

Commutator Segment Symmetry

Introduction

This applies to commutators that have slots milled into each copper segment for the purpose of making winding connections. Positional accuracy of the segments is important in automated processes such as milling slots, lead insertion, and fusing. It may also be significant to motor performance relating to precision of electrical timing. Product quality, scrap losses, and throughput rates of these processes will improve if segment position variability can be reduced. The characteristics of particular interest are the axial skew and the circumferential spacing (true position variation) of the segments.

Conventional assembled segment commutators are made from individual copper and mica segments. Precise segment position control of these assemblies is adversely affected by variation in the segments themselves, particularly mica segments, and by positioning variation that is inherent in their associated manufacturing processes.

Resinoid has developed a molded, segmented commutator process that does not use mica. The insulation between copper segments is molded phenolic compound that is integrally connected to the molded commutator body. The inherent *segment position quality* of this Resinoid process is distinctly superior.

For the purpose of offering a quantified comparison, we have analyzed two randomly selected samples. They were made to the same drawing specifications except that one is a conventional mica molded design and the other is a Resinoid mica-less alternative. Both are 72 bars, 4 ½" diameter, and 1 ½" segment length. Two significant characteristics were measured and reported, skew and true position.

In addition to the quality and cost benefits in your product and your processes, there may be applications for automated processing that were considered infeasible or unpractical with conventional commutators, but would be workable with Resinoid mica-less commutators. Also, the technical complexities of the automated equipment developed to overcome commutator symmetry issues may be simplified or no longer needed.

Resinoid developed this segment positioning technology specifically to address the opportunities presented by your process needs. Our present customers have readily confirmed the benefits based on actual production experience. We would welcome an opportunity to work with you. Please contact us.

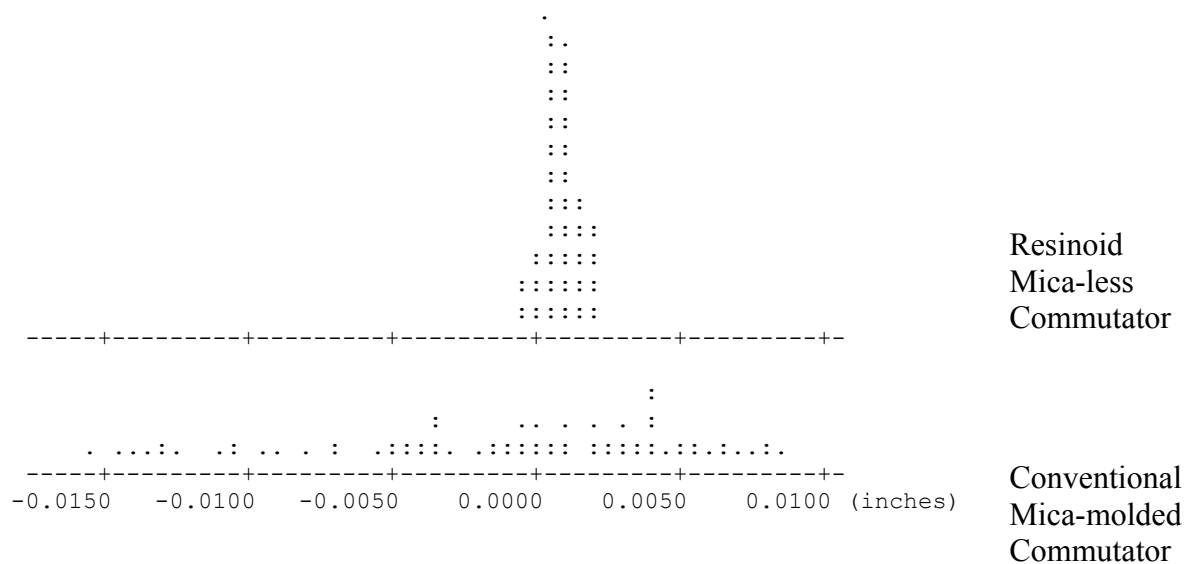
Commutator Segment Symmetry Segment Position Quality

Quantitative *measurement methods* for these aspects of segment symmetry quality have historically been somewhat underdeveloped. Visual attribute inspection or relative performance in automated processes have been common acceptance criteria.

