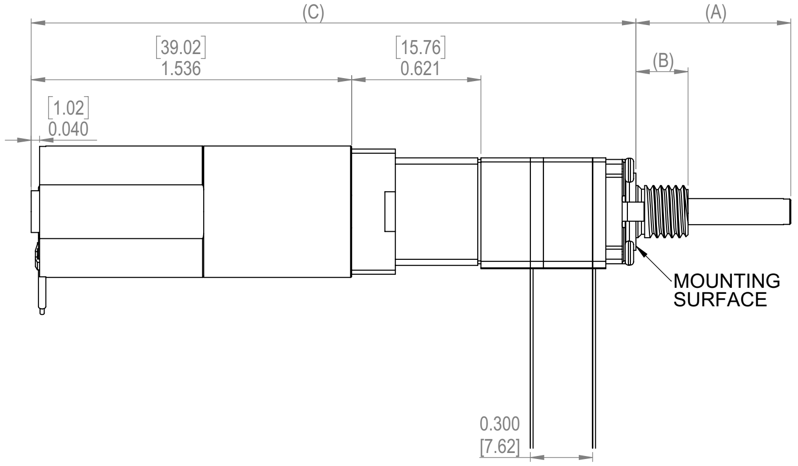
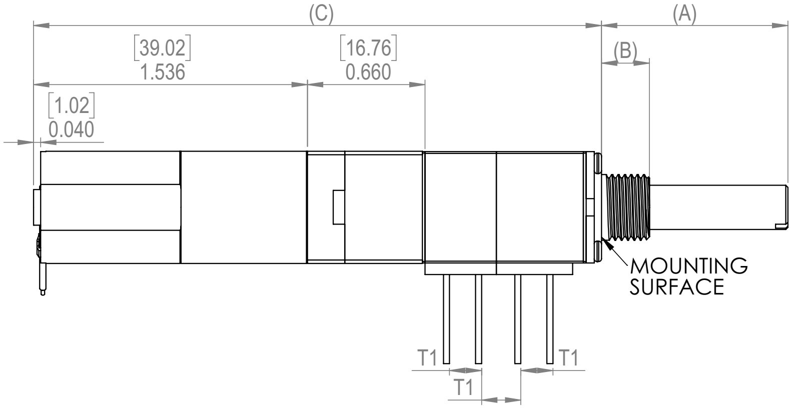
STATE
ELECTRONICS

MOTORIZED POTENTIOMETERS

Series S8X



Series S159



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POTENTIOMETER PROTOTYPES FAST!

Now almost any special combination potentiometer you specify can be manufactured and shipped within days of ordering.

State Electronics Mod Pot™ potentiometers are modular in construction. Our extensive inventory allows us to produce prototype quantities of 1/2 or 5/8 inch square, conductive plastic and cermet potentiometers within 24 hours for most designs and even production quantities in a matter of days with our VIP service!

Over one billion combinations of single, dual, triple and quad arrangements, and hundreds of shaft terminal variations can be produced.

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Series S8XMP - Single Shaft Horizontal Mounting Styles

PC Pin Terminals (B22) .875" long or Solder Hooks

Series S88MP and S89MP motorized controls are assembled from 1/2" square, stackable potentiometers . Combine up to 8 modules.. Series S88 potentiometer modules have conductive plastic resistive elements, and Series S89 potentiometer modules have cermet resistive elements.

The most common configurations are listed below. Contact your State Electronics sales representative for your custom requirements.

Series S159MP - Single Shaft Horizontal Mounting Styles

PC Pin Terminals or Solder Hooks

Series S159MP motorized controls are assembled from 5/8" square, stackable potentiometers. Combine up to 4 modules.. Series S159MP potentiometer modules have conductive plastic resistive elements or cermet resistive elements.

The most common configurations are listed below. Contact your State Electronics sales representative for your custom requirements.

Series S88 Potentiometer

Conductive Plastic - 1/2 inch square; .5 Watt

Series S89 Potentiometer

Cermet - 1/2 inch square; 1 Watt

Features

- **Small size** - 1/2 in. square
- **Stackable** - up to 8 modules
- **Versatility** - various shaft, bushings, terminal styles, resistance values, tapers and tolerances. Available in Conductive Plastic or Thick Film Cermet
- **RoHS Compliant**

Description

The S88 and S89 series are 1/2 in. square, modular, stackable potentiometers. The basic construction suits the series for countless design options.

The S88 and S89 series can be found in a wide range of sophisticated systems in a broad scope of industries.

	Operational Specifications Resistive Modules Series S88	Operational Specifications Resistive Modules Series S89
Resistance Range	Linear: 100 ohm to 5 megohm Tapered: 500 ohm to 1 megohm *See chart, page 7*	Linear: 50 ohm to 5 megohm Tapered: 100 ohm to 1 megohm *See chart, page 7*
Resistance Tolerance	Linear: thru 500K ohm , ±10%; above 500K ohm , ±20%. Tapered: thru 100K ohm , ±10%; above 100K ohm ±20%	Linear: ±10%; ±20% special Tapered: ±10% Under 20 ohm ±20%
Taper	See *Taper Curve* charts on page 6 for standard and special tapers available	See *Taper Curve* charts on page 6 for standard and special tapers available
Taper Tolerance	±20% of nominal resistance at 50% ±3% mechanical rotation	±20% of nominal resistance at 50% mechanical rotation
Independent Linearity	±5% standard with specials available	±5% standard with specials available
End Resistance	4 ohms max. each end linear and low side of taper. 1% of total R high side of taper.	2 ohms max. each end (5 ohms - 2.5K ohms) 4 ohms max. each end (above 2.5K)
Dynamic Noise (C.R.V.)	1.5% of total R, standard linear; 1.0% of total R, special linear; 2.2% of total R, tapered.	3.0% of total R, standard linear; 1.5% of total R, special linear (500 ohms and above); 6.0% of total R, tapered.
Static Noise	Up to 30K ohms - 20db; 100K ohms - 12 db; 1 Megohms +3db	Up to 100 ohms - 25db; 10K ohms - 15 db; 100K ohms -10db.

Electrical Specifications continued, next page

	Operational Specifications Resistive Modules Series S88	**Operational Specifications Resistive Modules Series S89**
Power Rating	0.5 Watt @ 70°C bushing (panel) mounting 0.25 Watt @ 70°C PC mounting (no panel). Derate to 0 watts at 120°C. Derate 50% for non-linear tapers and Derate multiple sections 1/2 wattage of panel unit.	1.0 Watt @ 85°C bushing (panel) mounting 0.5 Watt @ 85°C PC mounting (no panel) Derate to 0 watts at 150°C. Derate 50% for non-linear tapers and Derate multiple sections 1/2 wattage of panel unit.
Working Voltage	350 Vdc across end terminals, but power not to exceed rating.	350 Vdc across end terminals, but power not to exceed rating.
Dielectric Withstanding Voltage (*Glossary Definition Link*)	750 VAC @ ATM pressure - 760mm Mercury, equivalent to sea level.	900 VAC single standard module and 750 VAC all non-standard constructions @ ATM pressure - 760mm Mercury, equivalentto sea level.
Dielectric Low Pressure	MIL-STD-202G Method 105C – Condition B, 350 VAC @ 3.4 in. [86,36mm] Mercury, equivalent to 50,000 feet.	MIL-STD-202G Method 105C – Condition B, 350 VAC @ 3.4 in. [86,36mm] Mercury, equivalent to 50,000 feet.
Insulation Resistance	1000 megohms minimum for dry, clean conditions @ 25°C	1000 megohms minimum for dry, clean conditions @ 25°C
Temperature Coefficient	See *Temperature Resistance Change* table on page 9	15 ohms to 100 ohms 250 MP/°C. 100 ohms to 5 Megohms 150 MP/°C Temperature range -55°C to 150°C.
Tracking	10% voltage ratio tracking between sections standard. Specials available.	10% voltage ratio tracking between sections standard. Specials available.
Electrical Rotation	295° ±5°	295° ±5°
Effective Rotation	265° ±7° without switch; 240° ±7° with switch.	265° ±7° -5° without switch; 240° ±7° with switch.
Load Life	10% maximum change in resistance and within end resistance limits with rated power across element, at 70°C ambient temperature. Power applied 1.5 hours "on" 0.5 hours "off" for 1000 hours.	5% maximum change in resistance and within end resistance limits with rated power across element, at 85°C ambient temperature. Power applied 1.5 hours "on" 0.5 hours "off" for 1000 hours.
Rotational Life	Potentiometer: 10% maximum resistance change up to 50,000 cycles under load. Trimmer: 5,000 cycles	Potentiometer: 10% maximum resistance change up to 25,000 cycles under load. Trimmer: 5,000 cycles
Low Temperature Operation	Less than 3% change in total R. Operating torque at -40°C is 30 oz.-in.	Less than 2% change in total R. Operating torque at -40°C is 30 oz.-in.

	Operational Specifications Resistive Modules Series S88	Operational Specifications Resistive Modules Series S89
MIL-R-94 Standard	Series S88 is designed to meet MIL-R-94 performance characteristics where applicable	Series S89 is designed to meet MIL-R-94 performance characteristics where applicable
Low Temperature Storage	Less than 2% change in total resistance	Less than 2% change in total resistance
Thermal Cycling	Less than 4% total R change as a result of 5 cycles @ -55°C to +120°C	Less than 3% total R change as a result of 5 cycles @ -55°C to +150°C
Moisture Resistance	10% maximum total R change when tested per method 103 of MIL-STD-202	5% maximum total R change when tested per method 103 of MIL-STD-202
Solderability	Meet the requirements of MIL-STD-202, Method 210, Condition A except immersed within .125 in. of element for 5 seconds.	Meet the requirements of MIL-STD-202, Method 210, Condition A except immersed within .125 in. of element for 5 seconds.
Shock	The total resistance setting change is 2% maximum between left and right terminals and 5% maximum between CCW terminal and center terminal when tested per method 213B condition I of MIL-STD-202. Applicable to single shaft potentiometers only.	The total resistance setting change is 2% maximum between left and right terminals and 5% maximum between CCW terminal and center terminal when tested per method 213 condition I of MIL-STD-202. Applicable to single shaft potentiometers only.
Vibration, High Frequency	No intermittent contacts or open circuits when tested per method 204D Condition C of MIL-STD-202. Resistance setting change is 5% maximum between left (CCW) terminal and center terminal. The total resistance change is 2% maximum between left and right terminals. Applicable to single shaft potentiometers only.	No intermittent contacts or open circuits when tested per method 204D Condition C of MIL-STD-202. Resistance setting change is 5% maximum between left (CCW) terminal and center terminal. The total resistance change is 2% maximum between left and right terminals. Applicable to single shaft potentiometers only.
Washability	Units may be adversely affected if subjected to conventional after-solder board-wash	Units may be adversely affected if subjected to conventional after-solder board-wash
Salt Atmosphere	Visual inspection revealed no damage, defects, or other abnormalities after testing per MIL-STD-202 Method 101E- Condition A	Visual inspection revealed no damage, defects, or other abnormalities after testing per MIL-STD-202 Method 101E- Condition A
Humidity Steady State	10% maximum total R change when tested per MIL-STD-202, Method 103B, Condition B, 96 Hours	5% maximum total R change when tested per MIL-STD-202, Method 103B, Condition B, 96 Hours

Mechanical Specifications - Series S88 & Series S89

Body Size
Single module: .5 in. square ±.047 in. (except at standoffs)

Terminals
Printed circuit style on 0.100 in. grid in line, 0.250 in. long.
Maximum PC terminal length: .875 in.
Terminal spacing in multiple section controls: 0.300 in.
Solder lugs formed from PC pins to accept 3 - #22 AWG wires.

Housing
Molded thermoplastic

Anti-turn Device
Location 1 supplied unless otherwise specified.
See Chart D.
Anti-turn Device radius: 6,35mm.

Shafts
Single shaft: 1/8 in. or 1/4 in. dia. Nickel-plated brass.

Seals
Mounting seal and shaft seal for single shafts only.
Caution: These seals are not designed to meet board washing requirements.

Bushing Diameter
1/4 in. x 32NEF-2A standard
3/8 in. x 32NEF-2A optional
When using 3/8 in. diameter bushing, distance from mounting surface to PC terminals is .170 in. *See page 8.*

Bushing Length
Plain: 1/4 in. , 3/8 in. , or 1/2 in.
Split-locking style: 3/8 in.

Rotational Torque
Single and dual concentric controls: 0.2 to 3.0 oz.-in.
Two Modules: 0.3 to 3.5 oz.-in.
Three Modules: 0.5 to 4.5 oz.-in.
Four Modules: 0.5 to 5.5 oz.-in.
Medium Torque Option for single shaft only: 1 to 6 oz.-in.
Torque Variation within a rotation: 1 oz.-in. max.

Stop Torque
Single shaft: 3 lb.-in. (standard)
High Stop Torque: 5 lb.-in. 1/8" shaft with O-ring
8 lb.-in. 1/4" or 1/8" shaft without O-Ring

Mechanical Rotation
With or without switch: 295°±5°.

Maximum Shaft Pull Force
.125 in. diameter shaft: 18 lbs. (20 lbs. Option)
.250 in. diameter shaft: 10 lbs. (20 lbs. Option)

Mounting Torque
Torque applied to the mounting nuts should not exceed 15 to 18 in.-lbs. [1,7 to 2,0 N-m]. Tap Terminal Strength 18 lbs. maximum pull

Hardware
Mounting Hardware available as the following:
A. Hex mounting nut 1/4 in. x 32 thread, 5/16 in. across flats, 1/16 in. thick.
B. Internal tooth lockwasher 13/32 in. OD x .025 in. thick.
C. Jam hex nut 5/16 in. across flats, 5/32 in. thick - supplied with locking type bushings.

Marking
Terminals are numbered for reference
State Electronics part number.

Customer part number optional.
Concentric Front & Rear Shaft: 7.5 lbs.
RS rotary and PP Push-Pull Switches: 10 lbs. (20 lbs. Option)
PP Push-Pull or Momentary Push Switches: 20 lbs.

