or 330° rotation for a 12 position switch. An operation is normally defined as the making and breaking of an electrical contact.

Contact Materials

Contact Material	Suggested Maximum Operating Temperature	Typical Life Cycles (No load, room ambient)	Suggested Application
Brass, silver plated with protective anti-tarnish coating (OMS106, CMS237, CMS80)	+100°C	10,000 cycles	Commercial
Special spring base material with silver alloy rolled on contact surface (CMS333)	+100°C	100,000 cycles Silver-to-silver contact	Commercial
	See MIL-S-3786 & QPL List	100,000 cycles Silver-to-silver contact	Military
Spring silver alloy (OMS132)	+100°C	200,000 cycles Silver-to-silver contact	Commercial & Military Increased life

Insulation Materials

The table below lists the types of stator and rotor insulation now available for ELECTROSWITCH's rotary switches.

Insulation Material	MIL Specification	Temperature Range (Non-Military)
Phenolic	L-P-513 Type PBE-P	-65°C to +100°C
Glass Silicone	MIL-P-997 Type GSG	-65°C to +85°C
Ceramic	MIL-1-10 Grade L-422	-65°C to +150°C
Diallyl Phthalate	MIL-M-14	-65°C to +85°C
Glass Epoxy	MIL-P-18177 Grade GEE	-65°C to +85°C

Lubrication of Contacts

All switch sections are lubricated using a process which deposits a very thin film on the rotor blades. This film is of sufficient thickness to provide lubrication for the life of a normally hand-operated switch. The film of lubricant will not readily collect dust and dirt, which could lead to reduced switch life.

Various lubricants that are compatible chemically and electrically are used. Lubricant used is dependent on switch specification and operation. If customer switch specification specifically calls for no lubricant, none will be applied.

Soldering to *ELECTROSWITCH* Switches

Care must be exercised when soldering to *ELECTROSWITCH* switches. Soldering irons, which can produce temperatures above 600°F should not be used. Excessive heat or prolonged periods of heating (above 5 seconds) can cause clips to loosen, and contribute to an increase in contact resistance due to a loss of contact pressure.

Never clean rosin from soldered connections on a switch or any other contacting device with solvent. Rosin dissolved by a solvent may float down onto the contacts where it cannot be removed easily, and no amount of contact pressure can cope with a rosin coating.

Type of Detent

Unidex—a dual ball detent indexing on a starwheel. This detent offers 100,000 cycles of mechanical life, with the torque remaining constant and crisp throughout the life of the switch. It should be used in place of ball index where possible.

Ball Index—single, dual or tri-ball indexing with ball bearing indexing over a hill and valley or punched hole plate. This index is common to the Type L and MF switches. The tri-ball index must be used for military switches.

Detenting Torque

Proper detenting torque is necessary to give the right feel to the switch. An approximate torque figure can be obtained by adding all the clips which are in contact with the rotor blade(s), and then adding the maximum number of clips entering in any one detented position. This figure, multiplied by 1 inch-ounce, will give an approximate but usable torque value. In order to mask out this drag, the detent mechanism itself must have at least 1½ times the torque of the section(s). This means that the total switch torque should be at least 2½ times the section torque for a crisp feel. The typical tolerance on the torque requirement is ±40%. If a closer torque tolerance is required, adjustments will be necessary (at additional cost).

In cases where clip and blade drag is greater than can be accommodated by a specific index, definite feel of index position becomes vague and there is a tendency to skip positions. Thus, in order to obtain a definite detent "feel," it is necessary to reduce section drag by using a thinner clip material or special slotted, low torque clips. (Consult our Application Engineering Department. They will gladly provide any information or assistance you might request.)

Maximum torque is related to the size and type of knob being used on the front panel. For a comfortable turning force, the following torque values are recommended:

½ in. dia. knob ..... 8 to 15 in.-oz.
¾ in. dia. knob ..... 10 to 20 in.-oz.
1 in. dia. knob ..... 15 to 35 in.-oz.
1½ in. dia. knob ..... 20 to 50 in.-oz.

(Bar knobs or deeply knurled knobs can be used with higher torques for the same size knob.)

Identification Marking of Switches

Oak switches are marked "249," our registered trademark, or "Oak." Our manufacturer's federal identification code number is 76854. These numbers do not identify any particular switch or item.

When specified, rotary switches may be marked with either the Oak part number or customer's part number. Since changes made in production might cause obsolescence of parts already marked, it is impractical to stamp revision letters.

Rotary Switch Terminology

FRAME

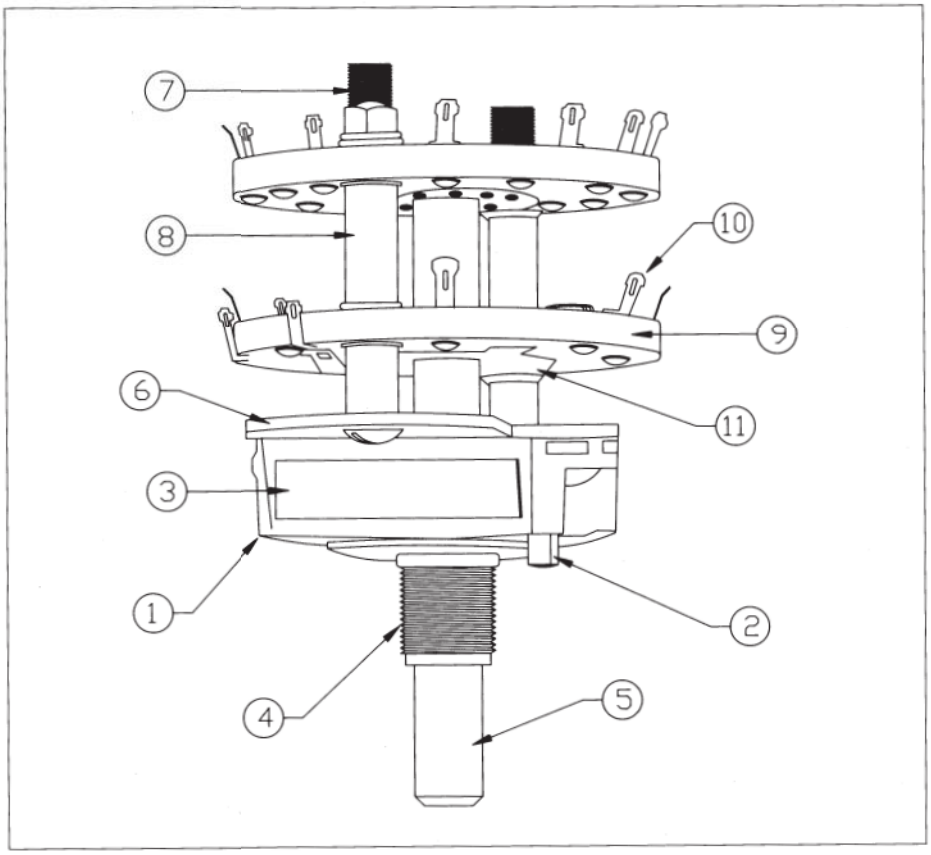
The frame includes those parts required to (A) support the switch sections, (B) fasten the switch to a mounting surface, and (C) index the shaft rotation. Included in the frame are:

1. **Unidex Housing**—The basic element of the frame. Includes indexing balls and springs and operates in conjunction with the index star wheel.
2. **Locating Tab**—An integral part of the Unidex housing used to prevent the switch from rotating with the shaft when mounted.
3. **Index Springs**—Provide necessary pressure to have snap action from one position to the next.
4. **Bushing**—An integral part of the Unidex housing used to provide the bearing surface for the shaft. The outside of the bushing is threaded and used for mounting the switch.
5. **Shaft**—Turning the shaft changes the position of the rotors in relation to the stators, altering the electrical path.
6. **Adapter Plate**—Used on some types of switches to facilitate mounting the Unidex housing to these switch frames. Not required on the Type A, F, or Multidex.
7. **Screws with Lockwashers and Nuts**—Fasten switch sections to the front plate.
8. **Spacers**—Separate switch sections from each other and from the front plate.