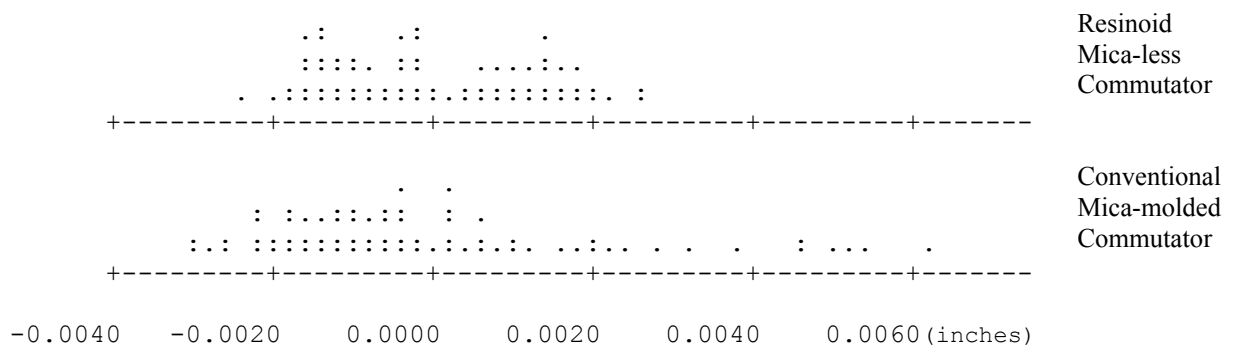
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- 1) *Skew*
- 2) *True Position Variation*

Skew Comparison



True Position Variation



Commutator Segment Symmetry Measurement Method

I. Skew Measurement

A. Description.

By use of a coordinate measuring machine, the amount of skew in inches was measured over an axial distance of 1.08 inches for each of the 72 segments. The results are shown in the following dot plots.

B. Method

1. Mount an indicating shaft through the bore of each comm.
2. Using the CMM, locate a parallel axis with the shaft and bore.
3. Locate 2 points on the leading edge of each slot one-inch apart.
4. For each of the 2 points, record the chord length for angular skew for each slot.
5. Generate a histogram of data for comparison.

