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.

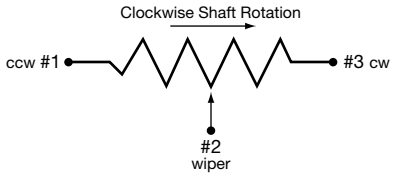

Figure 1

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.

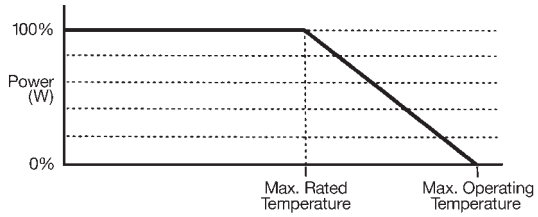

Figure 2: Example of Power Derating Curve

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.

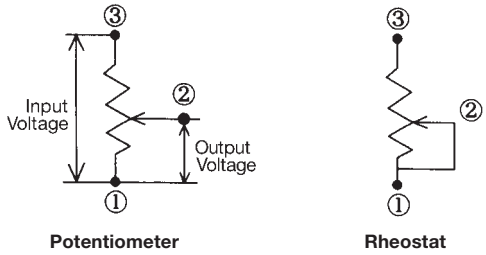

Figure 3

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.*

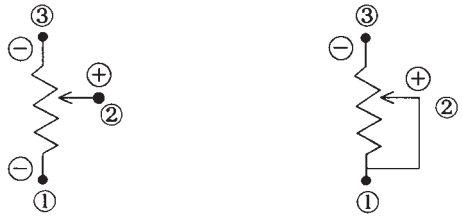

Figure 4

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.

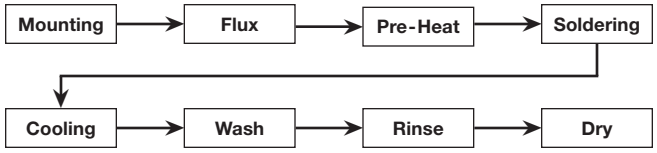

Figure 5

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.*

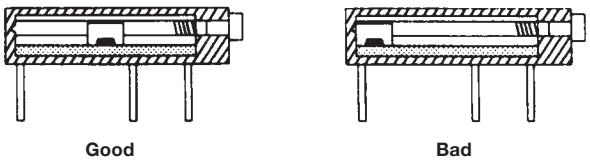

Figure 6

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.

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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.*

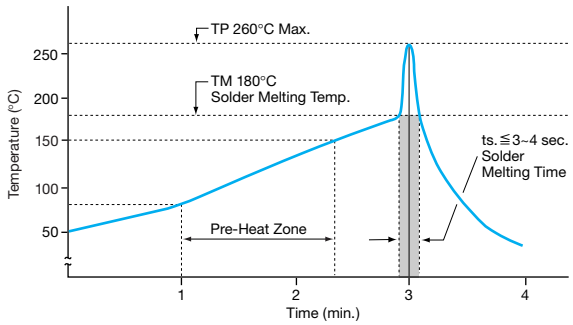

Figure 7: Example of Flow Soldering Temperature Profile For SMD Trimmers

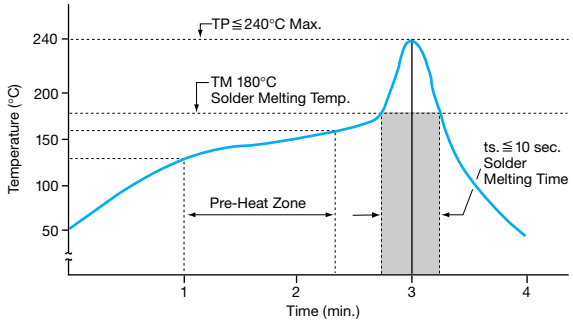

Figure 8: Example of Reflow Soldering Temperature Profile For SMD Trimmers

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.

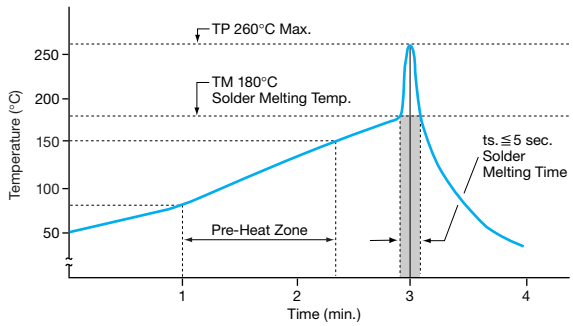

Figure 9: Recommended Flow Soldering Temperature Profiles For Through-Hole Trimmers.

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.

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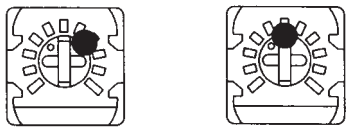
3. Locking Paint, Coating and Potting. Special processes may be required during production such as the application of locking paint, coating or potting materials. Make sure that the substances used for these processes do not corrode metals or attack plastic materials of the trimmers. Do not subject trimmers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