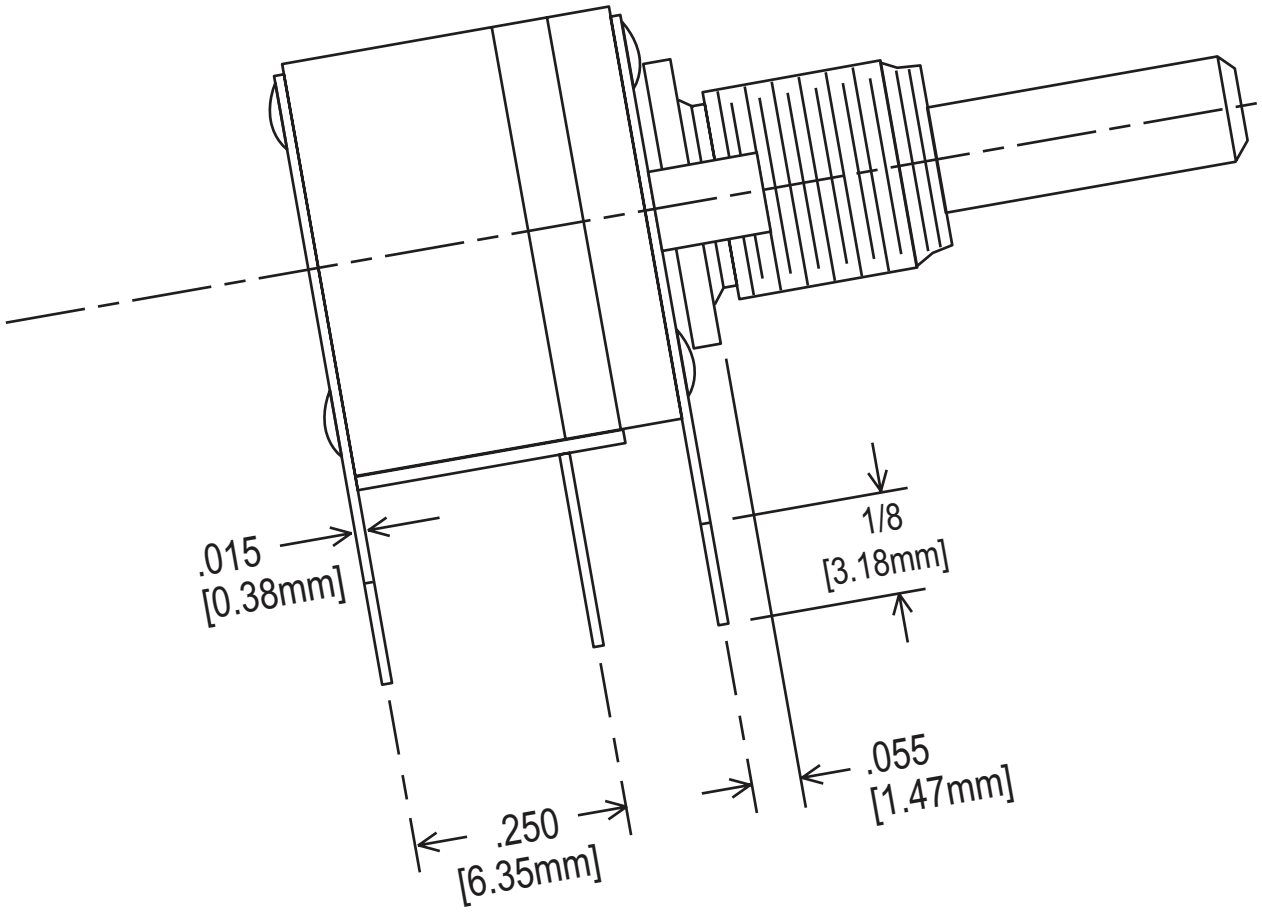
STATE ELECTRONICS

Series 408/409 Custom Potentiometer Designer Guide



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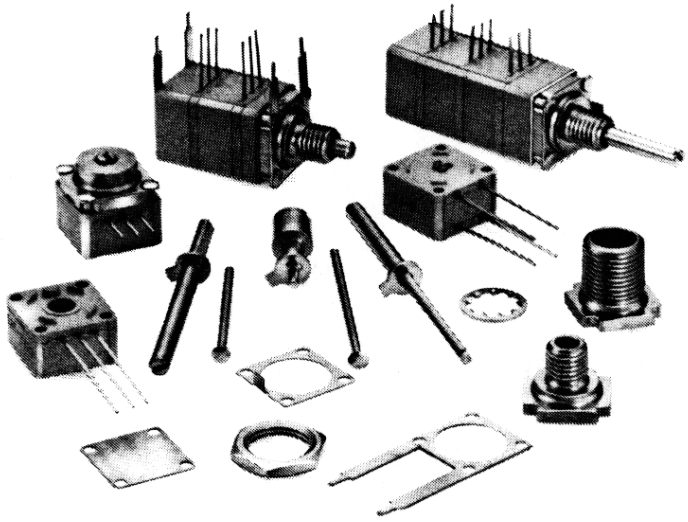
POT PROTOTYPES PRONTO!



Now almost any special combination potentiometer you specify can be manufactured and shipped soon after your order is received.

Since Clarosystem and Mod Pot potentiometers are modular in construction, we can produce prototype quantities of 1/2 or 5/8 inch square, conductive plastic, cermet, or hot molded carbon pots for you in just a few hours . . . . and even production quantities in a matter of days with our VIP (Very Important Potentiometer) service!

