Cross Reference Guide

TOCOS® POTENTIOMETERS

Surface Mount Cermet Trimmers

3mm Square, Single-Turn, Sealed

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS®
22A	3313J	TS3YJ	ST-3A			G3A
22B						G3B

4mm Square, Single-Turn, Sealed, Industrial

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS®
23A, 23J	3314J	ST53YJ, TS4YJ	ST-4A		4J	G4A
23B, 23G, 23GL	3314G	ST53YL, TS4YL	ST-4B		4G	G4B
	3314H		ST-4C			G4C
23S	3314S, 3314Z		ST-4G			G4SA

4mm Square, Multi-Turn, Sealed

B.I. (Beckman)	Bourns		Dale	BC Components	Murata	Spectrol	TOCOS®
10-Turn	11-Turn	5-Turn	11-Turn	12-Turn	11-Turn		12-Turn
44J	3224J	3214J	TSM43ZJ	SM-4A	POG5HN		GV4J
44G	3224G	3214G	TSM43ZL				GV4G
44W	3224W	3214W	TSM43YJ	SM-4W	POG5AN		GV4W

4mm Square, Single-Turn, Open Frame

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS® *Discontinued
21X	3304A, 3364A	ST-23		RVG4J03A		TRG043S1*
21W	3304C			RVG4J04A		TRG042S1*
21Z	3304W, 3364W	ST-22		RVG4H01A	4H	TRG043S4*

Through-Hole Cermet Trimmers

1/4" and 3/8" Square, Single-Turn

B.I. (Beckman)		Bourns		Dale		BC Components		Murata	Spectrol		TOCOS®
1/4"	3/8"	1/4"	3/8"	1/4"	3/8"	1/4"	3/8"	3/8"	1/4"	3/8"	1/4"
25P		3323P, 3362P		T70YE		CT-6P, FT-6P			76P		GF06P
						CT-6P, FT-6P					GF06P1
	72P	3362R	3386P	T70YP	T20YP	CT-6R	8038EKP	3104P		63P	GF06P2
25W		3362H		T70YB		CT-6W			76H		GF06W
25U		3323U, 3362U	3386U	T70YU		CT-6V, FT-6V					GF06U
	72PL		3386T				8038EKA	3104T			GF06U1
			3386Y				8038EKI	3104Y			GF06Y
	72PM		3386F		T20YM		8038EKH	3104F			GF06Y1
25X		3323X, 3362X	3386H	T70XH	T20XH	CT-6N	8038EKX	3104H		63M	GF06X
25RX	72X	3323W, 3362W	3386X			CT-6X, FT-6X	8038EKU	3104X	76W	63X	GF06X1
25S		3323S		T70XF		CT-6S, FT-6S					GF06S
25RS						CT-6G					GF06S1
25V		3362M	3386W	T70XW	T20XW	CT-6H, FT-6H		3104W			GF06V
25RV	72XL		3386C				8038EKV	3104C		63S	GF06V1
25UTR		3362U				CT-6TV, FT-6TV					GF06UT, UT2
25VTR		3362M				CT-6TH, FT-6TH					GF06VT, VT2

TOCOS AMERICA, INC.
1177 East Tower Road, Schaumburg, IL 60173 Tel: 847-884-6664 Fax: 847-884-6665 E-mail: sales@tocos.com www.tocos.com

Through-Hole Cermet Trimmers (Continued)

4mm Round, Single-Turn

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS®
24W			RJ-4W	1103H		GF04W
24S			RJ-4WS	1104B		GF04S
						GF04V
24U						GF04U
						GF04VT
24UF						GF04UT

1/4" Round, Single-Turn

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS®
62M, (82M)	3329P	T7RYA	RJ-6P	3321P	75P	RJC06P
62P, (82P)	3329H	T7RYB	RJ-6W	3321H	75H	RJC06W
(82PA)	3329W	T7RXX	RJ-6X	3321N		RJC06X
	3329S		RJ-6S	3321S		RJC06S
			RJ-6F	3321F		RJC06F

1/2" Round, Single-Turn

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS®
93P (Reverse Pin-out)			RJ-13P			G12P
			RJ-13S			G12S
						G12X

1/4" Square, 2-Turn

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS®
	3339P		TM-7P	1102P (4-Turn)		GV6P
			TM-7S	1102S (4-Turn)		GV6S

1/4" Square, 11-Turn

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS®
64W	3262W, 3266W	T63YB	RJ-5W, 8026EKW	3107W	74W	RJC26W
64X	3262X, 3266X	T63XB	RJ-5X, 8026EKX	3107X	74X	RJC26X

3/4" Rectilinear, 15-Turn

B.I. (Beckman)	Bourns	Dale	BC Components	Murata	Spectrol	TOCOS®
89P	3006P	T18	CT-20P	2103P	43P	RJC097P
89X	3006Y		CT-20X	2103Y	43Y	RJC097X

This Cross Reference Guide does not infer exact interchangeability in all instances. For further information concerning product substitutes, contact Tocos at 847-884-6664 or your Tocos representative.

Guidelines & Precautions
For Using Trimmer Potentiometers

TOCOS POTENTIOMETERS

TOCOS Trimmer Potentiometers are designed and manufactured with emphasis on dependability and cost-effectiveness. For reliable performance and general safety, follow these guidelines and precautions for using trimmer potentiometers when designing, manufacturing and operating devices.

Guidelines for Circuit Design

1. Terminal Arrangement. When using trimmer potentiometers in circuit designs, be aware of the terminal arrangement, and in which rotational direction the shaft or rotor is turned to increase or decrease the resistance. As shown in *Figure 1,* turning the shaft or rotor clockwise will increase the resistance between the #1 and #2 terminals.