C. Target/specification

Chord length target = 0 inches

Chord length specification (@ 1.67Cpk) = .005 inches

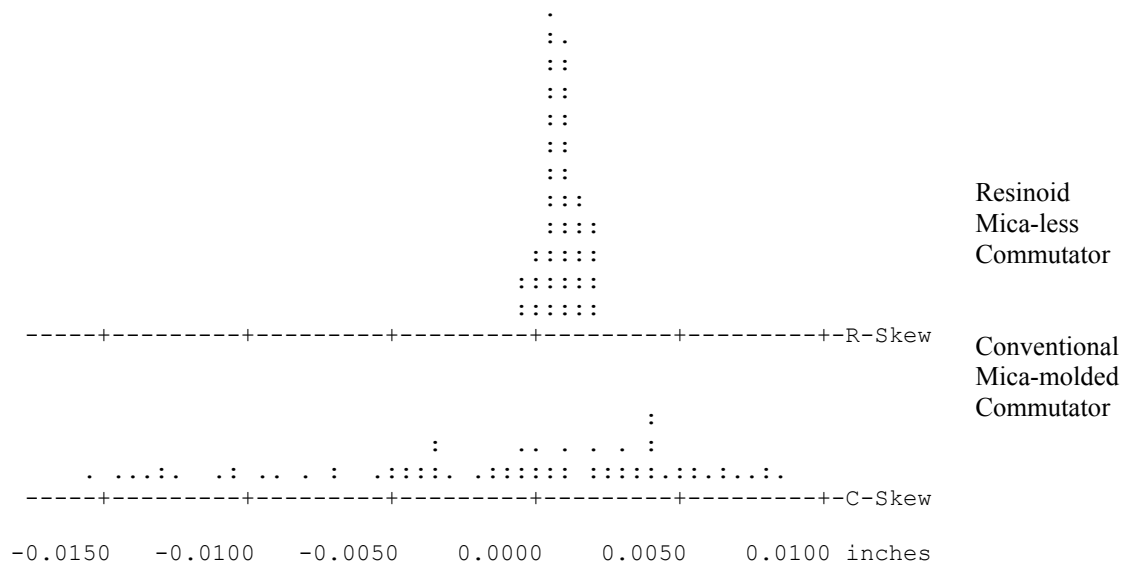
D. Results

1. Description of Groups:

a) R-Skew: Resinoid 72 bar - skew between 2 points on slot using the CMM

b) C-Skew: Competitor 72 bar - skew between 2 points on slot using the CMM

2. Dot Plot of Comparison: Chord Length Measurement of Skew



	N	Mean	Minimum	Maximum	Stdev	Cpk
R- Skew	72	.00083	-.0007	.0019	.00061	2.27
C-Skew	72	-.00121	-.0157	.0083	.00634	.20

Commutator Segment Symmetry Measurement Method

II. True Position Variation Measurement

A. Description.

By use of an optical comparator, the true position variation of each segment was located at a radial distance of 2.04 inches from the axis of the bore. The angular variation from true position relative to the starting point was recorded for each segment. These angular readings were then converted to a chord length in inches and shown in dot plots.

B. Method.

1. Using the comparator, determine the true position of the centerline of the riser end of the slot to the id.
2. Calculate the variation in degrees from true position by subtracting the true position angular measurement from the theoretical angular measurement for a 72 bar commutator.
3. Convert angular variation to a chord length variation based on radius of measurement point.
4. Generate a histogram of data for comparison in inches.

C. Target/specification.

Position Variation target: 0 inches

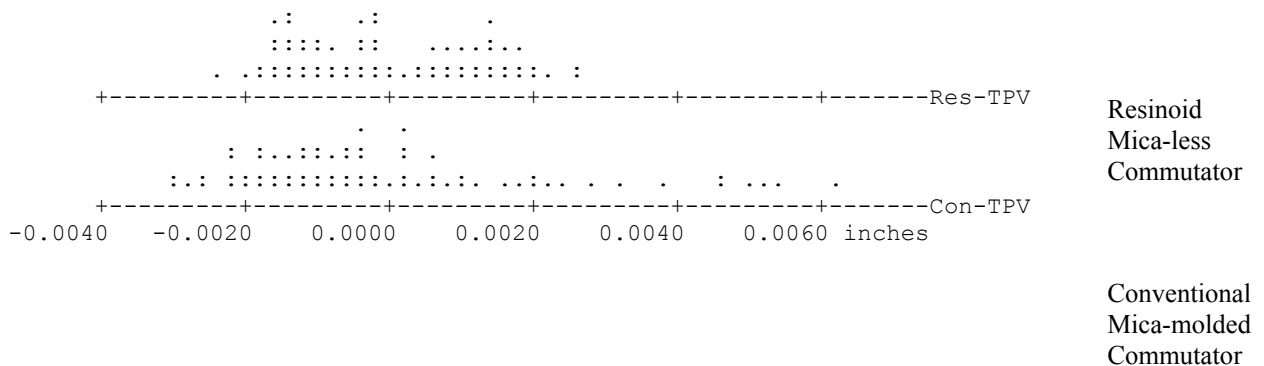
Position Variation Specification: (@ 1.67Cpk) = .007 inches

D. Results:

1. Description of Groups:

- a) Resinoid-TPV: RESINOID 72 BAR: Variation between True position and theoretical at the centerline of the riser end slot to the id.
- b) Convent-TPV: CONVENTIONAL 72 BAR: Variation between True position and theoretical at the centerline of the riser end slot to the id.

2. Dot Plot of Comparison: Variation of True Position at Riser End to Theoretical (in inches)



	N	Mean	Minimum	Maximum	Stdev	Cpk
Res-TPV	72	0.00000	-0.0231	0.00262	.00129	1.81
Con-TPV	72	0.00000	-0.0309	0.00625	.00217	1.08