Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



# SERIES 50 SERIES 51

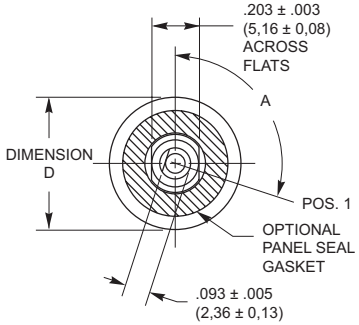
**0.5" Diameter, 200mA,**
**.698" Behind Panel**

## FEATURES

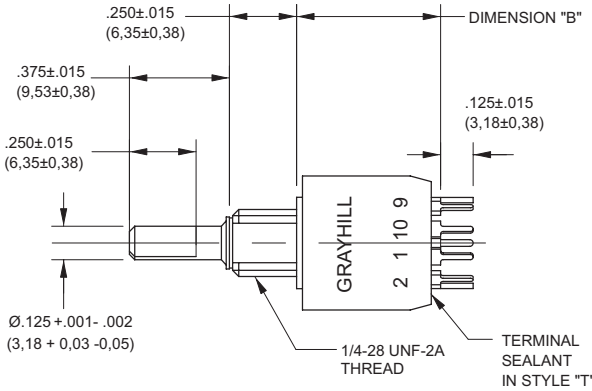
- Optional Complete Seal for PC Board Assembly and Cleaning
- Small 1/2" Diameter
- Choice of 22.5°, 30°, 36°, 45°, 60° and 90° Angles of Throw
- Up to 4 Poles on 1 Deck
- Up to 16 Positions Per Switch
- PC or Solder Lug Termination
- Positive Shaft Grounding for EMI/RFI Shielding

## DIMENSIONS in inches (and millimeters)

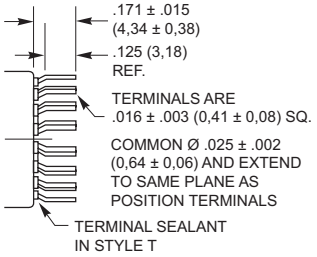
### PC Mount Style



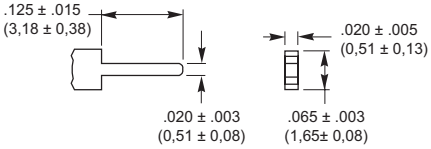

Grayhill part number and date code marked on label. Customer part number marked on request. Military part number marked when required.



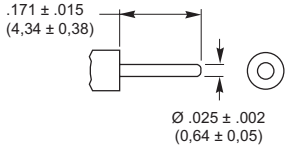

**Side View** 22.5°
All others as shown at left




**PC TERMINAL DETAIL**
All angles of throw, except 22.5°




**PC COMMON DETAIL**
All angles of throw, except 22.5°

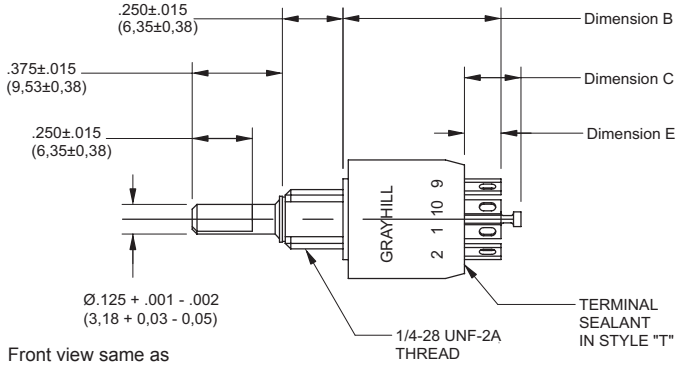



| Angle of Throw | Angle A | Angle of Throw | Angle A |
|---|---|---|---|
| **22.5°** | 101.25° | **45°** | 112.5° |
| **30°** | 105° | **60°** | 120° |
| **36°** | 108° | **90°** | 135° |

| Dimension | Series 50 | Series 51 |
|---|---|---|
| D | .500 ± .015 (12,70 ± 0,38) | .562 ± .015 (14,27 ± 0,38) |

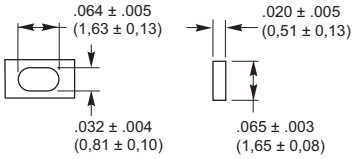
| Dimension | Style T | All Others | All 22.5° |
|---|---|---|---|
| B | .576 ± .015 (14,63 ± 0,38) | .537 ± .015 (13,64 ± 0,38) | .537 ± .015 (13,64 ± 0,38) |

### Solder Lug Style

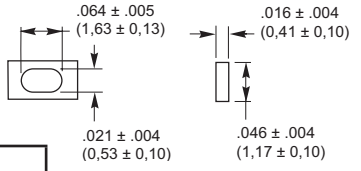



Front view same as PC Mount style.

**SOLDER LUG TERMINAL DETAIL**
All angles of throw, except 22.5°




**SOLDER LUG TERMINAL DETAIL 22.5°**

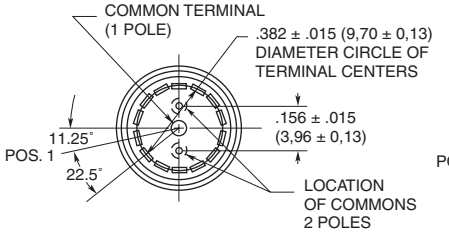



| Dimension | 30°, 36°, 45°, 60°, 90° | 22.5° |
|---|---|---|
| B | .658 ±.015 (16,71 ±0,38) | .591±.020 (15,01±0,50) |
| C | .234 ±.015 (5,94 ±0,38) | .200±.015 (5,08±0,38) |
| E | .153±.015 (3,89±0,38) | .12±.015 (3,05±0,38) |

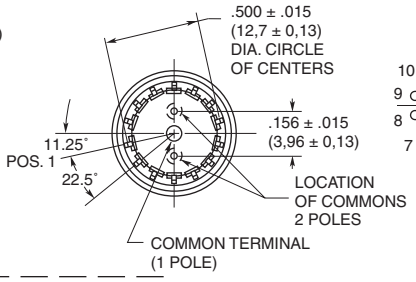
## CIRCUIT DIAGRAMS AND REAR VIEWS: Solder Lug and PC Mount

### Rear View

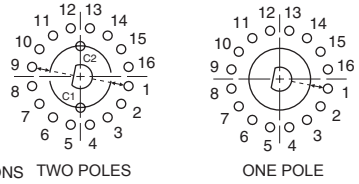
**SOLDER LUG**



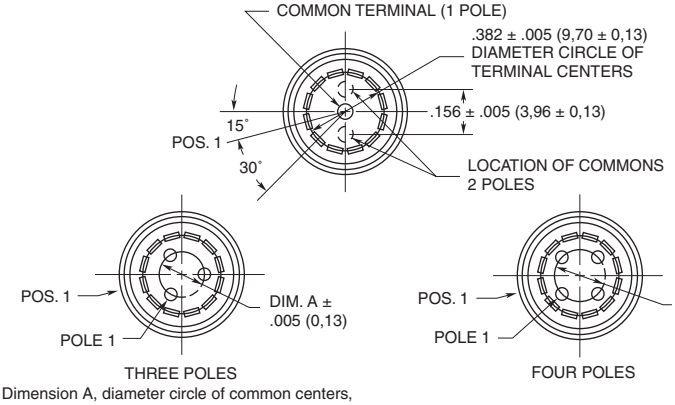

**PC MOUNT**



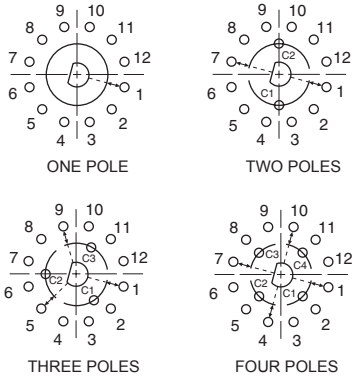

### Circuit as Viewed From Shaft End



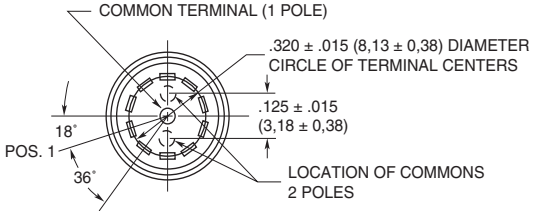

**22.5° Angle of Throw**

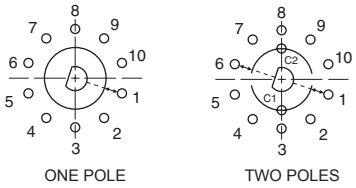



Dimension A, diameter circle of common centers, is .175 (4,45) for Solder Lug and .232 (5,89) for PC.

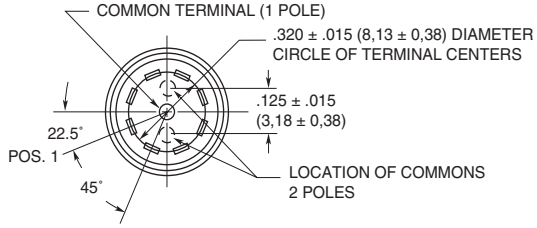


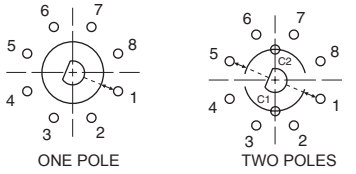

**30° Angle of Throw**



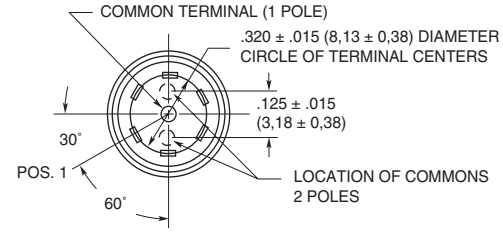



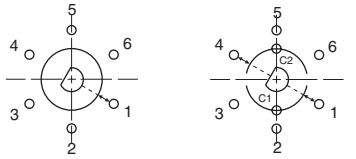

**36° Angle of Throw**



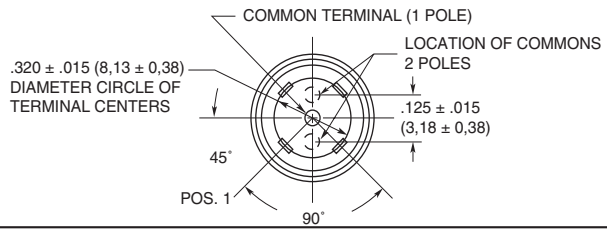



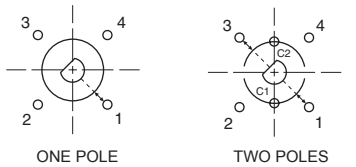

**45° Angle of Throw**




**60° Angle of Throw**




**90° Angle of Throw**

## SPECIFICATIONS

### Military Qualification

The dimensions for qualified switches are the same as those indicated in the drawings of standard switches. Switches with standard variations, such as shaft and bushing length, which do not affect switch performance, can be marked as qualified product. Contact Grayhill for complete information on variations.

**36°, 45°, 60°, 90° (Series 50):** The C and M style switches are qualified to MIL-S-3786/20. They include the following:

Solder lug or PC terminals
With or without panel seal

Series 50 qualified switches may be ordered by the 'M' number or by the Grayhill part number.

**30° (Series 51):** The C and M style switches are qualified to MIL-S-3786/35. They include the following:

Solder lug or PC terminals
With or without panel seal

Series 51 qualified switches may be ordered by the 'M' number or by the Grayhill part number.

### Electrical Ratings

**Life Expectancy:** With the limiting criteria stated here, the Series 50 and 51 with non-shorting contacts will switch the following loads at atmospheric and reduced pressures for 25,000 cycles of operations. One cycle is 360° rotation clockwise and 360° return.

At 85°C, atmospheric pressure

| | | |
|---|---|---|
| 200 mA, | 28 | Vdc resistive |
| 150 mA, | 115 | Vac resistive |
| 30 mA, | 28 | Vdc inductive |
| 100 mA, | 28 | Vdc lamp load |
| 75 mA, | 220 | Vac lamp load |

At 25°C, reduced pressure (70,000 feet)

| | | |
|---|---|---|
| 200 mA, | 28 | Vdc resistive |
| 150 mA, | 115 | Vac resistive |
| 75 mA, | 220 | Vac resistive |

**Contact Resistance:** 20 milliohms maximum, (10 milliohms initially).

**Insulation Resistance:** 1,000 Mohms minimum between mutually insulated parts.

**Voltage Breakdown:** 600 Vac minimum between mutually insulated parts at standard atmospheric pressure.

**Life Expectancy:** Listed for the voltage source and make and break current levels. Contact Grayhill for more information if any of the following is true: the life limiting criteria are more critical than those listed; longer operation is required; a larger make and break current is required; the operating environment includes elevated temperatures or reduced pressures.