SWITCH SECTION

The switch section provides the electrical conductors that make and break the actual circuit. Parts included are:

9. **Stators**—Insulating material on which the contacts are mounted. The stator is rigidly attached to the frame.
10. **Contact**—Electrical conductor mounted on the stator.
11. **Rotor**—A round piece of insulating material on which are mounted metal conducting strips. The rotors turn within the center of the stator completing the electrical path between contacts.



Unidex is a major improvement in indexing switches. Its advantages are:

- Torque feel is tailored to customer's requirements.
- Simple construction.
- High reliability.
- Long life. Surpasses present indexes by thousands of operations.
- Close tolerances—a specific torque is available within closer limits than possible with other indexes.
- Greater uniformity of indexing. A more precise feeling is provided on every index.
- Greater protection from dust and abrasives by shielded housing.
- Guaranteed electric continuity between the mounting bushing and front plate. Housing is simple casting.
- Torque range accommodates most applications. 8 inch-ounces to 60 inch-ounces. Higher range on request.
- Speedy delivery. Simplication of design reduces production problems.

Type A (Acorn)

1 inch diameter switches with ELECTROSWITCH's patented Unidex® detent for positive action, feel and torque control. Double-wiping, self-cleaning contacts in silver plated brass, or silver alloy. Unique protective coating guards against tarnish and corrosion, extends shelf life.

Specifications

Size
1" diameter nominal, with 1 to 3 sections. Max. depth, 1.281"

Mounting
Clearance holes for a .375" -32 bushing and a .120" diameter locating key on a .375" radius

Shaft
.250" diameter (+.000 -.003); 1.50" long; grooved for break-off at .75" and 1.125" from mounting surface

Indexing
Unidex® dual ball, 30°

Terminal Strength
2.5 lb. pull

Stator Insulation
Diallyl phthalate per MIL-M-14

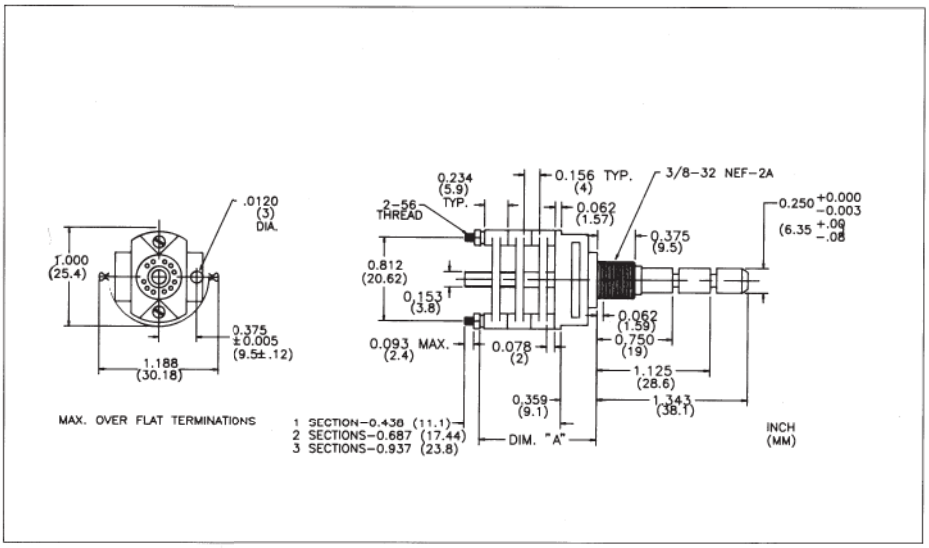
Rotor Insulation
Thermoplastic

Section Thickness
.078"

Contacts
Silver-plated brass or silver alloy. Protective coating extends shelf life

Contact Resistance
.003 to .015 ohms between adjacent clips

Electrical Rating
Break .5 amp at 28 volts DC, .25 amp at 110 volts AC, resistive. Carry 5 amps



Type AM Switch Assemblies

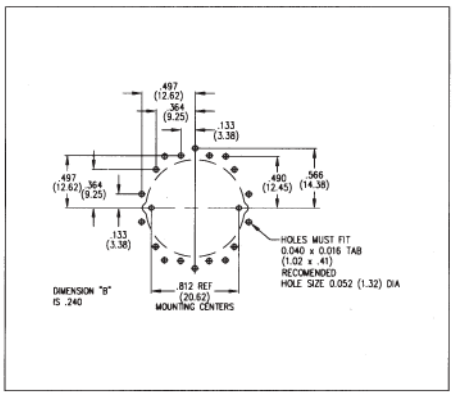
With silver-plated brass contacts and solder terminals

Total Poles	Active Positions	Poles/Section	Figure Number§	Number of Sections	Catalog Number	
					Shorting	Non-Shorting
1	2-12	1	1	1	399279-AM	399280-AM
2	2-6	2	2	1	399281-AM	399282-AM
2	2-12	1	1	2	399283-AM	399284-AM
3	2-5	3	7	1	399260-AM	399261-AM
3	2-12	1	1	3	399285-AM	399286-AM

§See standard printed circuit configurations, page 11.

Type A Switch Components

Basic Type A components provide the additional flexibility of meeting specific design requirements through distributor assembly of these components into other switch configurations.



PC Hole Pattern

Type A Rotary Section

AM rotary sections with silver-plated brass contacts and solder terminals

Total Poles	Active Positions	Section Type	Figure Number§	Catalog Number	
				Shorting	Non-Shorting
1	2-12	Standard	1	399114-AM	399174-AM
2	2-6	Standard	2	399115-AM	399175-AM
3	2-5	Standard	7	399106-AM*	399107-AM
1	2-12	Notched Blade	9	399117-AM*	---
1	2-10	Consecutive Shorting	10	399118-AM*	---
1	---	Capacitor Decade	12	---	399177-AM*
1	---	Resistor Decade	13	---	399178-AM*
1	---	Binary Coded 0-11	11	---	399259-AM*
With printed circuit terminals					
1	2-12	Standard PC	1	399136-AM*	399137-AM*
2	2-6	Standard PC	2	399138-AM*	399139-AM*
3	2-5	Standard PC	7	399156-AM*	399157-AM*
Type A 'PCB' sections with silver alloy printed circuit terminals, glass epoxy insulation					
1	2-12	APCB	21	4-1432-755*	4-1442-140*
2	2-6	APCB	20	4-2552-115*	4-2552-415*

§See standard printed circuit configurations, page 11.
*Available made-to-order only.

Shaft and Index Assemblies

Includes mounting nut and lockwasher, stopwasher, strut screws, assorted spacers, washers, and nuts.

Catalog Number	Dimension "A" (See Drawings)
399257-A	1.375" (35.0 mm)
399258-A	4.875" (123.8 mm)

Custom Applications Available

ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

Type F
Type FC

1.312 inch diameter switch with dual ball-type indexing for a positive feel and uniform torque. Double-wiping, silver-plated brass contacts, or silver alloy. Unique protective coating guards against tarnish and corrosion, extends shelf life. Type F, phenolic insulation; Type FC, ceramic insulation.

