# Moisture Protection Using 3M™ Novec™ Electronic Grade Coatings

## Introduction

Increasingly compact and sophisticated electronics are highly susceptible to environmental contaminants, such as moisture, sulfur, pollution and grime. Without proper protection, sensitive electronic components can quickly corrode, often leading to electrical shorts, poor performance and device failure.

3M™ Novec™ Electronic Grade Coatings are clear, low viscosity, low surface tension solutions of a fluorinated polymer carried in a segregated hydrofluoroether solvent. They form coating films designed to repel and protect against moisture, chemicals and corrosion.

This report highlights two of these coatings, 3M™ Novec™ 2704 and 2708 Electronic Grade Coatings, demonstrating their ability to help provide moisture protection to electronic circuitry under elevated heat and humidity conditions. These solutions consist of the same fluorinated polymer at different percent solids, 4 wt% and 8 wt% respectively, in 3M™ Novec™ 7200 Engineered Fluid, a segregated hydrofluoroether solvent.

## Summary

Test results show Novec 2704 and 2708 coatings meet the qualification requirements for insulation resistance, as stated in the IPC-CC-830 standard, at >500 MΩ during the required test intervals.

## Test Procedure

3M™ Novec™ 2704 and 2708 Electronic Grade Coatings were tested according to the IPC-TM-650 2.6.3.4 (rev. A) "Moisture and Insulation Resistance – Conformal Coating."[1] This test was designed to measure the moisture and insulation resistance of applied conformal coatings under prescribed conditions of temperature and humidity. Testing was conducted by 3M, at 3M facilities, using equipment owned, operated and calibrated by 3M personnel.

### Sample Preparation

The test used IPC-B-25A[1] test boards which have bare copper traces on FR4 (Figure 1). Ten boards were first cleaned using 3M™ Novec™ 72DA Engineered Fluid in a vapor degreaser. The boards were cleaned in one batch using the following method:

1. Immersion cleaning for three and a half minutes with 40 kHz ultrasonication.
2. Vapor rinse for one minute.
3. Drying in the freeboard region for thirty seconds.

Total cleaning time was five minutes.

After cleaning, Novec 2704 coating or Novec 2708 coating were then applied to dry boards. Using an automated dip coating machine with a coating tank, each individual board was dipped into the coating solution for approximately 10 seconds and then withdrawn at a rate of 30 cm/min.

Novec 2704 and 2708 coatings were each applied to four boards. The coated boards were allowed to hang at room temperature with no further processing. For the test, the Novec 2704 coating film thickness was 0.5 microns and the Novec 2708 coating film thickness was 1 micron.

Following the coating application, 22 AWG solid conductor hook-up wire was hand-soldered to the D-pattern contact pads of all the boards. Soldering was done directly through the coating with no chemical or mechanical removal of the coating prior to soldering.

All boards were then placed in a rack that held them in a near-vertical orientation with the hook-up wire facing up. The rack of boards was placed inside an environmental chamber and the heat/humidity aging profile was run as specified in the IPC-TM-650 2.6.3.4 test method. The test was designed to measure the moisture and insulation resistance of applied conformal coatings after 20 temperature cycles going from 25°C to 65°C over 1.75 hours with a three hour hold at 65°C and then back to 25°C over 1.75 hours. The humidity was maintained at 85% minimum throughout the cycles, except when going to low temperatures where the humidity may drop to 80% minimum.

### Sample Testing

All surface insulation measurements were made using a calibrated ohmmeter with an upper range of 6.667 PΩ ($10^{15}$ Ω). Test voltage for the Surface Insulation Resistance (SIR) measurements was 100 V DC, one minute dwell, followed immediately by resistance measurement. SIR measurements were made at six different time points.

The initial SIR measurements were made with the boards in the test chamber at 25°C and 50% RH. Following these measurements, the boards were connected to a power supply that placed a 50 V DC bias across the D-pattern of each board. The boards remained energized throughout the duration of the test with the only exception being when test measurements were made. During heat and humidity exposure in the chamber, SIR measurements were made during the first, fourth, seventh, and tenth heat cycles while the boards were in the middle of a three hour heat soak of 65°C and >90% RH. Final SIR measurements were made after the tenth heat cycle once the boards had equilibrated back to 25°C and 50% RH.