**Contact Carry Rating:** Switch will carry 6 amperes continuously with a maximum contact temperature rise of 20°C.

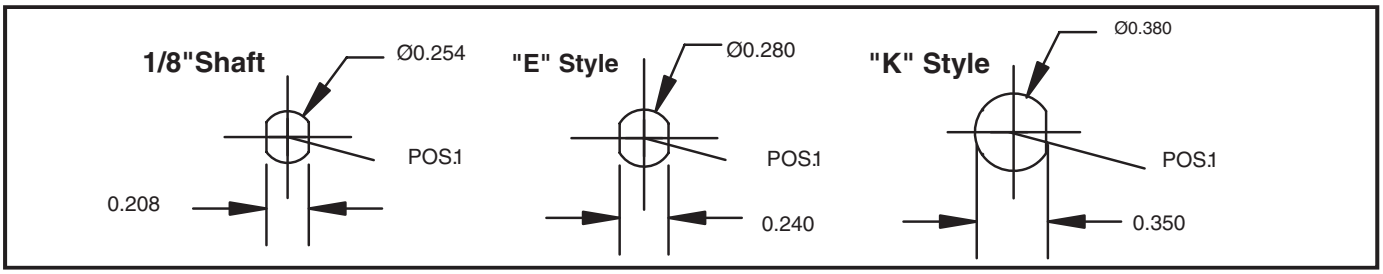
### Materials and Finishes

**Switch Base:** Thermoset
**Detent Rotor:** Nylon
**Shaft, Stop Blades, Stop Arm, Thrust washer, and Retaining Ring:** Stainless steel
**Detent Balls:** Steel, nickel-plated
**Bushing:** Zinc, tin-zinc plated
**Detent and Contact Springs:** Stainless steel
**Common Ring:** Brass, gold-plated over silver plate.
**Terminals:** Brass, gold-plated over silver plate and nickel plate
**Rotor Contact:** Precious metal alloy, gold-plated
**Panel Seal:** Silicone rubber
**Shaft Seal:** Fluorosilicone
**Mounting Nuts:** Brass, tin-zinc plated **Mounting Hardware:** One mounting nut .089" thick by .375" across flats and one internal tooth lockwasher are supplied with the switch. **Maximum Mounting Torque:** 15in-lbs

### Additional Characteristics

**Contact Type and Forces:** Shorting or non-shorting wiping contacts with over 80 grams of contact force.
**Shaft Flat Orientation:** Flat opposite contacting position of pole number one (see circuit diagrams).
**Terminals:** Switches have the full circle of terminals, regardless of number of active position.
**Stop Strength:** 7.5 pound-inches minimum
**Rotational Torque:** 8–24 ounce-inches, depending on the number of poles.
**Operating Temperature Range (Standard Style):** -40 °C to +85 °C
**Operating Temperature Range (MIL-DTL-3786):** -65 °C to +85 °C

## RECOMMENDED PANEL CUTOUT

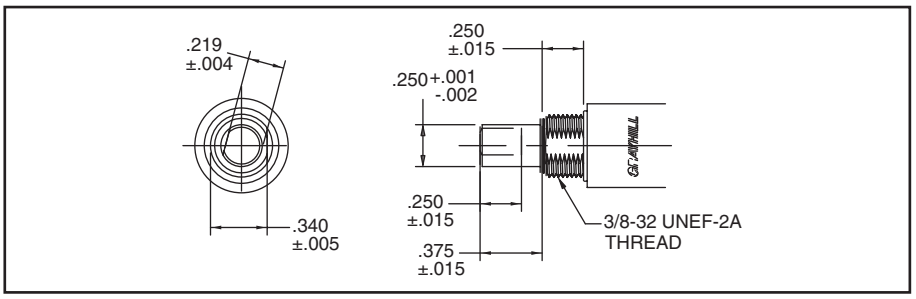



## PROCESS SEALED–Style T

Switch can be mounted on PC board with other components and subjected to wave soldering and conventional board cleaning techniques. No secondary wiring or soldering is necessary.

Bushing is o-ring sealed; epoxy potting seals the terminals and the rear of the switch. Designed for PC assembly, this sealing technique can also be applied to solder lug terminal switches. A bushing to panel seal can also be added to the process sealed versions. Military qualified versions are available, see ordering information.

## 1/4" SHAFT: Style K



Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



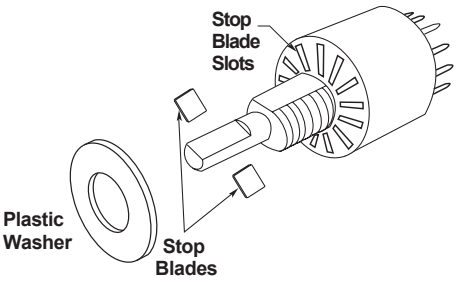
## SUGGESTED ADJUSTABLE STOP SUBSTITUTION GUIDE

| Fixed Stop Style | Adj. Stop Style Equivalent | Fixed Stop Style | Adj. Stop Style Equivalent |
|---|---|---|---|
| 50A | 50D | 51A | 51D |
| 50C | 50CD | 51C | 51CD |
| 50CP | 50CDP | 51CP | 51CDP |
| 50M | 50CD* | 51M | 51CD* |
| 50MP | 50CDP* | 51MP | 51CDP* |
| 50P | 50DP | 51P | 51DP |
| 50S | 50D* | 51S | 51D* |
| 50SP | 50DP* | 51SP | 51DP* |

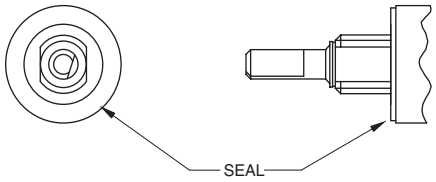
*Form fit and function equivalents, but not watertight sealed to the panel.

## ADJUSTABLE STOPS: Style D

Adjustable stops permit the user to set and reset the number of positions per poles. Shown in the diagram, a plastic washer can be removed to reveal slots at the base of the bushing. Stop blades can be inserted into the appropriate slots to limit switch rotation. Positions per pole configuration can thus be changed to meet the needs of the application. Dimensions are the same as the fixed stop version, when plastic washer is in place. Most desirable for prototype work. Readily available from local distributor.

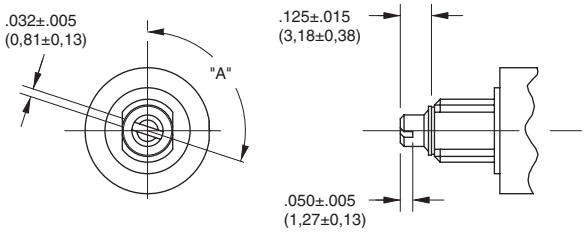



## SHAFT AND PANEL SEAL: Styles S and M



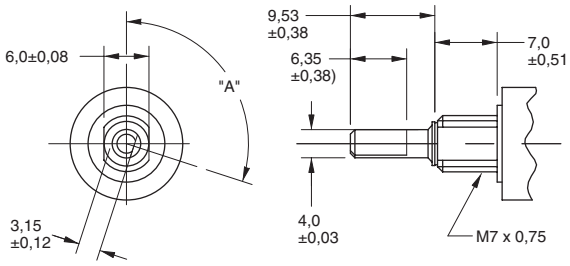

Shaft and panel seal switches are watertight to the panel. They are not totally process sealed like the Style "T". Panel is sealed by a gasket at the base of the bushing. Shaft is sealed by an O-ring inside the bushing. After mounting, seals do not alter switch dimensions. See Style "S" (standard switches) and Style "M" (military switches) in the Choices and Limitations chart.

## SCREWDRIVER SLOTTED SHAFT: Style B




Form, fit and function equivalent to standard shaft switches. The dimensions shown have evolved as the most popular for this type of switch. See Style "B" in the Choices and Limitations chart. Previous users may have ordered these switches by a non-descriptive part number containing a "Y". Contact Grayhill, if in doubt about a cross-reference.

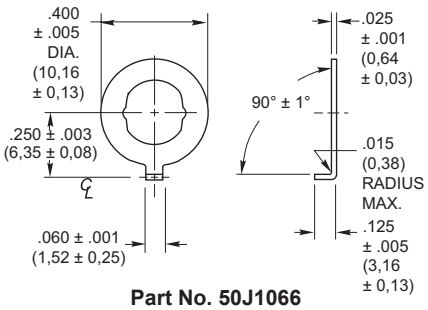
## METRIC SHAFT AND BUSHING: Style E




Metric standard dimensions for the shaft and bushing are shown in the drawing. Other dimensions approximately the same as shown in dimensional drawing. Contact Grayhill for exact dimensions. See Style "E" in the Choices and Limitations chart.

## ACCESSORY: Non-Turn Washers

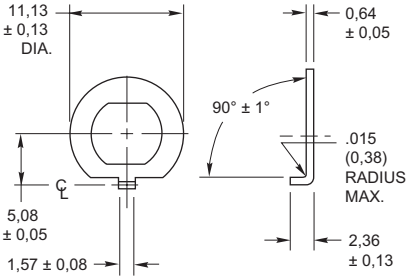
In Inches (and millimeters)




**Part No. 50J1066**

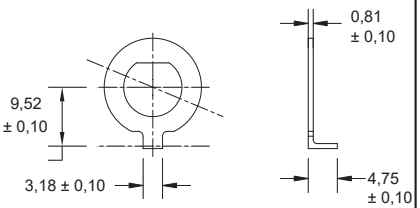
Cut round hole for the bushing and for the non-turn tab. Washer fits the double D bushing flats. Washer is sold only when accompanied by an order for a like number of switches. Washer is 302 stainless steel.

Dimensions are in millimeters




**Part No. 71J1103**

Designed to fit the double flatted bushing of the metric dimensioned bushing, this non-turn washer permits a round hole for the bushing and the tab while still preventing switch rotation. Washer is only sold when accompanied by a like number of switches. Washer is 302 stainless steel.




**Part No. 50J5140-4**

Designed to fit the single flatted bushing of the "K" style switches, this non-turn washer prevents switch rotation when using a full round hole in the panel. Washer is only sold when accompanied by a like number of switches. Washer is 302 stainless steel.

## CHOICES AND LIMITATIONS: Series 50

A = Standard, 1/8" Shaft
B = Screwdriver Slot Shaft
C = Military, Without Panel Seal
D = Adjustable Stop (Adj. Stop)
E = Metric, 4mm Shaft
K = 1/4" Shaft
M = Military
P = PC Mount Terminals
S = Shaft/Panel Seal (S/P Seal)
T = Process Sealed

### Standard Style

| Series | Style Choices[1] Std., 1/8" Shaft | 1/4" Shaft | Metric, 4mm Shaft | Terminals | Angle of Throw | Number of Poles | Number of Positions Per Pole | Shorting or Non-Shorting Contacts |
|---|---|---|---|---|---|---|---|---|
| 50 | A<br>AT<br>B<br>BS<br>BST<br>BT<br>D<br>S<br>ST | K<br>KS<br>KST<br>KT<br>KB<br>KBS<br>KBST<br>KT | E<br>ES<br>EST<br>ET<br>EB<br>EBS<br>EBST<br>EBT | Solder Lug | 36° | 1<br>2 | 02 thru 10<br>02 thru 05 | N or S<br>N or S |
| | | | | | 45° | 1<br>2 | 02 thru 08<br>02 thru 04 | N<br>N |
| | | | | | 60° | 1<br>2 | 02 thru 06<br>02 or 03 | N<br>N |
| | | | | | 90° | 1<br>2 | 02 thru 04<br>02 | N<br>N |
| | BP<br>BPT<br>BSP<br>BSPT<br>DP<br>P<br>PT<br>SP<br>SPT | KP<br>KPT<br>KSP<br>KSPT<br>KBP<br>KBSP<br>KBSPT<br>KBT | EP<br>EPT<br>ESP<br>ESPT<br>EBP<br>EBSP<br>KBSPT<br>EBT | PC Mount | 36° | 1<br>2 | 02 thru 10<br>02 thru 05 | N or S<br>N or S |
| | | | | | 45° | 1<br>2 | 02 thru 08<br>02 thru 04 | N<br>N |
| | | | | | 60° | 1<br>2 | 02 thru 06<br>02 or 03 | N<br>N |
| | | | | | 90° | 1<br>2 | 02 thru 04<br>02 | N<br>N |