Over one billion combinations of single, dual, triple, quad arrangements, push-pull or rotary switches and hundreds of shaft terminal variations can be produced.

If you need a potentiometer and you need it fast, call our product manager or fax us your requirements using the Custom Potentiometer Order Form included in this catalog.

WHY WAIT?

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Series 408 Sealed Potentiometer

1/2 in. sq. 0.5 Watt

Series 409 Sealed Potentiometer

1/2 in. sq. 1.0 Watt

408: Modular Style, Conductive Plastic

409: Modular Style, Thick-Film Cermet

Description

The Series 408 and 409 are high-performance potentiometers, designed to meet wave soldering applications for mounting to PC boards.

They are also available with S.P.S.T. or S.P.D.T. rotary switch modules, S.P.D.T. push-pull or momentary switch modules and/or potentiometer modules in multiple sections up to three sections.

Features

- ***Return to center*** - after shaft rotation (clockwise or counter clockwise), automatic return to center point.
- ***Compact*** - 1/2 in. (12.7mm) miniature, totally sealed, modular size.
- ***Precision Made*** - screen-printed conductive plastic and thick-film cermet elements.
- ***Cost-effective*** - Eliminaltion of hand soldering.
- ***Rugged*** - Horizontal or vertical mountings with support plates. Nickel-plated brass shaft and bushings in various diameters and lengths. Insert molded gold plated terminals for strength.
- ***Stability*** - Series 408 -40ºC to +120ºC; Series 409 -40ºC to 150ºC operating temperature.

	Series 408 Electrical Specifications	Series 409 Electrical Specifications
Resistance	100 ohms to 5 Megohms, linear; 500 ohms to 2 Megohms, non-linear	Linear: 5 ohms to 5 Megohms Taper: 100 ohms to 2 Megohms
Resistance Range	Linear: thru 500Kohms, ±10%; above 500K to 5 Megohms, ±20%. Non-linear: thru 100K ohms, ±10%; above 100K ohms ±20%	± 10% standard; ±5% special. Trimmers ±20%.
End Resistance	Linear: 4 ohms maximum each end. Taper low side 4 ohms maximum; high side 1% of total R.	2 ohms maximum, 5 ohms to 2500 ohms; 4 ohms maximum, 5K ohms and above.
Power Rating	.5 watt @ 70ºC. Derated linearly to zero watts at 120ºC. *See Chart B, page 25.* For non-linear tapered units or PC mounting, derate by 50%. Trimmer style, derate by 50%.	1 watt @ 85ºC. Derate linearly to zero watts at 150ºC. For tapered units, trimmers or PC mounting, derate 50%.
Effective Rotation	265º ±5º without rotary switch; 240º ±5º with rotary switch.	250º +10º -5º without rotary switch; 225º +10º -5º with rotary switch.
Dynamic Noise	Standard: Linear single controls maximum initial noise level of 1.5% of total resistance. Measurement made using constant current source and oscilloscope detection technique. Special: 1%	Standard: Linear single controls maximum initial noise level of 3% of total resistance. Measurement made using constant current source and oscilloscope detection technique. Special: 1.5%

Electrical Specifications continued, next page

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Electrical Specifications continued, next page

Electrical Rotation	295º ±5º	295º ±5º
Working Voltage	350 Vdc across end terminals, but power not to exceed rating.	350 Vdc across end terminals, but power not to exceed rating.
Resistance Temperature Characteristics	*See Chart C, page 26.*	*See Chart C, page 26.*
Linearity	±5% independent	±5% independent
Non-linear Tapers	Right or left-hand available. *See Chart A, page 25.*	Right or left-hand available. *See Chart A, page 25.*
Taper Tolerance	±20% of nominal resistance @ 50%; ±3% of mechanical rotation	±20% of nominal resistance @ 50%; ±3% of mechanical rotation
Voltage Coefficient	.008%/Volt maximum.	.008%/Volt maximum
Dielectric Withstanding Voltage	750 Vac for 60 seconds @ ATM pressure. 350 Vac for 6 seconds @ 3.4 in. Hg.	900 Vac for 60 seconds @ ATM pressure. 350 Vac for 6 seconds @ 3.4 in. Hg.

Series 408/409 Mechanical Specifications

Mechanical Rotation
295º ±5º

Stop Torque
3 lb. in. minimum (metal shaft)

Torque Range
.20 to 3.0 oz. in. (Single); .3 to 3.5 oz. in. (Dual);
.4 to 4.5 oz. in. (Triple).
Other torque options available. Please consult Factory.

Torque Variation
Within control .5 oz. in. maximum

Bushing Lengths
.25 in. (6.35mm), .375 in. (9.53mm), .5 in. (12.7mm)

Shafts, Standard
.125 in. (3.18mm) diameter; brass, nickel-plated

Shaft Lengths
Lengths from mounting surface to 3 in. (76.2mm) in 1/64 in. (.397mm) increments

Push-Pull and Momentary Switch
S.P.D.T., 250ma, 30Vdc, push-pull (Type BL)
Momentary (Type BLM)

Rotary Switch
S.P.S.T. or S.P.D.T., CCW or CW, 125ma, 28Vdc. (Type AL)

Mechanical Specifications continued, next column

Electrical Specifications continued, next page

Seal
O-ring shaft seal standard all styles, and the complete unit is sealed for wave solder and wash processing. The shaft seal withstands 3 PSI pressure. Mounting seals are available. *See Chart D, page 26.*

Housing
Thermoplastic polyester, blue. (U.L. SE-O rating)

Hardware
Nut: brass, nickel-plated
Lockwasher: phosphorous bronze, nickel-plated

Solvent Resistance
Housing resistant to trichlorethylene, *Chlorethene NU, Freon TMS, **Freon TMC, toluene, MEK, ethyl acetate and gasoline. For solvents not listed, please consult Factory.