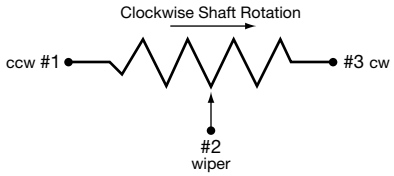


Figure 1

2. Power Rating and Performance Testing. Always use the trimmer potentiometer when testing rated performance. Carefully check the rated power, maximum operating voltage, operating temperature range, and other rated performance specifications. Increase or decrease the rated power according to the power derating curve. A typical power derating curve is shown in *Figure 2.* Use a trimmer potentiometer with sufficient allowable power rating to maintain stable performance over a long period of time. TOCOS recommends that the maximum working power should not be more than one-half the rated power of the trimmer potentiometer.

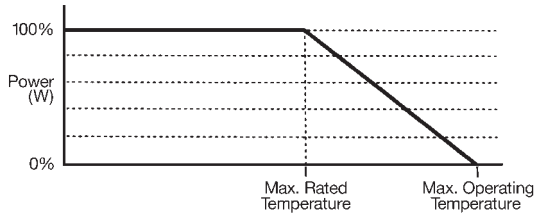


Figure 2: Example of Power Derating Curve

3. Trimmer Accessibility. During design of the board layout, always take into consideration the accessibility of trimmer potentiometers. The style of trimmer and its board location should be convenient for setting and resetting. Also consider when and how adjustment will be performed, on the assembly line or in the field, manually or by robotics.

4. Trimmer Applications. Normally, as shown in *Figure 3,* a trimmer may be used in a circuit as a potentiometer (three-terminal voltage divider) or as a rheostat (two-terminal variable resistor where all the current passes through the wiper). Wiper current, therefore, is especially important in rheostat applications. The potentiometer circuit is preferred because of more stable performance; however, if the trimmer is used as a rheostat, the resistance constriction and temperature coefficient should be checked carefully. Since the rated power is a partial load, it is increased or decreased in proportion to the position of the wiper. Remember that the power capability is always proportional to the amount of element in use in a rheostat connection. If wiper current is not specified for the trimmer, then you may safely use the current rating (not to exceed 100 mA) that produces maximum power dissipation when applied through the element only.

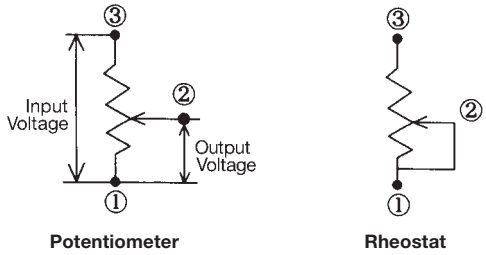


Figure 3

5. Applied Voltage. When DC voltage is applied, local resistance may be abnormally high depending on how the trimmer potentiometer is connected. Always connect the positive (+) current to the wiper terminal as illustrated in *Figure 4.*

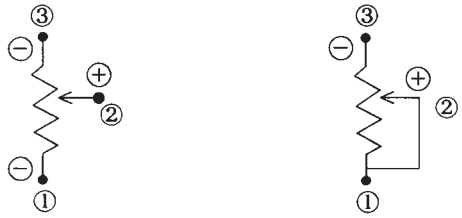


Figure 4

If you have any questions concerning the use of trimmer potentiometers, please do not hesitate to contact us.

Guidelines for Production Processes

It is very important to consider the environmental extremes of the production line as well as those typically taken into account when selecting trimmers and other components for new circuit designs. The mounting, soldering and cleaning processes used during production may be more severe than any conditions encountered during actual end use.

Follow the recommended guidelines and precautions to minimize production line stress and don't overlook testing and verifying the ability of trimmers and other components

to withstand your assembly operations. Typical operations during production as illustrated in *Figure 5* are similar for both surface mount and through-hole products.

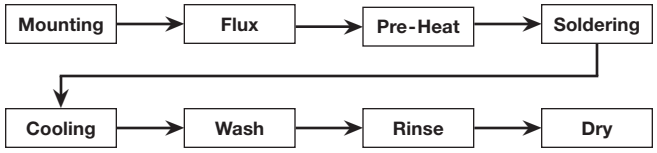


Figure 5

Mounting

1. Mounting SMD Trimmers. Because surface mount products have been designed for automatic assembly systems, the operations involved for handling SMD products is more complicated, but far more reliable and cost effective in the long run than the techniques now used for leaded components.

Packaged in embossed tape on reels, SMD trimmers are automatically mounted by pick-and-place equipment. The alignment, leveling, orientation and stability of these SMD trimmers and other board components before soldering are critical factors during this operation. It is therefore very important to follow the recommended PC board land patterns for all SMD trimmer models.

In preparation for mounting SMD trimmers by flow or reflow soldering, solder paste land patterns are printed on the PC board. The density, thickness and joint quality of the solder paste is essential for reliable connections. Sn 63% Pb 37% is recommended for the solder paste and should be 8 to 10 mils thick. All solder paste residue must be removed during the cleaning process because it usually contains a high percentage of activators. If no-clean, low solids paste is used, the cleaning is not as critical.

When using the flow soldering method for mounting SMD trimmers, an adhesive must be applied to assure placement stability during physical handling and the curing process. The amount of adhesive to use is dependent upon its holding strength, and the curing time and temperature should be in accordance with manufacturer's specifications. Be sure the curing time is sufficient for changing the liquid adhesive into a solid before soldering. An epoxy is recommended but should be used sparingly, as with any adhesive, to avoid overflow onto solder pads and terminals.

2. Mounting Through-Hole Trimmers. Always use the recommended PC board mounting hole layouts and specified maximum hole diameters for through-hole trimmers. Do not force lead terminals into PC board holes that do not match the lead spacing of the trimmer unit. To avoid undue stress on the lead wires from vibration or mechanical shock, mount the trimmer body as close as possible to the PC board. Clinch lead wires after insertion to prevent any stress on the body of the trimmer before soldering. Never bend or pull lead wires unnecessarily and avoid applying excessive bending stress to the terminals during normal insertion operations.