### Military Style

| Series | Style Choices Std., 1/8" Shaft | 1/4" Shaft | Metric, 4mm Shaft | Terminals | Angle of Throw | Number of Poles | Number of Positions Per Pole | Shorting or Non-Shorting Contacts |
|---|---|---|---|---|---|---|---|---|
| 50 | C<br>CB<br>CBT<br>CD<br>CT<br>M<br>MB<br>MBT<br>MT | KM<br>KMB<br>KMBT<br>KMT | EM<br>EMB<br>EMBT<br>EMT | Solder Lug | 36° | 1<br>2 | 02 thru 10<br>02 thru 05 | N or S<br>N or S |
| | | | | | 45° | 1<br>2 | 02 thru 08<br>02 thru 04 | N<br>N |
| | | | | | 60° | 1<br>2 | 02 thru 06<br>02 or 03 | N<br>N |
| | | | | | 90° | 1<br>2 | 02 thru 04<br>02 | N<br>N |
| | CBP<br>CBPT<br>CDP<br>CP<br>CPT<br>MBP<br>MBPT<br>MP<br>MPT | KMBP<br>KMBPT<br>KMP<br>KMPT | EMBP<br>EMBPT<br>EMP<br>EMPT | PC Mount | 36° | 1<br>2 | 02 thru 10<br>02 thru 05 | N or S<br>N or S |
| | | | | | 45° | 1<br>2 | 02 thru 08<br>02 thru 04 | N<br>N |
| | | | | | 60° | 1<br>2 | 02 thru 06<br>02 or 03 | N<br>N |
| | | | | | 90° | 1<br>2 | 02 thru 04<br>02 | N<br>N |

## CHOICES AND LIMITATIONS: Series 51

A = Standard, 1/8" Shaft
B = Screwdriver Slot Shaft
C = Military, Without Panel Seal
D = Adjustable Stop (Adj. Stop)

E = Metric, 4mm Shaft
K = 1/4" Shaft
M = Military

P = PC Mount Terminals
S = Shaft/Panel Seal (S/P Seal)
T = Process Sealed

### Standard Style

| Series | Std., 1/8" Shaft | Style Choices[1] 1/4" Shaft | Metric, 4mm Shaft[1] | Terminals | Angle of Throw | Number of Poles | Number of Positions Per Pole | Shorting or Non-Shorting Contacts |
|---|---|---|---|---|---|---|---|---|
| 51 | A AT<br>B BT<br>S ST<br>BS BST | SEE BELOW | SEE BELOW | Solder Lug | 22.5° | 1<br>2 | 02 thru 16<br>02 thru 08 | N or S<br>N or S |
| | A<br>AT<br>B<br>BS<br>BST<br>BT<br>D<br>S<br>ST | K<br>KS<br>KST<br>KT | E<br>ES<br>EST<br>ET | Solder Lug | 30° | 1<br>2<br>3<br>4 | 02 thru 12<br>02 thru 06<br>02 thru 04<br>02 or 03 | N or S<br>N or S<br>N or S<br>N or S |
| | P PT<br>BP BPT<br>SP SPT<br>BSP BSPT | SEE BELOW | SEE BELOW | PC Mount | 22.5° | 1<br>2 | 02 thru 16<br>02 thru 08 | N or S<br>N or S |
| | BP<br>BPT<br>BSP<br>BSPT<br>DP<br>P<br>PT<br>SP<br>SPT | KP<br>KPT<br>KSP<br>KSPT | EP<br>EPT<br>ESP<br>ESPT | PC Mount | 30° | 1<br>2<br>3<br>4 | 02 thru 12<br>02 thru 06<br>02 thru 04<br>02 or 03 | N or S<br>N or S<br>N or S<br>N or S |

### Military Style

| Series | Std., 1/8" Shaft | Style Choices 1/4" Shaft | Metric, 4mm Shaft | Terminals | Angle of Throw | Number of Poles | Number of Positions Per Pole | Shorting or Non-Shorting Contacts |
|---|---|---|---|---|---|---|---|---|
| 51 | C<br>CB<br>CBT<br>CD<br>CT<br>M<br>MB<br>MBT<br>MT | KM<br>KMB<br>KMBT<br>KMT | EM<br>EMB<br>EMBT<br>EMT | Solder Lug | 30° | 1<br>2<br>3<br>4 | 02 thru 12<br>02 thru 06<br>02 thru 04<br>02 or 03 | N or S<br>N or S<br>N or S<br>N or S |
| | CBP<br>CBPT<br>CDP<br>CP<br>CPT<br>MBP<br>MBPT<br>MP<br>MPT | KMBP<br>KMBPT<br>KMP<br>KMPT | EMBP<br>EMBPT<br>EMP<br>EMPT | PC Mount | 30° | 1<br>2<br>3<br>4 | 02 thru 12<br>02 thru 06<br>02 thru 04<br>02 or 03 | N or S<br>N or S<br>N or S<br>N or S |

[1] Contact Grayhill if 1/4" or metric shaft required with a 22.5° angle of throw.

## ADDITIONAL FEATURES

Economy keylock switch, isolated position, spring return, and coded switches are available in similar series. See Keylock and Special Function Rotary Switch sections.

**Available from your local Grayhill Distributor.** For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

## ORDERING INFORMATION: Series 50

**50AT36–01–1–10N–F**

- **Series:** Series 50 (36°, 45°, 60°, or 90°)
- **Style*:** Letters from Choices Chart
- **Angle of Throw:** 36, 45, 60, or 90
- **Stop Arrangement:** Needed only with 1 pole switches with maximum positions. Leave blank for continuous rotation; add F for fixed stop.
- **Type of Contacts:** N = Non-shorting, S = Shorting
- **Positions Per Pole:** 02 as a minimum to the maximum allowable for the angle of throw and the number of poles per the Choices Chart. Use Letters AJ in this location if adjustable stop switch is ordered.
- **Poles per Deck:** See chart
- **Number of Decks:** 01 only

* All rotary switches that are required to have military designated markings and testing adhering to MIL-3786 are to be ordered by specifying the military part number identified on the appropriate slash sheet.

## ORDERING INFORMATION: Series 51

**51SPT30–01–1–12S–F**

- **Series:** Series 51 (30°; 22.5°)
- **Style*:** Letters from Choices Chart
- **Angle of Throw:** Use 22 (for 22.5°), 30
- **Stop Arrangement:** Needed only with 1 pole switches with maximum positions. Leave blank for continuous rotation; add F for fixed stop.
- **Type of Contacts:** N = Non-shorting, S = Shorting
- **Positions Per Pole:** 02 as a minimum to the maximum allowable for the angle of throw and the number of poles per the Choices Chart. Use Letters AJ in this location if adjustable stop switch is ordered.
- **Poles per Deck:** See chart
- **Number of Decks:** 01 only

* All rotary switches that are required to have military designated markings and testing adhering to MIL-3786 are to be ordered by specifying the military part number identified on the appropriate slash sheet.

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



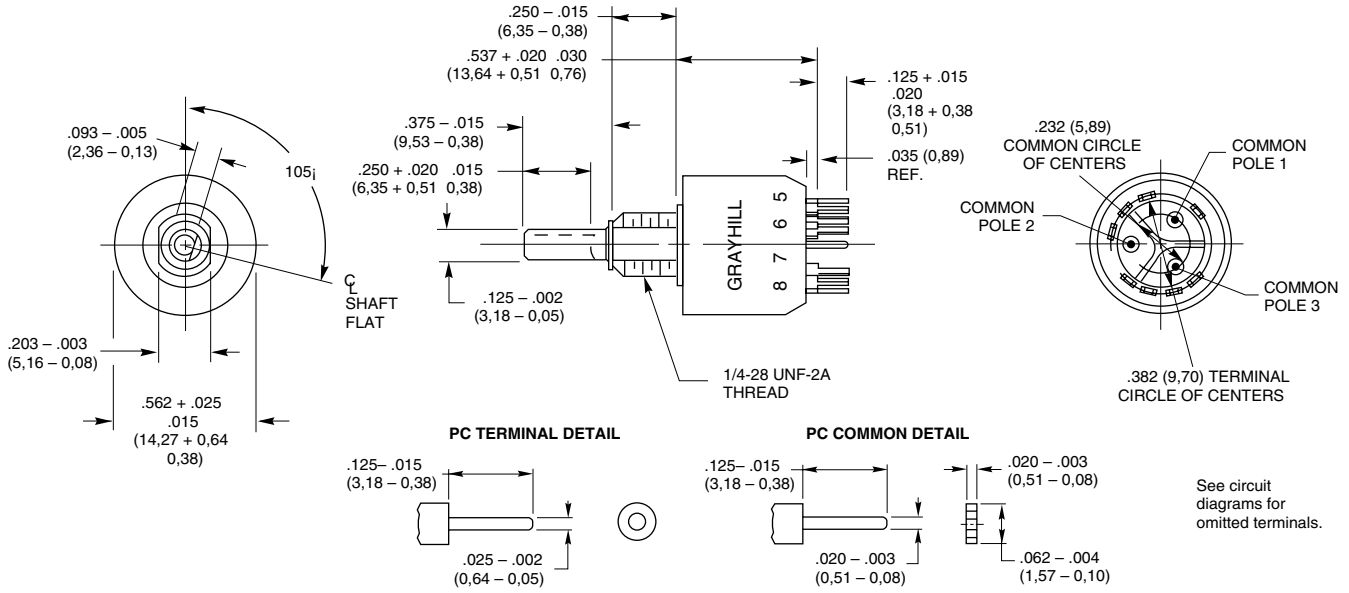
# SERIES 51

## Binary or Binary Complement Code

## FEATURES

- PC Mount, 30° Angle of Throw
- 2 to 12 Positions
- .562" Diameter, 200 mA
- Shaft and Panel Seal
- Adjustable Stop Versions

## DIMENSIONS in Inches (and millimeters)




All switches are provided with PC mount terminals.
Grayhill part number and date code marked on label. Customer part number marked on request.

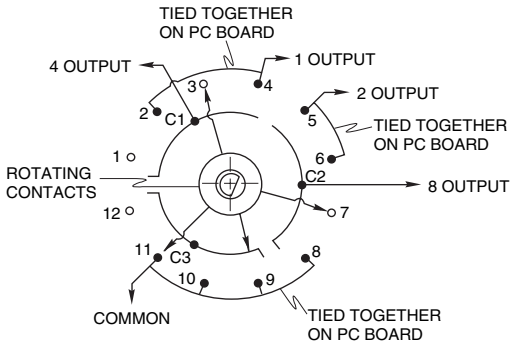
## CIRCUIT DIAGRAMS

Switch is viewed from the shaft end and shown in switch position number 1, which is decimal number zero and BCD number zero.

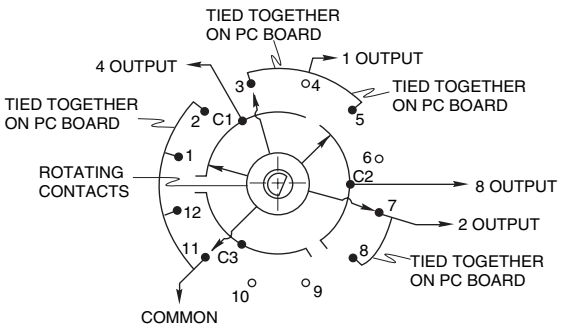
● Indicates Terminal is present.
O Indicates Terminal is omitted.
Note: Connections must be made on PC board to generate code output.

Switch position numbers do not correspond to the decimal input or binary output.
See Truth Tables.

### BCD




### BCD Complement



Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



## TRUTH TABLES

### Binary Code Decimal

| Dec. No. | Switch Pos'n.* | 2nd Pin** | Output Terminal 1 | 2 | 4 | 8 |
|---|---|---|---|---|---|---|
| 0 | 1 | 4-5 | | | | |
| 1 | 2 | 5-6 | ● | | | |
| 2 | 3 | 6-7 | | ● | | |
| 3 | 4 | 7-8 | ● | ● | | |
| 4 | 5 | 8-9 | | | ● | |
| 5 | 6 | 9-10 | ● | | ● | |
| 6 | 7 | 10-11 | | ● | ● | |
| 7 | 8 | 11-12 | ● | ● | ● | |
| 8 | 9 | 12-1 | | | | ● |
| 9 | 10 | 1-2 | ● | | | ● |
| 10 | 11 | 2-3 | | ● | | ● |
| 11 | 12 | 3-4 | ● | ● | | ● |

### Binary Code Decimal Complement

| Dec. No. | Switch Pos'n.* | 2nd Pin** | Output Terminal 1 | 2 | 4 | 8 |
|---|---|---|---|---|---|---|
| 0 | 1 | 12-1 | ● | ● | ● | ● |
| 1 | 2 | 1-2 | | ● | ● | ● |
| 2 | 3 | 2-3 | ● | | ● | ● |
| 3 | 4 | 3-4 | | | ● | ● |
| 4 | 5 | 4-5 | ● | ● | | ● |
| 5 | 6 | 5-6 | | ● | | ● |
| 6 | 7 | 6-7 | ● | | | ● |
| 7 | 8 | 7-8 | | | | ● |
| 8 | 9 | 8-9 | ● | ● | ● | |
| 9 | 10 | 9-10 | | ● | ● | |
| 10 | 11 | 10-11 | ● | | ● | |
| 11 | 12 | 11-12 | | | ● | |

● Indicates contact made to common
* The switch position number is the terminal location opposite the shaft flat; it is not the same as the decimal number.
** To limit an adjustable stop switch to the decimal number shown, insert the second pin in the hole lying between the 2 switch positions indicated.