[1]IPC-Association Connecting Electronics Industries is an organization that sets standards used by the electronics manufacturing industry: https://www.ipc.org/default.aspx

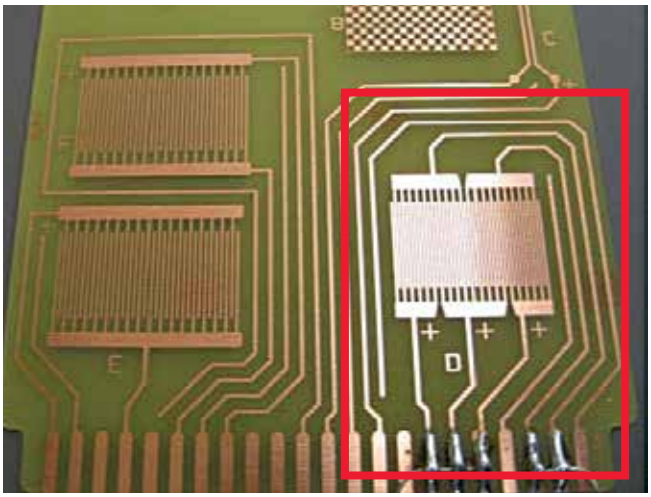

Figure 1. IPC-B-25A test board coated with 3M™ Novec™ 2708 Electronic Grade Coating prior to testing. The D-pattern with attached hook-up wire is highlighted in the red box.

## Test Results

All coated boards showed SIR measurements above the IPC-CC-830 lower specification limit of 500 MΩ during the course of the test.

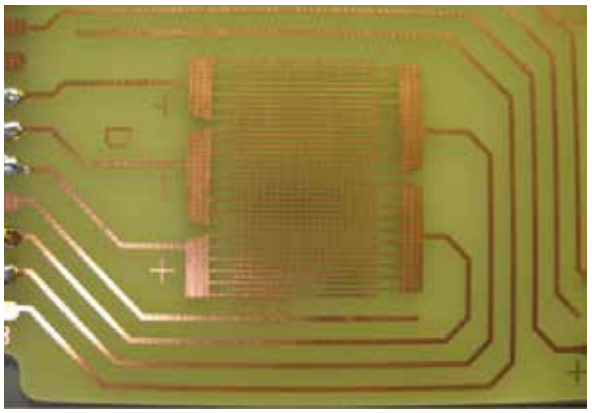

Figure 2. IPC-B-25A test board coated with 3M™ Novec™ 2704 Electronic Grade Coating (test sample 2704-1) after testing per IPC-TM-650 2.6.3.4 (rev. A) test method.

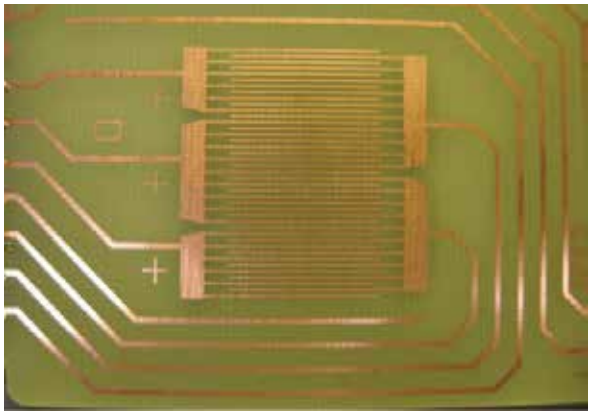

Figure 3. IPC-B-25A test board coated with 3M™ Novec™ 2708 Electronic Grade Coating (test sample 2708-1) after testing per IPC-TM-650 2.6.3.4 (rev. A) test method.

