NCSX

Copper Cable Keystone Tests

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NCSX
Copper Conductor Keystoning Tests

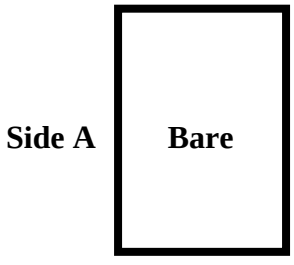
SCOPE: Perform tests on the proposed rectangular compacted copper cable to determine the amount of Keystoning which would result during winding of the Modular coils for NCSX. Two Keystone trials were performed winding the copper braid conductor in both directions. Trial #1 was performed winding the conductor with the narrow side against the mandrel. Trial #2 was performed winding the conductor with the wide side against the mandrel.

1. Measurements were taken with the copper cable conductor bare. (See Table 1)
2. One half-lapped layer of dry glass insulation was applied over the bare conductor. (1 inch wide x 0.007 inches thick)
3. Measurements were taken with insulation on conductor. (See Table 1)
4. The insulated conductor was hand wound onto a mandrel with a measured diameter of 3.181 inches.(8.08 cm).
5. Once wound, conductor measurements were taken. These steps were repeated for both trial sets.

Table 1- Initial Conductor Measurements

Location	Bare Side A	Insulated Side A	Bare Side B	Insulated Side B
1	0.631	0.653	0.519	0.541
2	0.637	0.655	0.520	0.542
3	0.640	0.660	0.525	0.553
4	0.640	0.660	0.529	0.548
5	0.640	0.664	0.525	0.547
6	0.640	0.660	0.534	0.554
7	0.640	0.665	0.539	0.558
8	0.642	0.668	0.538	0.556
9	0.633	0.660	0.537	0.557
10	0.635	0.660	0.535	0.557
11	0.635	0.650	0.535	0.556
12	0.635	0.665	0.530	0.548
Average	**0.637**	**0.660**	**0.531**	**0.551**

Trial #1- *Conductor Winding Direction*

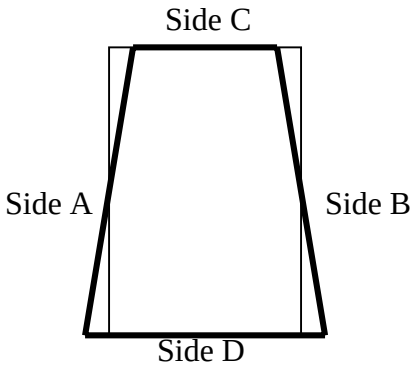


Trial #2- *Conductor Winding Direction*

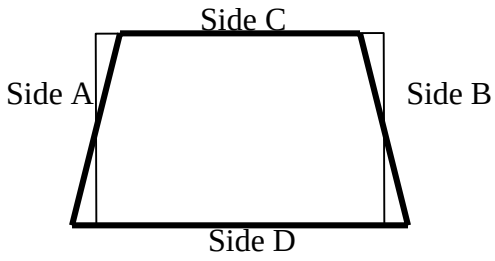
Center Line- Winding Axis

Results of Keystone Tests

Trial #1



Trial #2



Center Line- Winding Axis

Table –2 Keystone Results- Trial #1

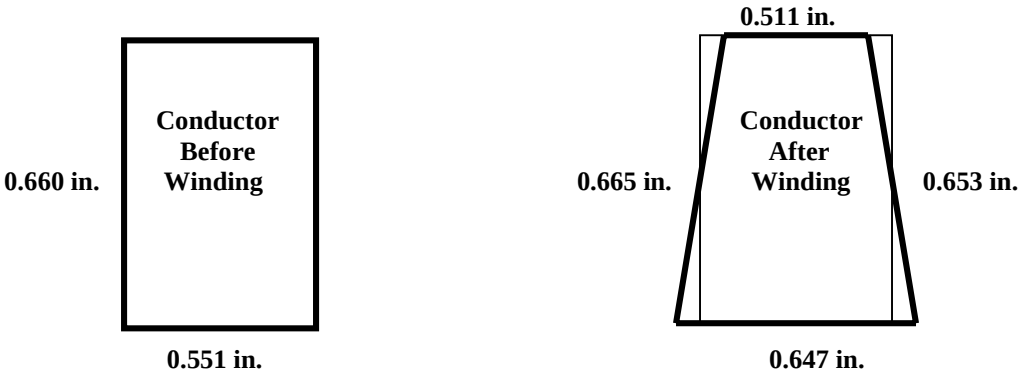
Location	Insulated Side A	Insulated Side B	Insulated Side C	Insulated Side D
1	0.663	0.650	0.505	0.631
2	0.652	0.647	0.510	0.645
3	0.668	0.655	0.504	0.638
4	0.658	0.662	0.510	0.649
5	0.680	0.670	0.520	0.661
6	0.667	0.660	0.512	0.646
7	0.658	0.650	0.515	0.650
8	0.665	0.640	0.514	0.662
9	0.670	0.645	0.510	0.640
Average	**0.665**	**0.653**	**0.511**	**0.647**