Terminals
Gold-coated PC terminals or solder hook style. PC pins fit .100 grid spacing. Terminal mounting options available

Weight (approx.)
Metal shaft & bushing: (Single) .19 oz., (Dual) .27 oz., (Triple) .35 oz.

* T.M. Dow Chemical Co.
**T.M. Dupont

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Series 408/409 Operational Specifications

Operating Temperature Range
Series 408: -40ºC to +120ºC
Series 409: -40ºC to +150ºC

Storage Temperature Range
Series 408: -55ºC to +120ºC
Series 409: -55ºC to +150ºC

Rotational Life
Series 408: linear control, 50,000 cycles under load, (plain bushing).
Change not to exceed 10% R.
Trimmer life under load is 5,000 cycles.
Series 409: linear control, 25,000 cycles under load, (plain bushing).
Change not to exceed 5% R.
Trimmer life under load is 5,000 cycles.

AL Switch Specifications

Rating
125ma 28Vdc (dry circuit)

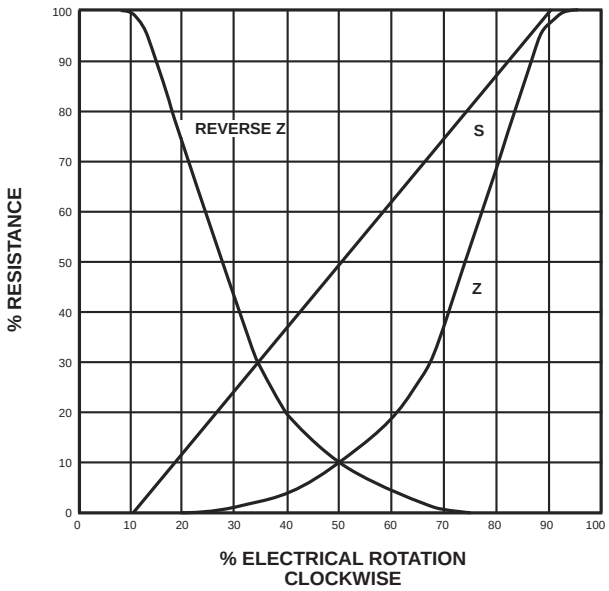
Rotational Life
25,000 cycles under rated load

BL and BLM Switch Specifications

Rating
125ma 30Vdc (dry circuit)

Rotational Life
15,000 cycles under rated load

Figure 1
Chart A



Curves Standard

The "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.

The "Z" taper attains 10% resistance value at 50% of clockwise rotation (left hand).

The reverse "Z" taper attains 10% resistance value at 50% of counter-clockwise rotation (right-hand).

For conformity and special output curves, consult Factory.

Chart B

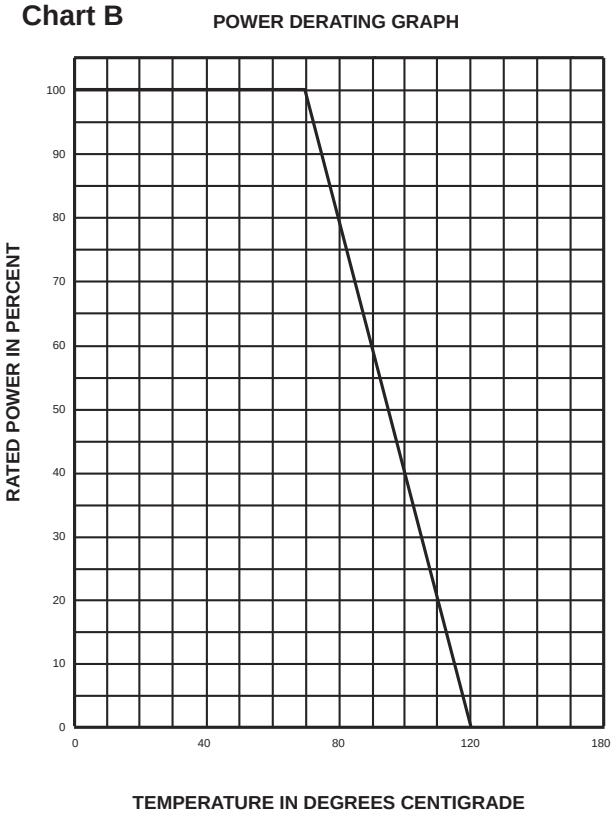


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Figure 3

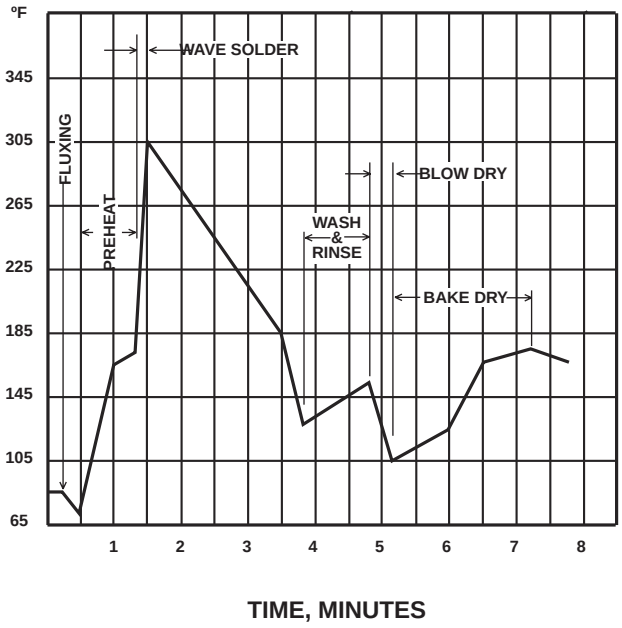
Chart C

Nominal Resistance	Maximum Percent Temporary Resistance Change From 25º						
	-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