Specifications

Size
Type F: 1.281" width x 1.312" height.
Type FC: 1.25" width

Mounting
Clearance holes for a .375" -32 bushing and a .125" x .037" locating key on a .531" radius

Shaft
.250" diameter (+.000 -.003); 2.375" long; grooved at .75", 1.125", and 1.875" from switch mounting surface

Indexing
Hill and valley dual ball type, 30°

Terminal Strength
5 lb. pull

Rotor Insulation
Type F, phenolic PBE-P per LP-513 or thermoplastic; Type FC, ceramic

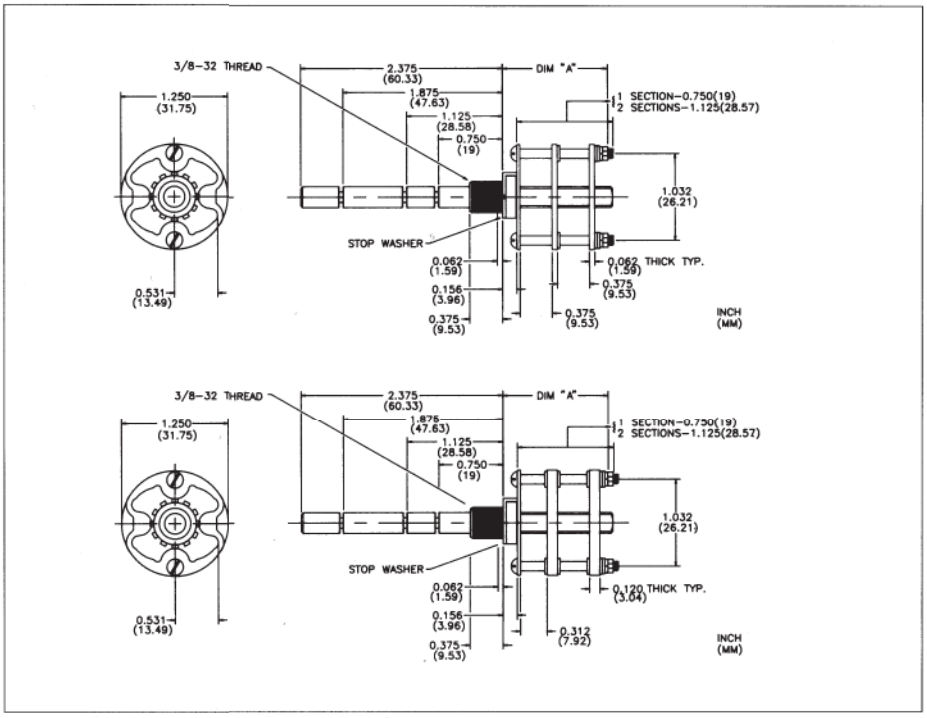
Stator Insulation
Type F: phenolic PBE-P per LP-513;
Type FC: ceramic

Section Thickness
Type F: .062"
Type FC: .120"

Contacts
Silver-plated brass, or silver alloy. Protective coating extends shelf life

Contact Resistance
.003 to .015 ohms between adjacent clips

Electrical Rating
Break 1 amp at 28 volts DC, .5 amp at 110 volts AC, resistive. Carry 5 amps



Type F/FC Switch Assemblies

Total Poles	Active Positions	Poles/Section	Figure Number§	Number of Sections	Catalog Number	
					Shorting	Non-Shorting
With silver-plated brass contacts and solder terminals						
1	2-11	1	6	1	399322-F*	399323-F*
2	2-5	2	4	1	399326-F*	399327-F*
1	2-11	1	6	1	399366-FC	399367-FC
2	2-5	2	4	1	399370-FC	399371-FC
2	2-11	1	6	2	399368-FC	399369-FC
3	2-3	3	5	1	399374-FC	399375-FC
With silver-plated brass contacts and printed circuit terminals						
1	2-11	1	6	1	399300-F*	399301-F*
2	2-5	2	4	1	399302-F*	399303-F*
3	2-3	3	5	1	399304-F*	399305-F*

§See standard printed circuit configurations, page 11.
*Available made-to-order only.

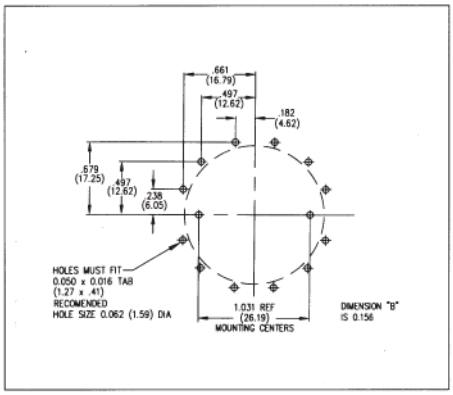
Type F/FC Rotary Section

Total Poles	Active Positions	Section Type	Figure Number§	Catalog Number	
				Shorting	Non-Shorting
With silver-plated brass contacts and solder terminals					
1	2-11	Standard	6	399070-F*	399071-F
2	2-5	Standard	4	399072-F*	399073-F
3	2-3	Standard	5	399074-F*	399075-F
1	2-11	Notched Blade	8	399060-F*	---
1	2-11	Standard	6	399090-FC	399091-FC
2	2-5	Standard	4	399092-FC*	399093-FC
3	2-3	Standard	5	399094-FC*	399095-FC
1	2-11	Notched Blade	8	399062-FC*	---

§See standard printed circuit configurations, page 11.
*Available made-to-order only.

Type F and Type FC Switch Components

Basic Type F/FC components provide the additional flexibility of meeting specific design requirements through distributor assembly of these components into other switch configurations.



PC Hole Pattern

Shaft and Index Assemblies

Includes mounting nut and lockwasher, stopwasher, strut screws, assorted spacers, washers, and nuts.

Catalog Number	Dimension "A" (See Drawings)
399039-F/FC	1.25" (31.7 mm)
399021-F/FC	6.125" (155.5 mm)

Custom Applications Available

ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

Type JC
Type K

1.531 inch diameter switches. Double-wiping, self-cleaning, silver-plated brass contacts. Phenolic insulation. Unique protective coating guards against tarnish and corrosion, extends shelf life. Provides up to 6 sections and 12 poles.

Specifications

Size
Type JC: 1.375" width x 1.531" height
Type K: 1.406" width x 1.531" height

Mounting
Clearance holes for a .375" -32 bushing and a .125" x .037" locating key on a .438" radius

Shaft
.250" diameter (+.000 -.003); 2.375" long; grooved at .75", 1.125", and 1.875" from switch mounting surface

Indexing
Hill and valley single ball type 30°

Terminal Strength
5 lb. pull

Rotor Insulation
Type JC: Ceramic
Type K: Thermoplastic or phenolic PBE-P per LP-513

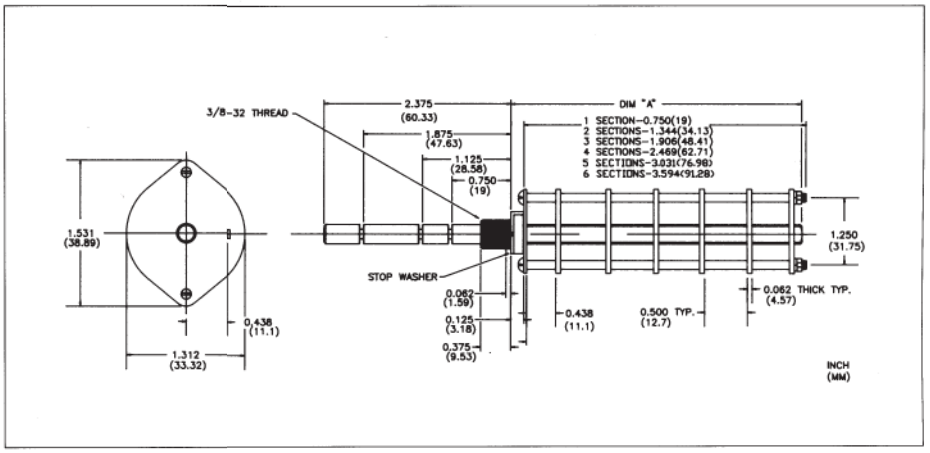
Stator Insulation
Type JC: Ceramic
Type K: Phenolic PBE-P per LP-513

Section Thickness
Type JC: .125"
Type K: .062"

Contacts
Silver-plated brass or silver alloy. Protective coating extends shelf life

Contact Resistance
.003 to .015 ohms between adjacent clips

Electrical Rating
Break 1 amp at 28 volts DC, .5 amp at 110 volts AC, resistive. Carry 5 amps