## OPTIONS

### Adjustable Stops

Set and reset stops to limit rotation. All dimensions are the same as for fixed stop switches. Switches are shipped with the stop blades located to limit rotation to 11 switch positions. For continuous rotation, remove both blades. For limited rotation, remove the 2nd (clockwise) blade and move it to the hole located between the positions shown in the Truth Tables. Removal of a plastic washer provides access to the blades and slots. Adjustable stop versions are available in unsealed styles only.

### Shaft and Panel Seal

Switches are available in sealed or unsealed styles. For sealed style, the panel is sealed by an o-ring at the base of the bushing. The shaft is sealed by an o-ring inside of bushing. After the switch is mounted, seals do not alter the dimensions of the unsealed style.



## SPECIFICATIONS

### Electrical Rating

**Rated:** To make and break 125 mA 30 Vdc resistive load for 25,000 cycles of operation.
**Cycle:** (1 cycle = 360° rotation and return) Test conditions are standard atmospheric pressure, 25°C and 68% relative humidity.
**Contact Resistance:** 20 milliohms initially, 300 milliohms maximum after life
**Insulation Resistance:** 50,000 megohms initially, 10,000 megohms after life
**Voltage Breakdown:** 500 Vac between mutually insulated parts

### Materials and Finishes

**Bases:** Thermoset plastic
**Detent Rotor:** Nylon
**Shaft, Stop Blades, Stop Arm, Thrust Washer And Retaining Ring:** Stainless steel
**Detent Balls:** Steel, nickel-plated
**Bushing:** Zinc, Tin-zinc-plated
**Detent Spring:** Stainless steel
**Common Terminals and Rings:** Brass, gold plate .00003" minimum over silver plate .0003" minimum
**Terminals:** Brass with silver contact surface, gold-plated .00003"
**Rotor Contact:** Berillium copper with silver contact surface
**Shaft And Panel Seal:** Silicone rubber
**Mounting Hardware:** One mounting nut, .089" thick by .375" across flats, and one internal tooth lockwasher are supplied with the switch.

### Additional Characteristics

**Contact Type:** Wiping contacts
**Shaft Flat Orientation:** Switch position is defined as that position that is opposite the shaft flat. The location of the contacts in relation to the shaft flat is shown on the circuit diagram.
**Terminals:** Only the active position terminals, as shown in the circuit diagram are supplied with the switch. All common terminals are supplied.
**Stop Strength:** 7.5 in-lbs minimum
**Rotational Torque:** 8 to16 in-oz
**Bushing Mounting:** Required for these switches
**Maximum Mounting Torque:** 15 in-lbs.

## ORDERING INFORMATION

| Type Of Switch | Maximum No. Of Positions | BCD Output Unsealed | BCD Output Sealed | BCD Complement Unsealed | BCD Complement Sealed |
|---|---|---|---|---|---|
| Fixed Stop | 7 | 513360-7 | 513374-7 | 513361-7 | 513375-7 |
| | 8 | 513360-8 | 513374-8 | 513361-8 | 513375-8 |
| | 9 | 513360-9 | 513374-9 | 513361-9 | 513375-9 |
| | 10 | 513360-10 | 513374-10 | 513361-10 | 513375-10 |
| | 11 | 513360-11 | 513374-11 | 513361-11 | 513375-11 |
| | 12 | 513360-12-F | 513374-12-F | 513361-12-F | 513375-12-F |
| Continuous Rotation | 12 | 513360-12-C | 513374-12-C | 513361-12-C | 513375-12-C |
| Adjustable Stop | 12 | 513385 | ——— | 513384 | ——— |

The -C suffix indicates continuous rotation. The -F suffix indicates a fixed stop between positions 1 and 12.

For prices and discounts, contact a local Sales Office, an authorized local Distributor or Grayhill.

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.

INTUITIVE HUMAN INTERFACE SOLUTIONS

# Adjustable Stop Rotary Switches

## Features

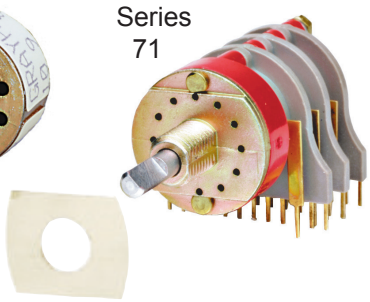
- Quick Route to Rotary Switches
- For Prototypes and Small Production Runs

Series 42/44

Series 50/51

Series 56

Series 71



## BEST AVAILABILITY

### The Problem

Procurement lead time on rotary switches for prototypes and small production runs can be long. This is often a source of headache for design engineers and production control managers.

Grayhill makes more than 300,000 combinations of rotary switch styles; number of decks, poles per deck, positions per pole, military qualified or commercial grade, etc. This wide variety makes it impractical for either distributors or manufacturers to stock completed switches. Consequently, even small quantities must be built to order.

### The Solution

Grayhill Electronic Distributors can supply a wide variety of rotary switches with Adjustable Stops. This feature gives you a switch immediately with exactly the electrical properties you need. These Adjustable Stop switches have the basic mechanical characteristics of their fixed stop counterparts. To get the right number of positions per pole for your application, simply adjust the stop washers or stop pins.

By stocking a few switches, the Distributor provides over 100,000 possible combinations of switches. This includes the popular styles, sizes, angles of throw, number of decks, poles per deck, positions per pole, and types of contacts. Availability of these switches through Distributors speeds prototype development time. There is no time lag in waiting for factory made samples.

### The Substitution

Writing an equivalent part number is easy. To obtain an adjustable-stop equivalent to a fixed-stop rotary switch you must substitute style letters and possibly series number. Then replace the positions-per-pole number in the fixed-stop number with the letters AJ. See the examples for the scheme.

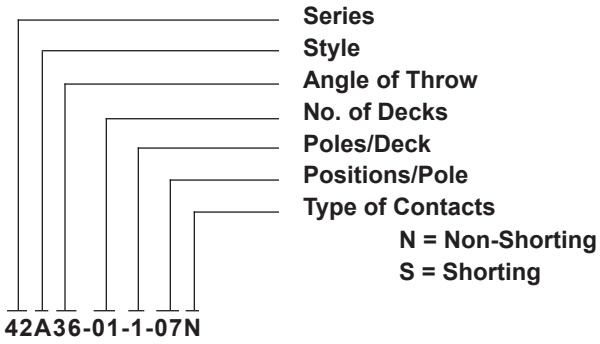
When adjustable equivalents apply, the rotary switch pages will indicate the substitutions. A chart will show the fixed stop rotary switch series, style and angle of throw as well as the adjustable stop rotary switch series, style and angle of throw. Then the letters AJ in the positions-per-pole location, gives you the part number of the equivalent.

### Suppliers

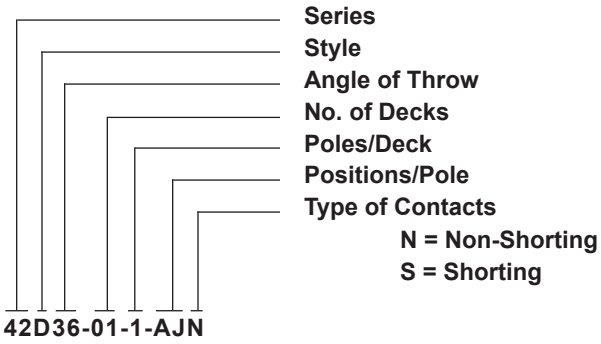
Distributors can supply 1 and 2-deck adjustable-stop switches from stock (one or two poles per deck). They can also quickly secure other variations from factory stock. Reduce prototype development time. Use Grayhill Adjustable Stop Rotary Switches for all of your prototype requirements.

These electronic distributors also maintain a representative stock of Grayhill products. Local availability can often "save the day", and simplify your paperwork.

### Fixed Stop Rotary Switch



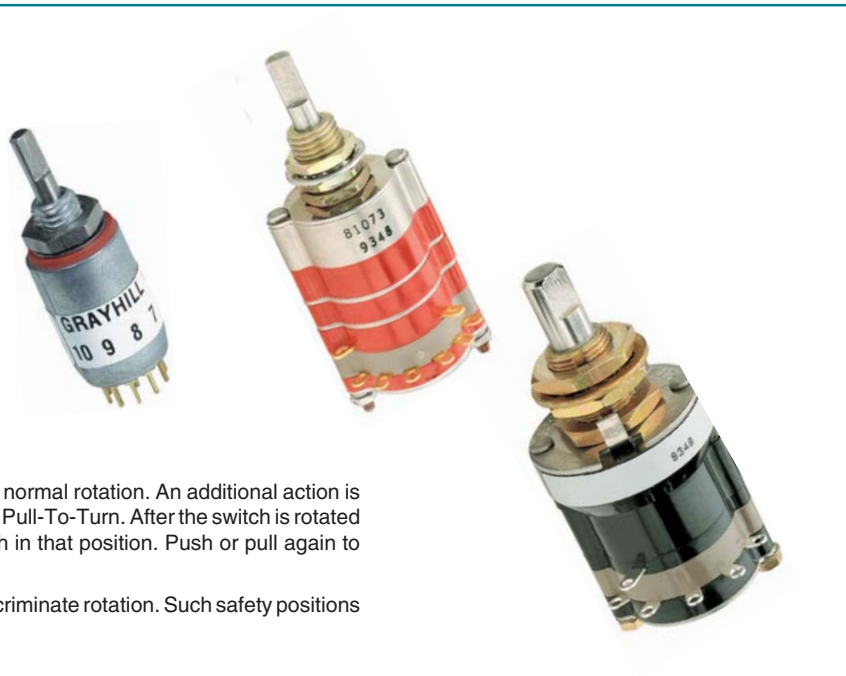

### Adjustable Stop Equivalent



Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



# SERIES 09, 42, 44, 50, 51
## Isolated Position



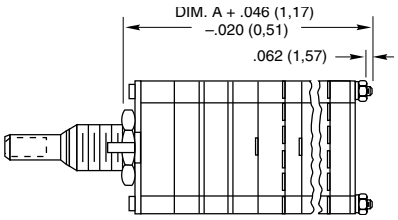

## FEATURES
- Protected Switch Positions For Safety, Calibration, or Stand-by
- Choice of Push- or Pull-To-Turn
- 1/2" Diameter, 200 mA and 1" Diameter, 1 Amp Switch
- 10,000 Cycles of Operation

## DESCRIPTION
An isolated position is one which cannot be reached by the normal rotation. An additional action is required by the operator. It could be either Push-To-Turn, or Pull-To-Turn. After the switch is rotated to the isolated position, releasing the shaft locks the switch in that position. Push or pull again to rotate the switch again.

Use isolated positions to protect a switch position from indiscriminate rotation. Such safety positions might include “calibrate”, “off” and/or “stand-by”.

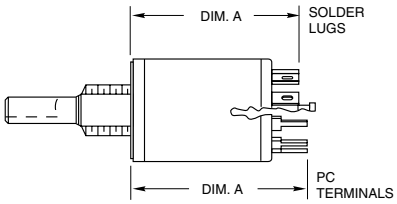
## DIMENSIONS

**Series 09**



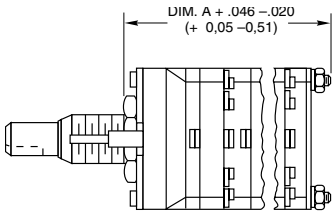

| | Dimension A |
|---|---|
| **1 Deck** | 1.228 (31,19) |
| **2 Decks** | 1.496 (38,0) |
| **3 Decks** | 1.764 (44,81) |
| **4 Decks** | 2.032 (51,61) |

**Series 50 & 51**




| | Dimension A |
|---|---|
| **Solder Lug** | .893 ± .025 (22,68 ± 0,64) |
| **PC Style** | .897 ± .025 (22,78 ± 0,64) |

**Series 42 & 44**




| | Dimension A |
|---|---|
| **1 Deck** | 1.371 (34,82) |
| **2 Decks** | 1.717 (43,61) |
| **3 Decks** | 2.063 (52,40) |
| **4 Decks** | 2.409 (61,19) |

Grayhill part number and date code marked on label.
Customer number marked on request.