For non-linear tapers, multiply chart values by 1.25

Figure 4

Chart D



Wave Solder and Board Wash Parameters Recommended Profile, Temperature on PC Board

Process Limits	Temp.	Time
Preheat Maximum	195ºF	1 Min.
Solder Temperature Maximum	550ºF	
Maximum Differential Temperature After Solder Into Wash (3/4T)	72ºF	
Wash Temperature	150-160ºF	1-1/2 Min.
Dry Temperature	160-220ºF	2 Min.

Tolerance specifications apply to all layout drawings unless otherwise specified:
fractions ±1/64 in. (.379mm)
±1/32 in. (.792mm) over 1 in. (25.4mm);
decimals ±.005 in. (.127mm);
PC board layout ±.010 in. (.254mm).

Figure 3

Series 408/409

Single, Dual or Triple
(Second or Third Section May Be AL Series Rotary Switch)
Printed Circuit – Type B-22
"C" Terminal Lenght: .875" (22.3mm) Maximum
Standard PC Terminal Length: .250" (6.36mm)

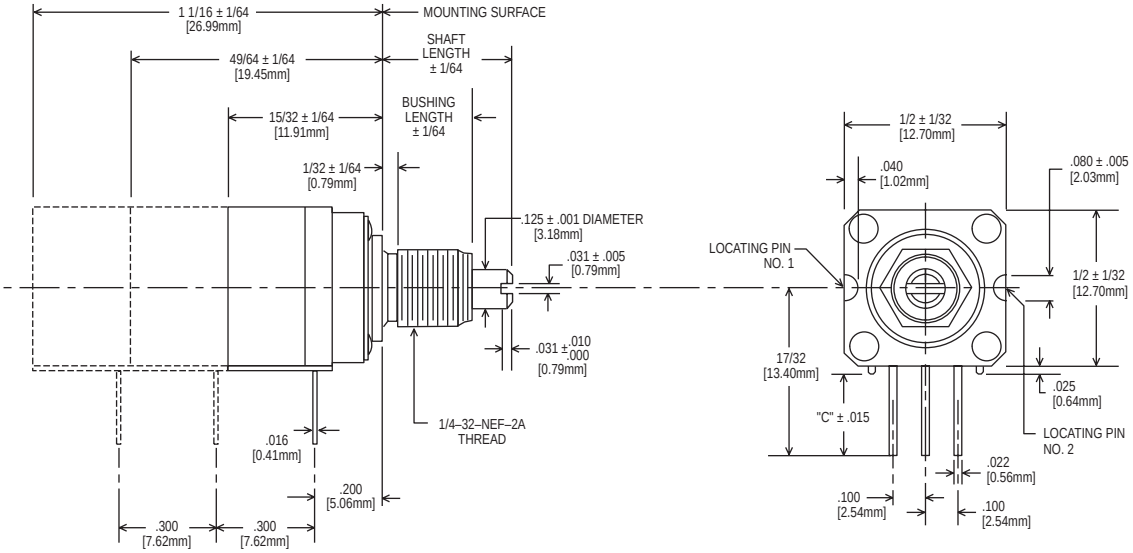


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Figure 6

Series 408/409 Solder Lug Terminals

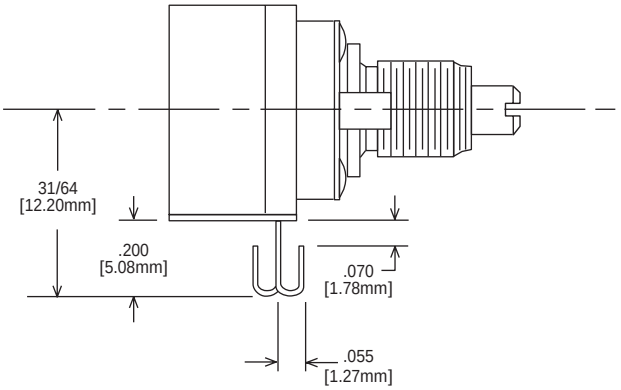


Figure 7

Series 408/409 Bushingless Trimmer

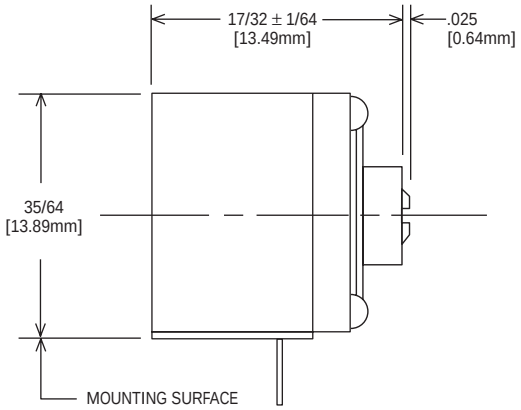
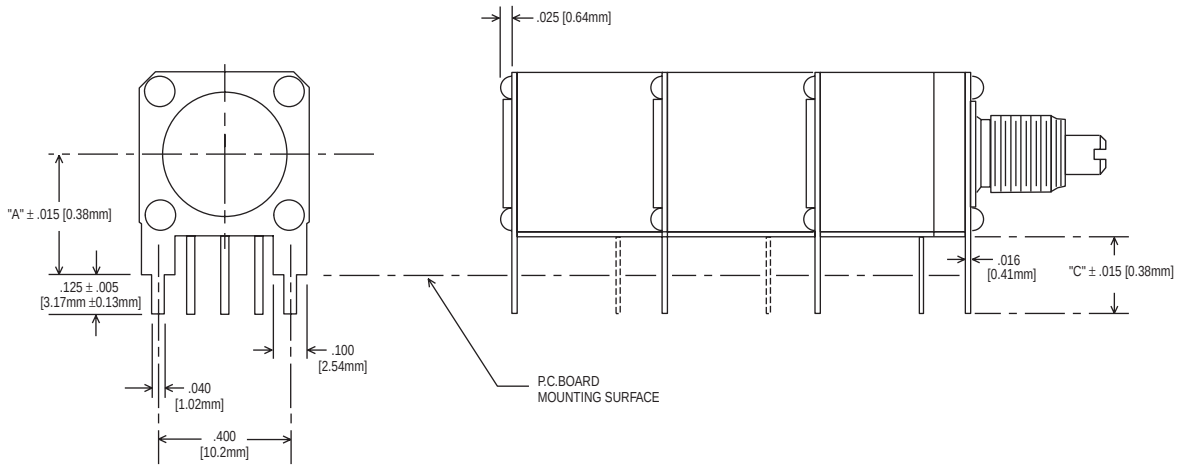
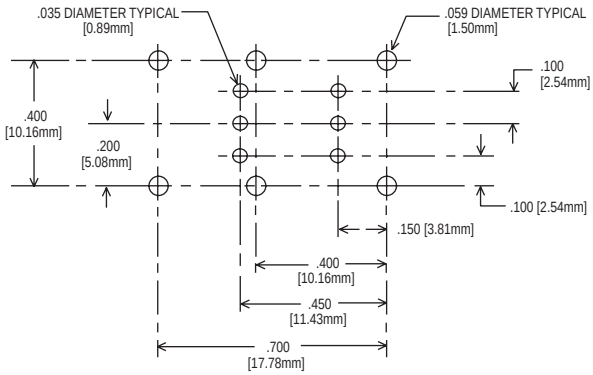


Figure 3

Series 408/409 Single, Dual, or Triple with Panel & Rear Support Plates, Horiz. Mounting



PC Board Lay-out



TYPE	"A" (PLATE)	"C" (TERMINAL)
B–24–1	3/8 [9.52MM]	.250 [6.35]
B–24–2	1/2 [12.70MM]	.375 [9.40]
B–24–3	5/8 [15.88MM]	.500 [12.70]
B–24–4	3/4 [19.05MM]	.625 [15.88]
B–24–5	.255 [6.48MM]	.125 [3.18]

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Figure 9

Series 408/409 POT and BL Series Push-Pull or BLM Momentary Switch Printed Circuit Board Layout (Available with B-24 Support Plates)