Flux Application

Flux Application. Before soldering, flux is applied to remove surface oxides, prevent reoxidation and promote wetting to ensure reliable intermetallic connections. The most common application method is controlled foam.

Do not allow flux to adhere to any part of the trimmer other than the terminals. Flux residue may penetrate the trimmer housing causing poor wiper contact or malfunction of the adjustment mechanism. Resin based or no-clean synthetic resin based (SRB) fluxes are recommended. Highly activated fluxes should be avoided. If an organic acid (OA) will be used, please consult TOCOS before use.

Pre-Heating

Pre-heating is the controlled gradual heating of trimmers, other components and PC boards in order to stabilize temperature conditions before entering the actual solder zone. Pre-heating prevents thermal shock and also vaporizes all solder paste solvents and moisture. To minimize temperature difference between the top and bottom of a PC board, pre-heat both sides of the board. To avoid any adverse affect on trimmer performance and reliability, use the lowest possible pre-heat temperature.

For screw actuated trimmers, make sure the position of the wiper is *not* in contact with either end termination before pre-heating and soldering as illustrated in *Figure 6.*

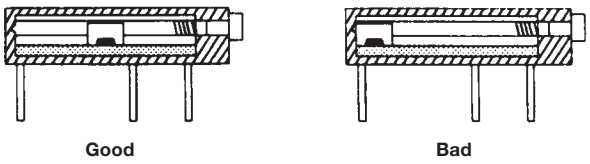


Figure 6

1. Surface Mount Trimmers. For pre-heat time and temperature for surface mount trimmers and the specially designed G4C through-hole series, refer to the reflow and flow temperature profiles specified for individual trimmer series. A typical temperature profile in shown in *Figure 7.*

2. Through-Hole Trimmers. Because the through-hole trimmer series encompass an extensive group of products, individual temperature profiles are not included under each through-hole trimmer series. The recommended pre-heating parameters for through-hole trimmers are 50°C to 150°C within a maximum exposure time of 3 minutes. The pre-heating and soldering temperature profile is specified in *Figure 9* under Soldering, Subsection 3.

Soldering

Using the appropriate soldering technique during the production process ensures good solder connections without degrading electrical and mechanical performance of trimmers and other components. Generally, controlling the maximum temperature and exposure time is the most important concern during the soldering phase.

TOCOS AMERICA, INC.
1177 East Tower Road, Schaumburg, IL 60173 Tel: 847-884-6664 Fax: 847-884-6665 E-mail: sales@tocos.com www.tocos.com

1. General Soldering Precautions. Before pre-heating and soldering screw actuated trimmers, make sure the position of the wiper is *not* in contact with the end terminals, as illustrated in *Figure 6,* to avoid malfunction of trimmers.

Avoid soldering more than once using the reflow system. Do not allow solder to flow onto any portion of the PC board or any part of the trimmer other than the terminals. Follow the recommended maximum temperature and exposure time specified for each trimmer product. Limit solder exposure time to the shortest time possible. Use a minimum soldering temperature of 215°C.

After soldering, allow appropriate cooling time for trimmers, other components and PC board to prevent extreme temperature difference between the soldering stage and the washing cycle.

2. Soldering Surface Mount Trimmers. Reflow or flow soldering may be used for SMD trimmer assembly. Usually, four methods may be used for soldering SMD products: IR (infrared), forced hot air convection, or vapor phase for reflow soldering, and dual wave system for flow soldering.

The recommended temperature profiles for flow and reflow soldering methods are specified under each series of SMD products. Examples of flow and reflow temperature profiles are shown in *Figure 7* and *Figure 8.*

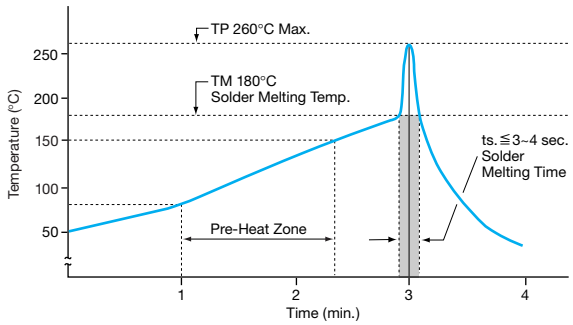


Figure 7: Example of Flow Soldering Temperature Profile For SMD Trimmers

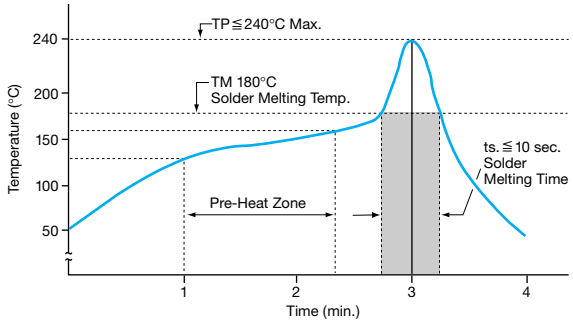


Figure 8: Example of Reflow Soldering Temperature Profile For SMD Trimmers

However, it should be noted that soldering temperature and exposure time may have to be adjusted depending on which heating source is used for reflow.

If infrared radiation is the heat source, the temperature increase of trimmers and other components should be carefully checked because the radiation absorption rate depends on the color and structure of material of trimmers and other components. User must always test and verify pre-heating and soldering processes as well as other production-line assembly before final production.

If the solder temperature exceeds the maximum allowable limit, trimmers with silver terminations may have degraded solder joints and loss of mechanical function due to the leaching of silver into the solder.