## EXTERNAL DIFFERENCES
The isolated position mechanism increases the depth of the Series 50 and 51 by 0.217" (5,51 mm). All other dimensions remain unchanged. In Series 9, 42 and 44, it has the appearance of an additional deck section without terminals, located directly behind the detent system.

## SPECIFICATIONS
### Electrical Ratings
The switching elements, and therefore ratings, are the same in an isolated position switch as in a conventional rotary switch. Mechanical life is also the same.

### Additional Characteristics
**Shaft Movement or Vertical Travel:**

| | |
|---|---|
| Series 09 | .062 ± .020 (1,57 ± 0,51) |
| Series 42 & 44 | .070 ± .020 (1,78 ± 0,51) |
| Series 50 & 51 | .080 ± .020 (2,03 ± 0,51) |

**Push or Pull Force Required:**

| | |
|---|---|
| Series 09 | 1.75 ± .5 lbs |
| Series 42 & 44 | 2 ± .5 lbs |
| Series 50 & 51 | 2 ± .5 lbs |

**Stops:** Single pole per deck switches with the maximum number of positions are supplied with stops only on request: 12 positions in 30° throw, 10 in 36°, and 8 in 45°.
**Stop Strength:** Approximately 7.5 pound-inches for the isolated position stop.

### Materials and Finishes
Materials and finishes for the isolation mechanism are listed here.

**Series 50 and 51**
**Housing:** Zinc casting, tin/zinc-plated
**Shaft:** 303 stainless steel
**Stop Pin and Stop Post:** 303 stainless steel
**Spring:** Tinned music wire

**Series 09**
**Housing:** Phenolic for style A; Diallyl, for M
**Shaft:** 303 stainless steel, electro-polished
**Stop Pin and Stop Post:** 303 stainless steel
**Spring:** Tinned music wire

**Series 42 and 44**
**Housing:** Diallyl per MIL-M-14
**Shaft:** 303 stainless steel
**Lock Plate:** 302 stainless steel
**Lock Arm:** 316 stainless steel
**Lock Post:** Brass, tin/zinc-plated
**Compression Spring:** Tinned music wire

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



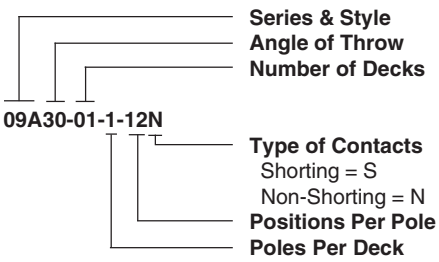
## CHOICES AND LIMITATIONS

| Standard Style | Military Style** | Style Description | Angle Of Throw | No. Of Decks | Poles Per Deck | Positions Per Pole | Shorting Or Non-Shorting |
|---|---|---|---|---|---|---|---|
| 09A | 09M | Solder Lug | 30° | 01 to 04<br>01 to 04<br>01 to 04<br>01 to 04<br>01 to 04<br>01 to 03 | 1<br>2<br>3<br>4<br>5<br>6 | 02 to 12<br>02 to 06<br>02 to 04<br>02 or 03<br>02<br>02 | N or S<br>N or S<br>N or S<br>N or S<br>N or S<br>N or S |
| 42A<br>42S<br>—<br>— | 42M<br>—<br>42H<br>42HS | Solder Lug<br>Sealed<br>125° Temperature Rating<br>125° Temp Rating, Sealed | 36° | 01 to 04<br>01 to 04 | 1<br>2 | 02 to 10<br>02 to 05 | N or S<br>N or S |
| 44A<br>44S<br>—<br>— | 44M<br>—<br>44H<br>44HS | Solder Lug<br>Sealed<br>125° Temperature Rating<br>125° Temp Rating, Sealed | 30° | 01 to 04<br>01 to 04<br>01 to 04<br>01 to 04<br>01 to 04<br>01 to 04 | 1<br>2<br>3<br>4<br>5<br>6 | 02 to 12<br>02 to 06<br>02 to 04<br>02 or 03<br>02<br>02 | N or S<br>N or S<br>N or S<br>N or S<br>N or S<br>N or S |
| | | | 45° | 01 to 04<br>01 to 03<br>01 or 02<br>01 or 02 | 1<br>2<br>3<br>4 | 02 to 08<br>02 to 04<br>02<br>02 | N or S<br>N or S<br>N or S<br>N |
| --<br>--<br>--<br>-- | 50C<br>50CP<br>50M*<br>50MP* | Solder Lug<br>PC Mount<br>Solder Lug, Sealed<br>Sealed, PC | 36° | 01 | 1<br>2 | 02 to 10<br>02 to 05 | N or S<br>N or S |
| --<br>--<br>--<br>-- | 51C<br>51CP<br>51M*<br>51MP* | Solder Lug<br>PC Mount<br>Solder Lug, Sealed<br>PC Mount, Sealed | 30° | 01 | 1<br>2<br>3<br>4 | 02 to 12<br>02 to 06<br>02 or 03<br>02 or 03 | N or S<br>N or S<br>N or S<br>N or S |

*(Pull-to-Turn only) **For specifics on military qualified products, see Standard Switch Pages.

## CONVENTIONAL NUMBERS

Start by creating a conventional switch number in the manner which follows:




Note: No stop arrangement suffix is needed. See Describing Stops.

## DESCRIBING POSITIONS

The Grayhill system for isolating positions lets you choose the positions to be isolated. Grayhill inserts isolation posts next to the positions to be isolated. Consider a continuous rotation switch of the Series 09A with a 30° angle of throw. The terminals are listed here from 1 through 12 with a space between each to indicate where isolation posts might be inserted.

12 1 2 3 4 5 6 7 8 9 10 11 12

Let's isolate position 1 and position 2 from all other positions and from each other. We indicate isolation posts as shown here:

12P1P2P3 4 5 6 7 8 9 10 11 12

To isolate just position 1, describe like this:

12P1P2 3 4 5 6 7 8 9 10 11 12

To isolate positions 1 and 2 from all other positions, but not from each other, do this:

12P1 2P3 4 5 6 7 8 9 10 11 12

## DESCRIBING STOPS

When a 1-pole switch has less than the maximum number of positions, consider also the stop system. Following is the arrangement for a 6 position switch with the position 1 isolated.

STOP 1P2 3 4 5 6 STOP

The word "STOP" indicates the conventional switch stops, which limit rotation to positions 1 through 6. To isolate position 1 we insert only one isolation post–between terminals 1 and 2. The stop system already prevents rotation beyond terminal 1.

In multi-pole switches, the stop system and isolation system described for the first pole, automatically affects the other poles. In the example above, isolating position #1 on the first pole isolates the first position (terminal #7) of the second pole. See Standard Switch Pages for a 2 pole circuit diagram for a 30° throw switch.

## ORDERING INFORMATION

Indicate this as a SPECIAL switch to ensure that no error is made when the order is entered. Sample part number:

SPECIAL
09A30-04-1-12N
PULL 12P1P2P3 4 5 6 7 8 9 10 11 12

This sample part number orders a Series 9 standard style, four deck, one pole per deck, twelve positions per pole rotary switch with non-shorting contacts and isolation posts between positions 12 and 1, between 1 and 2, and between 2 and 3.

This lengthy order number is required to prevent any possible confusion in ordering the switch. When we receive your order, we will assign a special "short form" part number to facilitate future identification of this special switch. This number is sequentially assigned as the need arises, and is non-descriptive. A typical "short form" special part number might be 09YY12345. Contact Grayhill for price.

**Not available through Distributors.**

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.

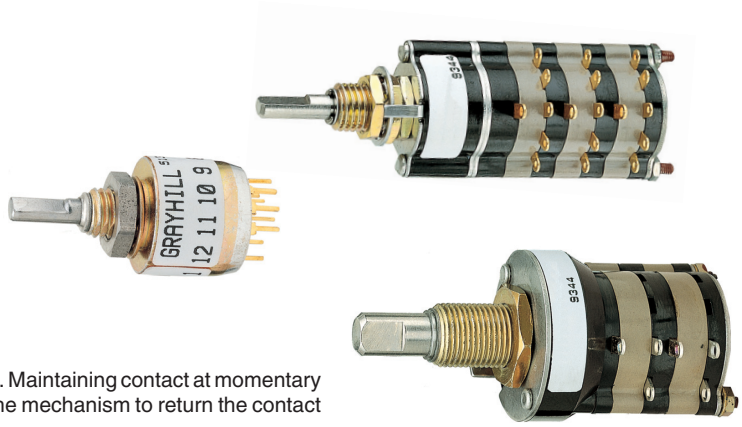


# SERIES 08,09,42,44,50

## Spring Return

## FEATURES

- Hold-To-Test, Hold-To-Calibrate, And Other Momentary Applications
- Choice of Configurations, Ratings, Styles and Circuitry
- 10,000 Cycles of Operation

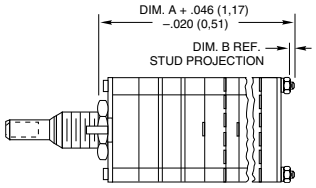



## DESCRIPTION

A spring return rotary switch has 1 or more momentary positions. Maintaining contact at momentary positions requires rotational force. Releasing the force allows the mechanism to return the contact to a normal, or detent, position.

## DIMENSIONS

### Series 08 & 09

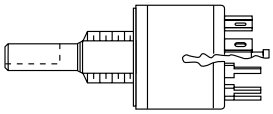


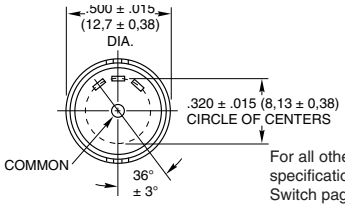

| No. of Decks | Dim A | Dim B |
|---|---|---|
| 1 | .960 (24,38) | .062 (1,57) |
| 2 | 1.228 (31,19) | .062 (1,57) |
| 3 | 1.496 (38,0) | .062 (1,57) |
| 4 | 1.764 (44,81) | .062 (1,57) |
| 5 | 2.032 (51,61) | .062 (1,57) |
| 6 | 2.550 (64,77) | .312 (7,92) |

For all other dimensions and specifications, see Standard Switch pages.

### Series 50

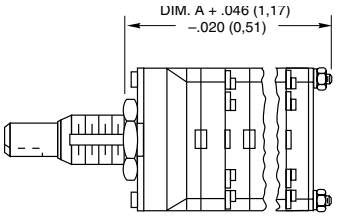
Equivalent to Series 50 Standard Switches






For all other dimensions and specifications, see Standard Switch pages.

### Series 42 & 44




| No. of Decks | Dim. A |
|---|---|
| 1 | 1.025 (26,04) |
| 2 | 1.371 (34,82) |
| 3 | 1.717 (43,61) |

For all other dimensions and specifications, see Standard Switch pages.

## CONFIGURATIONS

This configuration indicates a counterclockwise force is required to hold the switch at position #1. "M" indicates a momentary position counterclockwise of "D" and "D", detented ones.

| Positions | 1 | 2 | 3 |
|---|---|---|---|
| | M | D | D |

Releasing this force breaks contact with position #1 and returns the switch to #2. Normal rotary switch detent action occurs when the switch is rotated between position #2 and #3.

All of the configurations (except *MDM*) list a basic 2 position arrangement which is shown in italics. Example: *MD*DDDD or DDDD*DM*. Several positions can be added during the switch construction at the factory; but, any configuration must always contain the 2 basic positions.

## SELECTING A SWITCH

**1. Select a Configuration:** The total number of positions always includes the 2 basic positions. A (4) position switch of DDD*DM* configuration would have 3 detent positions counterclockwise of the momentary position.

**2. Select Series, Angle of Throw, and Style:** See the Choices Chart. The basic switch description, series, and throw are as follows:

| | | |
|---|---|---|
| 1/2", 1/4 Amp, multi-deck | 08 = 36° | 09 = 30° |
| 1", 1 Amp, multi-deck | 42 = 36° | 44 = 30° |
| 1/2", 200 mA, single deck | 50 = 36° | |

Electrical ratings are the same as those of the conventional switches with the exception of life. Life is limited to 10,000 cycles of operation (25,000 cycles for Series 50) due to the spring arrangement. Dimensions are the same as for conventional types except for the shaft flat orientation of the 3, 4, 5, and 6 pole, Series 09 and 44 in the DDDD*DM* configuration (see chart).