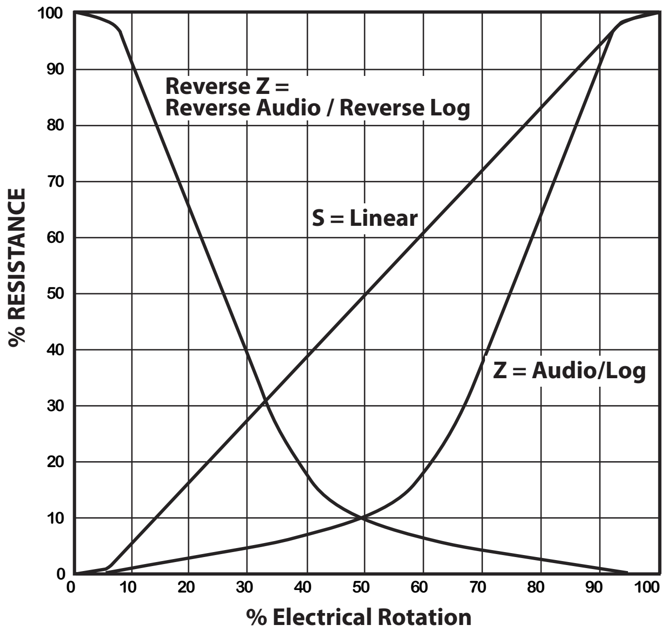
Shaft Radial Play (single shaft potentiometer)
.028 in. maximum 1 in. from mounting surface with .250 in. diameter bushing

Shaft End Play
.020 in. maximum

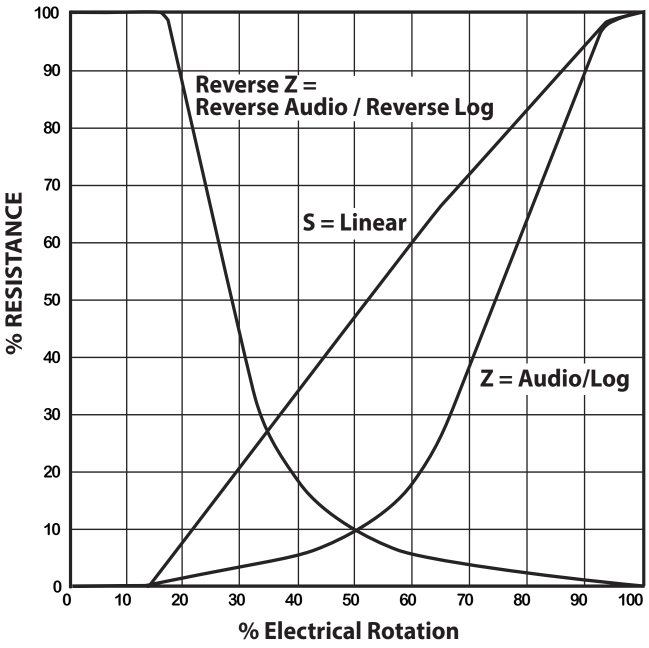
Construction
Riveted construction is standard.
Screw construction is available as an option.
Screws may be required depending on design.

Disclaimer: Unless otherwise indicated, specifications apply to the potentiometer functions and not to the motor.

Standard Tapers for Designs without RS



Modified Taper for Designs with RS Honeywell / Clarostat Standard



"S" Taper is linear, the change in resistance value being directly proportional to the degree of rotation. It can be used either as right-hand or left-hand taper. This taper corresponds to **Mil-R94 type "A"**

"Z" Taper is measured between the wiper and the counter-clockwise terminals **(pins1 & 2)** attains 10% resistance value at 50% of clockwise rotation (left-hand). This taper corresponds to **Mil-R94 type "C"**

"Reverse Z" Taper is measured between the wiper and the clockwise terminals **(pins 2 & 3)** attains 10% resistance value at 50% of counterclockwise rotation (right-hand). This taper corresponds to **Mil-R94 type "E"**

Important - The modified tapers were used by Honeywell and Clarostat for all 388/389 series designs that incorporated a RS. The modified taper is used for all legacy Honeywell or Clarostat designs that incorporated a RS.

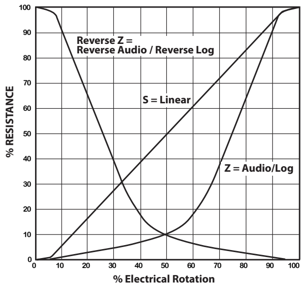
For new designs, State can provide either the standard taper or the modified taper. Unless otherwise specified, the modified tapers will be supplied for all new designs that incorporate a RS.

General Information about Tapers

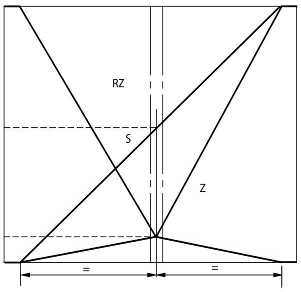
Resistance tapers, curves or laws are terms used to describe the relationship between the mechanical rotation of the potentiometer shaft (wiper positions) and the resulting resistance change or output. To avoid confusion, the measurements must reference the terminals used and the direction of the shaft rotation.

While all manufacturers display the tapers as smooth curves, those curves actually consist of straight line segments which correspond to the number of conductive ink passes during the screening process. The more passes, the smoother the curve.

Design Reference



Printed Resistive Track



Mil-Spec Tapers

The S8x series potentiometers utilize resistance tapers as defined in Mil-R94; i.e. Linear, Log and Reverse Log. The Mil-spec defines these tapers to correspond to resistance value at the mid-point of the mechanical rotation as follows:

Linear Taper (A) - 50% of the nominal resistance at 50% of the mechanical rotation. Same as our "S" Taper.

Log Taper (C) - 10% of the nominal resistance at 50% of the mechanical rotation. Shown as measured using terminals 1 & 2. Same as our "Z" taper.

Reverse Log Taper (E) - 90% of the nominal resistance at 50% of the mechanical rotation. Shown as measured using terminals 2 & 3. Same as our "Z" taper.

Log tapers are often referred to as Audio tapers with Reverse log as Reverse Audio.

Mechanical Rotational Angle (M.R.A.) is the total number of degrees between each rotational stop (~295°). Electrical Rotational Angle (E.R.A.) is the total number of degrees over which the resistance changes (~265°).

The electrical track consists of a narrow pad (~15°) of high-conductive material at each end of the rotation and a center track of resistive material. While there is electrical continuity throughout the entire M.R.A., the resistance change occurs only within the resistive track. The angle representing the resistance track is referred to as the E.R.A.

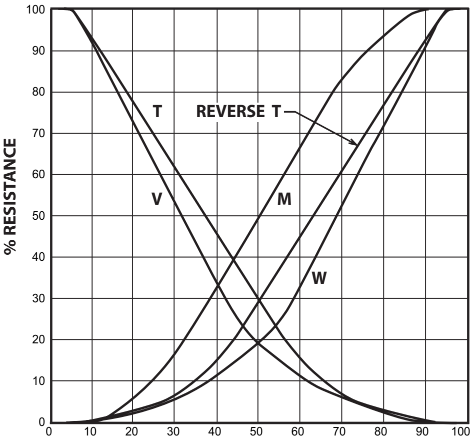
When a switch is used in combination with a resistive element, the resistive track begins after the switch actuation angle. The logic is that if you are simultaneously using a RS and potentiometer, you would want to have the beginning of the resistance change after the switch is actuated. Also, and by design, the switch snaps into or out of detent and that can result in a spike in the resistance output.

The actuation angle for a typical RS is ~15° so when the resistive track begins after the switch actuation, the E.R.A. is reduced by ~30° to ~240° in total.

Unless otherwise specified, a potentiometer with a RS will utilize resistive modules that have the E.R.A. beginning after the switch is activated.

However, if you prefer to have a wider E.R.A., we can accommodate that choice as well.

Special Tapers - Special Order Only



"W" Taper (A-20) attains 20% resistance value at 50% of clockwise rotation (left-hand).

"V" Taper (C-20) attains 20% resistance value at 50% of counterclockwise rotation (right-hand).

"T" Taper (A-30) attains 30% resistance value at 50% of clockwise rotation (left-hand).

"Reverse T" Taper (C-30) attains 30% resistance value at 50% of counterclockwise rotation (right-hand).

"M" Taper is such that a "W" taper is attained from either the 1 or 3 terminal to the center of the element.

There are hundreds of special curves available and there are no industry standards defining each variation.

The closest actual standard is defined in the Mil-R94 specification (*see page 7)*.

Many companies use an "A B C" method for tapers where A=Log, B=Linear and C=Reverse Log or; A=Linear, B=Log and C=Reverse Log.

To make matters worse, the tapers may not have the same slope (Law) which results in a different resistance value at the mid-point of the rotation. When this is the case, there is typically a number after the taper designation indicating the percentage of the nominal resistance at the mid-point of the shaft rotation.

For example: Assuming that an "A" represents a log taper, and an A-10 designation would result in 10% of the nominal resistance at the mid-point of the shaft rotation—i.e. the same as what is designated in Mil-R94 as a "C" taper—if the mid-point of the shaft rotation results in 20% of the nominal resistance, then in the above example it could be designated an A-20.

State Electronics has custom-designed equipment that allows us to plot the curve of any potentiometer. Once the curve has been identified, we can usually match it with a custom curve, or come close to it with one of our standard curves.

Standard Resistance Values & Tapers

	S88 Linear	S88 Log	S88 Reverse Log	S89 Linear	S89 Audio	S89 Reverse Log
50				🔴		
100	●			●	●	●
250	●			●	●	●
500	●	●	●	●	●	●
1K	●	●	●	●	●	●
2.5K	●	●	●	●	●	●
5K	●	●	●	●	●	●
10K	●	●	●	●	●	●
22K	●	●	●	●	●	●
25K	●	●	●	●	●	●
50K	●	●	●	●	●	●
100K	●	●	●	●	●	●
250K	●	●	●	●	●	●
500K	●	●	●	●	●	●
1M	●	●		●	●	●
2.5M	●			●		
5M	🔴			🔴		

🔴 Not Normally Stocked

Disclaimer

Due to the unlimited design combinations, certain designs may not perform in accordance with all of the specifications.

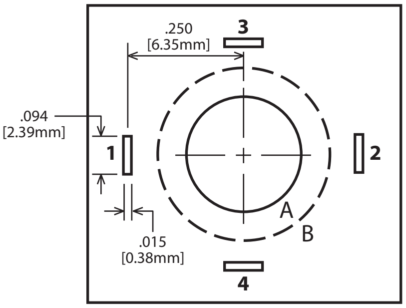
Temperature Resistance Change

Nominal Resistance	Maximum Percent Temporary Resistance Change From 25°						
	-55ºC	-40ºC	0ºC	+25ºC	+85ºC	+105ºC	+120ºC
100 Ohms	±5.0	±4.0	±1.5	0	±1.5	±2.0	±3.5
10K Ohms	+7.0	+5.5	+2.0	0	±1.5	±2.5	±5.5
100K Ohms	+8.0	+6.0	+2.5	0	±2.0	±3.5	±6.0
1 Megohm	+10.0	+8.0	+3.0	0	±2.5	±4.0	±7.5

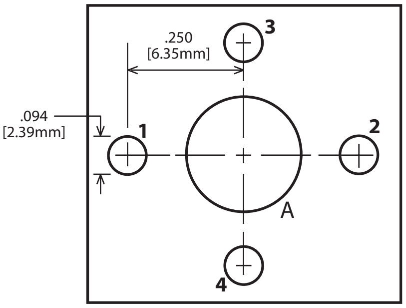
Note: For non-linear tapers, multiply chart values by 1.25

Locating Tab Options

P.C. Board & Panel Mounting Dimensions
Using Slots for Locating Tab(s)



P.C. Board & Panel Mounting Dimensions
Using Holes for Locating Tab(s)



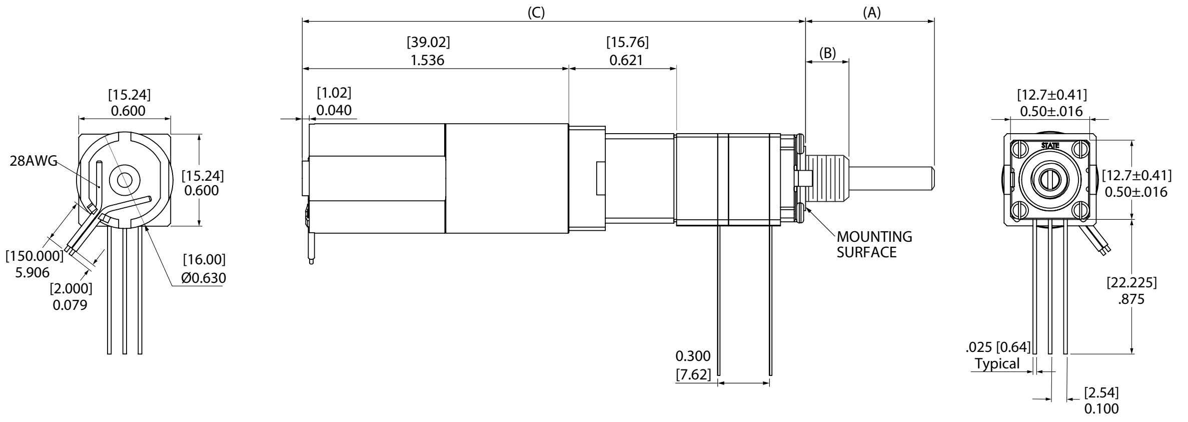
Ref	Bushing	Mounting Panel Hole
A	1/4 – 32-NEF Max Dia. (0.249 [6,32mm])	0.265” [6,76mm]
B	3/8 – 32-NEF Max Dia. (0.375” [9,53mm])	0.390” [9,91mm]

Series S88 Locating Lug Style:
Tab width: .091"
Tab Height: .041±.005" FMS
Spacing: .250"

Option Number
1 = one tab - at 9 o'clock (standard)
2 = one tab - at 3 o'clock
3 = one tab - at 12 o'clock
4 = one tab - at 6 o'clock
5 = two tabs - at 3 and 9 o'clock
6 = two tabs - at 6 and 12 o'clock
7 = No Locating Lug

NOTE: Slots are recommended for the locating tab(s) when using 3/8” diameter bushings because of clearance issues.