3. Soldering Through-Hole Trimmers. Through-hole trimmers are soldered using flow (wave) equipment. Two popular methods for flow soldering are single wave or drag system. Since temperature profiles are not specified under each series of through-hole trimmers, follow the pre-heating and soldering temperature profile for through-hole trimmers specified in *Figure 9.*

Note: The G4C series trimmers are through-hole versions of the surface mount G4 series and are designed to withstand either flow or reflow soldering. Follow the recommended temperature profiles specified for the SMD G4 series.

Because there are many variations of board types and circuit designs with similar or mixed components, the parameters in *Figure 9* will serve as a guideline for user's production process. User must always test and verify pre-heating and soldering parameters as well as other phases of production before final production.

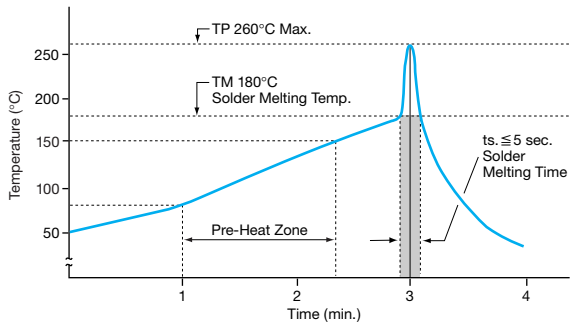


Figure 9: Recommended Flow Soldering Temperature Profiles For Through-Hole Trimmers.

4. Using A Soldering Iron. Use the appropriate soldering iron size, shape and heat capacity for soldering trimmer potentiometers. Do not exceed the maximum time and temperature parameters specified for each trimmer series. Soldering should be performed in the shortest amount of time possible to avoid flux and solder from adhering to the caulked area around the base of the terminals or to any other part of the trimmer. Never touch the body of a trimmer with the soldering iron.

When inserting leaded terminals of a trimmer into the PC board, do not apply excessive force when bending or forming the wire leads. Always crimp wire leads to prevent stress on the body of the trimmer and to provide stability before soldering. To avoid poor connections and possible component or circuit damage, do not expose trimmers to excessive or repeated high temperature while using a soldering iron.

5. Board Reworking. When board reworking is necessary such as removing and replacing components or resoldering connections, keep in mind that excessive and repeated exposure to high temperatures may affect the performance and reliability of a trimmer. If a soldering iron is used, follow the guidelines specified in the previous section.

For reworking surface mount trimmers, it is not advisable to use a soldering iron or flow (wave) soldering. Hot air reflow is the safest method for SMD trimmers.

No matter what soldering method is used for reworking, be sure to monitor the internal and external temperature of the trimmer to avoid extreme temperature changes which may damage trimmers.

6. Wire Soldering. If wiring is required such as external wire jumpers, avoid using solid wire. Use stranded wire to minimize stress on the terminals. If vibration is a problem, use longer wire to alleviate added stress.

When soldering wire to a PC board, use the shortest time possible to avoid excessive heat which may damage the copper foil traces.

Cleaning

The cleaning process is a combination of washing, rinsing and drying cycles that are necessary to remove flux and contaminants from the PC board after soldering. Extra cleaning precautions should always be taken for trimmers because of their moving parts that are typically sealed with a silicone O-ring or the more advanced chevron seal design. The following guidelines will protect trimmers from the harsh environment of the cleaning process and prevent deterioration, degradation of performance and short circuit.

To prevent thermal shock and excessive saturation from the washing and rinsing solutions, the temperature, exposure time, spraying pressure and drying techniques must be strictly controlled as the trimmer enters each cleaning cycle.

To protect the seal from high-pressure cleaning sprays, select a suitable style trimmer that can be mounted on the PC board so the rotor is not directly exposed to high-pressure sprays.

TOCOS sealed trimmer potentiometers are designed for immersion cleaning in a variety of cleaning agents. To insure compatibility with any cleaning agent, test for adverse reactions with the materials of the trimmer such as the housing, shaft and O-ring, and also, make sure the integrity of the markings is not affected after testing. Avoid using cleaning solvents such as trichloroethane or Freon® which endanger the environment.

Temperature control, especially during the transition from the soldering process to the cleaning process, is extremely important. After soldering, gradually cool down trimmers to room temperature (25°C) before the cleaning phase. If a trimmer is not sufficiently cooled down before entering the lower temperature of the wash cycle, and it is soaked with a cleaning solution, the sudden drop in air temperature will create a partial vacuum within the trimmer causing the cleaning solution to be sucked into the trimmer.

Also, minimize temperature variations as trimmers move through the cleaning cycles to avoid thermal shock and trimmer damage during the cleaning process.

To avoid the effects of excessive moisture during the cleaning process, limit the wash-rinse and rinse-dry cycles to as few as possible.

Make sure cleaning solutions are completely evaporated during the drying cycle before any adjustment is made.

Because of the variations in time, temperature, cleaning agents and board types, the cleaning processes should be tested and verified before final production.

Adjustment Guidelines

1. Adjustment Tool. Use the appropriate adjustment tool which conforms to the geometric slot design of the trimmer. Do not use a tool that is designed for high torque applications. For better control, the tool should have an adequate length and comfortable handle or knurled shaft.

During actuation, the applied rotational force should be within the shaft torque range specified for each trimmer series. To prevent discontinuity or mechanical damage, never apply any force greater than the stop torque specified for the trimmer.

2. Adjustment and Terminations. For electrical stability, the setting position of the wiper in relationship to the termination at either end of the resistive element is very important when adjusting trimmers. Set the resistance within a range that excludes at least 10% at each end of the total electrical operation range (adjustment travel).

Never set the wiper at either end stop or in the dead band area of a continuous rotation trimmer.

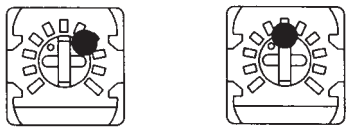
If you find that the wiper contact of a trimmer is set too close to either end termination after adjustment testing, select a trimmer with a more appropriately rated resistance value that will allow more latitude for setting within the recommended 80% range of adjustment travel.