**3. Select Poles & Positions Per Pole:** If you do not find the poles and positions per pole you need in one series, try another or contact the factory. If the behind panel length is a problem, select a multi-pole type instead of a single deck.

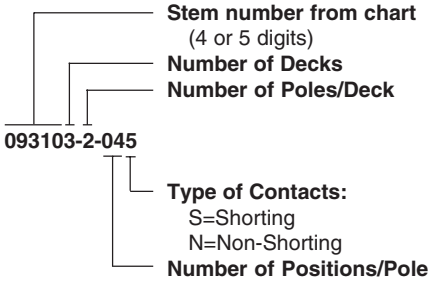
## OPTIONS

Watertight panel seal; Multi-pole switches that exceed the limits noted in the Selector Chart; Series 50 *MD* or *DM* configurations in Military styles; Series 08, 09, & 44 in MM*MDM*MM, and in MM*DD*MM, and in MMM*MMD*.

**Not available through Distributors**

## ORDERING INFORMATION

Create the part number using this example.




Exception: Numbers beginning with 5 are already complete part numbers.

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



## CHOICES AND LIMITATIONS

| Con-figur-ation | Conven-tional Switch | Description Of Style | Spring Return Stem Number (See Ordering Info.) | No. Of Decks | Poles Per Deck | Positions Per Pole & Contact Type | Location Of Unique Position, Detent or Momentary | Term. Opp. Flat** |
|---|---|---|---|---|---|---|---|---|
| DDDD***DM*** | 08A36 | Standard | 08317 | 1 to 6<br>1 to 3 | 1<br>2 | 02 to 05 (N or S)<br>02 to 05 (N or S) | M 5<br>M 5, 10 | 5<br>5 |
| | 09A30 | Standard | 09310 | 1 to 6<br>1 to 3<br>1 or 2<br>1<br>1 | 1<br>2<br>3<br>4<br>5 or 6 | 02 to 06 (N or S)<br>02 to 06 (N or S)<br>02 to 04 (N or S)<br>02 or 03 (N or S)<br>02 (N or S) | M 6<br>M 6, 12<br>M 4, 8, 12<br>M 3, 6, 9, 12<br>M 2, 4, 6, 8, 10, 12 | 6<br>6<br>4<br>3<br>2 |
| | 42A36 | Standard | 42349 | 1 to 3<br>1 | 1<br>2 | 02 to 05 (N or S)<br>02 to 05 (N or S) | M 5<br>M 5, 10 | 5<br>5 |
| | 42M36 | Military | 42352 | 1 to 3<br>1 | 1<br>2 | 02 to 05 (N or S)<br>02 to 05 (N or S) | M 5<br>M 5, 10 | 5<br>5 |
| | 44A30 | Standard | 44346 | 1 to 3<br>1 | 1<br>2 | 02 to 06 (N or S)<br>02 to 06 (N or S) | M 6<br>M 6, 12 | 6<br>6 |
| | 44M30 | Military | 44350 | 1 to 3<br>1 | 1<br>2 | 02 to 06 (N or S)<br>02 to 06 (N or S) | M 6<br>M 6, 12 | 6<br>6 |
| ***MD***DDDD | 08A36 | Standard | 08319 | 1 to 6<br>1 to 3 | 1<br>2 | 02 to 05 (N or S)<br>02 to 05 (N or S) | M 1<br>M 1, 6 | 1<br>1 |
| | 09A30 | Standard | 09312 | 1 to 6<br>1 to 3<br>1 or 2<br>1<br>1 | 1<br>2<br>3<br>4<br>5 or 6 | 02 to 06 (N or S)<br>02 to 06 (N or S)<br>02 to 04 (N or S)<br>02 or 03 (N or S<br>02 (N or S) | M 1<br>M 1, 7<br>M 1, 5, 9<br>M 1, 4, 7, 10<br>M 1, 3, 5, 7, 9, 11 | 1<br>1<br>1<br>1<br>1 |
| | 09M30 | Military | 09356 | 1 to 3<br>1<br>1 | 1<br>2<br>3 | 02 to 06 (N or S)<br>02 to 06 (N or S)<br>02 to 04 (N or S) | M 1<br>M 1, 7<br>M 1, 5, 9 | 1<br>1<br>1 |
| | 42A36 | Standard | 42350 | 1 to 3<br>1 | 1<br>2 | 02 to 05 (N or S)<br>02 to 05 (N or S) | M 1<br>M 1, 6 | 1<br>1 |
| | 42M36 | Military | 42353 | 1 to 3<br>1 | 1<br>2 | 02 to 05 (N or S)<br>02 to 05 (N or S) | M 1<br>M 1, 6 | 1<br>1 |
| | 44A30 | Standard | 44312 | 1 to 3<br>1 | 1<br>2 | 02 to 06 (N or S)<br>02 to 06 (N or S) | M 1<br>M 1, 7 | 1<br>1 |
| | 44M30 | Military | 44351 | 1 to 3<br>1 | 1<br>2 | 02 to 06 (N or S)<br>02 to 06 (N or S) | M 1<br>M 1, 7 | 1<br>1 |
| ***MDM*** | 50A36 | Std., Solder Lug | 503265-1-03N* | 1 | 1 | 03N | D 2 | 2 |
| | 50P36 | Std., PC Mount | 503267-1-03N* | 1 | 1 | 03N | D 2 | 2 |
| | 8A36 | Standard | 08316 | 1 to 6<br>1 to 3 | 1<br>2 | 03 (N or S)<br>03 (N or S) | D 2<br>D 2, 7 | 2<br>2 |
| | 9A30 | Standard | 09311 | 1 to 6<br>1 to 3<br>1 or 2<br>1 | 1<br>2<br>3<br>4 | 03 (N or S)<br>03 (N or S)<br>03 (N or S)<br>03 (N or S) | D 2<br>D 2, 8<br>D 2, 6, 10<br>D 2, 5, 8, 11 | 2<br>2<br>2<br>2 |
| | 42A36 | Standard | 42348 | 1 to 3<br>1 | 1<br>2 | 03 (N or S)<br>03 (N or S) | D 2<br>D 2, 7 | 2<br>2 |
| | 42M36 | Military | 42351 | 1 to 3<br>1 | 1<br>2 | 03 (N or S)<br>03 (N or S) | D 2<br>D 2, 7 | 2<br>2 |
| | 44A30 | Standard | 44345 | 1 to 3<br>1 | 1<br>2 | 03 (N or S)<br>03 (N or S) | D 2<br>D 2, 8 | 2<br>2 |
| | 44M30 | Military | 44349 | 1 to 3<br>1 | 1<br>2 | 03 (N or S)<br>03 (N or S) | D 2<br>D 2, 8 | 2<br>2 |

*This is a complete (not stem) part number.
**Terminal opposite shaft flat when switch is in its unique (detent or momentary) position.

**Available from your local Grayhill Distributor**

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



# Rotary Switch Engineering Information

## Catalog Ratings

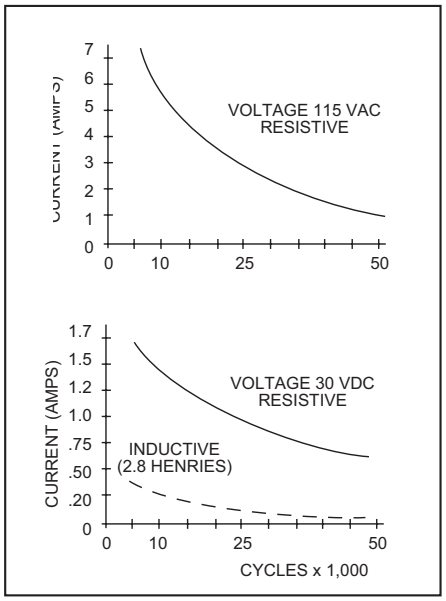
Are catalog ratings misleading? In most cases, yes. Load and life ratings shown in most catalogs are usually invalid for most applications. This results from the complex interplay of such factors as environment, duty cycle, life limiting or failure criteria, actual load, etc. Circuit designers should be aware of these factors, and the effect they have on the useful life of the switch in their applications.

The problem of switch rating arises from the wide variety of requirements placed on the switch. This includes various applications, and the sensitivity of the switch to a change in requirements. If we attempted to establish life ratings for all possible applications, we would have an almost infinite variety of ratings.

To simplify the problem, switch manufacturers, switch users, and the military, have established certain references for ratings. These include loads, life requirements, environments, duty cycles, and failure criteria. These references are arbitrarily established. But, they allow you to compare different switch designs. They do not, however, match the actual requirements for most applications.

The curves shown here are an example of some of the life load curves. These curves are life load characteristics of the Grayhill 42M and 44M switches. Note that the curves consider only two voltage sources and two types of loads. These voltages and loads are, however, considered as standards for testing procedures by the industry.

Curve data is based on tests conducted at sea level, 25°C and 68% relative humidity. Cycle = 360° rotation and return. Cycling rate is 10 cycles per minute. Switch rating is for non-shorting contacts.




These curves allow you to predict the expected life of the switch once you know the voltage, current and type of load. Also note that each cycle is approximately a 360° rotation and a return. For a ten position switch this would be a rotation from position 1 to position 10 and back to 1. This cycle runs approximately ten times a minute. Thus testing causes more electrical and mechanical wear than what the switch incurs in actual use.

## Summary

The life and load ratings in this and other catalogs are probably not totally valid for your application. The bright side of the picture is that in most applications the switch will perform better than its ratings. This is because the standard industry test conditions are more stringent than those found in most applications.

This difference can be very dramatic. For example, Grayhill's 42A and 44A Series Rotary Switches, are rated at 1 ampere (115 Vac resistive). However, they will operate at 5 amperes in many applications. To see how some major factors influence switch performance, read on.

## USEFUL LIFE CRITERIA

The "useful" life of a switch in your application depends on what you demand of it. This includes parameters such as contact resistance, insulation resistance, torque, detent feel, dielectric strength, and many other factors. For example, a contact resistance of 50 milliohms may be totally unusable in certain applications such as a range switch in a micro-ohm meter. In other applications a contact resistance of 5 ohms may be perfectly satisfactory.

In establishing "useful" life for a switch in your application, you must first determine "failure criteria," or "end of life" parameters. At what level of contact resistance, dielectric strength, etc., is the switch no longer acceptable for your application?

Most switches are acceptable on all parameters when new. There is a gradual deterioration in performance with life. The rate of deterioration varies greatly with basic switch design. Often, circuit designers select a switch on the basis of its performance when new. This is a mistake. The performance of the switch after several years of equipment use is more significant. To estimate this, first determine the life limiting or failure criteria for your application. In most uses, important life-limiting (failure) criteria include the following parameters:

- Contact Resistance
- Insulation Resistance
- Dielectric Strength
- Actuating Force

## Contact Resistance

This is the resistance of a pair of closed contacts. This resistance effectively appears in series with the load. Typical values are in the range of a few milliohms for new switches. These values usually increase during life. The rate of increase is greatly affected by the voltage, current, power factor, frequency, and environment of the load being switched. Typical industry standard "end of life" criteria for this parameter are:

| | |
|---|---|
| MIL-DTL-3786: | 20 milliohms (Rotary Switches) |
| MIL-S-6807: | 20 milliohms (Snap Pushbuttons) |
| MIL-S-8805: | 40 milliohms (Pushbuttons) |
| MIL-S-83504: | 100 milliohms (DIP Switches) |

Contact resistance can be measured by a number of different methods. All of them are valid depending upon the switch application and the circuit. Grayhill uses the method in applicable military specifications. This method specifies an open circuit test voltage and a test current. The voltage drop across the closed contacts is measured. The contact resistance is determined by Ohm's Law from the test current and the measure voltage drop. MIL-DTL-3786, MIL-S-6807 and MIL-S-8805 require a maximum open circuit test voltage of 2 Vdc; they require a test current of 100 milliamperes. MIL-S-83504 requires a maximum test voltage of 50 millivolts and a test current of 10 milliamperes.

When a switch is rated to make and break 5 or more amperes, there is a difference. Contact resistance is determined by measuring the voltage drop while the switch is carrying the maximum rated current.

The voltage drop that occurs across the contacts determines, in part, the contact temperature. If the temperature rise of the contacts is sufficient, it affects contact material. A chemical reaction will take place that can cause an insulating film to appear on the contacts. This film is present between the contacts during the next switching operation. This film formation can cause failure due to increasing contact resistance. For switching of very low voltages and currents, this resistance may be the failure criteria.