MOTORIZED POTENTIOMETERS



Back View

Front View

The series S8XMP Motorized Potentiometer is an assembly utilizing any single shaft S8x potentiometer (as many as four ganged units) and a geared motor, coupled by a slip clutch for limited mechanical rotation and manual adjustment of the potentiometer.

Features

- Small size
- Remote operation
- Slip clutch for manual operation
- Memory reset applications
- 1/2" square potentiometer
- Gear Motor: 0.63" Diameter

To Request a Quotation:

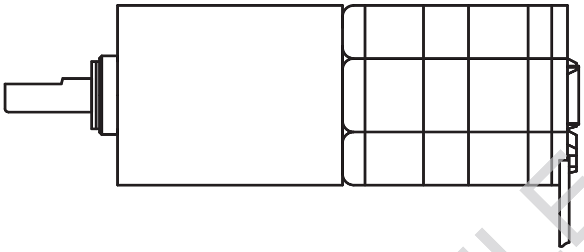
Step 1: Using our online Request a Quote option, create a detailed specification for the S8X potentiometer.

Step 2: Choose the appropriate gear ratio for the motor.

Step 3: Choose the operating voltage (6 or 12 VDC).

S8X MOTORS

RoHS compliant



TYPICAL PART NUMBER DESIGNATION

Part number of S8x series potentiometer coupled to this motor

S8XM - L##### - 060 - 00

Series name

Rated voltage
6 = 6V OR **12** = 12V

Gear ratio

030=1/30 **60**=1/60 **120**=1/120 **240**= 1/240=/300

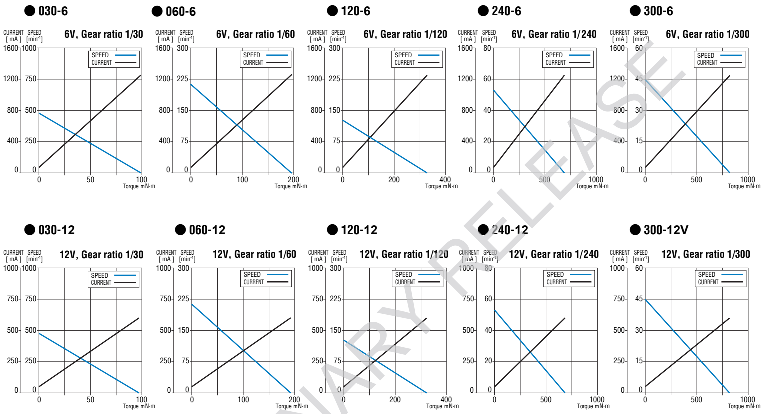
LIST OF PART NUMBER & SPECIFICATIONS

Gear Ratio	Rated Voltage	Part Number	Torque (mNm)			Speed (nin^{-1}) (Reference) RPM		Current (mA)			Length (mm)		Weight (g) (Reference)
			Rated	Max.	Starting	No-Load	Rated	No-Load	Rated	Starting	Motor	Gear	
1/30	DC6 V	M030-6V	20	30	> 50	477	380	< 160	< 400	< 1600	35	14	25
	DC12 V	M030-12V						< 80	< 250	< 800			
1/60	DC6 V	M060-6V	40	60	> 100	213	160	< 160	< 400	< 1600	38	17	30
	DC12 V	M060-12V						< 80	< 250	< 800			
1/120	DC6 V	M120-6V	60	90	> 170	127	100	< 160	< 400	< 1600			
	DC12 V	M120-12V						< 80	< 250	< 800			
1/240	DC6 V	M240-6V	120	180	> 350	53	40	< 160	< 400	< 1600	41	20	35
	DC12 V	M240-12V						< 80	< 250	< 800			
1/300	DC6 V	M300-5V	160	240	> 400	45	34	< 160	< 400	< 1600			
	DC12 V	M300-12V						< 80	< 250	< 800			

S8X MOTORS

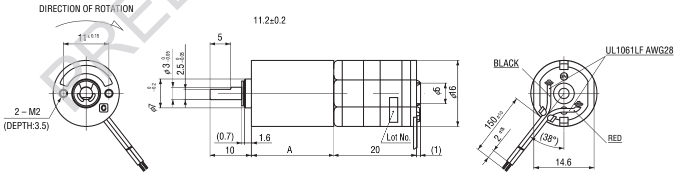
■ PERFORMANCE CURVES

(Figures in the table are typical values under rated operating condition.)



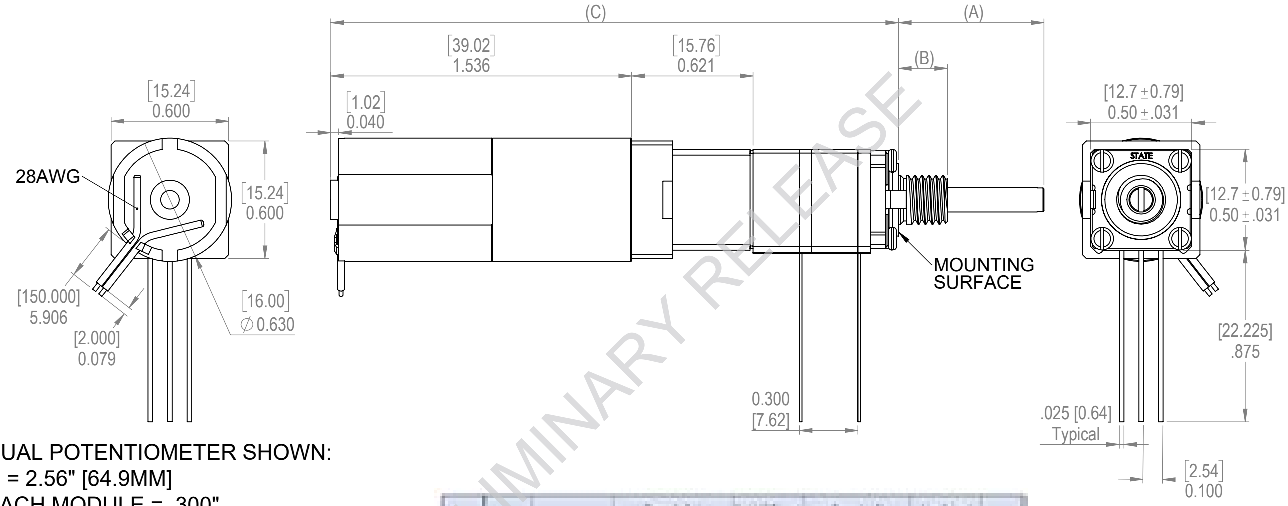
■ OUTLINE DIMENSIONS

(Unit: mm)

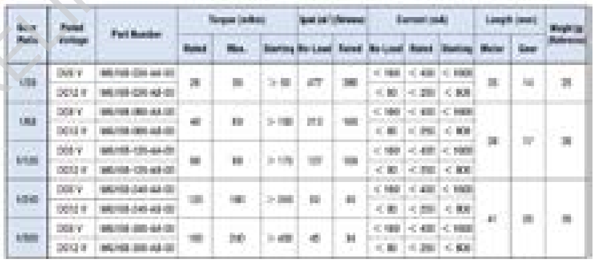


Mark A

Gear ratio	1/30	1/60	1/120	1/240	1/300
A	14	17		20	

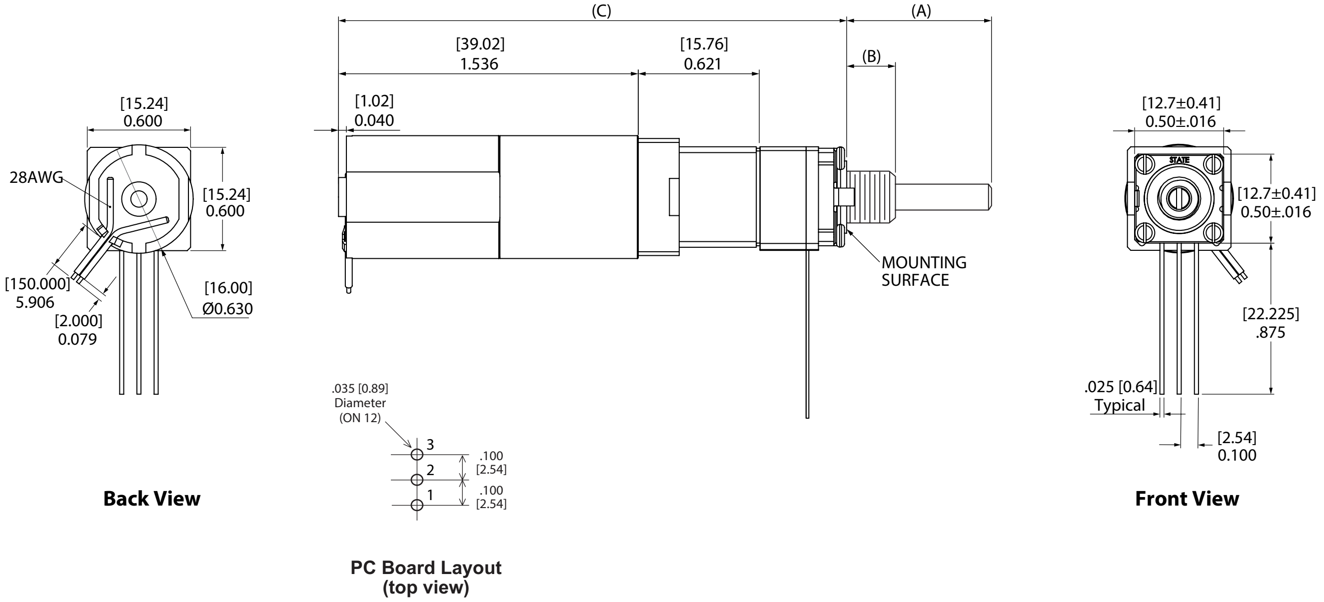


DUAL POTENTIOMETER SHOWN:
C = 2.56" [64.9MM]
EACH MODULE = .300"
(ADD OR SUBTRACT FROM ABOVE FOR
FINAL DEPTH
STANDARD MOTOR = 1:120



Series S88/S89 - Horizontal Mounting Styles

Drawing 111-1-B22: B-22 Single Potentiometer or RS, PC Pin Terminals, 1/4" Dia. Bushing

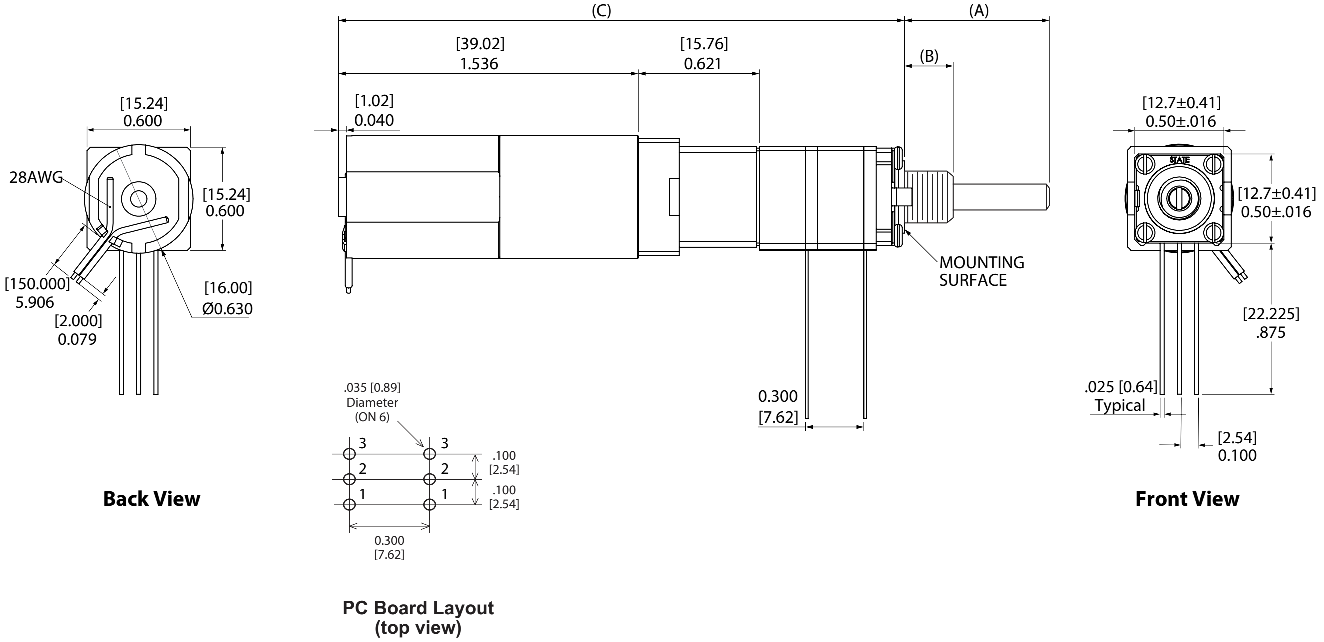


Back View

PC Board Layout
(top view)

Front View

Drawing 211-1-B22: B-22 Dual Potentiometer or RS, PC Pin Terminals, 1/4" Dia. Bushing



Back View

PC Board Layout
(top view)

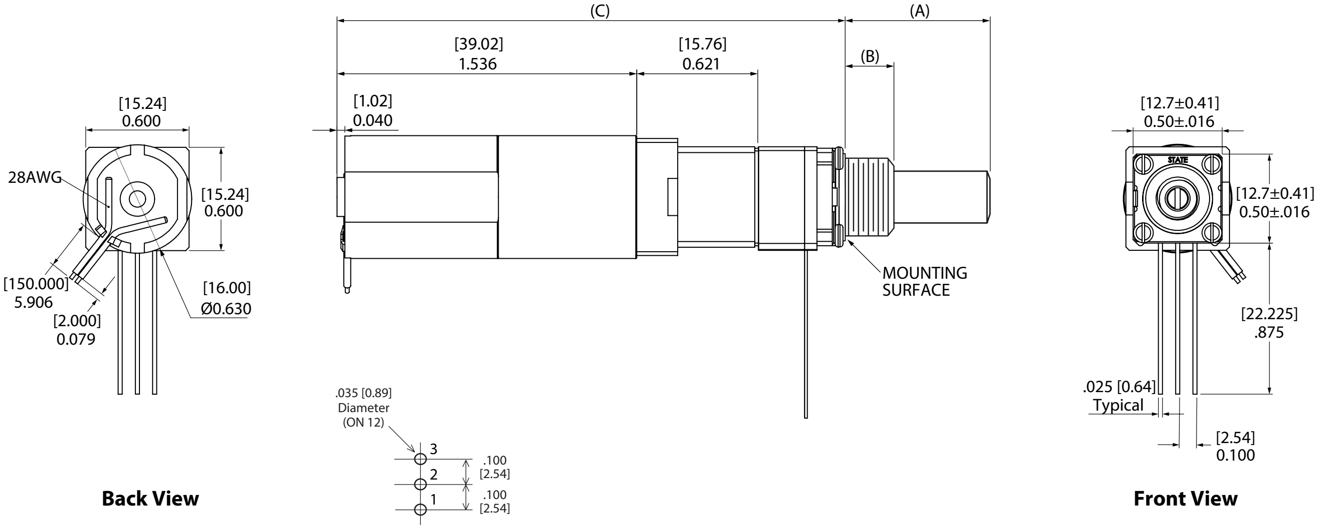
Front View

Notes:

1. Basic dimensions are in inches.
   Dimensions in brackets are in millimeters.
   Dimensional Tolerance ±.016 [0,40], except as specified.
2. B-22 PC pin length standard is 0.250". Maximum of .875" [22.22]
3. Drawings are not to scale.