To prevent electrical or mechanical damage while testing trimmer performance, avoid using test equipment that may inadvertently apply current greater than the maximum allowable limit.

TOCOS AMERICA, INC.
1177 East Tower Road, Schaumburg, IL 60173 Tel: 847-884-6664 Fax: 847-884-6665 E-mail: sales@tocos.com www.tocos.com

3. Locking Paint, Coating and Potting. Special processes may be required during production such as the application of locking paint, coating or potting materials. Make sure that the substances used for these processes do not corrode metals or attack plastic materials of the trimmers. Do not subject trimmers to excessive heat during the curing of any substance used for locking, coating or potting.

Because a trimmer is normally the only component on a PC board with moving parts, the quantity, viscosity and application of these substances is critical. Locking paint, which is used to seal the position of the rotor after adjustment, as well as coating and potting materials should be of optimum viscosity. Low viscous substances (too thin) will flow into moving parts of a trimmer; high viscous substances (too thick) will impede the movement of the adjustment mechanism. Use the minimal amount of any substance and avoid applying them in the adjustment slots or obliterating critical markings. For example, the proper placement of locking paint is shown in *Figure 10.*



Good Bad

Figure 10

4. Environmental Conditions. If a trimmer is wet or condensation has formed on the terminals and housing, do not attempt any adjustment. Actuation under these conditions may allow moisture to penetrate into the trimmer causing silver migration and eventual burning or short circuit.

It is important to note that silver migration is also likely to occur if high DC current is applied under high humidity and high temperature conditions.

Avoid exposing the adjustment mechanism, terminals and other portions of trimmers to solvents such as ammonium, alcohol, esters, halogenized hydrocarbons and silicone, or to any toxic gas or oil.

Storage

Avoid storing trimmer potentiometers in high temperature and high humidity areas. The recommended storage conditions are 25°C (room temperature) at a maximum relative humidity of 75%. An air-conditioned area is the most ideal storage environment.

Keep trimmers in a dust-free area, and do not store them in direct sunlight.

Do not store trimmers within the vicinity of any corrosive gases such as hydrogen sulfide, sulfurous acid, chlorine or ammonium. The oxidation of metals caused by such toxic gases may affect solderability as well as the electrical and mechanical performance of these products.

Keep trimmer products in the original packages until just before use, and unpack only the quantity needed. Always seal any opened packages to protect trimmers from oxidation and contaminants.

If any special storage conditions are specified for trimmer products, it is the user's responsibility to comply with the special requirements.

Explanation of Terms

TOCOS® POTENTIOMETERS

The following explanation of terms, based on the booklet of industrial standards published by the Variable Electronic Components Institute (VECI), will help you understand the purpose, construction and applications for trimmer potentiometers.

General Terms

Trimmer Potentiometer. An electrical mechanical variable resistor with three terminals. Two of the terminals are connected to the resistive element (one at each end), and one terminal is connected to a movable conductive contact which slides over the element, thus allowing the input voltage to be divided as a result of the mechanical input. It is designed to function as a voltage divider or rheostat. These trimmers are commonly included in a circuit for easy adjustment and are used to correct variations in other circuit components or for changes due to aging. They are used for infrequent adjustment and, therefore, usually not accessible to the operator.

Wirewound Trimmer Potentiometer. A trimming potentiometer characterized by a resistance element made up of turns of wire on which the wiper contacts only a small portion of each turn.

Non-Wirewound Trimmer Potentiometer. A trimming potentiometer characterized by the continuous nature of the surface area of the resistance element to be contacted. Contact is maintained over a continuous, unbroken path. The resistance is achieved by using material compositions other than wire such as cermet, carbon, conductive plastic or metal film.

Resistance Element. A continuous, unbroken length of resistive material without joints, bonds or welds except at the junction of the element and the electrical terminals connected to each end of the element.

Terminal. An external part that provides electrical access to the resistance element and wiper.

Leadwire Type Terminal. Flexible insulated conductor.

Printed Circuit Terminal. Rigid uninsulated electrical conductor suitable for printed circuit board plug-in.

Solder Lug Terminal. Rigid uninsulated electrical conductor suitable for external lead attachment.

Wiper. The part of a trimmer which makes contact with the resistive element that allows the output to be varied when the adjustment shaft is rotated.

Stop, Clutch Action. An internal device which allows the wiper to idle at the ends of the resistive element without damage as the adjustment shaft continues to be actuated in the same direction.

Stop, Solid. A positive limit to mechanical and/or electrical adjustment.

Stacking. The mounting of one trimmer potentiometer adjacent to or on top of another utilizing the same mounting hardware.

Theoretical Resolution. (wirewound only) The theoretical measurement of sensitivity to which the output ratio may be adjusted and is the reciprocal of the number of turns of wire in resistance winding expressed as a percentage.

N = Total number of resistance wire turns.

$\frac{1}{N} \times 100$ = Theoretical resolution percent.

Input and Output Terms

Total Applied Voltage. The total voltage applied between the designated input terminals.

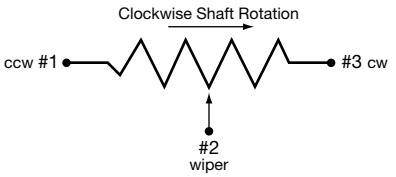
Output Voltage. The voltage between the wiper terminal and the designated reference point. Unless otherwise specified, the designated reference point is the counter-clockwise (CCW) terminal.

Output Ratio. The ratio of the output voltage to the designated input reference voltage. Unless otherwise specified, the reference voltage is the total applied voltage.

Load Resistance. An external resistance as seen by the output voltage (connected between the wiper terminal and the designated reference point).

Adjustment Terms

Direction of Travel. Clockwise (CW) or counterclockwise (CCW) rotation when viewing the adjustment shaft end of the potentiometer. The designation of terminals in the figure below corresponds to the direction of wiper travel.



