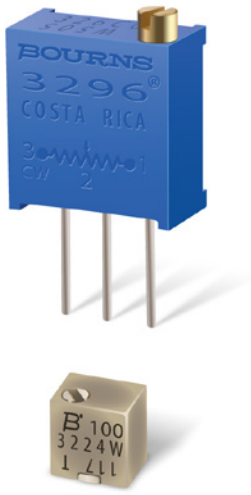
Bourns® Precision Trimming Potentiometers with Improved Linearity and Lower CRV

WHITE PAPER



Precision Trimpot®
Trimming Potentiometers

INTRODUCTION

Trimming potentiometers or "trimmers" are mechanically adjustable resistors utilized in electronic circuits to balance out component tolerances, and to adjust the behavior of the circuitry. Their many applications include adjusting the gain of an amplifier to calibrate a measurement function. Trimmers are primarily used as voltage dividers or as rheostats.

When used as a voltage divider, the trimmer employs input voltage (EI) connected to one of the element terminals, where the other element terminal is connected to ground and monitors the wiper output (EO). In this mode, the trimmer adjusts power voltages as needed, ensuring an adjustable output voltage that is a fractional value of a selected input voltage. The voltage divider mode is most commonly used in a control device. Control devices are needed in applications where frequent manual adjustment is anticipated and convenient adjustment is desired. Many of these applications involve Man-Machine Interfaces (MMIs) including controls for sensor automation equipment.

A trimmer can also act as a rheostat to control current. More than half of all trimmer applications are used in a rheostat mode, using the wiper terminal and only one of the element's terminals. This enables the device to be a variable resistor used to adjust the flow of current in a circuit. When using a trimmer in this manner, there is no basic input-output relationship, except as defined by the associated circuitry in which the trimmer is being used.

Trimmers that adjust, regulate or control circuits are essential in the design steps to enhance the application's operating functions by helping to ensure the application is calibrated and tuned as precisely as possible, not to the edge. These "adjustable resistors" consist of a two-terminal resistive element and a wiper. The wiper is a movable contact spring. Figure 1 illustrates the typical components of a trimmer which has two fixed and one movable electrical contact.

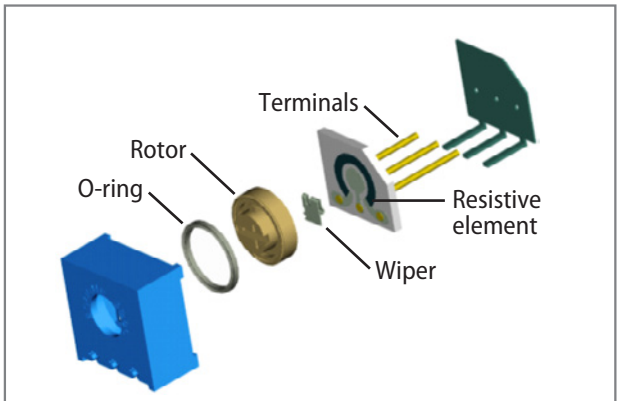


Figure 1 - Typical elements of a trimmer

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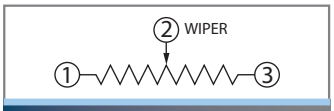

Figure 2 - Adjustable Resistor

Figure 2 shows that changing the position of the wiper on the resistive element terminals leads to different resistive values between the movable and the fixed terminal. The most important electrical characteristics required in selecting the correct trimmer are the resistive element resistance tolerance, linearity and Contact Resistance Variation or CRV.

BASICS OF LINEARITY

Linearity is the relationship between output voltage and the mechanical rotation of the shaft. Linearity is specified in one of four ways: absolute, independent, zero-based or terminal-based. Independent linearity is the most commonly specified linearity because it gives the tightest tolerance specification at a given cost. Independent linearity is the maximum permissible deviation of the actual output curve from the reference line. The slope and position of this reference line are chosen to minimize deviations over either all or a portion of the actual electrical travel. The reference line is placed for the best straight line fit through the actual output curve as referenced in Figure 3.