Series S88/S89 - Horizontal Mounting Styles

Drawing 121-1-B22: B-22 Single Potentiometer or RS, PC Pin Terminals, 3/8" Dia. Bushing

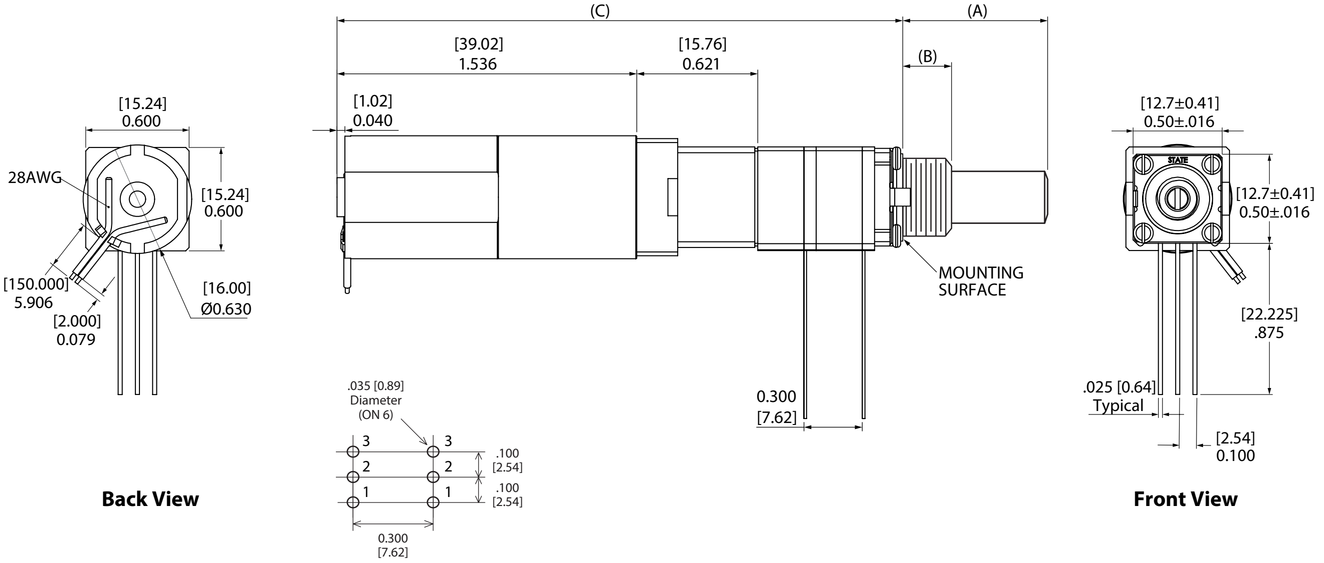


Back View

PC Board Layout
(top view)

Front View

Drawing 221-1-B22: B-22 Dual Potentiometer or RS, PC Pin Terminals, 3/8" Dia. Bushing



Back View

PC Board Layout
(top view)

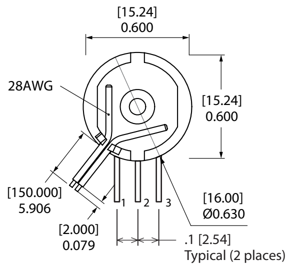
Front View

Notes:

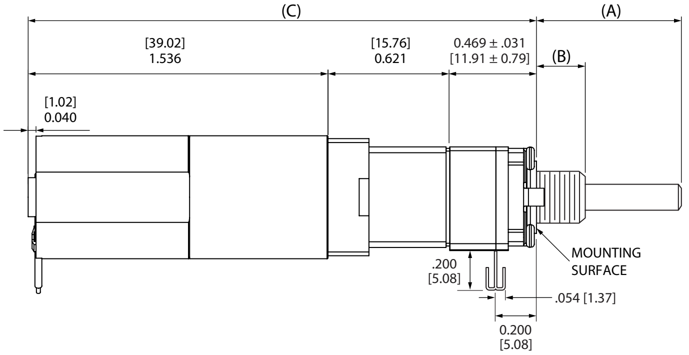
1. Basic dimensions are in inches.
   Dimensions in brackets are in millimeters.
   Dimensional Tolerance ±.016 [0,40], except as specified.
2. B-22 PC pin length standard is 0.250". Maximum of .875" [22.22]
3. **Drawings are not to scale.**

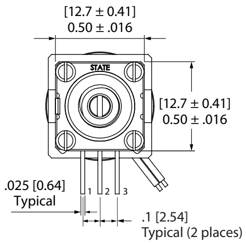
Series S88/S89 - Horizontal Mounting Styles

Drawing 111-1-SH: Single Potentiometer or RS, Solder Hooks, 1/4" Dia. Bushing



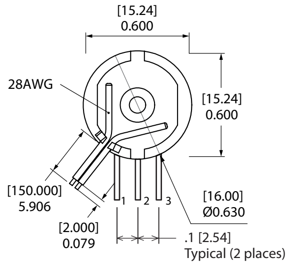
Back View



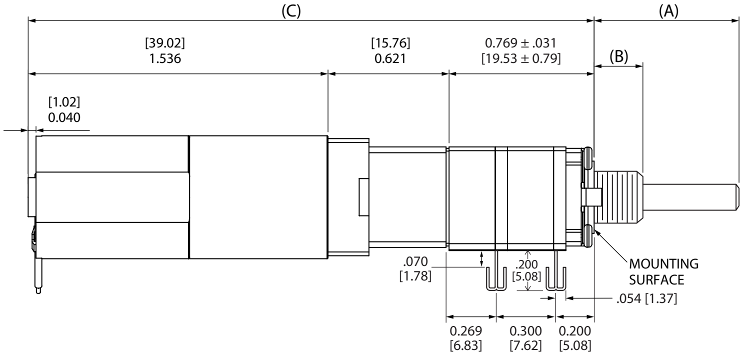


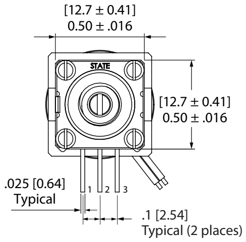
Front View

Drawing 211-1-SH: Dual Potentiometer or RS, Solder Hooks, 1/4" Dia. Bushing



Back View





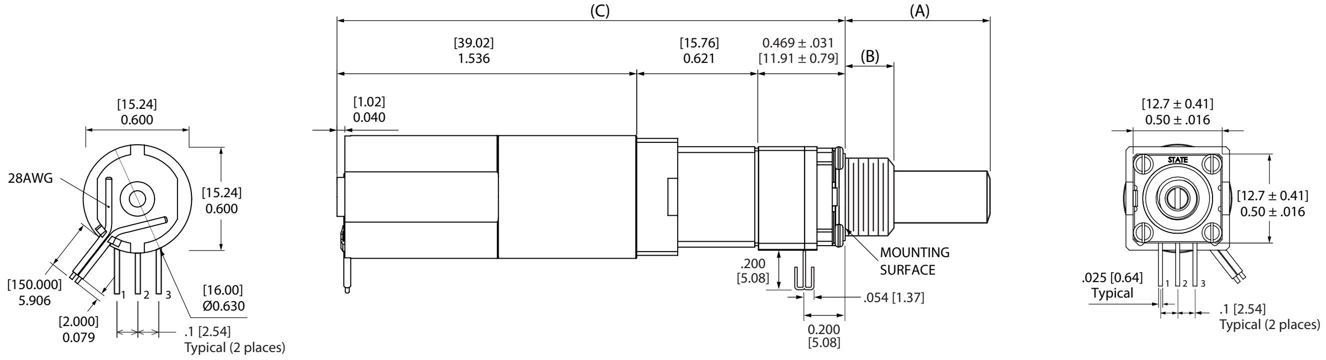
Front View

Notes:

1. Basic dimensions are in inches.
   Dimensions in brackets are in millimeters.
   Dimensional Tolerance ±.016 [0,40], except as specified.
2. B-22 PC pin length standard is 0.250". Maximum of .875" [22.22]
3. Drawings are not to scale.

Series S88/S89 - Horizontal Mounting Styles

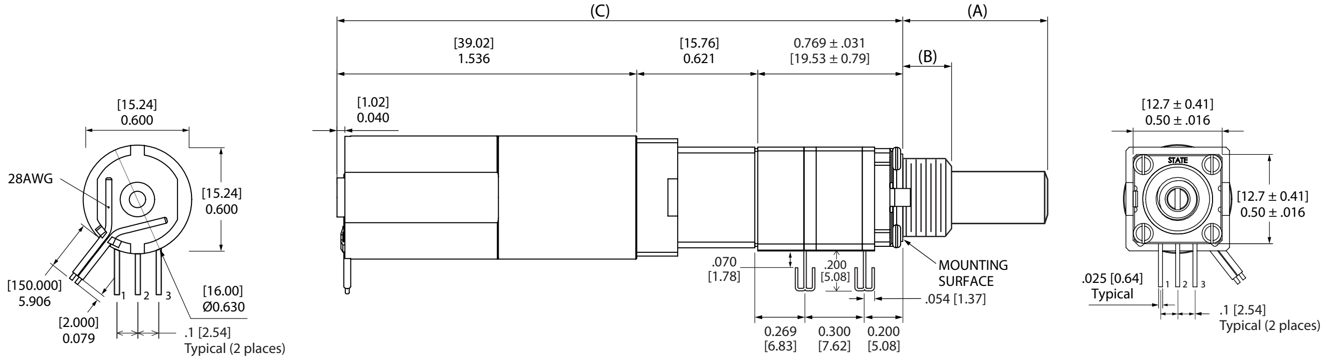
Drawing 121-1-SH: Single Potentiometer or RS, Solder Hooks, 3/8" Dia. Bushing



Back View

Front View

Drawing 221-1-SH: Dual Potentiometer or RS, Solder Hooks, 3/8" Dia. Bushing



Back View

Front View

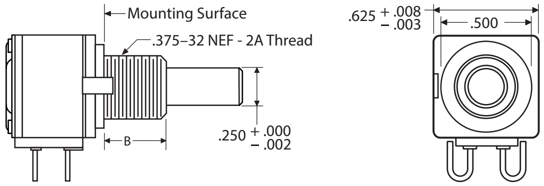
Notes:

1. Basic dimensions are in inches.
   Dimensions in brackets are in millimeters.
   Dimensional Tolerance ±.016 [0,40], except as specified.
2. B-22 PC pin length standard is 0.250". Maximum of .875" [22.22]
3. **Drawings are not to scale.**

DIMENSIONS

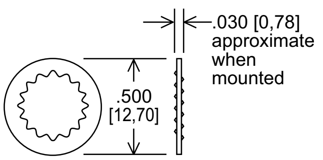
Bushing and Hardware Dimensions

3/8" Plain Bushing

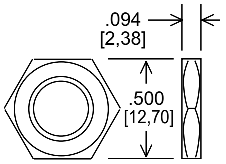


"B" STANDARD BUSHING LENGTHS
.250 [6,35] – **.375** [9,53] - **.500** [12.7]

Mounting Hardware for 3/8" Bushing



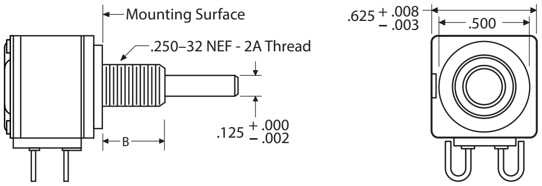
LOCK WASHER
LOCK NUT



MOUNTING NUT

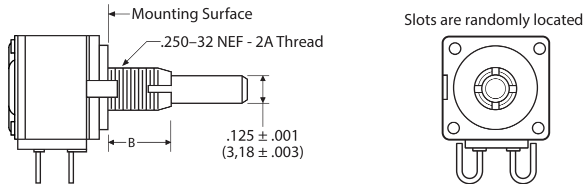
MAXIMUM MOUNTING PANEL THICKNESS:
.062–.188 [1,59–4,76]
when used with
one standard M-2898 Lock Washer
and one standard M-2786 Mounting Nut

1/4" Plain Bushing



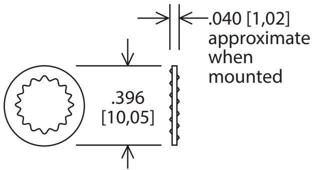
"B" STANDARD BUSHING LENGTHS
.250 [6,35] – **.375** [9,53] - **.500** [12.7]

1/4" Locking Bushing

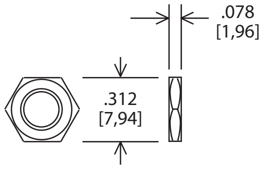


"B" STANDARD BUSHING LENGTHS
.375 [9,53] - **.500** [12.7]

Mounting Hardware for 1/4" Bushing



LOCK WASHER
LOCK NUT



MOUNTING NUT

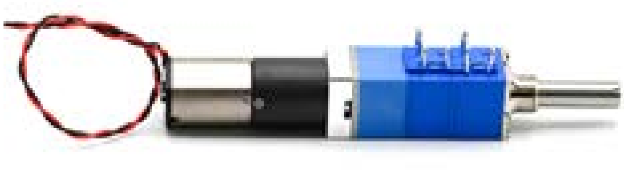
MAXIMUM MOUNTING PANEL THICKNESS:
.062–.188 [1,59–4,76]
when used with
one standard M-2898 Lock Washer
and one standard M-2786 Mounting Nut

Dimensions
Basic dimensions are in inches.
Dimensions shown in brackets are in millimeters.