Actuation. Turning the shaft or other mechanical movement of a trimmer in order to move the wiper over the surface of the resistive element.

Adjustability. The precision with which the output of a trimmer can be adjusted to the desired value.

Adjustment Locking. Refers to the sealing or marking of the position of the adjustment screw after initial setting with viscous paint or other similar substance.

Adjustment Shaft. The mechanical input part of a trimmer potentiometer which when actuated causes the wiper to traverse the resistance element resulting in a change in output voltage or resistance.

Adjustment Travel, Electrical. The total travel of the adjustment shaft between minimum and maximum output voltages.

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Backlash. The play or unimpeded motion of the adjustment mechanism which causes poor adjustability.

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

Mechanical Cycle. Movement of the wiper from one end of travel to the other and back again.

Mechanical Travel, Solid Stops. The total travel of the adjustment shaft between integral stops. Continuity must be maintained throughout the travel.

Mechanical Travel, Clutch Action. The total travel of the adjustment shaft between the points where clutch actuation begins. Continuity must be maintained throughout the travel and during clutch actuation.

Mechanical Travel, Continuous Rotation. The total travel of the adjustment shaft when the wiper movement is unrestricted at either end of the resistive element as the adjustment shaft continues to be actuated.

Multi-Turn Adjustment. Requires more than 360° mechanical input to cause the wiper to traverse the total resistance element.

Single-Turn Adjustment. Requires 360° or less mechanical input to cause the wiper to traverse the total resistance element.

Electrical and Operational Terms

Absolute Minimum Resistance. The resistance measured between the wiper terminal and each end terminal with the wiper positioned to give a minimum value.

Adjustability, Output Resistance. The precision with which the output resistance of a device can be set to the desired value.

Adjustability, Output Voltage Ratio. The precision with which the output voltage ratio of a device can be set to the desired value.

Adjustment Noise. Random unpredictable and undesirable electrical signals that are superimposed on the output of a trimmer during the adjustment rotation.

Contact Resistance Variation (CRV). The apparent resistance seen between the wiper and the resistance element when the wiper is energized with a specified current and moved over the adjustment travel in either direction at a constant speed. The output variations are measured over a specified frequency bandwidth, exclusive of the effects due to roll-on or roll-off of the terminations and is expressed in ohms or percentage of total resistance.

Continuity. Continuity is the maintenance of continuous electrical contact between the wiper and both end terminals of the resistive element.

Dielectric Strength. The ability to withstand the application of a specified potential of a given characteristic between the terminals and all other external conducting parts such as shaft, housing and mounting hardware without exceeding a specified leakage current value.

End Resistance. The resistance measured between the wiper terminal and an end terminal when the wiper is positioned at the corresponding end of mechanical travel. Absolute minimum resistance and end resistance are synonymous for continuous rotation trimmers.

Equivalent Noise Resistance (ENR). (wirewound only) 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 resistive element when the shaft is rotated or translated.The ENR is defined independently of the resolution, functional characteristics and the total travel. The magnitude of the ENR is the maximum departure from a specific reference line. The wiper of the potentiometer is required to be excited by a specific current and moved at a specific speed.

Inductance. Wirewound trimmers generally exhibit inductance function or phase shift, associated with the construction of the element, when operated in a high frequency application.

Insulation Resistance. The resistance to a specified DC voltage impressed between the terminals and all other external conducting parts such as shaft, housing and mounting hardware.

Linear Taper. The plot of the trimmer output that is directly proportionate to constant rate of shaft movement.

Load Life. The number of hours at which a device may dissipate rated power under specified operating conditions while remaining within specified allowable degradations.

Log Taper. The plot of the trimmer output that is logarithmetically proportionate to constant rate of shaft movement.

Ohm. The basic unit of electrical resistance.

Power Rating. The maximum power that a trimmer potentiometer can dissipate across the total resistive element under specified conditions while meeting specified performance requirements.

Resistance-Temperature Characteristic (RTC). The difference between the total resistance values measured at a reference temperature of +25°C and the specified test temperature expressed as a percent of the total resistance.

$$RTC = \frac{R_2 - R_1}{R_1} \times 100$$

Where: R_1 = Resistance at reference temperature (+25°C) in ohms.
R_2 = Resistance at test temperature in ohms.

Explanation of Terms

Resistance Tolerance. The total resistance range that can be tolerated by the circuit after giving consideration to changes due to aging and wear. It is NOT a measure of variable resistor quality. This tolerance applies to total resistance only, not to the set point of the wiper circuit.

Roll-On Step. The abrupt change in output that occurs as the wiper moves from the termination area onto the resistive material of a non-wirewound element.

Resolution. The ability of a trimmer to make very fine adjustments. In a wirewound trimmer, the percent of total output produced by a single turn of wire. Non-wirewound trimmers have essentially infinite resolution. Wirewound trimmers have a step function increase in resistance across the element, so ohmic values between these steps cannot be obtained.

Rotational Life. The number of cycles obtainable under specific operating conditions while remaining within specified allowable degradation. A cycle is defined as one complete traversal of the wiper over the resistive element in both directions.

Setting Stability. The amount of change in the output voltage, without readjustment, expressed as a percentage of the total applied voltage.

Temperature Coefficient of Resistance (TC). The unit change in resistance per degree celsius change from a reference temperature, expressed in parts per million per degree celsius as follows:

$$TC = \frac{R_2 - R_1}{R_1 (T_2 - T_1)} \times 10^6$$

Where: R_1 = Resistance at reference temperature in ohms.
R_2 = Resistance at test temperature in ohms.
T_1 = Reference temperature in degrees celsius.
T_2 = Test temperature in degrees celsius.

Total Resistance. The DC resistance between the input terminals with the wiper positioned to either end stop, or in dead band for continuous rotation potentiometers.