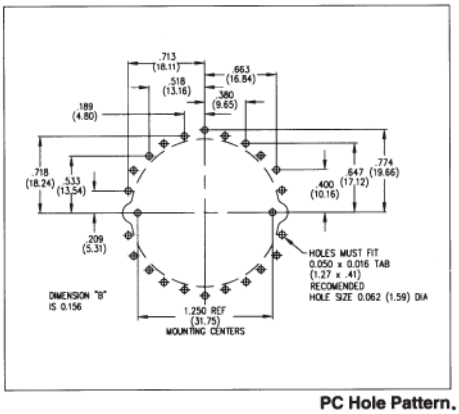
Type JC and Type K Switch Assemblies

Total Poles	Active Positions	Poles/Section	Figure Number§	Number of Sections	Catalog Number	
					Shorting	Non-Shorting
With silver-plated brass contacts and solder terminals						
1	2-12	1	1	1	399468-JC	399469-JC
2	2-6	2	3	1	399476-JC	399477-JC
2	2-12	1	1	2	399470-JC	399471-JC
3	2-5	3	7	1	399704-JC	399705-JC
3	2-12	1	1	3	399472-JC	399473-JC
4	2-6	2	3	2	399478-JC	399479-JC
6	2-5	3	7	2	399696-JC	399697-JC
6	2-6	2	3	3	399480-JC	399481-JC
1	2-12	1	1	1	399418-K	399419-K
2	2-6	2	3	1	399426-K	399427-K
2	2-12	1	1	2	399420-K	399421-K
3	2-5	3	7	1	399490-K	399491-K
4	2-6	2	3	2	399428-K	399429-K
6	2-3	3	5	2	399734-K	399735-K
6	2-5	3	7	2	399492-K*	399493-K*
6	2-6	2	3	3	399430-K	399431-K
8	2-5	2	4	4	399738-K	399739-K
With silver-plated brass contacts and printed circuit terminals						
1	2-12	1	1	1	399400-K*	399401-K*
2	2-6	2	3	1	399402-K*	399403-K

§See standard printed circuit configurations, page 11.
*Available made-to-order only.

Type JC and Type K Switch Components

Basic Type JC/K components provide the additional flexibility of meeting specific design requirements through distributor assembly of these components into other switch configurations.



PC Hole Pattern.

Custom Applications Available

Type JC and Type K Rotary Section

Total Poles	Active Positions	Section Type	Figure Number§	Catalog Number	
				Shorting	Non-Shorting
1	2-10	Standard	1	399438-JC	---
1	2-12	Standard	1	399150-JC	399151-JC
2	2-6	Standard	3	399152-JC	399153-JC
3	2-5	Standard	7	399444-JC	399445-JC
1	2-11	Notched Blade	8	399066-JC	---
1	2-12	Standard	1	399130-K*	399131-K*
1	2-11	Standard	6	399242-K	399243-K
2	2-6	Standard	3	399132-K*	399133-K*
2	2-5	Standard	4	399244-K	399245-K
3	2-3	Standard	5	399246-K*	399247-K
3	2-5	Standard	7	399254-K*	399255-K*
1	2-11	Notched Blade	8	399064-K*	---
With silver-plated brass contacts and printed circuit terminals					
1	2-12	Standard PC	1	399396-K*	399397-K*
2	2-6	Standard PC	3	399398-K*	399399-K*
3	2-5	Standard PC	7	399442-K*	399443-K*

§See standard printed circuit configurations, page 11.
Available made-to-order only.

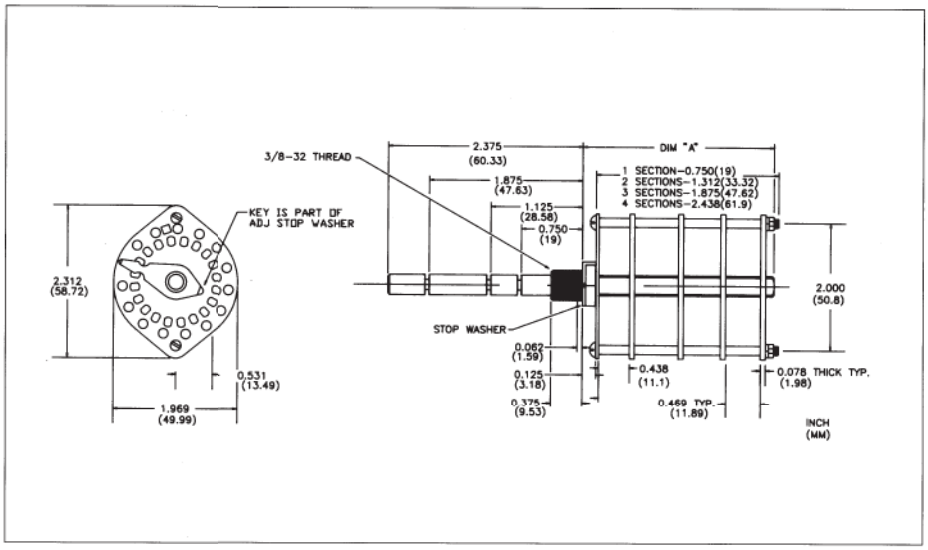
Shaft and Index Assemblies

Includes mounting nut and lockwasher, stopwasher, strut screws, assorted spacers, washers, and nuts.

Catalog Number	Dimension "A" (See Drawings)
399043-JC/K	2.468" (63 mm)
399024-JC/K	6.125" (155.5 mm)

Type L

2.312 inch diameter with 18 detent positions and 1 to 4 sections. Double-wiping, self-cleaning, silver-plated brass contacts, phenolic insulation. Unique protective coating guards against tarnish and corrosion, extends shelf life.



Specifications

Size
1.968" width x 2.312" height

Mounting
Clearance holes for a .375" -32 bushing and a .125" x .037" locating key on a .531" radius on the adjustable stopwasher

Shaft
.250" diameter (+.000 -.003); 2.375" long; grooved at .75", 1.125", and 1.875" from switch mounting surface

Indexing
Tri-ball type, 20°

Terminal Strength
5 lb. pull

Rotor Insulation
Phenolic PBE-P per LP-513

Stator Insulation
Phenolic PBE-P per LP-513

Section Thickness
.078"

Contacts
Silver-plated brass. Protective coating extends shelf life

Contact Resistance
.003 to .015 ohms between adjacent clips

Electrical Rating
Break at 1 amp at 28 volts DC, .5 amp at 110 volts AC, resistive. Carry 5 amps

Type L Switch Assemblies

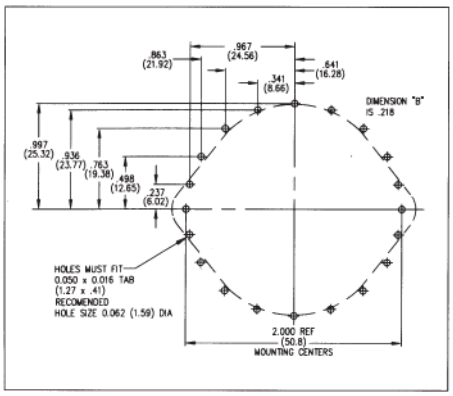
With silver-plated brass contacts and solder terminals

Total Poles	Active Positions	Poles/Section	Figure Number§	Number of Sections	Catalog Number	
					Shorting	Non-Shorting
1	2-18	1	14	1	399621-L	399622-L
2	2-18	1	14	2	399623-L	399624-L
3	2-18	1	14	3	399625-L	399648-L
4	2-18	1	14	4	399649-L	399616-L
With silver-plated brass contacts and printed circuit terminals						
1	2-17	1	15	1	399818-L*	399819-L*
2	2-8	2	16	1	399826-L*	399827-L*

§See standard printed circuit configurations, page 11.
*Available made-to-order only.

Type L Switch Components

Basic Type L components provide the additional flexibility of meeting specific design requirements through distributor assembly of these components into other switch configurations.