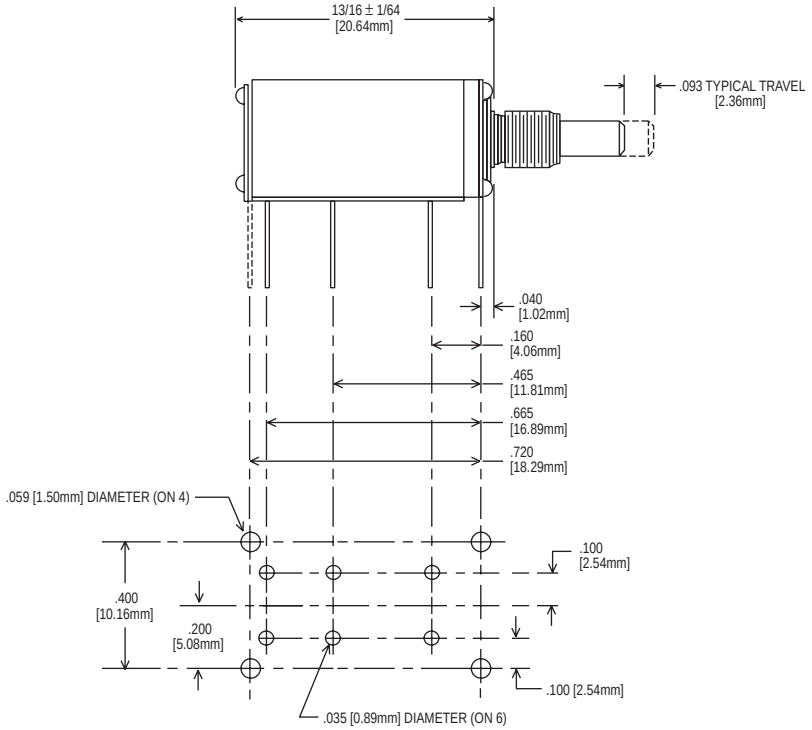

Figure 10

Series 408/409 Type C-10 Printed Circuit Terminals

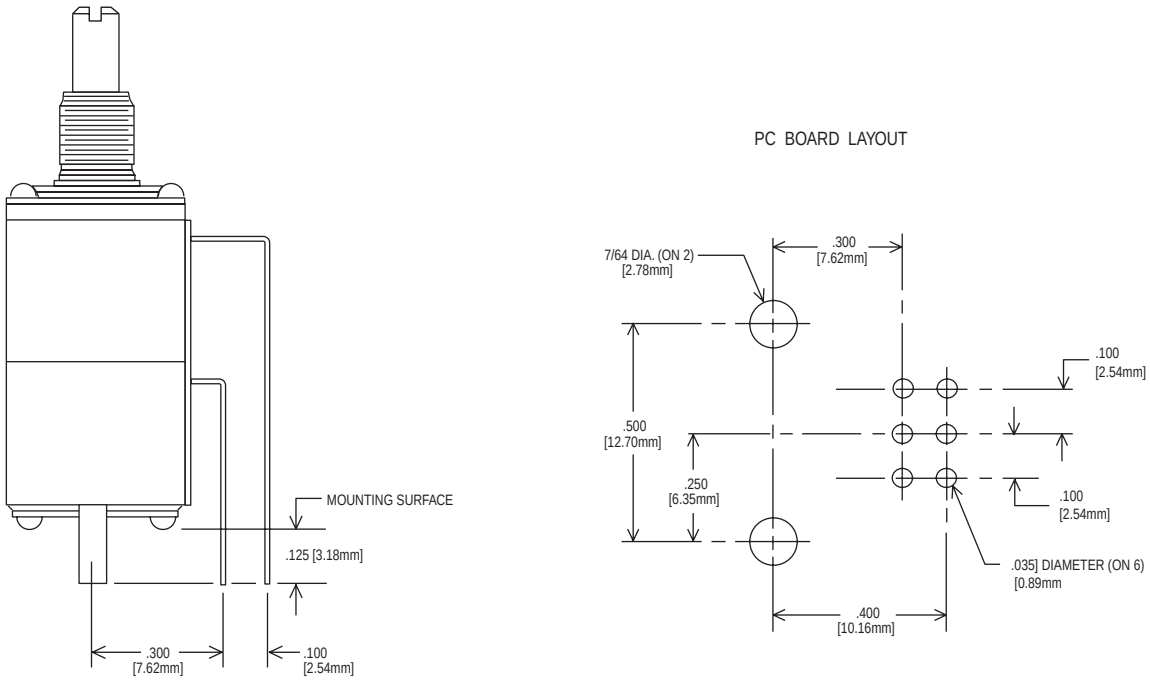

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Figure 11

Series 408/409 Type A-18 Printed Circuit Terminals

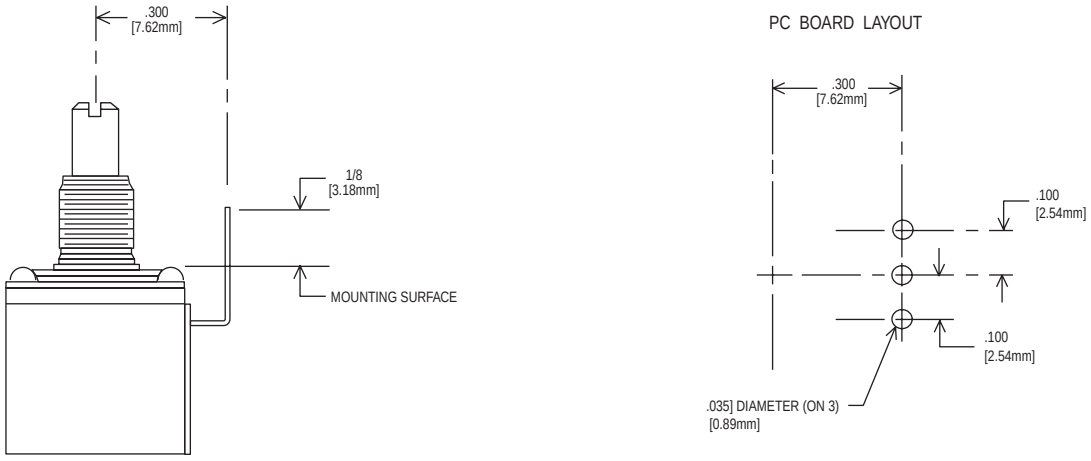

Figure 12

Series 408/409 Type C-8 Printed Circuit Terminals

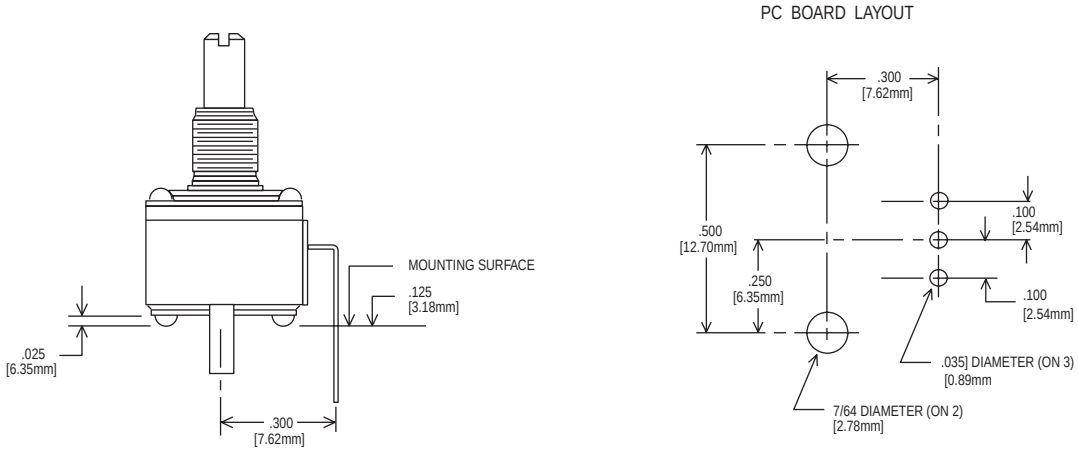

Figure 13

Series 408/409 Type C-9 Printed Circuit Terminals

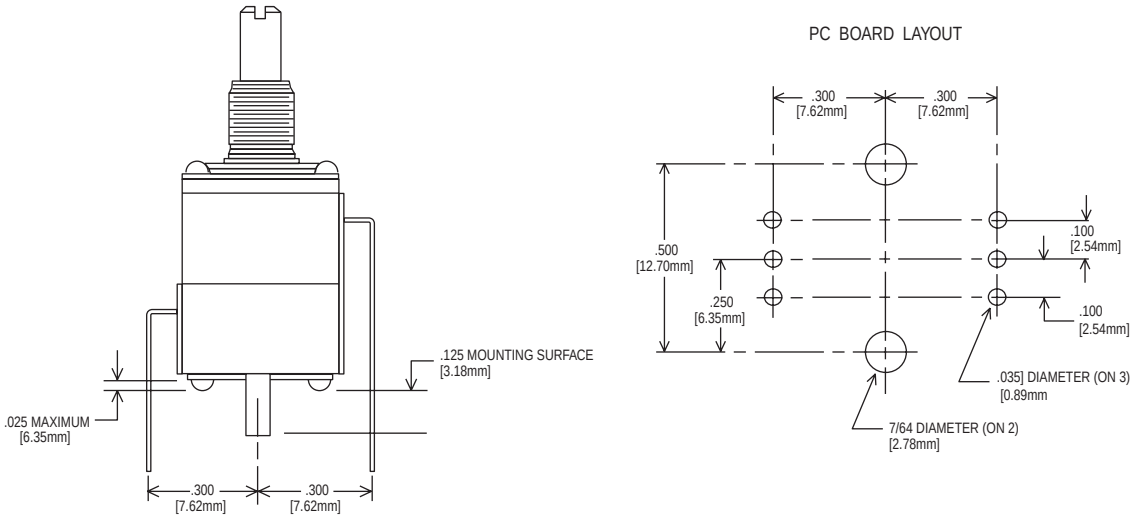

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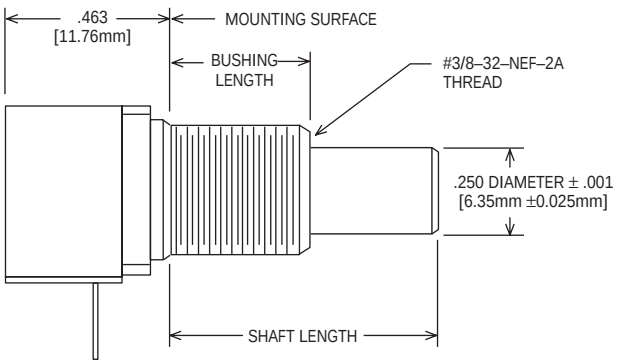
Figure 14

Series 408/409 *(See Figure 4 for other dimension)*

1/4 in. (6.35 mm) Diameter Shaft
3/8 in. (9.53 mm) Diameter Bushing



Series 408/409 Standard Resistance Values

Stock Values (Ohms)

408N

100	2.5K	50K	1Meg