Wiper Current. The maximum allowable sustained current through the wiper contact. This value is essentially independent of total resistance. It is especially important in rheostat mode applications.

Mechanical Terms

Carbon Composition. A type of resistive element made from a mixture of carbon powders in a binder molded into a solid mass, under heat and pressure, as an integral part of its substrate.

Cermet. (from CERamic and METals) A type of resistive element consisting of a mixture of metal particles, precious metal oxides and glass powders, which are mixed with a liquid vehicle, screened onto a ceramic substrate and fired at vitrifying temperatures.

Collector Rail. The part of a trimmer on which the wiper travels that is electrically connected to the wiper terminal.

Contact Force. The force that holds the wiper in contact with the surface of the element.

Immersion Sealed. The ability of the unit to withstand submersion in acceptable cleaning solutions used in normal soldering processes without performance degradation under specific environmental conditions.

Potting. Process in which the space between a component and its case is filled with a compound which hardens to provide an airtight, moisture-proof, insulating seal.

Rotor. An insulated part of a trimmer, attached to the shaft, to which the wiper is connected.

Solderability. The ability of the terminals to accept a uniform coating of solder under specified conditions.

Starting Torque. The maximum moment in the clockwise and counterclockwise directions required to initiate shaft adjustment anywhere in the mechanical travel.

Stick-Slip. A condition in which starting torque is greater than running torque. This creates a very abrupt transition between the two, making fine adjustments difficult.

Stop Torque. The maximum static moment that can be applied to adjustment shaft at each mechanical stop for a specified period of time without loss of continuity or mechanical damage affecting operational characteristics.

Terminal Strength. The ability of the terminals to withstand specified mechanical stresses without sustaining damage that would affect utility of the terminals or operation of the trimming potentiometer.

Termination. The connection between the resistive element and the terminals.

Weldability. The ability of materials to be welded together under specified conditions.

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1177 East Tower Road, Schaumburg, IL 60173 Tel: 847-884-6664 Fax: 847-884-6665 E-mail: sales@tocos.com www.tocos.com

Selection Guide

TOCOS® POTENTIOMETERS

Surface Mount, Cermet Trimmer Potentiometers

Series	G3 Series	G4 Series	GV4 Series
Model Examples			
Nominal Size and Construction	3mm Square Sealed SMD	4mm Square Sealed SMD	4mm Square Sealed SMD
Resistive Element	Cermet	Cermet	Cermet
Adjustment Travel	Single-Turn: 220°±10°	Single-Turn: 200°±10°	Multi-Turn: 12 Turns±2 nominal
Adjustment Type	Top Adjust	Top, Side and Bottom Adjust	Top and Side Adjust Flush with Housing
Terminal Style	J-Hook: A Gull-Wing: B	J-Hook: A, D, S Gull-Wing: B, E, BF	J-Hook: W & J Gull-Wing: G
Resistance Range	50Ω to 2MΩ	50Ω to 2MΩ	10Ω to 2MΩ
Resistance Tolerance	±20% Standard	±20% Standard (±10% Optional)	±10% Standard
Power Rating	0.125 W at +70°C 0 W at +125°C	0.25 W at +70°C 0 W at +125°C	0.25 W at +85°C 0 W at +150°C
Temperature Range	−55°C to +125°C	−55°C to +125°C	−65°C to +150°C
Other Features	Single-Slot or Automatic Adjust Cross-Slot Design Space-Saving Size Embossed Tape & Reel	Single-Slot or Automatic Adjust Cross-Slot Design Space-Saving Size Embossed Tape & Reel	Excellent Adjustability TCR = ±100ppm/°C Low CRV = 1% Embossed Tape & Reel
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Single-Turn, Through-Hole, Cermet Trimmer Potentiometers

Series	G4C Series	GF04 Series	RJC06 Series
Model Examples			
Nominal Size and Construction	4mm Square Sealed Through-Hole	4mm Round Sealed Through-Hole	1/4" Round Sealed Through-Hole
Resistive Element	Cermet	Cermet	Cermet
Adjustment Travel	Single-Turn: 200°±10°	Single-Turn: 190°	Single-Turn: 240°±10°
Adjustment Type	Top and Bottom Adjust	Top and Side Adjust	Top, Side and Bottom Adjust
Terminal Style	Triangular: C & CF	Triangular: W & S In-Line: U & V	Triangular, 15mmℓ: P & W Triangular, 5mmℓ: S & X Triangular, 8mmℓ: F
Resistance Range	50Ω to 2MΩ	100Ω to 1MΩ	10Ω to 1MΩ
Resistance Tolerance	±20% Standard (±10% Optional)	±10% and ±20%	±10% and ±20%
Power Rating	0.25 W at +70°C 0 W at +125°C	0.5 W at +70°C 0 W at +125°C	0.5 W at +70°C 0 W at +125°C
Temperature Range	−55°C to +125°C	−55°C to +125°C	−55°C to +125°C
Other Features	Through-Hole Versions of SMD G4 Series Designed for Flow or Reflow Soldering	Excellent Stability Low Noise and Low TC High Power Rating Space-Saving Size	Excellent Adjustability and Stability Low CRV and Low TC Gold Flushed Terminals
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TOCOS® POTENTIOMETERS