PC Hole Pattern

Type L Rotary Section

With silver-plated brass contacts and solder terminals

Total Poles	Active Positions	Section Type	Figure Number§	Catalog Number	
				Shorting	Non-Shorting
1	2-18	Standard	14	399185-L*	399186-L
1	2-17	Notched Blade	17	399802-L*	----
With silver-plated brass contacts and printed circuit terminals					
1	2-17	Standard	15	399814-L*	399815-L*
2	2-8	Standard	16	399828-L*	399829-L*

§See standard printed circuit configurations, page 11.
*Available made-to-order only.

Shaft and Index Assemblies

Includes mounting nut and lockwasher, stopwasher, strut screws, assorted spacers, washers and nuts.

Catalog Number	Dimension "A" (See Drawing)
399183-L	2.593" (65.8 mm)
399184-L	6.125" (155.5 mm)

Custom Applications Available

Type MF

2.312 inch diameter with 24 detent positions and 1 to 4 sections. Double-wiping, self-cleaning, silver-plated brass contacts, phenolic insulation. Unique protective coating guards against tarnish and corrosion, extends shelf life.

Specifications

Size
1.75" width x 2.312" height

Mounting
Clearance holes for a .375" -32 bushing and a .125" x .037" locating key on a .531" radius on the adjustable stopwasher

Shaft
.250" diameter (+.000 -.003); 2.375" long; grooved at .75", 1.125", and 1.875" from switch mounting surface

Indexing
Tri-ball type, 15°

Terminal Strength
5 lb. pull

Rotor Insulation
Phenolic PBE-P per LP-513

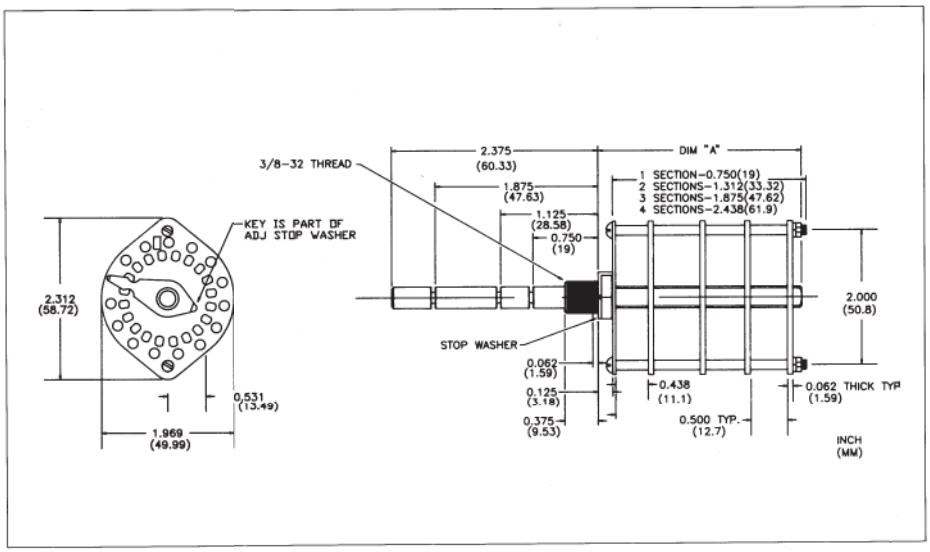
Stator Insulation
Phenolic PBE-P per LP-513

Section Thickness
.062"

Contacts
Silver-plated brass. Protective coating extends shelf life

Contact Resistance
.003 to .015 ohms between adjacent clips

Electrical Rating
Break at 1 amp at 28 volts DC, .5 amp at 110 volts AC, resistive. Carry 5 amps



Type MF Switch Assemblies

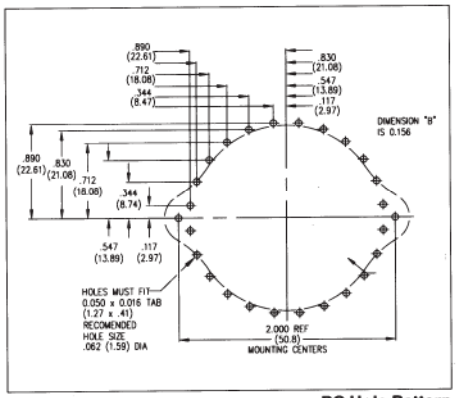
With silver-plated brass contacts and solder terminals

Total Poles	Active Positions	Poles/Section	Figure Number§	Number of Sections	Catalog Number	
					Shorting	Non-Shorting
1	2-24	1	18	1	399684-MF	399685-MF
2	2-24	1	18	2	399686-MF	399687-MF
3	2-24	1	18	3	399688-MF	399689-MF
4	2-24	1	18	4	399690-MF	399691-MF

§See standard printed circuit configurations, page 27.

Type MF Switch Components

Basic Type MF components provide the additional flexibility of meeting specific design requirements through distributor assembly of these components into other switch configurations.



PC Hole Pattern

Type MF Rotary Section

With silver-plated brass contacts and solder terminals

Total Poles	Active Positions	Section Type	Figure Number§	Catalog Number	
				Shorting	Non-Shorting
1	2-24	Standard	18	399145-MF*	399182-MF
2	2-12	Standard	19	399832-MF*	399833-MF*

§See standard printed circuit configurations, page 27.
*Available made-to-order only.

Shaft and Index Assemblies

Includes mounting nut and lockwasher, stopwasher, strut screws, assorted spacers, washers, and nuts.

Catalog Number	Dimension "A" (See Drawings)
399143-MF	2.468" (63 mm)
399144-MF	6.125" (155.5 mm)

Custom Applications Available

Standard Circuit Configurations

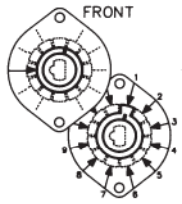


FIG.1
1–POLE
12 POSITION

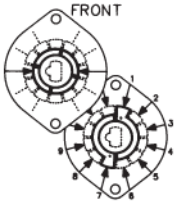


FIG.2
2–POLE
6 POSITION

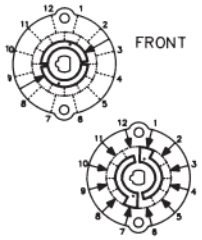


FIG.3
2–POLE
6 POSITION

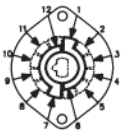


FIG.4
2–POLE
5 POSITION

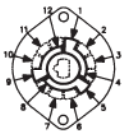


FIG.5
3–POLE
3 POSITION

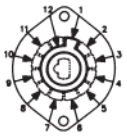


FIG.6
1–POLE
11 POSITION

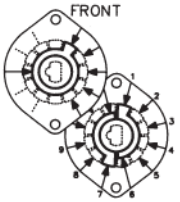


FIG.7
3–POLE
5 POSITION

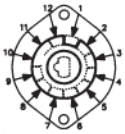


FIG.8
NOTCHED
BLADE

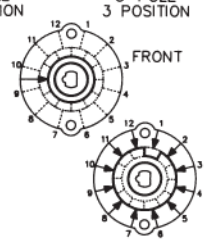


FIG.9
NOTCHED
BLADE

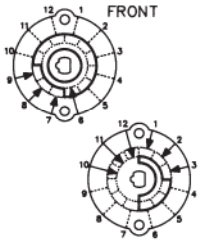


FIG.10
10 POSITION
CONSECUTIVE SHORING

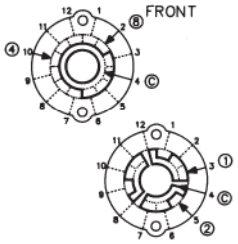


FIG.11
BINARY CODED
DECIMAL (NS) 0–11

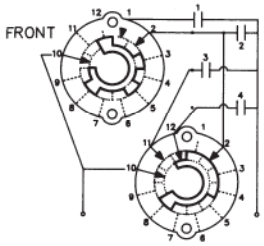


FIG.12
CAPACITOR
DECADE (NS)

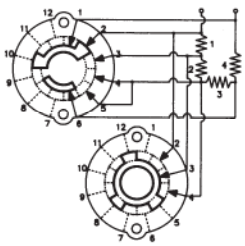


FIG.13
RESISTOR
DECADE (NS)