250	5K	100K	2.5Meg
500	10K	250K	5Meg
1K	25K	500K	

408N(Z)

1K	10K	50K
5K	25K	100K

408N(RZ)

500	10K	50K
1K	25K	100K

408NS

100	1K	10K	100K
500	5K	50K	

408NS(Z)

1K	10K	50K
5K	25K	100K

408NPPS

100	1K	10K	50K
500	5K	25K	100K

408NPPS(Z)

500	5K	25K	100K
1K	10K	50K	

D408N *(Same resistance in both sections)*

100	2.5K	50K	1Meg
250	5K	100K	2.5Meg
500	10K	250K	5Meg
1K	25K	500K	

Standard Resistance Values continued, next column

Standard Resistance Values continued

D408N(Z) *(Same resistance & taper in both sections)*

1K	10K	50K
5K	25K	100K

408N(RZ) *(Same resistance & taper in both sections)*

500	10K	50K
1K	25K	100K

408N(RZ) *(Same resistance both sections. Panel Z taper, rear RZ taper)*

1K	10K	50K
5K	25K	

409N

100	2.5K	50K	1Meg
250	5K	100K	2.5Meg
500	10K	250K	5Meg
1K	25K	500K	

409N(Z)

1K	10K	50K
5K	25K	100K

SUPPORT MOUNTING (Optional)*

Catalog Number	*"A" (Plate)*	*"C" (Terminal)*
B-24A-1	.375	.250
B-24A-2	.500	.375
B-24A-3	.625	.500
B-24A-4	.750	.625
B-24A-5	.255	.125

*Rear plate only

Series 408/409 How to Order

Example: **D408-N-PPS-100-Z**

D408 — Series
408=Single
D408=Dual
409=Single

N — Shaft & Bushing
N = Shaft: 1/8 in (3.18mm) diameter x 3/4 in. (19.05mm) FMS screwdriver slotted Bushing: 1/4 in. (6.35mm) diameter x 1/4 in (6.35mm) length

PPS — Switches
S = Rotary switch S.P.D.T.
PPS = Push/pull switch S.P.D.T.
No switch requirement = Blank

100K — Resistance Value (Ohms)

Z — Taper
Z = Log
RZ = Reverse Log
Linear = Blank

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Series 408 and 409

1/2" square modules
Conductive Plastic or Cermet Resistive Element

This series has been discontinued.