Tolerance
Dimensional tolerance ±.016 [0,40]
Angular tolerance ± 5°, except as specified

Series S159 Potentiometer

5/8" [15,88mm] Square



Description:

The Series S159 modules are 5/8" square [15,88mm], with metal shaft and bushing.

Combine up to 4 modules.

For more information about this product, visit our website at: **www.potentiometers.com**

Features:

- ***Stackable*** - up to 6 modules
- ***Conductive Plastic or Cermet Resistance Element***
- ***Linear, CW or CCW audio Taper, S-Taper***
- ***Metal Shaft and Bushing***
- ***PCB or Solder Lug Terminals***
- ***Replacement for Honeywell 70-Series ModPot™***
- ***IP40 Rating***
- ***RoHS Compliant***

Electrical Specifications

Resistance Range - Conductive Plastic
Audio & Linear Taper: 1K ohms to 1 megohm

Resistance Range - Cermet
Linear Taper: 100 ohms to 1 megohm
Audio Taper: 1K ohms to 1 megohm

Total Resistance Tolerance
±10% Standard (±5% Optional)

Independent Linearity: ±5%

Absolute Minimum Resistance: 2 ohms maximum

Effective Electrical Angle - Conductive Plastic
Linear Taper: 240° ±5°; Audio Taper: 225° ±5°

Effective Electrical Angle - Cermet
Linear Taper: 240° ±6°; Audio Taper: 225° ±6°

Contact Resistance Variation
Conductive Plastic: ±1%
Cermet: ±1% or 3 ohms (whichever is greater)

Dielectric Withstanding Voltage (MIL-STD-202 - Method 301)
Sea Level: 1,500 VAC minimum
70,000 feet: 500 VAC minimum

Insulation Resistance: 1,000 megohms minimum

Power Rating at 70°C (Derate to 0 at 125°C)
(Voltage limited by power dissipation or 350 VAC, whichever is less)

Single Section:
Conductive Plastic - Linear Taper: 1 watt
Conductive Plastic - Non-linear Taper: 0.5 watt
Cermet - Linear Taper: 2 watts
Cermet - Non-linear Taper: 1 watt
Multiple Section:
Conductive Plastic - Linear Taper: 0.5 watt/section
Conductive Plastic - Audio Taper: 0.25 watt/section
Cermet - Linear Taper: 1.0 watt/section
Cermet - Non-linear Taper: 0.5 watt/section

Theoretical Resolution: Essentially Infinite

Mechanical Specifications

Mechanical Angle: 300° ±5°

Stop Strength:
1/4" and 1/8" diameter shafts: 4 lb.-in. [45,19 N-cm]

Starting and Running Torque (Non-Locking Bushing):
Single Section: 0.5 to 1.5 oz.-in. [0,35 to 1,06 N-cm]
Dual Section: 0.5 to 1.5 oz.-in. [0,35 to 1,06 N-cm]
Triple Section: 0.5 to 2.0 oz.-in. [0,35 to 1,41 N-cm]
Quad Section: 0.5 to 2.0 oz.-in. [0.35 to 1.41 N-cm]
(Increased Torque Range Available All Designs)

Starting and Running Torque (Locking Bushings):
0.2 to 4.0 oz.-in. [0,14 to 2,82 N-cm]

Shaft Locking Torque with Locknut @ 10 in-lb.
(B & E Bushings): 20 oz-in. [14 N-cm]

Mounting: 15-18 lb.-in. [1,7-2,0 N-m] maximum

Running Torque, Maximum:
Single Section: 0.5 to 2.0 oz.-in. [0,35 to 1,4 N-cm]
Dual Section: 0.5 to 2.0 oz.-in. [0,35 to 1,4 N-cm]

Weight:
Single Section: 21 grams maximum
Additional Sections: 6 grams maximum

Multiple Sections:
6 gangs maximum

Soldering Condition:
Recommended hand soldering using Sn95/Ag5 no clean solder, 0.025" wire diameter. Maximum temperature 750°F [399°C] for 3 seconds.
No wash process to be used with no clean flux.

Series S159 Potentiometer

5/8" (15,88mm) Square

Environmental Specifications

Operating Temperature Range: -40°C to +125°C

Storage Temperature Range: -55°C to +125°C

Temperature Coefficient over Storage Range:
  Conductive Plastic: ±1,000 ppm/°C;
  Cermet: ±150 ppm/°C

Vibration (Single Section): 15 G
  Total Resistance Shift: ±2% maximum
  Voltage Ratio Shift: ±5% maximum

Shock (Single Section): 30 G
  Total Resistance Shift: ±2% maximum
  Voltage Ratio Shift: ±5% maximum

Load Life: 1,000 hours
  Conductive Plastic Total Resistance Shift: ±10% max.
  Cermet Total Resistance Shift: ±5% max.

Rotational Life (No Load): 100,000 cycles
  Conductive Plastic Total Resistance Shift:
    Linear taper: 10 ohms or ±10% TRS max.
      (whichever is greater)
    Audio taper: ±20% TRS maximum
  Cermet Total Resistance Shift:
    All tapers: ±20% TRS maximum
  Contact Resistance Variation @ 50,000 Cycles:
    Audio taper: ±3%
    Linear taper: ±2%

Moisture Resistance (MIL-STD-202, Method 103, Condition B)
  Conductive Plastic Total Resistance Shift:
    (B & E tapers): ±10% TRS max.
    (D, G, S & T tapers): ±20% TRS max.
  Cermet Total Resistance Shift:
    (all tapers): ±5% TRS max.

Insulation Resistance (500 VDC): 100 megohms minimum

IP Rating: IP40

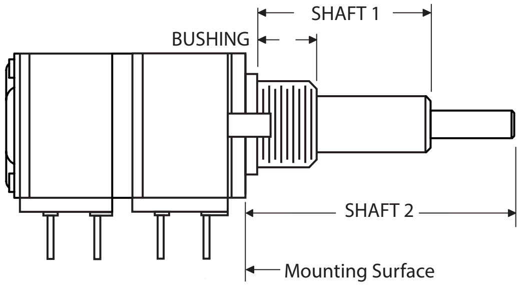
Disclaimer

Due to the unlimited design combinations, certain designs may not be feasible and/or perform in accordance with all of the specifications.

General Design Considerations

Most exterior dimensional references are measured from the potentiometer mounting surface. The mounting surface is the face of the bushing that rests against the inside surface of a panel. "From the Mounting Surface" is abbreviated as F.M.S.

Shaft and bushing lengths, PC Board layout and overall body length are always measured F.M.S. as well as the grid layout for PC board mounted versions.



The first section of the potentiometer is referred to as the "Panel Module". All designs begin with a panel module and may be followed by other modular components such as resistor modules, rotary switches, spacers and finally a rear plate.

The components are held together with 4 non-removable aluminum rivets. In certain application, where riveting may not be practical, small diameter screws may be used. After the panel module, there can be other resistive modules, each measuring .400" [10,16] deep, or switches, measuring .375" [9,52] deep. A spacer measuring 0.100" [2,54] is required between modules in all concentric shaft configurations, the position of which is determined by the controlling shafts.

The pin spacing is a simple .200" x .200" [5,08 x 5,08] pattern for single shaft potentiometers using resistive modules only. Concentric shafts and/or switches alter that pattern and we have included drawings for the most popular configurations.

While it is theoretically possible to have many modules coupled together, we do not recommend more than a total of 3 per shaft.

A rotary switch module must always have a resistive module in front of it; i.e. it can never be the only module, or first module, on a shaft. You can have a maximum of 2 switches per shaft as long as they are preceded by a resistive module.

Resistive modules are available in either straight p.c. leads or solder hooks. Switches are only available with solder terminals that can also use female quick-connects. If you require a switch to be p.c. board mounted, you can incorporate rectangular slots on the board to match the switch terminals. However, it is only possible to do this with one side of the switch; the other side would have to be hand-wired. Switches are also available in a 90° rotated version to reduce the height above the board.

Shafts are available in many lengths, with different end profiles. The most popular shaft ending for single shaft units would be a standard screwdriver slot. The standard orientation of the slot is in line with the internal contact at the full CCW position. When a flatted shaft is specified, it is typically opposite the contact in the full CCW position. However the flat can be orientated at any angle to meet your requirements. Plain round shafts are also popular and can, in many cases, be interchangeable with slotted shafts if delivery time is an issue.

Rotational torque is the amount of force required to turn the shaft on the potentiometer. Each module on a shaft will introduce additional torque. The torque specifications for the most popular configurations are shown elsewhere in this catalog. In every case, the rotational torque has a fairly wide minimum to maximum range and it is not possible to narrow that range. It is possible to increase the minimum rotational torque using internal components; for example high-vibration environments or cockpit applications where you don't want to change a setting by accidentally hitting a knob.

The part numbering scheme shown in the catalog will allow you to specify the most common variations. Once a design is finalized we will assign a unique 6-character part number that will take into consideration all of the options. That part number is also associated with the originating customer for future reference.

Due to the unlimited number of combination available, certain performance specifications may not apply.

Ordering Information

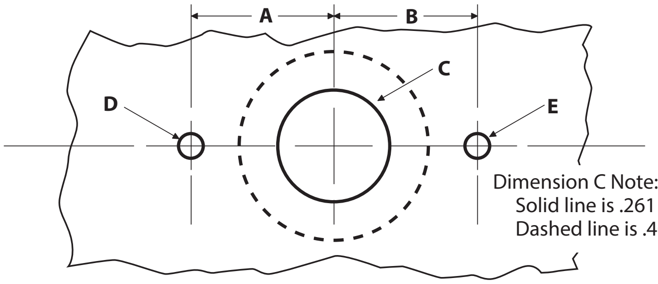
1. Basic type
2. Type of element (cermet or conductive plastic).
3. Type of terminals (resistor element only).
4. Number of sections.
5. Taper (each element on multi-section controls).
6. Total resistance value in ohms (each element on multi-section controls).
7. Bushing type (plain or locking).
8. Bushing length in inches or millimeters.
9. Bushing diameter .375" [9,52mm] or .250" [6,35mm]
10. Shaft ending (plain, slotted or flatted).
11. Shaft length FMS in inches or millimeters.
12. Switch type (maximum 2 rotary switches per shaft).
13. Locating lug option.
14. Mounting hardware.
15. Your part number, if any.
16. Marking requirement on the part.
17. Special features (forward complete detailed specs).

S159 Resistance Module Options

Element Type			Conductive Plastic = CP Cermet = CM			
Taper			Linear	Log/Audio	Reverse Log / Reverse Audio	S
Resis-tance (ohms)	Code	Ref				
100	101	100	CM	CM	CM	CM
1,000	102	1K	CP & CM	CP & CM	CP & CM	CP & CM
10,000	103	10K	CP & CM	CP & CM	CP & CM	CP & CM
100,000	104	100K	CP & CM	CP & CM	CP & CM	CP & CM
1,000,000	105	1Meg	CP & CM	CP & CM	CP & CM	CP & CM
150	151	150	CM	CM	CM	CM
1,500	152	1.5K	CP & CM	CP & CM	CP & CM	CP & CM
15,000	153	15K	CP & CM	CP & CM	CP & CM	CP & CM
150,000	153	150K	CP & CM	CP & CM	CP & CM	CP & CM
200	201	200	CM			
2,000	202	2K	CP & CM	CP & CM	CP & CM	CP & CM
20,000	203	20K	CP & CM	CP & CM	CP & CM	CP & CM
200,000	204	200K	CP & CM	CP & CM	CP & CM	CP & CM
250	251	250	CM			
2,500	252	2.5K	CP & CM	CP & CM	CP & CM	CP & CM
25,000	253	25K	CP & CM	CP & CM	CP & CM	CP & CM
250,000	254	250K	CP & CM	CP & CM	CP & CM	CP & CM
500	501	500	CP & CM			
5,000	502	5K	CP & CM	CP & CM	CP & CM	CP & CM
50,000	503	50K	CP & CM	CP & CM	CP & CM	CP & CM
500,000	504	500K	CP & CM	CP & CM	CP & CM	CP & CM
750	751	750	CM			
7,500	752	7.5K	CP & CM	CP & CM	CP & CM	CP & CM
75,000	753	75K	CP & CM	CP & CM	CP & CM	CP & CM
750,000	754	750K	CP & CM	CP & CM	CP & CM	CP & CM

DIMENSIONS

Mounting Holes



Dimension C Note:
Solid line is .261 inch diameter
Dashed line is .406 inch diameter