FIG.14
1–POLE
18 POSITION

FIG.15
1–POLE
17 POSITION

FIG.16
2–POLE
8 POSITION

FIG.17
NOTCHED

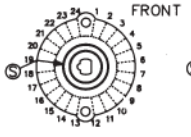


FIG.18
1–POLE
24 POSITION
BLADE

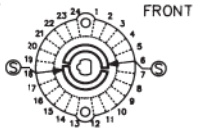
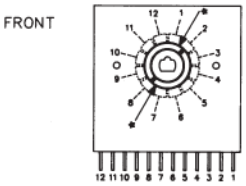


FIG.19
2–POLE
12 POSITION



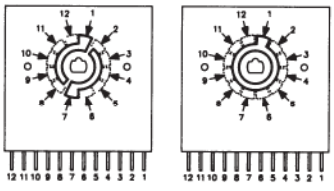


FIG.20
2–POLE
6 POSITION

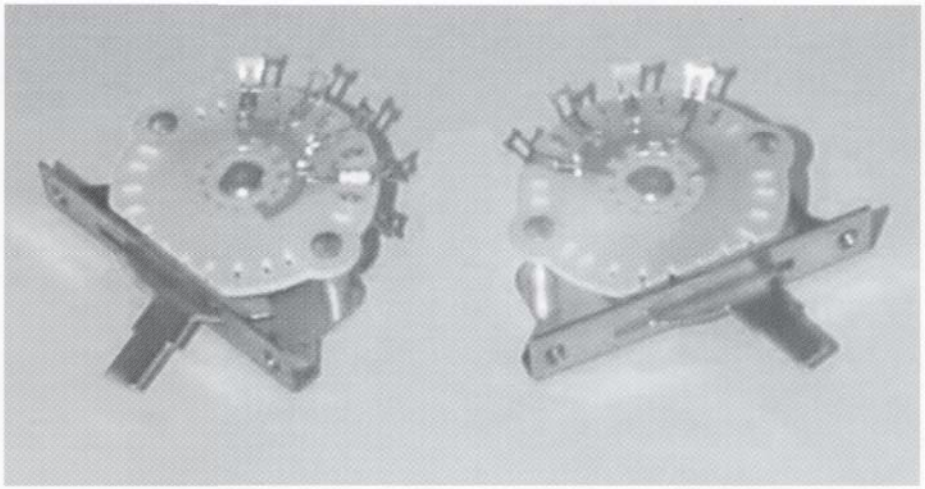
FIG.21
1–POLE
12 POSITION

*COMMON CLIPS MUST BE HAND WIRED

6MLR Type
LEVER SWITCHES

ELECTROSWITCH realizes the importance of the right "feel" required by guitarists and has continually designed and developed lever switches to provide a superior product.

For over a decade, our three and five position lever switches have been tested and refined to meet the needs and desires of guitar players all over the world. **ELECTROSWITCH**'s patented "T" slugs secure solder-lug clips to the stator.



General Specifications

Electrical Characteristics

Current and Voltage Ratings

Resistive load. Brass silver plated, make and break:

1.5 Amp at 28 VDC, .230 amp at 115 VAC RMS

.22 amp at 100 VDC, 1.75 amp at 24 VAC RMS

Current Carrying Capacity

Brass silver plated: 9 amps

Dielectric Strength

1,500 VAC between critical parts and ground

Contact Resistance

Silver plated parts: average initial 3 milliohms

Mechanical Characteristics

Index

The frame uses indexing bumps of the Hill & Valley type to ensure positive indexing at each of the positions available.

A single roller type bearing of Type 303 stainless steel to ensure positive engagement with the indexing valleys of the frame.

Contact Staking

Solder-lug clips are secured to the stator using **ELECTROSWITCH**'s patented "T" slugs

Insulation/Temperature/Levers

Insulation

Glass epoxy

Temperature

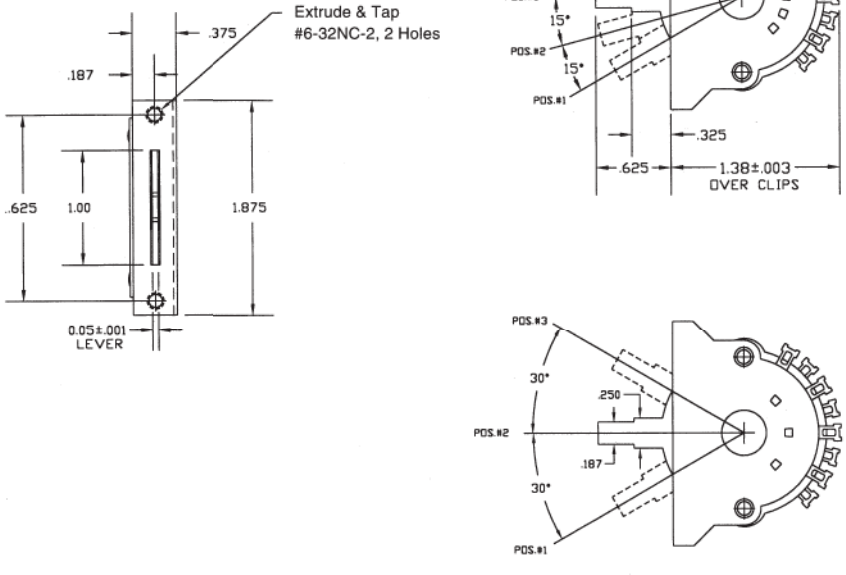
Standard commercial: -25°C to +85°C

Levers

Uses standard push button switch knobs that fit a .187" x .050" dimension

Part Number	Positions	Poles	Detent Angle	Lever Length Fms
51992	3	2	30°	.625"
51993	5	2	15°	.625"

6MLR Lever Switch Mechanical Drawings



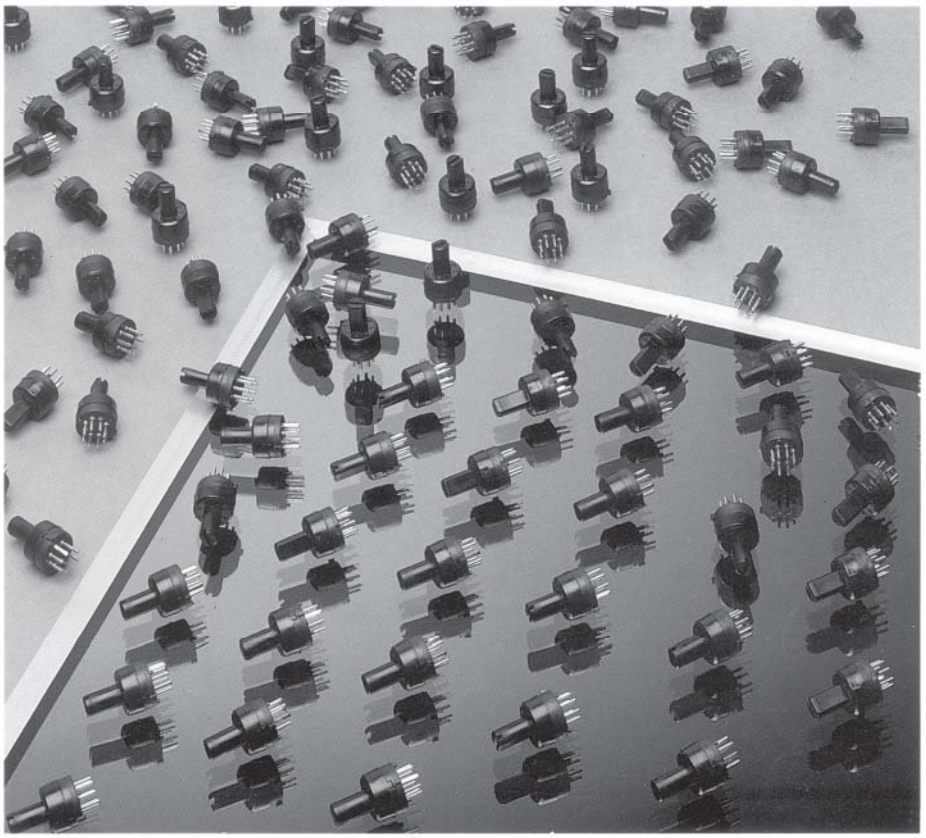
ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

T05 Series
ENCLOSED ROTARY SWITCHES

ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.