Table-3 Keystone Results- Trial #2

Location	Insulated Side A	Insulated Side B	Insulated Side C	Insulated Side D
1	N/A	N/A	0.716	0.635
2	0.545	0.543	0.719	0.624
3	0.542	0.541	0.721	0.641
4	0.577	0.572	0.723	0.640
5	0.552	0.591	0.735	0.640
6	0.570	0.593	0.733	0.650
7	0.561	0.575	0.735	0.641
8	0.521	0.554	0.748	0.628
9	0.539	0.550	0.722	0.628
Average	**0.551**	**0.565**	**0.728**	**0.636**

Summary of Results

Trial #1…..Conductor Measurements



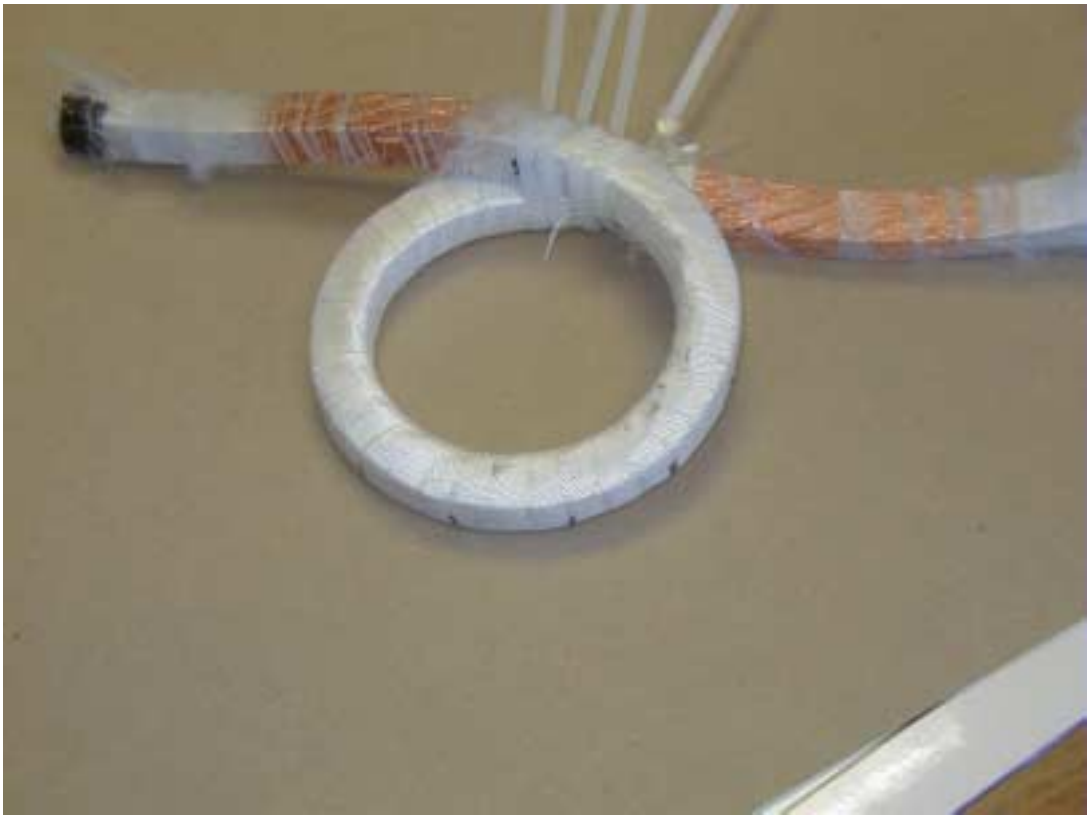
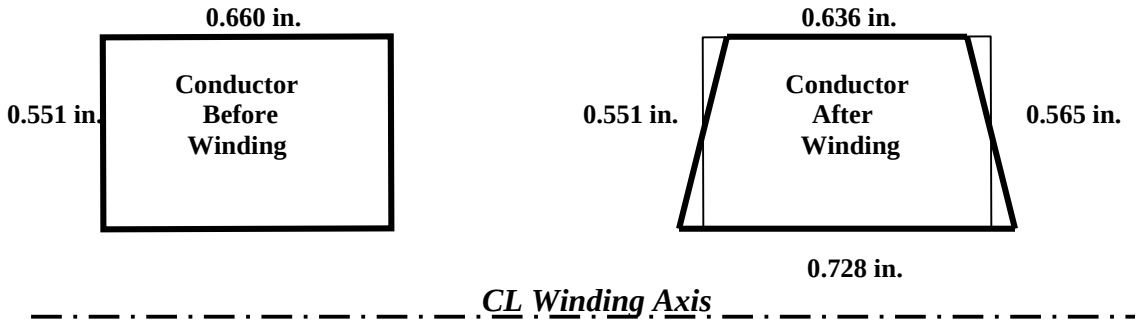