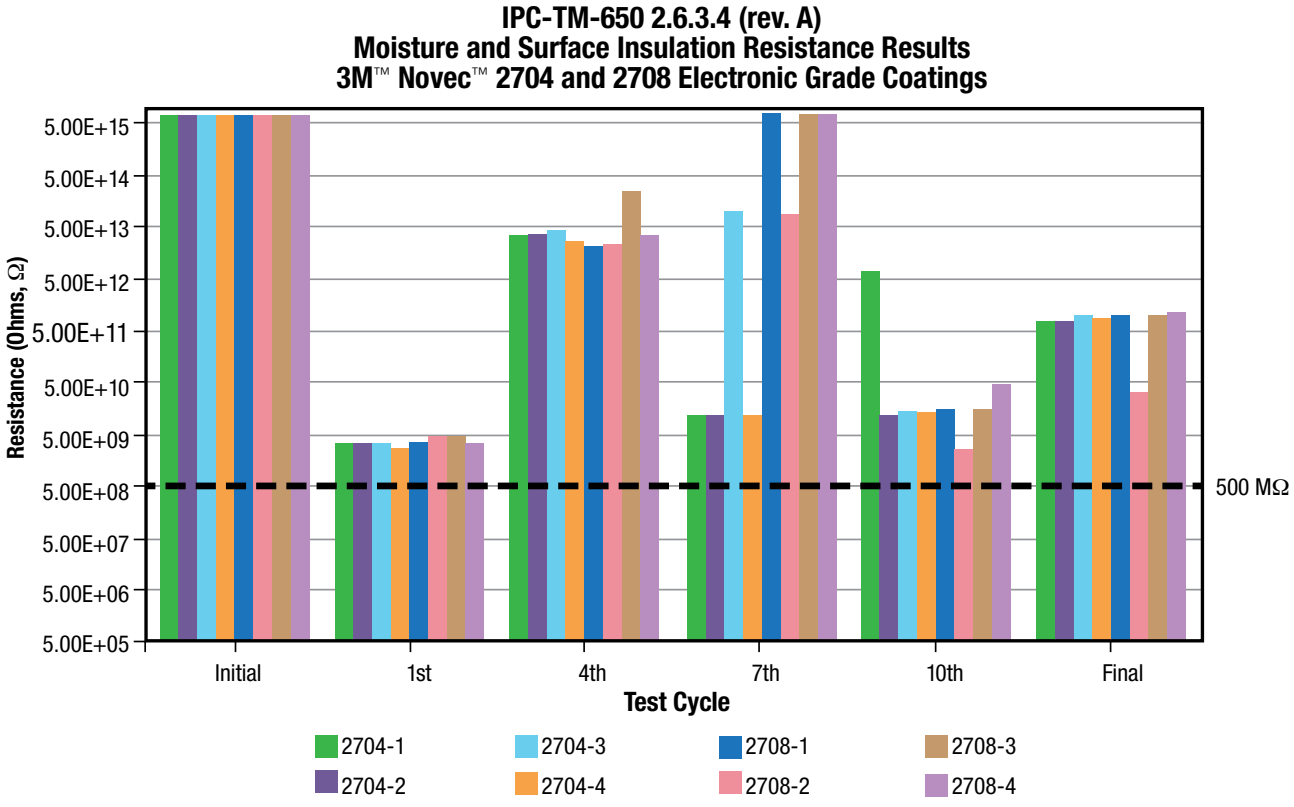


Chart 1. Measured surface insulation resistance across the D-pattern of the IPC-B-25A test board at various points in time.

## Summary and Conclusions

Visually, all D-patterns on the coated boards showed little change, as demonstrated by Figures 2 and 3. There were negligible visual signs of electrolytic corrosion due to leakage current between the finely spaced leads of the comb pattern.

Test results show 3M™ Novec™ 2704 and 2708 Electronic Grade Coatings meet the qualification requirements for insulation resistance, as stated in the IPC-CC-830 standard, of >500 MΩ during the required test intervals.

### The 3M™ Novec™ Brand Family

The Novec brand is the hallmark for a variety of proprietary 3M products. Although each has its own unique formula and performance properties, all Novec products are designed in common to address the need for safe, effective, sustainable solutions in industry-specific applications. These include precision and electronics cleaning, heat transfer, fire protection, protective coatings, immersion cooling, advanced insulation media replacement solutions and several specialty chemical applications.

3M™ Novec™ Engineered Fluids • 3M™ Novec™ Aerosol Cleaners • 3M™ Novec™ 1230 Fire Protection Fluid • 3M™ Novec™ Electronic Grade Coatings • 3M™ Novec™ Electronic Surfactants • 3M™ Novec™ Dielectric Fluids


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3M


**Electronics Materials Solutions Division**
3M Center, Building 224-3N-11
St. Paul, MN 55144-1000
www.3M.com/novec
1-800-810-8513



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