ELECTROSWITCH's T05 Series offers a customized product at economical prices. Only .362" in diameter, this series offers definite detent switching action with options that include a boot seal which prohibits contamination of contacts during cleaning.

ELECTROSWITCH's enclosed rotary switch offers distinctive options and customization at competitive prices.



General Specifications

Electrical Characteristics

Voltage
10 mA @ 1 VDC (resistive load)
500 mA @ 125 VAC (resistive load)

Contact Resistance
100 milliohms max. after life, (50 milliohms initial)
Break Before Make (non-shorting) Contacts

Insulation Resistance
10,000 megohms min.
(50,000 megohms min. initial @100 Volts)

Dielectric Breakdown Voltage
500 VAC min.

Life Expectancy
2500 Cycles

Current Carrying Capacity
.5 amps

Mechanical Characteristics

Rotational Torque
2 to 4 inch-ounces initial room ambient

Detent Angles
45°

Stops
Fixed, from 2 to 8 positions as required

Terminals
See mechanical drawing for contact arrangement

Materials

Switch Base/Index
Polyester, glass filled

Shaft
Acetal, homopolymer

Detent Balls
Steel, Nickel Plated

Rotor Contact
Brass, hard Gold Plate over Nickel Plate

Common Ring
Phosphor Bronze, hard Gold Plate over Nickel Plate

Terminals
Copper Alloy, hard Gold Plate over Nickel Plate

Shaft and Panel Seal
Ethylene Propylene

Options

- Screwdriver or Knob Actuated
- 2 to 8 Positions or Continuous
- Off Position at 1 or 8

Options Chart

Rotation	Number of Positions	Travel
Continuous	Off, 1, 2, 3, 4, 5, 6, 7	360°

Ordering the T05 Series Enclosed Rotary Switches

Series — T05

Shaft Length
1—Flush TO Body
2—.250"
3—.305"

Rotation
1—Off Position CCW
2—Off Position 8 Only

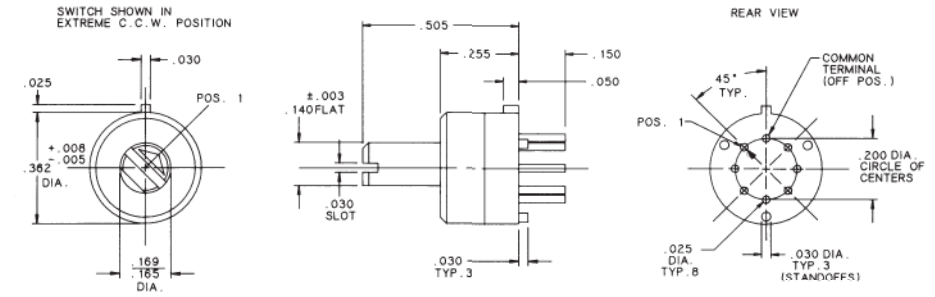
Number of Positions
02
03
04
05
06
07
08
0C—Continuous

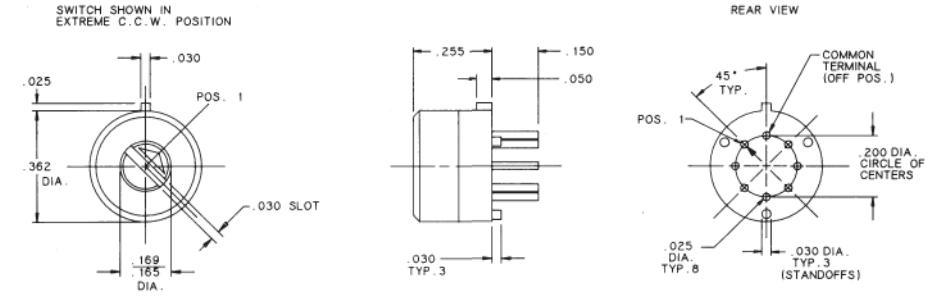
Options
1— Boot

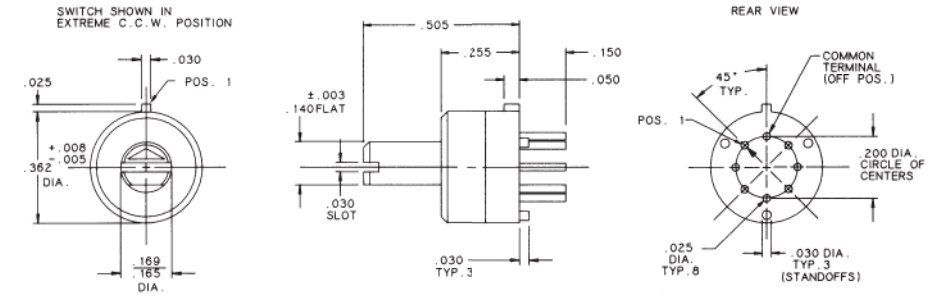
T05 — 2 — 1 — 07 — 1

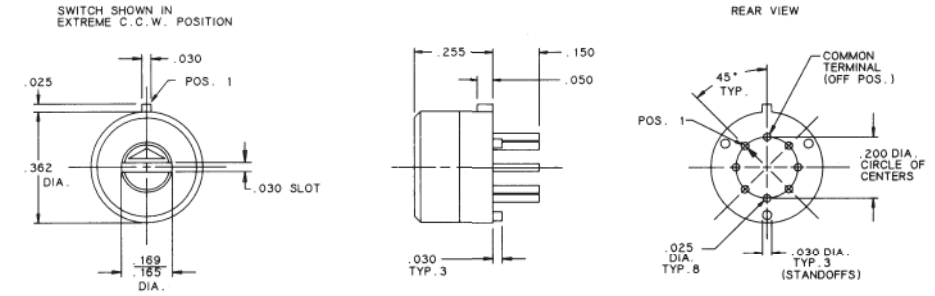
Example: T05-2-1-07-1
(T05 Series Rotary Switch, .250" long shaft, off position CCW, with 7 positions, and a protective boot.)

TO5 Mechanical Drawings



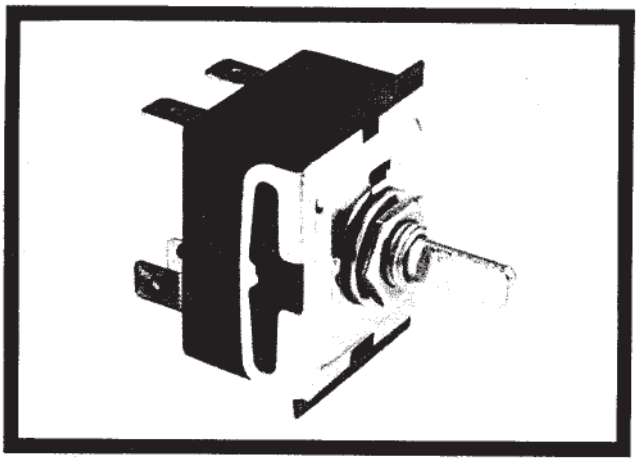






Rotary Switches
Series 240 & 390

ELECTROSWITCH
•ELECTRONIC PRODUCTS
UNIT OF ELECTRO SWITCH CORP.



DESIGNED FOR APPLICATIONS REQUIRING COMPACTNESS, HIGH CAPACITY AND LONG SERVICE LIFE.