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



### Insulation Resistance

This is the resistance between two normally insulated metal parts, such as a pair of terminals. It is measured at a specific high DC potential, usually 100 Vdc or 500 Vdc. Typical values for new switches are in the range of thousands of megohms. These values usually decrease during switch life. This is a result of build-up of surface contaminants. Typical industry standard "end of life" criteria for the parameter are:

| | |
|---|---|
| MIL-DTL-3786: | 1000 megohms (for plastic insulation) |
| MIL-S-6807: | Not specified |
| MIL-S-8805: | 2000 megohms |
| MIL-S-83504: | 1000 megohms |

Another special test condition is commonly specified. It measures insulation resistance for switches in a high humidity atmosphere (90%-98% R.H.). In this condition, condensation of moisture commonly occurs on the surface of the insulating material. Some types of insulation will absorb varying amounts of moisture. This will normally lower the insulation resistance. Typical industry values for this condition are:

| | |
|---|---|
| MIL-DTL-3786: | 10 megohms (for plastic insulation) |
| MIL-S-6807: | 3 megohms after drying |
| MIL-S-8805: | 10 megohms (for plastic material) |
| MIL-S-83504: | 10 megohms |

### Dielectric Strength

This is the ability of the insulation to withstand high voltage without breaking down. Typical values for new switches in this test are in excess of 1500 Vac RMS. During switch life, contaminants and wear products deposit on the surface of the insulation. This tends to reduce the dielectric withstanding voltage. In testing for this condition, a voltage considerably above rated voltage is applied. Then, the leakage current is measured at the end of life. Typical industry standard test voltages and maximum allowable leakage currents are as follows:

| | |
|---|---|
| MIL-DTL-3786: | 1000 Vac and 1 mA maximum leakage |
| MIL-S-6807: | 600 Vac RMS after life 10 microamperes maximum leakage |
| MIL-S-8805: | 1000 or 1000 plus twice working voltage (AC) RMS and 1mA maximum leakage |
| MIL-S-83504: | 500 Vac and 1 mA maximum leakage |
| UL Standard: | 900 Vac without breakdown (UL Standard (dependent on test) |

Voltage breakdown is another method for describing the ability of the insulating material to withstand a high voltage. Voltage breakdown describes the point at which an arc is struck and maintained across the insulating surface with the voltage applied between the conducting members.

## ADDITIONAL LIFE FACTORS

### Effect of Loads

On any switch, an arc is drawn while breaking a circuit. This causes electrical erosion of the contacts. This erosion normally increases contact resistance and generates wear products. These wear products contaminate insulating surfaces. This reduces dielectric strength and insulation resistance.

The amount of this erosion is a function of current, voltage, power factor, frequency and speed of operation. The higher the current is, the hotter the arc and the greater the erosion. The higher the voltage is, the longer the arc duration and the greater the erosion.

Inductance acts as an energy storage device. This returns its energy to the circuit when the circuit is broken. The amount of erosion in an inductive circuit is proportionate to the amount of inductance. Industry standard test inductance as described in MIL-I-81023 is 140 millihenries. Other test loads include 250 millihenries and 2.8 henries.

Frequency can also affect erosion. The arcing ends when the voltage passes through zero. To a certain extent, the following is true. The higher the frequency, the sooner arcing ends, the lower the erosion.

The speed of operation affects the duration of the arc. Fast operation can extinguish the arc sooner. This reduces the erosion, unless the air within the switch is completely ionized.

### Actuating Force

Rotational torque is the actuating force required to turn a rotary switch through the various positions. The actual torque or force required depends on the design of the switch. It varies widely from one design to another. See appropriate MIL Specs or manufacturers literature for typical industry values for specific designs.

When torque or force values are specified, it is customary to give a minimum and maximum value. During life, two offsetting factors may occur to change the initial value. Relaxation of spring members will tend to lower torque or force values. Wear or "galling" of mating surfaces, however, may tend to increase these values. Typical end of life specifications may require the switch to fall within the original range. Or, they may specify a maximum percentage change from original value. For example, "the rotational torque shall not change more than 50% from its initial value.

### Effect of Ambient Temperature

Temperature extremes may affect switch performance and life. Very high temperatures may reduce the viscosity of lubricants. This allows them to flow out of bearing areas. This can hasten mechanical wear of shafts, detents, plungers, and cause early mechanical failure. Contact lubricants are sometimes used. Too little lubrication can result in a high rate of mechanical wear. Too much lubrication flowing from other bearing areas can adversely affect dielectric strength and insulation resistance.

Through careful design and selection of lubricants most manufacturers attempt to minimize these affects. Nevertheless, continual operation in high ambient temperatures will shorten the life of a switch regardless of design.

Extremely low ambient temperatures may also create problems. Low temperatures may cause an increase in the viscosity of the contact lubricant. Higher viscosity can delay or prevent the closing of contacts, causing high operating contact resistance. Under certain atmospheric conditions, ice may form on the contact surfaces. This also causes high and erratic contact resistance.

Neither of these conditions may materially reduce the life of the switch. However, it may cause unsatisfactory operation. If the voltage of the circuit is high enough, it can break down the insulating layer. Some current will flow through the high resistance contacts. A local heating action is created, which tends to correct the condition in a short period of time.

Switches with high contact pressures may minimize the low ambient temperature effect. This is particularly true if the application calls for switching signal level voltages and currents.

### Effects of Altitude

In high altitudes, barometric pressure is lower. Low pressure reduces the dielectric strength of the air. The arc strikes at a lower voltage and remains longer. This increases contact erosion. Switches for use in high altitudes will therefore require de-rating in terms of loads and/or life.

### Effects of Duty Cycle

Mechanical life testers cause accelerated life testing. Testers operate switches at a rate of approximately 10 cycles per minute. This rate is greatly in excess of normal manual operation in equipment. It constitutes a severe test of the switch.

Lubricants do not have an opportunity to redistribute themselves over the bearing surfaces at this duty cycle. The contact heating caused by arcing does not have a chance to dissipate.

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



Thus, the switch runs "hot", increased mechanical wear and contact erosion result. Your application probably requires manual operation of the switch with an attendant low duty cycle. If so, you can usually expect much longer switch life than is shown by the accelerated life laboratory life tests.

## Conclusion

Remember, load and life ratings are based on manufacturers' selected references. They include accelerated life tests and an arbitrary set of application parameters and failure criteria. These parameters and criteria may not always fit your application.

Then how do you know if a switch will give reliable performance in your application?

How do you know if it will last the life of your equipment?
Ask the switch manufacturer. Grayhill, and most other reputable manufacturers have compiled vast quantities of test data. We are in a position to give a good estimate of a switch's performance in many nonstandard applications. You should provide the following data:

| | |
|---|---|
| Expected Life: | in number of cycles |
| Load: | voltage, current, power factor, and frequency |
| Operation: | manual or mechanical, duty cycle |
| Application: | type of equipment |
| Environment: | altitude, ambient temperature range relative humidity, corrosive atmosphere, shock, vibration, etc. |
| Failure Criteria: | end of life contact resistance, dielectric strength, insulation resistance, etc. |

With this information, we can usually estimate if a given switch is suitable for your application.

## Soldering

What causes failure in a new switch after it has been installed? The principle failure is high contact resistance caused by solder flux on the contact surfaces. To avoid this, be sure to follow good soldering practices. Use the proper solder with the proper flux core, maintain the proper soldering temperature, use the proper soldering iron tip for the work, and never use liquid flux when soldering a switch.

Do not use solvent baths or washes with any unsealed electromechanical parts. Switches, unless they have been especially protected suffer badly. Solvents readily dissolve fluxes and carry them into the contact area of switches. A thin, hard flux coats the contact surface after the solvent evaporates. Additionally, solvents may dissolve and wash away lubricants in switches. Lubricant loss may prevent proper mechanical action.

Exercise similar precautions when you mount a switch to a printed circuit board. Maintain proper solder temperatures and follow proper cleaning techniques. Avoid subjecting these switches to lengthy solder baths. The excessive heat can deform the plastics.

## RFI/EMI Shielding

Some applications require shielding against Radio Frequency Interference and/or Electro-Magnetic Interference. Experts feel that the most effective way to achieve shielding is to provide a conductive bridge across the component mounting hole. They also generally agree that there is no good method for testing shielding. So, the equipment manufacturers themselves must identify and solve specific problems. Component manufacturers can generally assist in the solution of shielding problems.

RFI/EMI testing is incorporated into MIL-DTL-3786 for rotary switches. Requirements are 1.0 ohm maximum dc resistance between the mounting bushing and operating shaft initially and 10.0 ohm maximum dc resistance following environmental and mechanical tests. Many equipment manufacturers feel they are satisfying their needs with a measurement of .025 to 10 ohms for the expected life of the switch. Under most circumstances, standard non-sealed switches pass the larger value easily. The lower value (.025 ohms) requires special attention and parts for compliance over the life of the switch.

## Switch Selection

Whenever possible, use standard switches and contact configurations. Standards provide the greatest economy and the best delivery. When you need a deviation, it pays to consult with your suppliers as soon as possible. At the early stages of the design, there are many low cost options for achieving the results. At the late stages of design, some of the options may no longer be open. For example, size may be restricted. This might result in a more costly redesign.

Typical standard rotary options are as follows: coded contacts, homing rotor effect, progressively shorting contacts, PC mountable terminals, rotary switch spring return positions, and push-to-turn or pull-to-turn mechanisms.

Limited panel space may be solved by a concentric shaft rotary switch. It is two rotary switches, located one behind the other. There are other concentric shaft possibilities. A rotary switch can be combined with another component. These include a potentiometer, a pushbutton switch, and a mechanical element. The most cost effective design may be one of these concentric options. But, selection must be made at the outset of equipment design.

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



# 1. SELECT A FACTOR

## FACTOR: Current Life Rating

All switches are rated to make and break at least 100 milliamperes for 10,000 cycles of operation. Rating becomes a matter of interpretation. Carefully review the Engineering Information on the previous pages. Ratings which assure a different life are possible; contact Grayhill.

| | Single Deck Switch Series | | | | | | | Multi-Deck Switch Series | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 19 | 24 | 50/51 | 56 | 75 | 77 | 5000 | 08/09 | 42/44 | 43/54 | 53,57,59 | 71 |
| 25,000 Cycles At Load (Amps) | — | 1 | .050 | — | — | .050 | 1 | .250 | 1,3,5* | 1,3,5* | — | .250 |
| 10,000 Cycles At Load (Amps) | — | — | .200 | .200 | .100 | — | — | .500 | 1,3,5* | 1,3,5* | .150, .250* | — |
| 6,000 Cycles At Load (Amps, UL) | 15 | — | — | — | — | — | — | — | — | — | — | — |

* Varies with angle of throw and style.

## FACTOR: Size

| Maximum Dimension In Inches (& Millimeters) | Single Deck Switch Series | | | | | | | | Multi-Deck Switch Series | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 19 | 24 | 50 | 51 | 56 | 75 | 77 | 5000 | 08 | 09 | 42 | 44 | 53 | 57 | 59 | 71 |
| Diameter, Behind Panel | 2.280 | 1.015 | .500 | .561 | .500 | .298 | | 1.015 | .687 | .750 | 1.015 | 1.170 | 1.350 | 1.190 | 1.190 | .750 |
| Length Behind Panel, 1 Deck | .950 | .580 | .698 | .698 | .355 | .500 | | .470 | .960 | .960 | 1.025 | 1.025 | .916 | .916 | .916 | .760 |
| Behind Panel, Add'l Deck | — | — | — | — | — | — | — | — | .268 | .268 | .346 | .346 | .329 | .326 | .326 | .218 |
| Diameter, Behind Panel | (57,9) | (25,8) | (12,7) | (14,2) | (12,7) | (7,6) | () | (25,8) | (17,4) | (19,0) | (25,8) | (29,7) | (34,3) | (30,2) | (30,2) | (19,0) |
| Length Behind Panel, 1 Deck | (24,1) | (14,7) | (17,7) | (17,7) | (9,0) | (12,7) | () | (11,9) | (24,4) | (24,4) | (26,0) | (26,0) | (23,3) | (23,3) | (23,3) | (19,3) |
| Behind Panel, Add'l Deck | — | — | — | — | — | — | — | — | (6,8) | (6,8) | (8,8) | (8,8) | (8,4) | (8,3) | (8,3) | (5,5) |

* If multi-deck switch is needed, contact Grayhill.