Current Inventory - Minimum Order of 100 Pieces.
Available in the Following Configurations Only

Contact a Sales Representative with your requirements

All Units — Shaft: 1/8" Dia. x 3/4" Long FMS, **Bushing:** 1/4" Dia. x 1/4" long FMS

Part Number	Material	Resistance	Switch
408N10K	Conductive Plastic	10K	No
408N1K	Conductive Plastic	1K	No
408N50K	Conductive Plastic	50K	No
408NPPS10K	Conductive Plastic	10K	Push-Pull
408NPPS5K	Conductive Plastic	5K	Push-Pull
408NS10K	Conductive Plastic	10K	Rotary
408NS2.5K	Conductive Plastic	2.5K	Rotary
408NS5K	Conductive Plastic	5K	Rotary
408NS50K	Conductive Plastic	50K	Rotary
408NS5KZ	Conductive Plastic	5K Z	Rotary
409N10K	Cermet	10K	No
409N1K	Cermet	1K	No
409N250	Cermet	250 Ohm	No
409N2500	Cermet	2.5K	No
409N5K	Cermet	5K	No

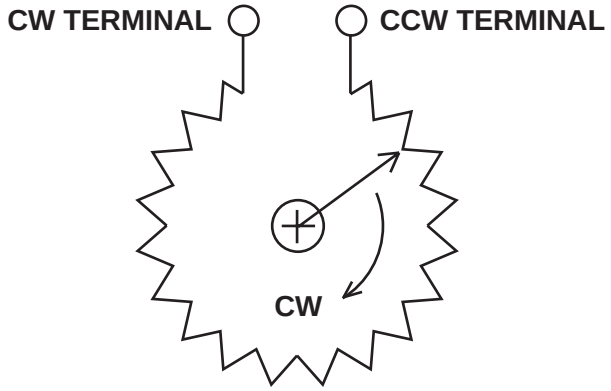
For designs or features not shown in the table above,
refer to the 388 or S127 series.

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.

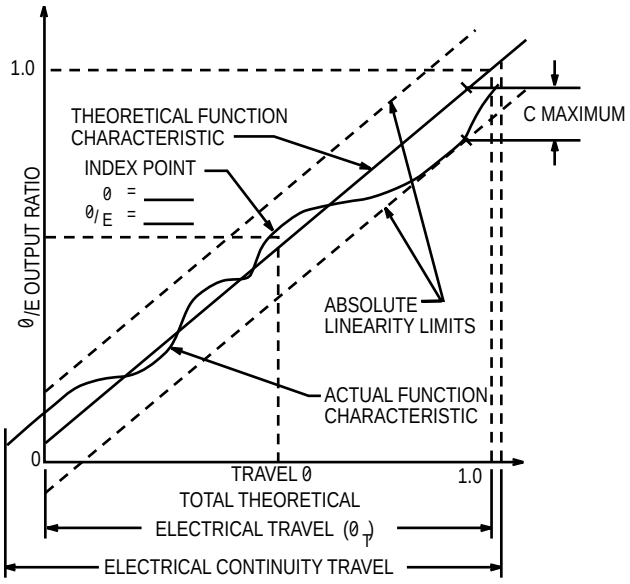
The straight reference line may be fully defined by specifying the low and high theoretical end Output Rations separated by the Theoretical Electrical Travel. Unless otherwise specified, these end Output Rations are 0.0 and 1.0 respectively.

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.

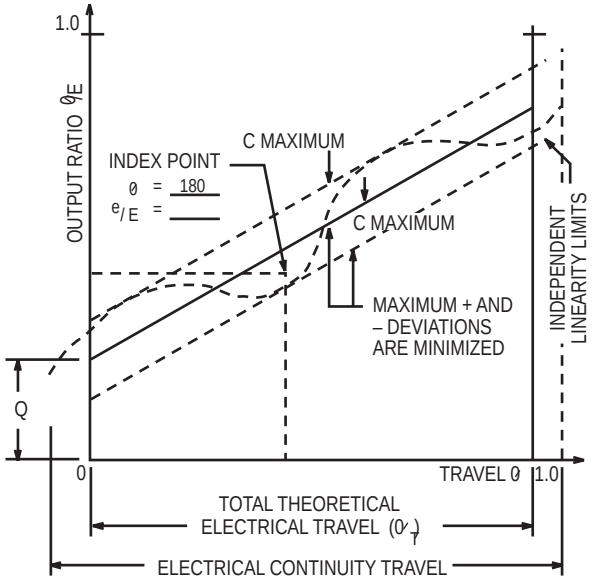
Mathematically:

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

Where:

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



State Electronics
36 State Route 10, STE 6 • East Hanover, NJ 07936-0436
973-887-2550 • Toll Free 1-800-631-8083 • Fax 973-887-1940
http://www.potentiometers.com

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.

Stop Strength

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 cash with order or C.O.D. at the option of the Company. 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 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

No products may be returned without a return authorization (RMA).

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