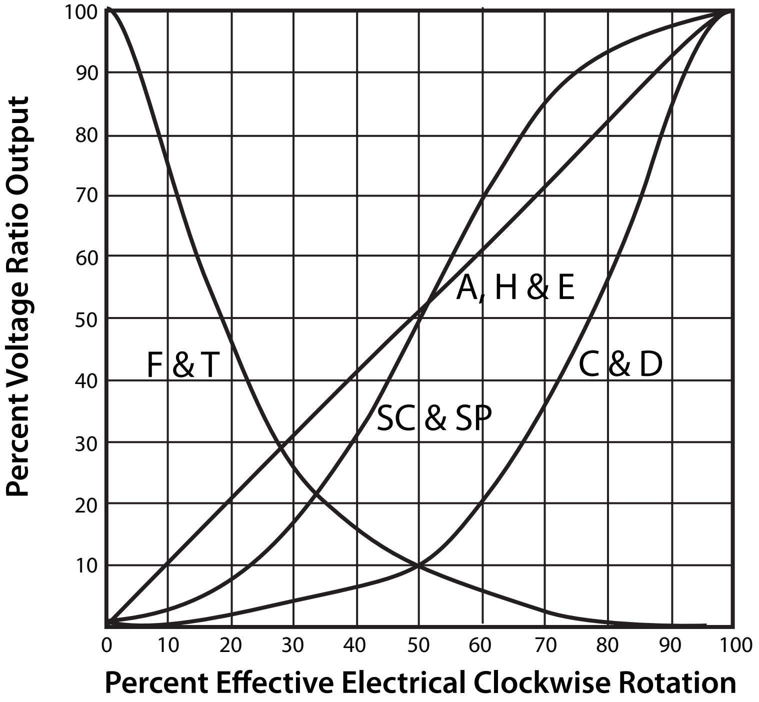
LUG OPTION	DIMENSION A	DIMENSION B	DIMENSION C Minimum hole dia. for 1/4" dia. bushing	DIMENSION C Minimum hole dia. for 3/8" dia. bushing	DIMENSION D Minimum hole dia	DIMENSION E Minimum hole dia.
1	.305 [7,75]	*	.261 [6,63]	.406 [10,31]	.096 [2,44]	*
2	.305 [7,75]	.305 [7,75]	.261 [6,63]	.406 [10,31]	.096 [2,44]	.096 [2,44]
3	.375 [9,52]	*	.261 [6,63]	.406 [10,31]	.096 [2,44]	*
4	*	*	.261 [6,63]	.406 [10,31]	*	*
5	.375 [9,52]	.375 [9,52]	.261 [6,63]	.406 [10,31]	.096 [2,44]	.096 [2,44]
6	.437 [11,10]	*	.261 [6,63]	.406 [10,31]	.128 [3,24]	*
7	.437 [11,10]	.437 [11,10]	.261 [6,63]	.406 [10,31]	.128 [3,24]	.128 [3,24]
8	.531 [13,49]	*	.261 [6,63]	.406 [10,31]	.128 [3,24]	*
9	.531 [13,49]	.531 [13,49]	.261 [6,63]	.406 [10,31]	.128 [3,24]	*
A	*	.305 [7,75]	.261 [6,63]	.406 [10,31]	*	.096 [2,44]
B	*	.375 [9,52]	.261 [6,63]	.406 [10,31]	*	.096 [2,44]
C	*	.437 [11,10]	.261 [6,63]	.406 [10,31]	*	.128 [3,24]
D	*	.531 [13,49]	.261 [6,63]	.406 [10,31]	*	.128 [3,24]

Dimension tolerance ± .016 [0,40]
* = Not Required

Series S159 Potentiometer

5/8" [15,88mm] Square

S159 Resistance Tapers



On chart:

Linear Taper (A, H, or E options)
Clockwise Audio Taper (C or D options)
Counterclockwise Audio Taper (F or T options)
Modified Linear Taper (SP or SC) (Special Order)

Element & Taper:

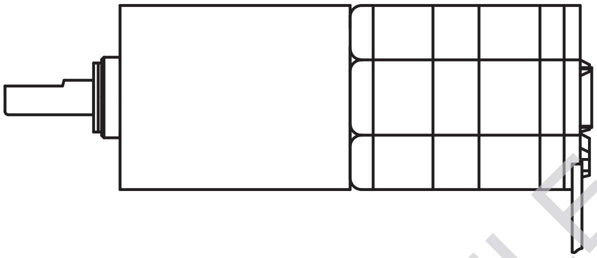
A = Linear Cermet 10%
H = Linear Cermet 5%
E = Linear Conductive Plastic 10%
C = CW Audio Cermet 10%
D = CW Audio Conductive Plastic 10%
F = CCW Audio Cermet 10%
T = CCW Audio Conductive Plastic 10%
SP = S Conductive Plastic 10%
SC = S Linear Cermet 10%

Tapers A, C, D, E, H, SC & SP are measured between the wiper and the counterclockwise terminal (pins 1 and 2).

Tapers F & T are measured between the wiper and the clockwise terminals (pins 2 and 3).

STATE ELECTRONICS S159 MOTORS

RoHS compliant



■ TYPICAL PART NUMBER DESIGNATION

Part number of S8x series potentiometer coupled to this motor

S159M - L##### - 060 - 00

Series name

Rated voltage
6 = 6V OR **12** = 12V

Gear ratio

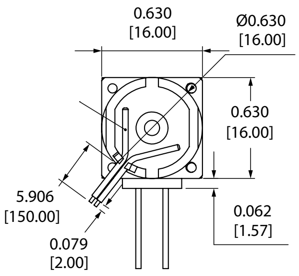
030=1/30 **60**=1/60 **120**=1/120 **240**= 1/240=/300

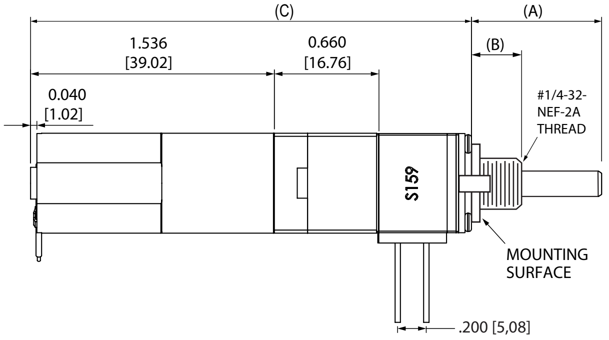
■ LIST OF PART NUMBER & SPECIFICATIONS

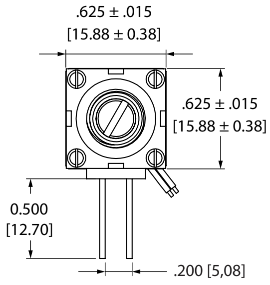
Gear Ratio	Rated Voltage	Part Number	Torque (mNm)			Speed (nin^{-1}) (Reference) RPM		Current (mA)			Length (mm)		Weight (g) (Reference)
			Rated	Max.	Starting	No-Load	Rated	No-Load	Rated	Starting	Motor	Gear	
1/30	DC6 V	M030-6V	20	30	＞ 50	477	380	＜ 160	＜ 400	＜ 1600	35	14	25
	DC12 V	M030-12V						＜ 80	＜ 250	＜ 800			
1/60	DC6 V	M060-6V	40	60	＞ 100	213	160	＜ 160	＜ 400	＜ 1600	38	17	30
	DC12 V	M060-12V						＜ 80	＜ 250	＜ 800			
1/120	DC6 V	M120-6V	60	90	＞ 170	127	100	＜ 160	＜ 400	＜ 1600			
	DC12 V	M120-12V						＜ 80	＜ 250	＜ 800			
1/240	DC6 V	M240-6V	120	180	＞ 350	53	40	＜ 160	＜ 400	＜ 1600	41	20	35
	DC12 V	M240-12V						＜ 80	＜ 250	＜ 800			
1/300	DC6 V	M300-5V	160	240	＞ 400	45	34	＜ 160	＜ 400	＜ 1600			
	DC12 V	M300-12V						＜ 80	＜ 250	＜ 800			

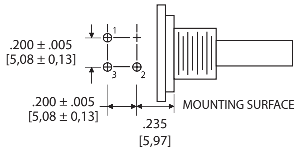
Single and Dual Modules, Single Shaft, Solder Pins

Single Potentiometer, Single Shaft, Solder Pins, 1/4" Dia. Bushing, 1/8" Dia. Shaft



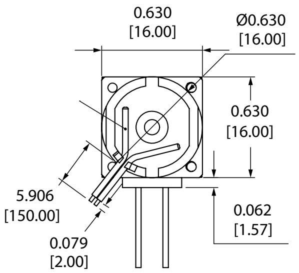


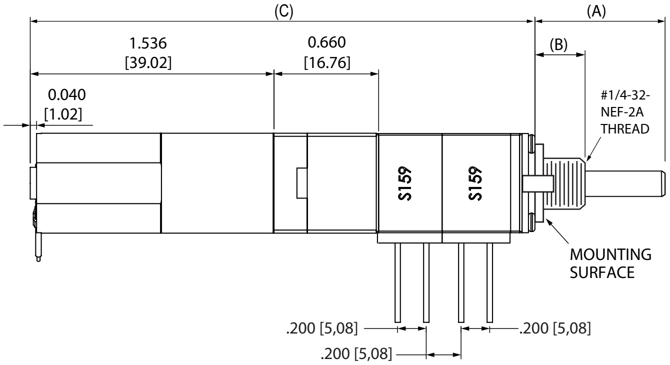


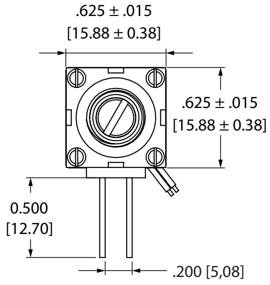


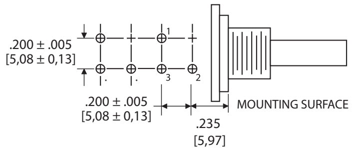
PC Board Layout

Dual Potentiometer, Single Shaft, Solder Pins, 1/4" Dia. Bushing, 1/8" Dia. Shaft









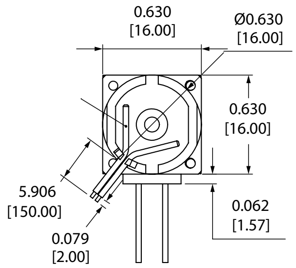
PC Board Layout

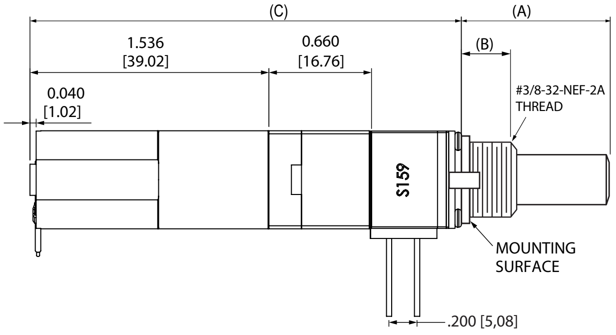
Notes:

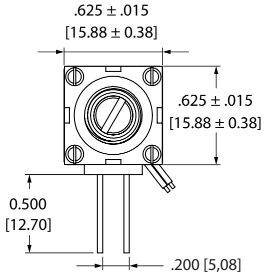
1. Potentiometer Terminals - .031 [,81] Dia., Soft Copper Cda Alloy 110, Tin Plate.
2. Refer to drawings for Printed Circuit Board Layouts. Refer to 29 for Bushing, Shaft and Hardware information. Refer to drawings for Locating Lug options.
3. Basic dimensions are in inches. Dimensions in brackets are in millimeters. Dimensional Tolerance ±.016 [0,40], except as specified.
4. Drawings not to scale.

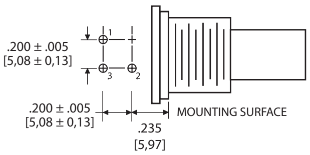
Single and Dual Modules, Single Shaft, Solder Pins

Single Potentiometer, Single Shaft, Solder Pins, 3/8" Dia. Bushing, 1/4" Dia. Shaft



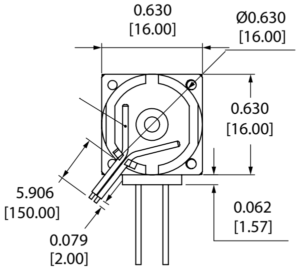


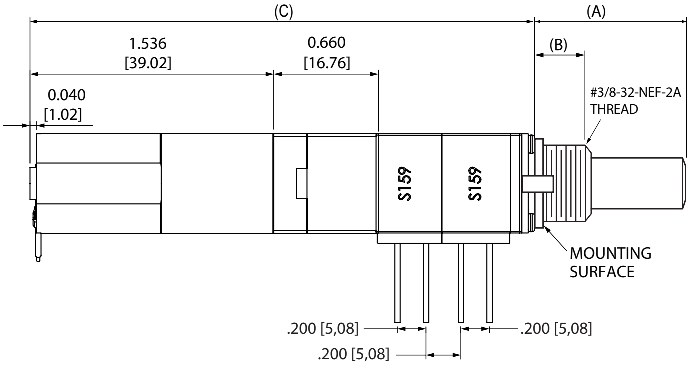


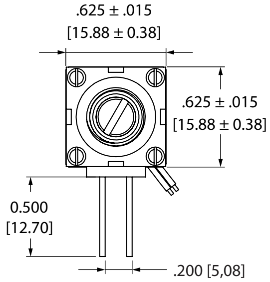


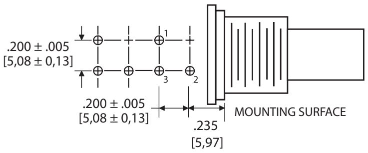
PC Board Layout

Dual Potentiometer, Single Shaft, Solder Pins, 3/8" Dia. Bushing, 1/4" Dia. Shaft









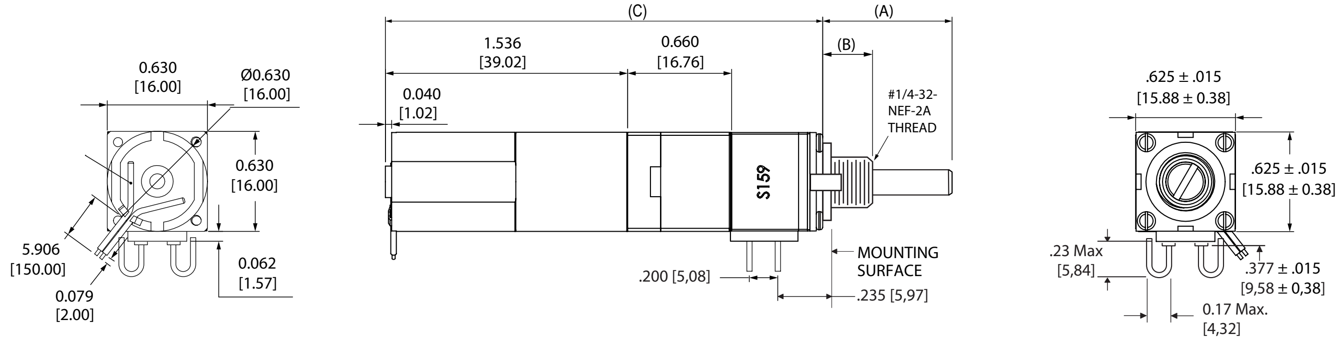
PC Board Layout

Notes:

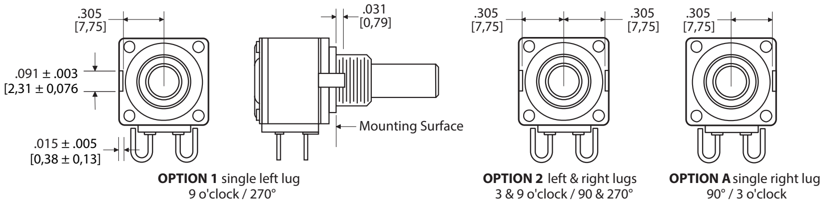
1. Potentiometer Terminals - .031 [,81] Dia., Soft Copper Cda Alloy 110, Tin Plate.
2. Refer to drawings for Printed Circuit Board Layouts. Refer to 29 for Bushing, Shaft and Hardware information. Refer to drawings for Locating Lug options.
3. Basic dimensions are in inches. Dimensions in brackets are in millimeters. Dimensional Tolerance ±.016 [0,40], except as specified.
4. Drawings not to scale.