Single-Turn, Through-Hole, Cermet Trimmer Potentiometers

Series	GF06 Series	GF063 Series	GF063-K Series
Model Examples			
Nominal Size and Construction	1/4" Square Sealed Through-Hole	1/4" Square Sealed Through-Hole	1/4" Square Sealed Through-Hole
Resistive Element	Cermet	Cermet	Cermet
Adjustment Travel	Single-Turn: 210°±10°	Single-Turn: 210°±10°	Single-Turn: 210°±10°
Adjustment Type	Top and Side Adjust	Top and Side Adjust	Top Knob and Side Knob Adjust
Terminal Style	Triangular: P, P1, P2, W, Y, Y1, S, S1, X & X1 In-Line: U, U1, V & V1	Triangular: P, P1, P2, W, Y, Y1, S, S1, X & X1 In-Line: U, U1, V & V1	Triangular: PK, P1K, W SK, S1K, XK & X1K In-Line: UK, VK & V1K
Resistance Range	10Ω to 5MΩ	10Ω to 5MΩ	10Ω to 5MΩ
Resistance Tolerance	±10% and ±20%	±10% and ±20%	±10% and ±20%
Power Rating	0.5 W at +70°C 0 W at +125°C	0.5 W at +70°C 0 W at +125°C	0.5 W at +70°C 0 W at +125°C
Temperature Range	−55°C to +125°C	−55°C to +125°C	−55°C to +125°C
Other Features	14 Models Available Cross-Slot Rotor Design Zero Backlash Tape & Reel or Ammo Box	18 Models Available Cross-Slot Design with Larger Rotor than GF06 Series Tape & Reel or Ammo Box	Same Housing Size and Design as GF063 Series Tape & Ammo Box for PK, P1K & UK Models
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Single-Turn, Through-Hole, Cermet and Wirewound Trimmer Potentiometers

Series	GF12 Series	G12 Series	RA12 Series
Model Examples			
Nominal Size and Construction	12mm Square Sealed Through-Hole	1/2" Round Sealed Through-Hole	12mm Round Sealed Through-Hole
Resistive Element	Cermet	Cermet	Wirewound
Adjustment Travel	Single-Turn: 270°±10°	Single-Turn: 270°±10°	Single-Turn: 270°±10°
Adjustment Type	0S, 5S, 10S 8.2SK Styles in Top and Side Adjust	Top and Side Adjust	Top and Side Adjust
Terminal Style	Triangular: P, S, X & R	Triangular: P, S & X	Triangular: P, S & X
Resistance Range	10Ω to 1MΩ	10Ω to 1MΩ	10Ω to 20kΩ
Resistance Tolerance	±10% and ±20%	±10% and ±20%	±10% Standard
Power Rating	0.75 W at +70°C 0 W at +125°C	1.0 W at +70°C 0 W at +125°C	0.5 W at +70°C 0 W at +125°C
Temperature Range	−55°C to +125°C	−55°C to +125°C	−55°C to +125°C
Other Features	Flush Rotor, 5 or 10mm Metal Shafts, or Knurled Plastic Shaft Stable, Infinite Resolution 5,000 Cycle Lifetime	Dial Markings Excellent Stability 1.0 Watt Power Rating Low Noise and Low TC	High Setting Stability Low Equivalent Noise Resistance Low Temperature Coefficient Long Rotational Life
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1177 East Tower Road, Schaumburg, IL 60173 Tel: 847-884-6664 Fax: 847-884-6665 E-mail: sales@tocos.com www.tocos.com

Selection Guide

TOCOS® POTENTIOMETERS

Multi-Turn, Through-Hole, Square Cermet Trimmer Potentiometers

Series	GV6 Series	RJC26 Series
Model Examples		
Nominal Size and Construction	1/4" Square Sealed Through-Hole	1/4" Square Sealed Through-Hole
Resistive Element	Cermet	Cermet
Adjustment Travel	Multi-Turn: 2 Turns (735°±10°)	Multi-Turn: 8.5 Turns±1
Adjustment Type	Top and Side Adjust	Top and Side Adjust
Terminal Style	Triangular: P & S In-Line: U & V	Triangular: W & X
Resistance Range	10Ω to 1MΩ	100Ω to 5MΩ
Resistance Tolerance	±10% and ±20%	±10% and ±20% (≦ 2MΩ); +30%,−20% (≧ 3MΩ)
Power Rating	0.5 W at +70°C 0 W at +125°C	0.25 W at +70°C 0 W at +125°C
Temperature Range	−55°C to +125°C	−55°C to +125°C
Other Features	Space-Saving, Low Profile Design Excellent Stability and Adjustability Low Noise Tape & Reel or Ammo Box	11-Turn Mechanical Travel High Setting Accuracy State-of-the-Art Brush Contact Design Stop-Clutch Action at Ends of Element
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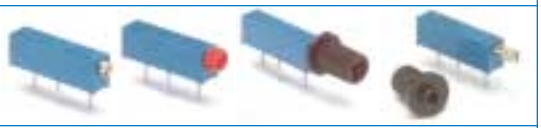
Multi-Turn, Through-Hole, Rectilinear Cermet Trimmer Potentiometers

Series	RJC07R Series	RJC097 Series
Model Examples		
Nominal Size and Construction	3/4" Rectilinear Sealed Through-Hole	3/4" Rectilinear Sealed Through-Hole
Resistive Element	Cermet	Cermet
Adjustment Travel	Multi-Turn: 13 Turns±3	Multi-Turn: 15 Turns±3
Adjustment Type	Top Adjust	Side Adjust
Terminal Style	Triangular: R (without knob) and RK2 (with permanent knob)	Triangular: P (without knob); PK (small knob); PK1 (removable knob); PK2 (permanent knob)
Resistance Range	10Ω to 1MΩ	10Ω to 1MΩ
Resistance Tolerance	±10% and ±20%	±10% and ±20%
Power Rating	0.75 W at +40°C 0 W at +125°C	0.75 W at +70°C 0 W at +125°C
Temperature Range	−55°C to +125°C	−55°C to +125°C
Other Features	Space-Saving, Vertical Mount Design High Performance, Excellent Stability Single-Slot Top Adjustment Knob Style for Fingertip Control	Single-Slot Short Shaft, Small or Large Permanent Knobs or Extended Shaft with Removable Knob Excellent Stability and Low Noise State-of-the-Art Brush Contact Design
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