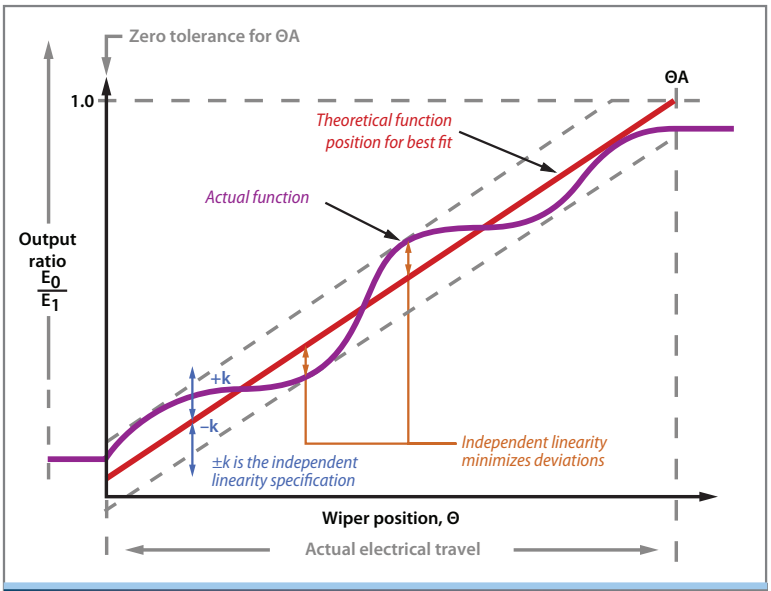

Figure 3 - Trimmer Linearity Specification: The average linearity in a standard Bourns® trimmer is about 4 %.

CONTACT RESISTANCE VARIATION FUNDAMENTALS

Contact Resistance Variation (CRV) is the maximum instantaneous change in contact resistance that will be encountered as the result of moving the wiper from one position to the other. The limit of CRV is expressed as a percentage of the unit's total resistance in ohms. When the wiper is actuated, the resistance at the wiper terminal, with respect to either end terminal, is apt to increase or decrease by a value within the CRV specification. The CRV can be seen as noise. Noise is also generated when microprocessors are used in the electronic design. Today's microprocessors are more sensitive to noise. CRV can limit the adjustability and/or the resolution of the unit.

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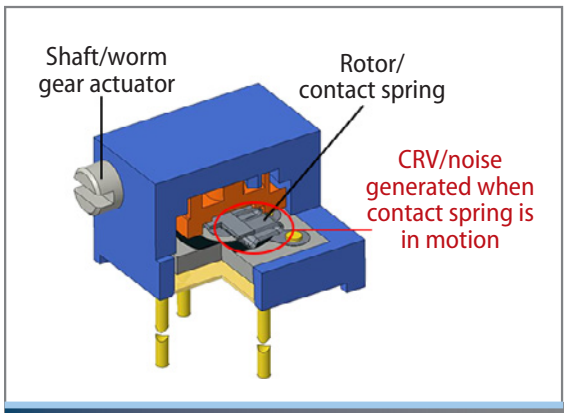
BENEFITS OF PRECISION TRIMMERS WITH OPTIMIZED LINEARITY AND CRV

Through extensive research and development, Bourns has been able to develop a precision trimmer that offers improved linearity and CRV. The Company's Precision Trimpot® Trimming Potentiometer offers a more consistent ratio of output (electrical reading) to input (mechanical rotation) to meet strict linearity requirements. This new generation of products provides linearity of <1.5 % compared to the typical linearity of 4 % for standard trimmer products. The CRV has been reduced from an average of 0.8 % on Bourns® standard trimmers to < 0.2 % in the new generation. The noise in a trimmer can spike up to about 3 %. The advancements made in the new Bourns® Precision Trimming Potentiometers essentially eliminate noise spikes.

This improved linearity and CRV means the Bourns® Precision Trimpot® Trimming Potentiometer is more consistent to the mechanical wiper position and the movement generates less noise. This offers the designer more predictable behavior and an easier adjustment. In theory, a trimmer has an infinite resolution. However, CRV limits the resolution, and improved trimmer performance allows for finer adjustment. Therefore, employing a new generation Bourns® Precision Trimming Potentiometer permits the reading of all output correctly from its tighter linearity and lower CRV. These features enable designers to meet the performance characteristic requirements in today's microprocessor-based applications that can benefit from more precise, accurate design adjustment settings. They also provide the ability to offer faster operator and machine adjustments to the target resistance while providing a more consistent output curve. The latest precision Trimpot® product design from Bourns allows customers to select the exact features required for their specific applications.



The average CRV in a standard Bourns® trimmer is about 1 % and noise can spike to about 3 % maximum.

ADDITIONAL RESOURCES

Please contact your local Bourns Application Engineer or Bourns Sales Representative for additional information.

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