Single and Dual Modules, Single Shaft, Solder Hooks

Single Potentiometer, Single Shaft, Solder Hooks, 1/4" Dia. Bushing, 1/8" Dia. Shaft



Locating Lug Options:

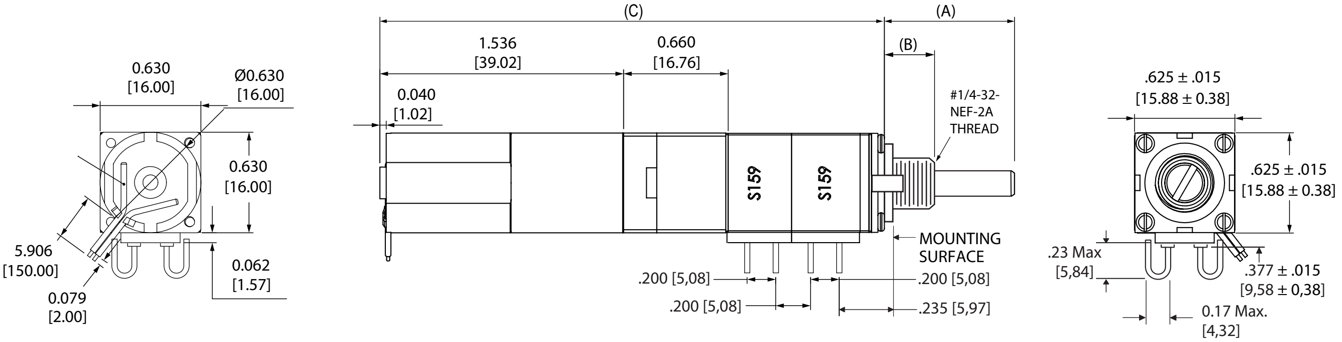


OPTION 1 single left lug
9 o'clock / 270°

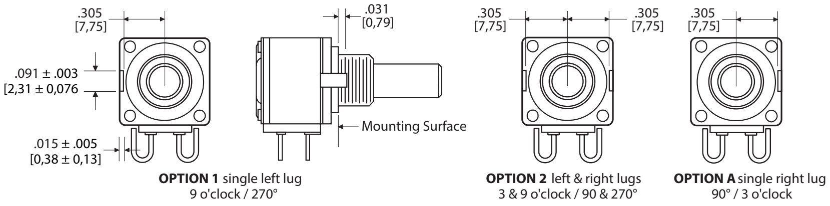
OPTION 2 left & right lugs
3 & 9 o'clock / 90 & 270°

OPTION A single right lug
90° / 3 o'clock

Dual Potentiometer, Single Shaft, Solder Hooks, 1/4" Dia. Bushing, 1/8" Dia. Shaft



Locating Lug Options:



OPTION 1 single left lug
9 o'clock / 270°

OPTION 2 left & right lugs
3 & 9 o'clock / 90 & 270°

OPTION A single right lug
90° / 3 o'clock

Notes:

1. Potentiometer Terminals - .031 [,81] Dia., Soft Copper Cda Alloy 110, Tin Plate.
2. Refer to drawings for Printed Circuit Board Layouts. Refer to 29 for Bushing, Shaft and Hardware information. Refer to drawings for Locating Lug options.
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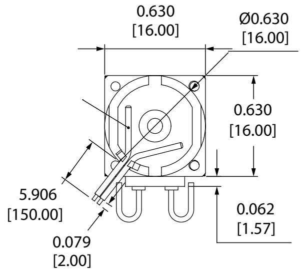
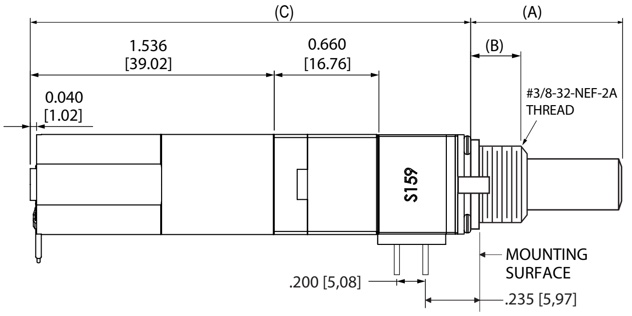
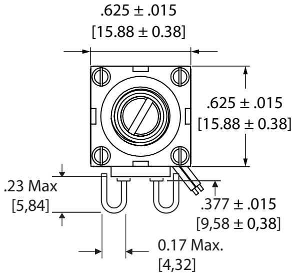
4. Drawings not to scale.

Single and Dual Modules, Single Shaft, Solder Hooks

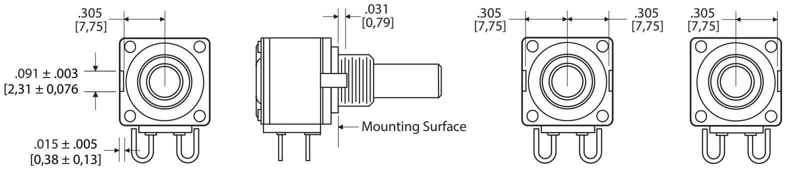
Single Potentiometer, Single Shaft, Solder Hooks, 3/8" Dia. Bushing, 1/4" Dia. Shaft







Locating Lug Options:

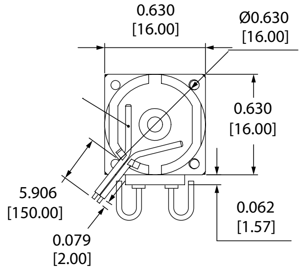


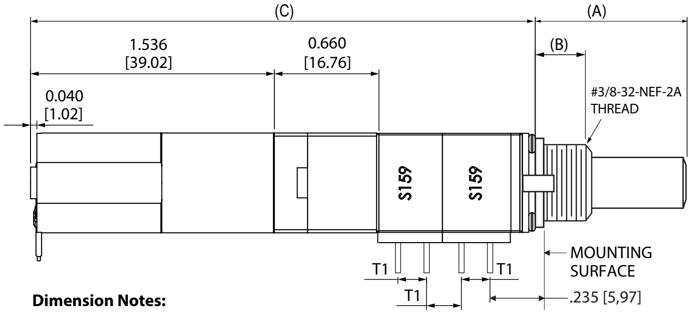
OPTION 1 single left lug
9 o'clock / 270°

OPTION 2 left & right lugs
3 & 9 o'clock / 90 & 270°

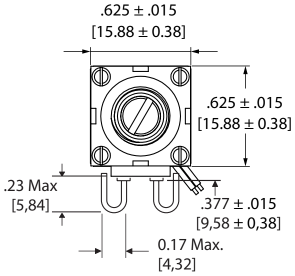
OPTION A single right lug
90° / 3 o'clock

Dual Potentiometer, Single Shaft, Solder Hooks, 3/8" Dia. Bushing, 1/4" Dia. Shaft

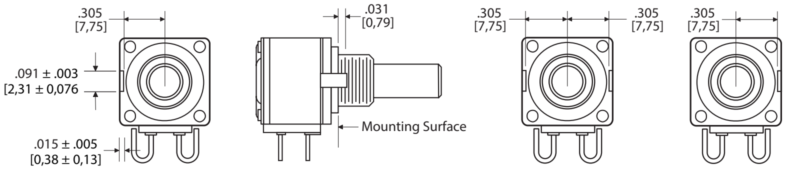




Dimension Notes:
T1 = .200 [5,08]



Locating Lug Options:



OPTION 1 single left lug
9 o'clock / 270°

OPTION 2 left & right lugs
3 & 9 o'clock / 90 & 270°

OPTION A single right lug
90° / 3 o'clock

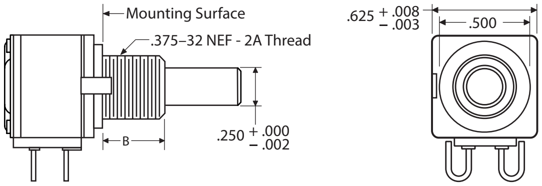
Notes:

1. Potentiometer Terminals - .031 [,81] Dia., Soft Copper Cda Alloy 110, Tin Plate.
2. Refer to drawings for Printed Circuit Board Layouts. Refer to 29 for Bushing, Shaft and Hardware information. Refer to drawings for Locating Lug options.
3. Basic dimensions are in inches. Dimensions in brackets are in millimeters. Dimensional Tolerance ±.016 [0,40], except as specified.
4. Drawings not to scale.

DIMENSIONS

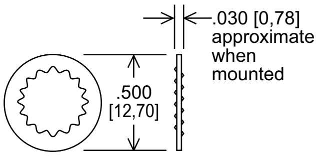
Bushing and Hardware Dimensions

3/8" Plain Bushing

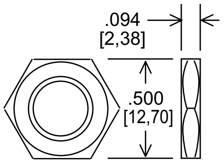


"B" STANDARD BUSHING LENGTHS
.250 [6,35] **– .375** [9,53] **- .500** [12.7]

Mounting Hardware for 3/8" Bushing



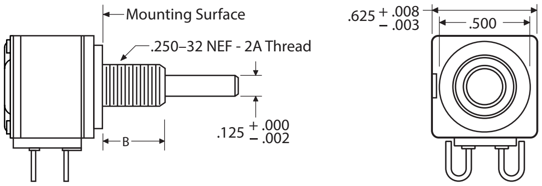
LOCK WASHER
LOCK NUT



MOUNTING NUT

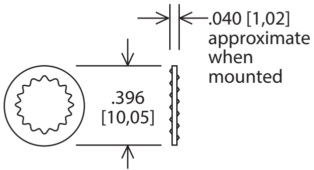
MAXIMUM MOUNTING PANEL THICKNESS:
.062–.188 [1,59–4,76]
when used with
one standard M-2898 Lock Washer
and one standard M-2786 Mounting Nut

1/4" Plain Bushing

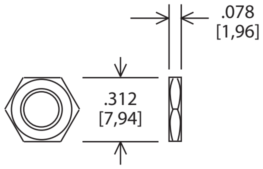


"B" STANDARD BUSHING LENGTHS
.250 [6,35] **– .375** [9,53] **- .500** [12.7]

Mounting Hardware for 1/4" Bushing



LOCK WASHER
LOCK NUT



MOUNTING NUT

MAXIMUM MOUNTING PANEL THICKNESS:
.062–.188 [1,59–4,76]
when used with
one standard M-2898 Lock Washer
and one standard M-2786 Mounting Nut

Dimensions
Basic dimensions are in inches.
Dimensions shown in brackets are in millimeters.

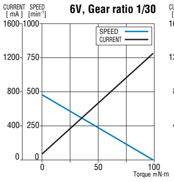
Tolerance
Dimensional tolerance ±.016 [0,40]
Angular tolerance ± 5°, except as specified

S159 MOTORS

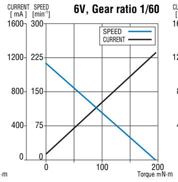
■ PERFORMANCE CURVES

(Figures in the table are typical values under rated operating condition.)

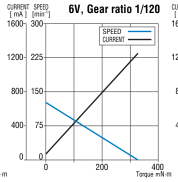
● 030-6



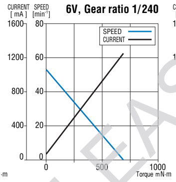
● 060-6



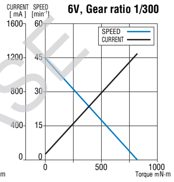
● 120-6



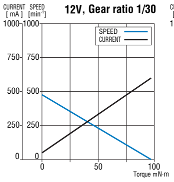
● 240-6



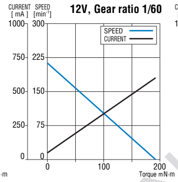
● 300-6



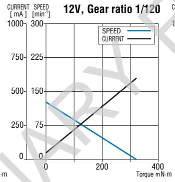
● 030-12



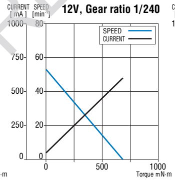
● 060-12



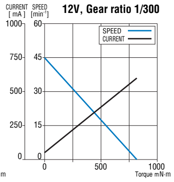
● 120-12



● 240-12

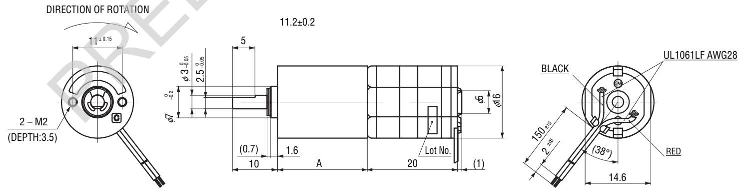


● 300-12V



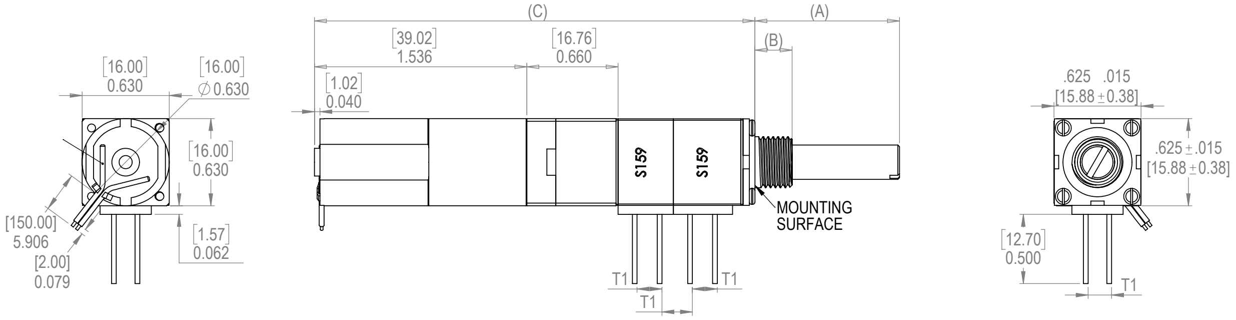
■ OUTLINE DIMENSIONS

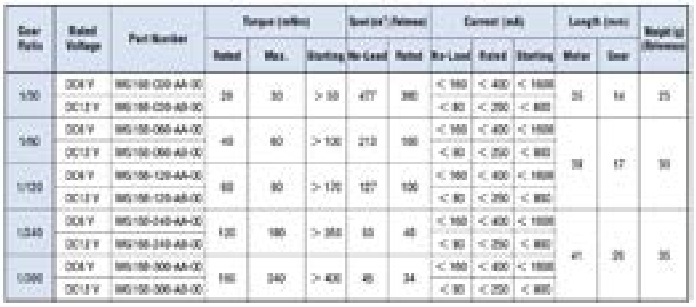
(Unit: mm)