## FACTOR: Circuitry

| Max. Positions 1 Deck (1Pole)* | Angle Of Throw | Maximum Decks** | Maximum Poles Per Deck*** | Shorting Or Non-Shorting | Solder Lug Or PC | Series Number |
|---|---|---|---|---|---|---|
| 24 | 15° | 12 | 12 | N or S | Solder | 53 |
| 20 | 18° | 12 | 10 | N or S | Solder | 59 |
| 16 | 22°30' | 12 | 8 | N or S | Solder | 57 |
| 16 | 22°30' | 1 | 2 | N or S | Both | 51 |
| 12 | 30° | 12 | 6 | N or S | Both | 71 |
| 12 | 30° | 12 | 6 | N or S | Both | 9 |
| 12 | 30° | 12 | 6 | N or S | Solder | 44 |
| 12 | 30° | 1 | 4 | N or S | Both | 51 |
| 12 | 30° | 1 | 4 | N or S | Both | 56 |
| 11 | 30° | 1 | 1 | N | **** | 19 |
| 10 | 36° | 12 | 2 | N or S | Both | 8 |
| 10 | 36° | 12 | 2 | N or S | Both | 71 |
| 10 | 36° | 12 | 2 | N or S | Both | 42 |
| 10 | 36° | 1 | 2 | N | PC | 75/77 |
| 10 | 36° | 1 | 2 | N or S | Both | 50 |
| 10 | 36° | 1 | 2 | N or S | Both | 56 |
| 10 | 36° | 1 | 1 | N or S | Both | 24 |
| 10 | 36° | 1 | 1 | N or S | Solder | 5000 |
| 8 | 45° | 12 | 4 | N or S | Both | 9 |
| 8 | 45° | 12 | 4 | N or S | Solder | 44 |
| 8 | 45° | 1 | 2 | N | Both | 50 |
| 6 | 60° | 6 | 3 | N | Both | 9 |
| 6 | 60° | 12 | 3 | N | Solder | 44 |
| 6 | 60° | 1 | 2 | N | Both | 50 |
| 4 | 90° | 12 | 2 | N | Solder | 44 |
| 4 | 90° | 6 | 2 | N | Both | 9 |
| 4 | 90° | 1 | 2 | N | Both | 50 |

* Maximum positions per pole depends on number of poles per deck.

** Based on 1 pole per deck. Number of decks is also limited by the total number of poles.

*** Limited by total number of poles per switch.

****Choice of Faston or Solder Lug terminals.

Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.

Grayhill

INTUITIVE HUMAN INTERFACE SOLUTIONS

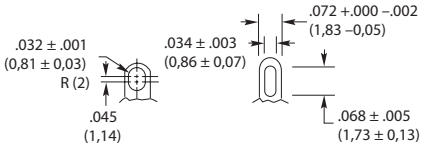
# Rotary Switch Standard Options

- Custom Switches With No Tooling Required
- Easily Ordered Specials

## 1. Dummy Terminal

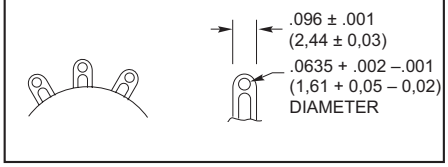
Used as tie point, it is not an active switch position. Can be located at any specified position outside of active switch terminals. Priced as active position. Example, a three position switch with 2 dummy terminals would be priced as a five position switch.

## 2. Enlarged Wire Holes



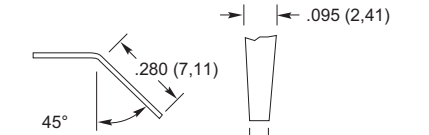

Series 08A, 09A, 42H, 42M, 44H, and 44M: Lug terminals for several wires; standard in Series 08M, 09M, 53, 57, and 59 switches.

## 3. High Density Wiring Terminal



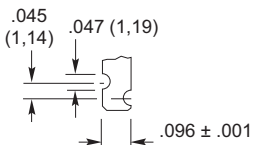

The gold-plated terminal features a slot to accept wires in addition to the conventional wire hole.

## 4. Taper Tab Terminals




Used in place of conventional solder lug terminals. Taper tab terminals are gold plated.

## 5. Notched Terminals




Used in place of the conventional solder lug terminals.

## 6. External Shorting Links

External shorting links, as shown in the drawing, can be used in place of conventional solder lug terminals in the Series 5000, 24, 42 or 43 rotary switches. Shorted terminals can also be accomplished internally in the Series 71 rotary switches. Solder lug terminals can be intermixed on the same deck.

## 7. Non-Standard, Non-Turn Devices

**Switches without tabs**

Series 08, 09, 42 and 44: There is no additional charge for a front support plate without a non-turn tab.

**Non-turn tab of non-standard projection**

Series 08:

All tabs located at .260 inch radius from centerline of switch. The following projections (inches) are available: .121; .094; .045; .032

Series 44:

| From Centerline | Projection |
|---|---|
| .375" (9,53 mm) | .062" (1,57 mm) |
| .531" (13,49 mm) | .121" or .049" (3,07 or 1,24 mm) |

## 8. RFI Grounding

A silver-plated shaft and wave washer improve DC grounding of shaft to mounting bushing, thus minimizing possible radio frequency interference. Example: static and dynamic DC resistance after 25,000 cycle life test is maximum 100 milliohms. For concentric shaft switches, discuss grounding with factory. Special handling charges apply to small lots.

## 9. Electrostatic, Electromagnetic Shielding

A metallic shield can be added between decks. Grounding of the shield provides additional RFV /EMI protection, Size and shape of the shield depends on the equipment configuration and the amount of protection required Price is dependant onthe number and type of shields required.

## 10. Unidirectional Rotation

The detenting system permits rotation in only one direction. Usable only with continuous rotation switches. Specify direction of rotation. Applicable to 30° and 36° throw switches only.

| Switch Series# | Options For Styles A and S | | | | | | | | Options For All Styles | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 08 | x | x | | | | | x | x | | | x | x | | | | |
| 09 | x | x | | | | | x | x | | | x | x | | | | |
| 24 | x | | x | x | x | x | | x | | | | | | | | |
| 42 | x | x* | x | x | x | x | x | x | x | x | x | x | | | | |
| 43 | x | | x | x | x | x | | x* | | | x | | | x | x | |
| 44 | x | x* | x | x | x | | x | x | x | x | x | | x | | | |
| 50/51 | | | | | | | | x | | | x | | | | | |
| 56 | | | | | | | | x | | | x | | | | | |
| 53/57/59 | | | | | | | | x | | | | | | | | |
| 54 | x | | x | x | x | | | x* | | | x | | | x | x | x |
| 71 | | | | | | | | x* | x | | x | | | | | |
| 5000 | x | | x | x | x | x | | x | | | | | | | | |

* See description below for limitations.



Patent Pending
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Specifications are subject to change. Please refer to the current datasheet on www.grayhill.com for the most current published specifications for this product.



## 11. Intermixing of Shorting and Non-Shorting Contacts

In some switches, non-shorting and shorting contacts can be intermixed between decks. A 2-deck switch, for example could have shorting contacts on deck 1 and non-shorting contacts on deck 2. In a few switches, non-shorting and shorting contacts can also be intermixed between poles. A 2-pole per deck switch, for example, could have non-shorting on pole #1, and shorting on pole #2.

Series 08 and 09:
An 09M30 or 08M36 rotary switch can have shorting and non-shorting contacts intermixed between decks. Shorting and non-shorting contacts can be intermixed between poles as well as decks in styles A, S, P, and SP.

Series 42, 43, 44, and 54, in 30° or 36°:
Non-shorting and shorting contacts can be intermixed between poles or decks.

Series 50, 51, and 56:
Non-shorting and shorting contacts can be intermixed between poles.

Series 71:
Non-shorting and shorting contacts can be intermixed between poles in fixed stop switches only.

Priced the same as standard switches. The type of contacts on each pole must be precisely indicated.

## 12. PC Mount Switches With Terminals From One Side of Switch

Series 71 PC mount switch has all terminals on one side.

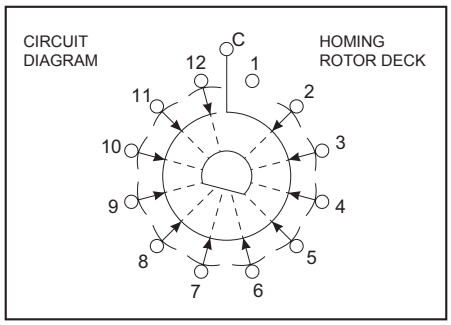
Series 08P, 09P, and 42P with non-shorting contacts are also available with terminals limited to one side. Contact Grayhill for a special part number. This is accomplished by using 2 decks per pole and placing the rotating contacts 180° out of phase on each deck. The first deck picks up the first half of the positions; the second deck picks up the last half of the positions. Common terminals are tied together by the PC board circuitry.

A total of 12 decks (6 usable poles) is the maximum per switch. Switches with the maximum number of positions (12 for 30°, or 10 for 36°) will have continuous rotation. Rotation can be limited to less than the maximum positions. For example, an 8 position Series 8P36 switch with terminals on one side, would pick up 5 positions on the first deck and 3 positions on the second deck.

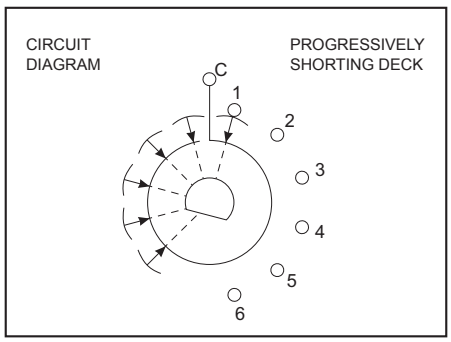
Price is the same as standard switches with comparable number of decks and positions. Example: an 08P36, 1-pole, 10 position switch with terminals on one side of the switch would be priced as a 2 deck, five position, one pole per deck switch.

## 13. Homing Rotor (Bridging and Shorting Deck) and Progressively Shorting Deck - Series 44 only

A homing rotor (bridging and shorting) switch deck connects all terminals to the common except the terminal in the selected switch position. For example, in position 1, terminals 2 thru 12 are

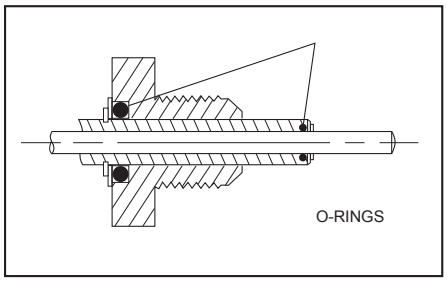



connected to the common, and terminal 1 is open. In position 2, terminal 3 thru 12 and 1 are connected to the common, and terminal 2 is open. A homing rotor deck will function for 25,000 mechanical cycles of operation.
The progressively shorting switch deck connects consecutive switch positions to the common. For example, in position 1, terminal 1 is connected to the common; in position 2, terminals 1 and 2 are connected to the common; in position




3, terminals 1,2, and 3 are connected to the common. A progressively shorting deck is limited to a maximum of 6 positions. A progressively shorting deck will function for 25,000 mechanical cycles of operation.

Homing Rotor or Progressively Shorting decks can be ordered as a deck of a 44A or 44M style switch, or their sealed equivalents. Order up to 11 conventional decks and 1 special circuitry deck. For a good detent feel, the switch is limited to a total of 12 poles plus the homing rotor or progressively shorting deck. Example: 6 2-pole decks and a homing rotor. When these special decks are used in combination with conventional decks, it is important to remember that the stop system limits the rotation of both types of decks. For example, when a homing rotor deck Is used in combination with a 6-position conventional deck, the homing rotor is likewise limited to six positions.




## 14. Shaft and Panel Seal on Concentric Shaft Switches

The following diagram shows the location of the O-rings required to seal the shafts to the bushings. When the concentric shaft switches are sealed in this manner, the .125 inch diameter shaft is supplied full round. Bushing-to-panel sealing is accomplished by the panel seal kit.

## 15. Fixed Stop, Add-A-Pot Switches

The rotary switch section of the Add-A-Pot rotary switches can be built with a fixed mechanism rather than the standard adjustable stop mechanism. The front end of a switch of this type is similar to the Series 43A or Series 54A style concentric rotary switches. The total number of decks is limited to three. The Series 43 is limited to 1 pole per deck. Series 54 to 2 poles per deck.

## 16. Series 54 Concentric Shaft Switch in 45°, 60°, and 90° Throws

The Series 54A switch is available with these angles of throw in Section A of the concentric rotary switch. Section B is available in 30° angle of throw only. Section A is limited to 1 to 3 decks, non-shorting contacts, and 1 or 2 poles per deck.