Our capability in the development of electrical switches over the past 40 years has transcended almost every possible application within the electrical and electronic industry. None has met greater acceptance or achieved more universal popularity than the Series 240 & 390 Rotary Switches. Designed for applications where space limitations require compactness, both are electrically and mechanically interchangeable. They are available single pole or double pole with indexing, in steps of 45, 51, 60, 72, 90, 120 or 180 degrees, operating full rotary or stops as required. Standard A.C. Rating — U.L. approved — range from 7-1/2 amperes to 38 amperes, including motor ratings of 1/4 H.P. to 1 H.P., 120 V., 2 H.P., 240 V. Typical applications include: Air conditioners, X-ray machines, medical, dental and other laboratory equipment, ranges, ovens, battery charges, kilns, space heaters, vending machines, washers, dryers, and a multitude of appliances or devices.

MANUAL MOTOR CONTROLLERS

Many 390 Series Switches are now classified as Manual Motor Controls and recognized under the component programs of Underwriters' Laboratories, Inc. and Canadian Standards Association.

These devices are open type manual motor controls and are rated single phase, same polarity with contact ratings to 38 amps total input and horsepower ratings to 2 H.P. at 240 VAC (resistive) plus locked rotor ratings to 125 amperes at 240 VAC.

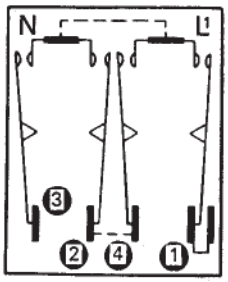
Mounting arrangements, circuitry details, and physical dimensions are the same as those described in this bulletin for 390 Series Rotary Switches.

TYPICAL CIRCUITS

Hundreds of circuit variations are possible

SINGLE POLE CIRCUITS AS USED IN AIR CONDITIONERS

Terminals L1 and N shunted internally. Line Terminal may connect with terminals 1, 2, 3, and 4 in any position with 45, 60, 72 and 90 degrees of throw.



REAR VIEW

DOUBLE POLE CIRCUITS AS USED IN ELECTRIC RANGES

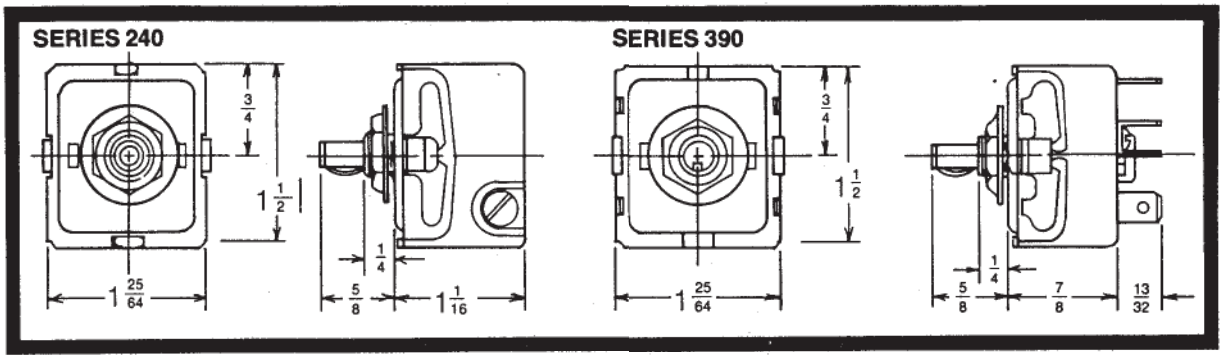
Terminal N may connect with terminals 2 and 3 only, in any position. Terminal L1 may connect with terminals 1 and 4 only, in any position. Available with 45, 51, 42, 60, 72, 90 and 180 degrees of throw.

Electrical ratings vary as to application, and are available to 38 A. 120/240 V. rating with 20 amps. max. on inside terminals (2 & 4) and 25 amps. max. on outside terminals (1 & 3) resistive load. Double pole applications can have 30 amps. max. rating with 20 amps. max. on any one circuit.

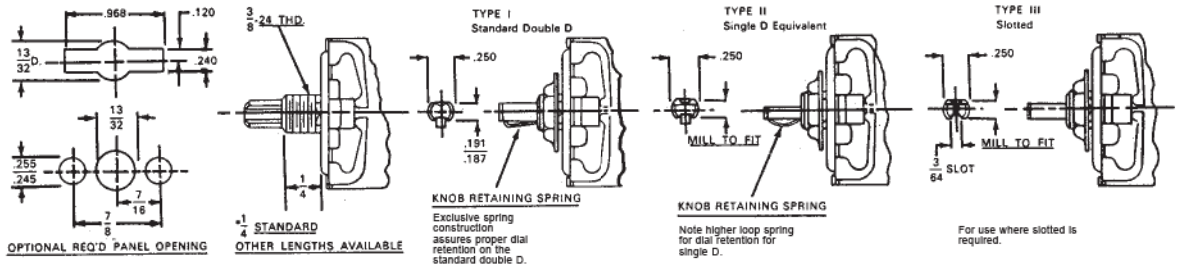
DUMMY AND AUXILIARY TERMINALS

Series 390 Switches may be provided with two, four or six dummy terminals, eliminating the need for auxiliary terminal blocks. Auxiliary terminals can be provided to permit additional connections on load or line terminals. Through the use of many standard cams and both internal and external shunts, the Series 240 and Series 390 small rotary switches can be designed to accommodate a vast number of different circuits.

Illustration shows coaxial spindle arrangement with outer hollow spindle (A) operating the switch itself, while the inner solid spindle (B) provides independent coaxial control of the auxiliary function.



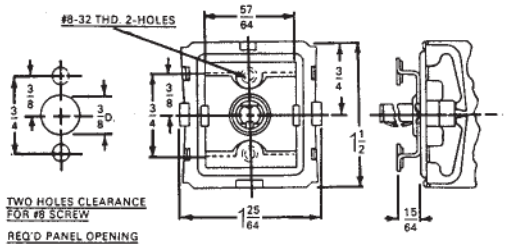
STANDARD MOUNTING ARRANGEMENTS



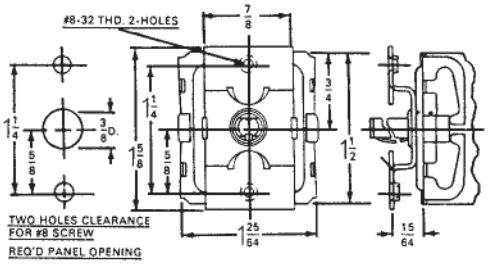
SINGLE HOLE MOUNTING

An exclusive spring arrangement of Types I and II gives uniform tension to hold knobs firmly in place. Various lengths are available. For spindle lengths exceeding 2", nylon back bearings will be supplied for added strength and rigidity.

Other types and sizes are available on special order.

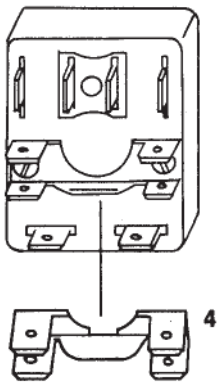


TWO HOLE 3/4" MOUNTING

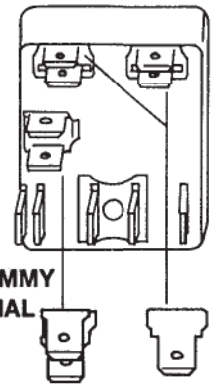


TWO HOLE 1-1/4" MOUNTING

DUMMY AND AUXILIARY TERMINALS

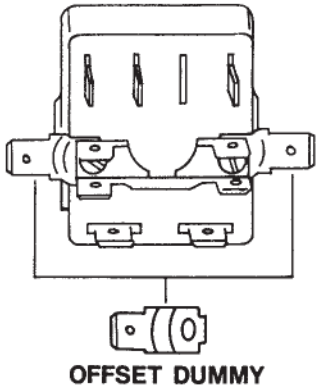


4 PRONG DUMMY TERMINAL



TWIN DUMMY TERMINAL

AUXILIARY TAB TERMINAL



OFFSET DUMMY TERMINAL

NOTES