Mark A

Gear ratio	1/30	1/60	1/120	1/240	1/300
A	14	17		20	





Gear Ratio	Rated Voltage	Part Number	Torque (mN·m)			Speed (min⁻¹)		Current (mA)			Length (mm)		Weight (g) (Reference)
			Rated	Max.	Starting	No-Load	Rated	No-Load	Rated	Starting	Motor	Gear	
1/30	DC6V	[illegible]	20	30	> 50	477	390	< 160	< 400	< 1600	[illegible]	14	[illegible]
	DC12V	[illegible]						< 80	< 250	< 800			
1/60	DC6V	[illegible]	40	60	> 100	213	[illegible]	< 160	< 400	< 1600	[illegible]	17	[illegible]
	DC12V	[illegible]						< 80	< 250	< 800			
1/120	DC6V	[illegible]	60	[illegible]	> 170	127	[illegible]	< 160	< 400	< 1600			
	DC12V	[illegible]						< 80	< 250	< 800			
1/240	DC6V	[illegible]	120	180	> 350	63	48	< 160	< 400	< 1600	41	20	[illegible]
	DC12V	[illegible]						< 80	< 250	< 800			
1/300	DC6V	[illegible]	150	240	> 400	45	34	< 160	< 400	< 1600			
	DC12V	[illegible]						< 80	< 250	< 800			

Dim "C"

1-Gang	2-Gang	3-Gang	4-Gang	Unit
0.575	0.975	1.375	1.775	Inches
14.61	24.77	34.93	45.09	MM

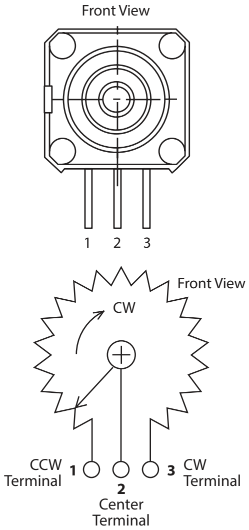
GLOSSARY OF TERMS

Input and Output Terms

Output Voltage

(e) The voltage between the wiper terminal and the designated reference point. Unless otherwise specified, the designated reference point is the CCW terminal (See 3.1).

Figure 1
Circuit and Travel Diagram



Output Ratio

(e/E) The ratio of the output voltage to the designated input reference voltage. Unless otherwise specified, the reference voltage is the total applied voltage.

Rotation and Translation

Total Mechanical Travel

The total travel of the shaft between integral stops, under the specified stop load. In potentiometers without stops, the mechanical travel is continuous.

Mechanical Overtravel - Wirewound

The shaft travel between each End Point (or Theoretical End Point for Absolute Conformity or Linearity units) and its adjacent corresponding limit of Total Mechanical Travel.

Mechanical Overtravel

The shaft travel between each Theoretical End Point and its adjacent corresponding limit of Total Mechanical Travel.

Backlash

The maximum difference in shaft position that occurs when the shaft is moved to the same actual Output Ratio point from opposite directions.

Theoretical Electrical Travel

The specified shaft travel over which the theoretical function characteristic extends between defined Output Ratio limits, as determined from the Index Point.

Electrical Overtravel - Nonwirewound

The shaft travel over which there is continuity between the wiper terminal and the resistance element beyond each end of the Theoretical Electrical Travel.

Electrical Continuity Travel

The total travel of the shaft over which electrical continuity is maintained between the wiper and the resistance element.

Tap Location

The position of a tap relative to some reference. This is commonly expressed in terms of an Output Ration and/or a shaft position. When a shaft position is specified, the Tap Location is the center of the Effective Tap Width.

Resistance

End Resistance

The resistance measured between the wiper terminal and an end terminal with the shaft positioned at the corresponding End Point.

Temperature Coefficient Of Resistance

The unit change in resistance per degree celsius change from a reference temperature, expressed in parts per million per degree celsius as follows:

$$\text{T.C.} = \frac{R_2 - R_1}{R_1(T_2 - T_1)} \times 106$$

Where:
R1 = Resistance at reference temperature in ohms.
R2 = Resistance at test temperature in ohms
T1 = Reference temperature in degrees celsius.
T2 = Test temperature in degrees celsius.

Conformity and Linearity

Linearity

A specific type of conformity where the theoretical function characteristic is a straight line.

Mathematically:

$$\frac{e}{E} = f(W) \pm C = A(W) + B \pm C$$

Where:
A is the given slope; B is given intercept at W=0.
W = Angle or slope

Absolute Linearity

The maximum deviation of the actual function characteristic from a fully defined straight reference line. It is expressed as a percentage of the Total Applied Voltage and measured over the Theoretical Electrical Travel. An Index Point on the actual output is required.

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General Electrical Characteristics

Noise

Any spurious variation in the electrical output not present in the input, defined quantitatively in terms of an equivalent parasitic, transient resistance in ohms, appearing between the contact and the resistance element when the shaft is rotated or translated. The Equivalent Noise Resistance is defined independently of the resolution, the functional characteristics, and the total travel. The magnitude of the Equivalent Noise Resistance is the maximum departure from a specified reference line. The wiper of the potentiometer is required to be excited by a specified current and moved at a specified speed.

Output Smoothness

(Non-wirewound Potentiometers Only)

Output Smoothness is a measurement of any spurious variation in the electrical output not present in the input. It is expressed as a percentage of the Total Applied Voltage and measured for specified travel increments over the Theoretical Electrical Travel. Output Smoothness includes effects of contact resistance variations, resolution, and other micrononlinearities in the output.

Resolution

A measure of the sensitivity to which the Output Ratio of the potentiometer may be set.

Dielectric Strength

Ability to withstand under prescribed conditions, a specified potential of a given characteristic between the terminals of each cup and the exposed conducting surfaces of the potentiometer, or between the terminals of each cup and the terminals of every other cup in the gang without exceeding a specified leakage current value.

Insulation Resistance

The resistance to a specified impressed DC voltage between the terminals of each cup and the exposed conducting surfaces of the potentiometer, or between the terminals of each cup and the terminals of every other cup in the gang, under prescribed conditions.

Power Rating

The maximum power that a potentiometer can dissipate under specified conditions while meeting specified performance requirements.

Power Derating

The modification of the nominal power rating for various considerations such as Load Resistance, Output Slopes, Ganging, nonstandard environmental conditions and other factors.

Life

The number of shaft revolutions or translations obtainable under specific operating conditions and within specified allowable degradations of specific characteristics.

Mechanical Characteristics

Shaft Runout

The eccentricity of the shaft diameter with respect to the rotational axis of the shaft, measured at a specified distance from the end of the shaft. The body of the potentiometer is held fixed and the shaft is rotated with a specified load applied radially to the shaft. The eccentricity is expressed in inches, TIR.

Lateral Runout

The perpendicularity of the mounting surface with respect to the rotational axis of the shaft, measured on the mounting surface at a specified distance from the outside edge of the mounting surface. The shaft is held fixed and the body of the potentiometer is rotated with specified loads applied radially and axially to the body of the pot. The Lateral Runout is expressed in inches.

Shaft Radial Play

The total radial excursion of the shaft, measured at a specified distance from the front surface of the unit. A specified radial load is applied alternately in opposite directions at a specified point. Shaft Radial Play is expressed in inches.

Shaft End Play

The total axial excursion of the shaft, measured at the end of the shaft with a specified axial load supplied alternately in opposite directions. Shaft End Play is expressed in inches.

Starting Torque

The maximum moment in the clockwise and counterclockwise directions required to initiate shaft rotation anywhere in the Total Mechanical Travel.

Running Torque

The maximum moment in the clockwise and counterclockwise directions required to sustain uniform shaft rotation at a specified speed throughout the Total Mechanical Travel.

Moment of Inertia

The mass moment of inertia of the rotating elements of the potentiometer about their rotational axis.

Static Stop Strength

The maximum static load that can be applied to the shaft at each mechanical stop for a specified period of time without permanent change of the stop positions greater than specified.

Dynamic Stop Strength

The inertia load, at a specified shaft velocity and a specified number of impacts, that can be applied to the shaft at each stop without a permanent change of the stop position greater than specified.

General Terms and Conditions of Sale

Orders

All orders are subject to acceptance by **State Electronics**, E. Hanover, NJ. No order or contract shall be deemed accepted unless and until such acceptance is made in writing by **State Electronics**.

All agreements are more contingent upon strikes, accidents or causes of delay beyond our control

Prices and Specifications

Prices, quotations, specifications and other terms and all statements appearing in the Company's catalogs and advertisements, and otherwise made by the Company, are subject to change without notice. **State Electronics** reserves the right to make changes in design at any time without incurring any obligation to provide same units previously purchased or to continue to supply discontinued items. The specifications shown in the sales literature are not always the latest version. Certified current specification prints are available upon request.

Unless specifically provided in writing, prices quoted are based upon manufacture of quantities and types originally specified and are subject to revision when interpretation or engineering changes are initiated by the customer. Quoted prices are based upon present cost of materials and labor and are subject to change without notice.

We are not responsible for typographical errors made in any of our publications or for stenographic or clerical errors made in preparations of quotations, all such errors are subject to correction.

Delivery

Delivery promise is based on our best estimate of the date material will be shipped from our factory and we assume no responsibility for losses, damage or consequential damages due to delays.

Terms of Payment

On approved orders, terms are net thirty (30) days from the date of invoice. The Company may at any time, when in its opinion the financial condition of the customer warrants it, either hold or suspend credit. In cases where credit is not established or satisfactory financial information is not available, the terms are credit card or bank transfer. Each shipment will be considered a separate and independent transaction and payment should be made accordingly.

Shipments

All shipments are made F.O.B. shipping point (unless otherwise specified) and packaging for domestic shipment is not included in the quoted price. When special domestic or export packaging is specified involving greater expense than is customary, a charge will be made to cover such extra expense. Unless otherwise specified, we will normally use the best, least expensive surface transportation. Reasonable care is exercised in packaging our products for shipment and no responsibility is assumed by the Company for delay, breakage or damage after having made delivery in good order to the carrier. All claims for breakage or damage should be made to the carrier, but will be glad to render all possible assistance in securing satisfactory adjustment of such claims.

Claims and Rejected Material

Claims for defective material must be made within 30 days of the customer’s receipt of shipment.
No products may be returned without a return authorization (RMA).

Country of Origin

The S8x, 38X, 70 series and S159 MOD-POT® & MOD-POT^{2}® products are assembled in the United States at our facility located in East Hanover, New Jersey, USA, using globally sourced components.

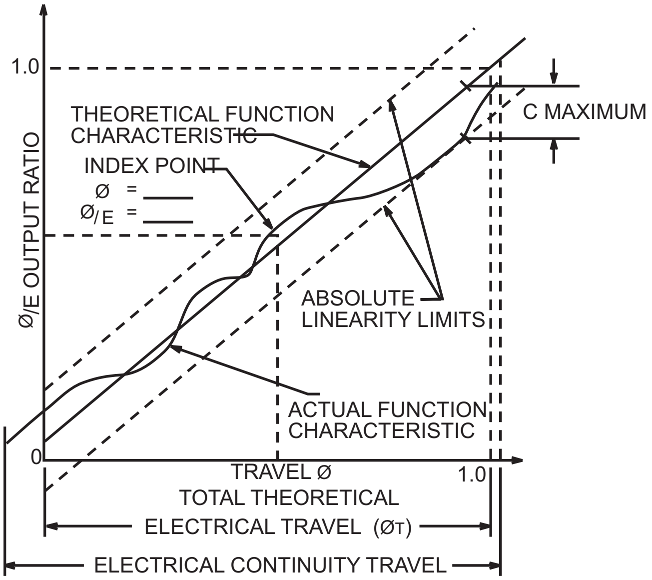
The straight reference line may be fully defined by specifying the low and high theoretical end Output Rations separated by the Theoretical Electrical Travel. Unless otherwise specified, these end Output Rations are 0.0 and 1.0 respectively.

Mathematically:

$$\frac{e}{E} = A(W/W_T) + B \pm C$$

Where:
A is the given slope; B is given intercept at W=0.
Unless otherwise specified: A-1; B=0

Figure 2
Absolute Linearity



Independent Linearity

The maximum deviation, expressed as a percent of the Total Applied Voltage, of the actual function characteristic from a straight reference line with its slope and position chosen to minimize deviations over the Actual Electrical Travel, or any specified portion thereof.

Note: End Voltage requirements, when specified, will limit the slope and position of the reference line.

Mathematically:

Where: $\frac{e}{E} = P(W/W_A) + Q \pm C$

P is unspecified slope; Q is unspecified intercept at W=0. And both are chosen to minimize C but are limited by the End Voltage requirements.

Figure 3
Independent Linearity