Figure 1- Trial #1 "Conductor Removed from Mandrel"

***Trial #2…..* Conductor Measurements**



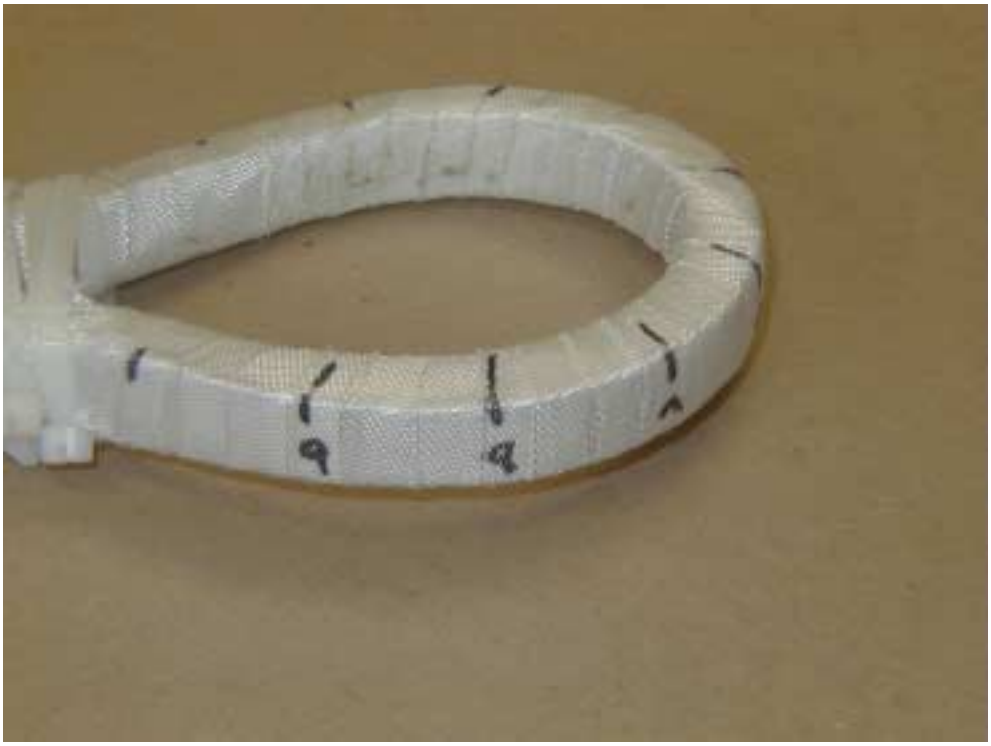


Figure 2- Trial #2 "Conductor Removed from Mandrel"

Note: Any discrepancies in measurements are a result of conductor not being entirely rectangular prior to start of Trial #1 and reuse of same copper cable conductor for Trial #2.