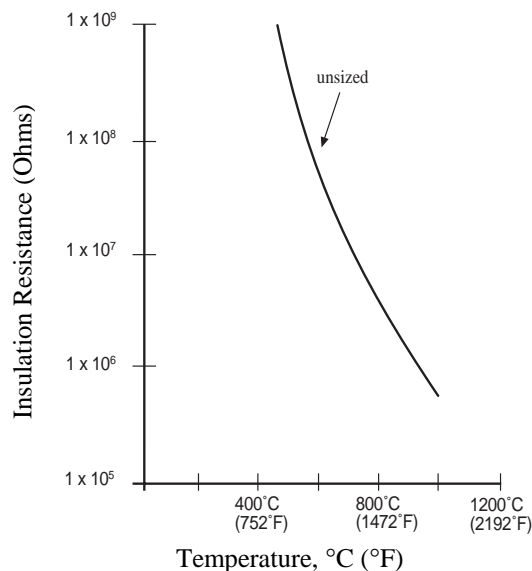


## Electrical Insulation Resistance

### 3M™ Nextel™ Braided Sleeving 312 (unsized)

Insulation resistance of 3M Nextel Braids on Type K thermocouple wire was measured as the temperature was increased from ambient to over 1832°F (1000°C). With 12 inch (30,5 cm) sections exposed to the test temperature, the remainder of the 18 inch (45,7 cm) thermocouple specimen extended through the oven wall and was connected to an ohmmeter. All wires were open-ended. A typical curve of insulation resistance as a function of temperature is shown in the figure below for thermocouple wires insulated with unsized yarn. The values of insulation resistance will change depending on thickness, length of thermocouple wire and braid construction.



Note: Sized sleeving will have lower insulation resistance and should be heat cleaned in air. Heating in a non-oxidizing environment will produce conductive carbon residue.

### 222 Sizing

This sizing consists of a proprietary inorganic coating which lubricates and protects the fiber during twisting and braiding. This produces a fiber that is tan in color. The 222 sizing has

been found to be useful in electrical applications where it is undesirable to heat clean the product to remove organic coatings. Organic coatings decompose to conductive carbon in neutral or reducing atmospheres when heated above 932°F (500°C).

Example: Standard Type K thermocouple wire was prepared by over-braiding with 3M Nextel Roving sized with 222 Sizing. One end of the braided thermocouple was cut with a wire cutter and inserted into a quartz protection tube while the opposite end was connected to an ohmmeter. (Since the Chromel and Alumel wires are not welded, the ohmmeter is measuring the insulation resistance between the two wires.) The quartz tube was then inserted into an electric furnace maintained at 1472°F (800°C) and the resistance was recorded as a function of time. The test was also repeated for 170 Sizing.

### Resistance (in ohms) of Thermocouple Constructions

Time (minutes)	222 Sizing	170 Sizing
0.5	20,000,000	120,000
1.0	10,000,000	20,000
1.5	5,000,000	5,000
2.0	4,000,000	300
3.0	3,000,000	60
10.0	2,500,000	9.5

After the testing the 222 sized thermocouple remained unchanged in appearance with a high insulation resistance between the two wires. The thermocouple with the 170 sizing showed evidence of a carbon char which provided a conductive path through the insulation between the two wires and produced a short circuit (9.5 ohms).

Yarn strengths of 222 sized material are comparable to our standard organic sized yarn strength. Braids of 222 sized material tend to be somewhat fuzzier than braids sized with our standard organic material.